

Tectonic Controls on the Great Dyke and the Bushveld Complex

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CARDIFF
UNIVERSITY

PRIFYSGOL
CAERDYDD

BA, GEBCO

els (Pty) Ltd.

Zimbabwe

Mozambique

Botswana

Swaziland

solid
living
changing

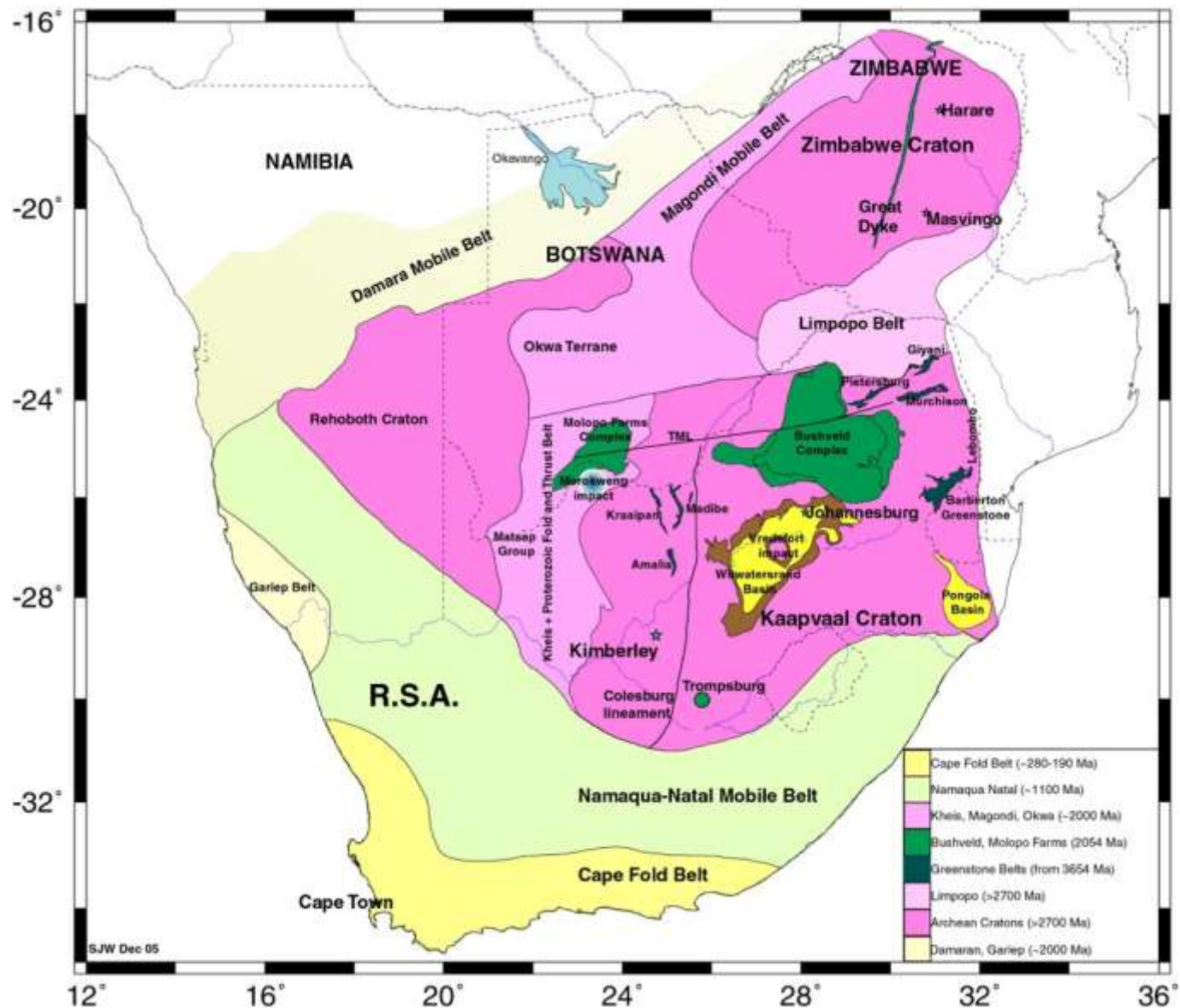
**EARTH
OCEAN**

800 km

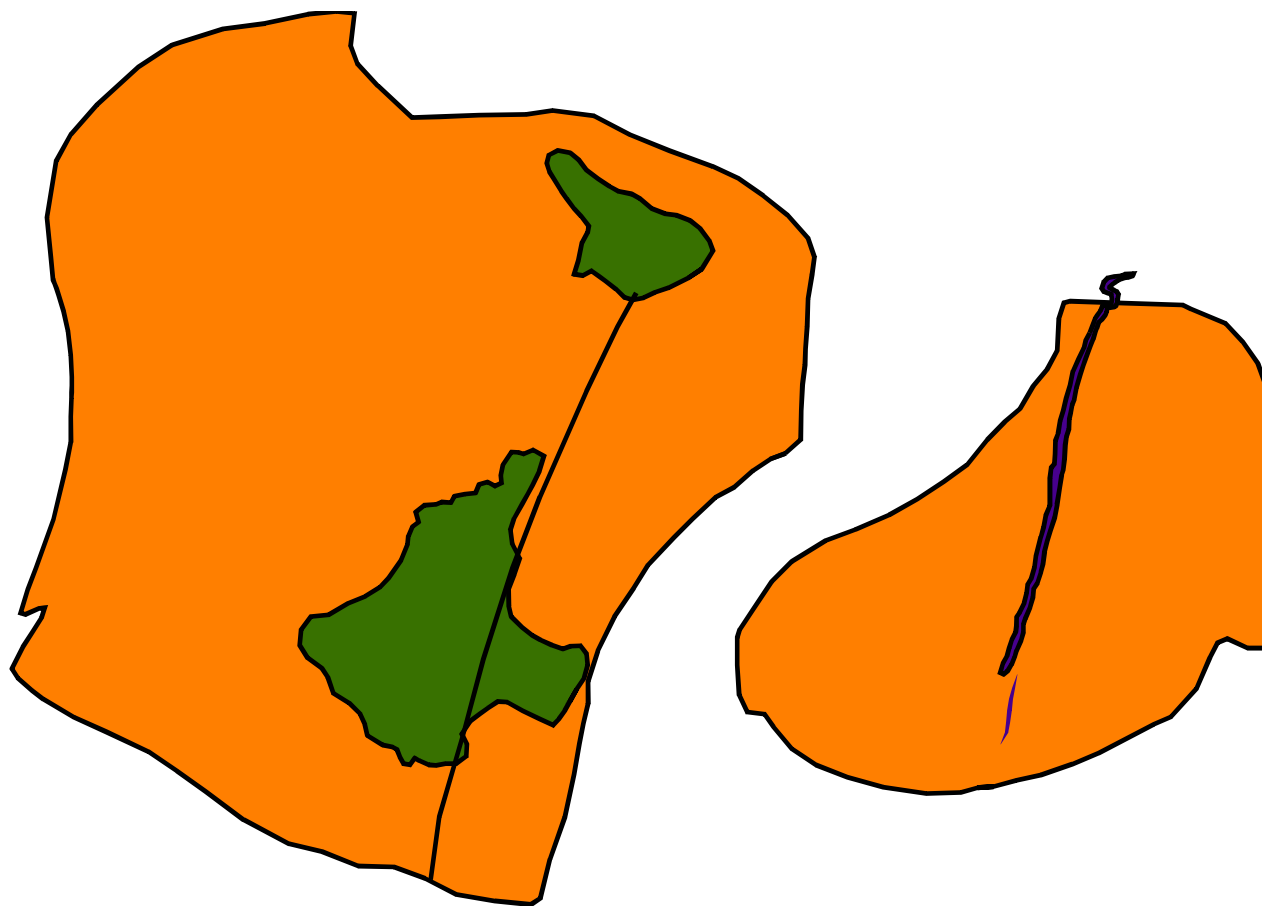
Themes:

- Intrusion mechanics
- Geodynamics, Supercontinents and Supercratons
- Volatile fluxed melting in the mantle

	Length km	Area km ²	Volume km ³	Max. Thickness km	Age
Great Dyke	550	~ 3245	33000	10	2575 Ma
Bushveld Complex	> 472	65 000	600 000	9	2060 Ma

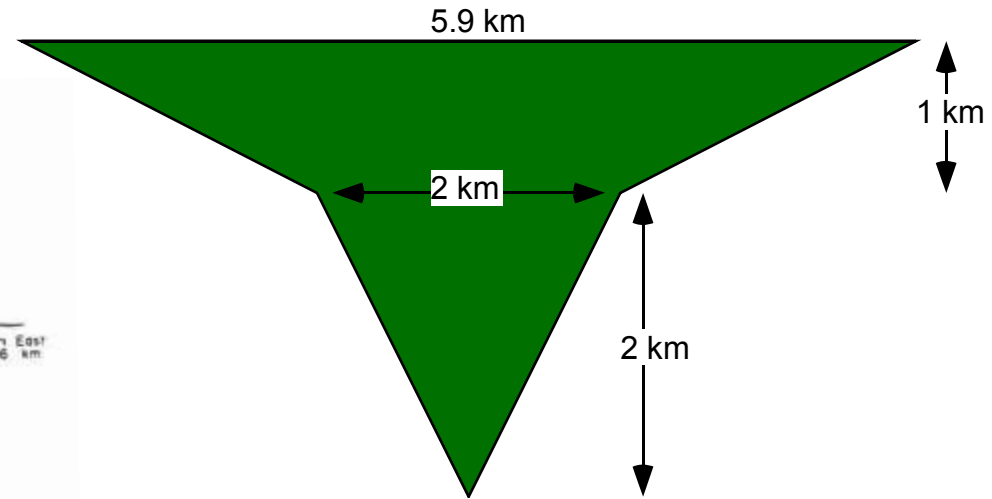
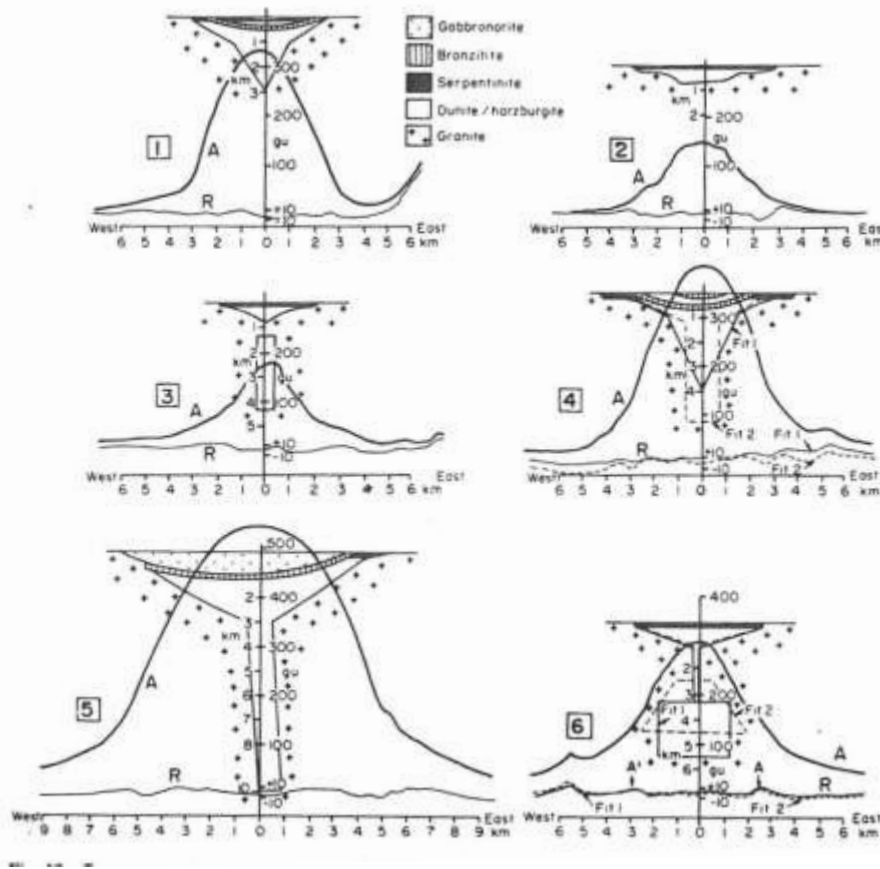


From Lew Ashwal



500 km

Estimate of the present volume of the Great Dyke

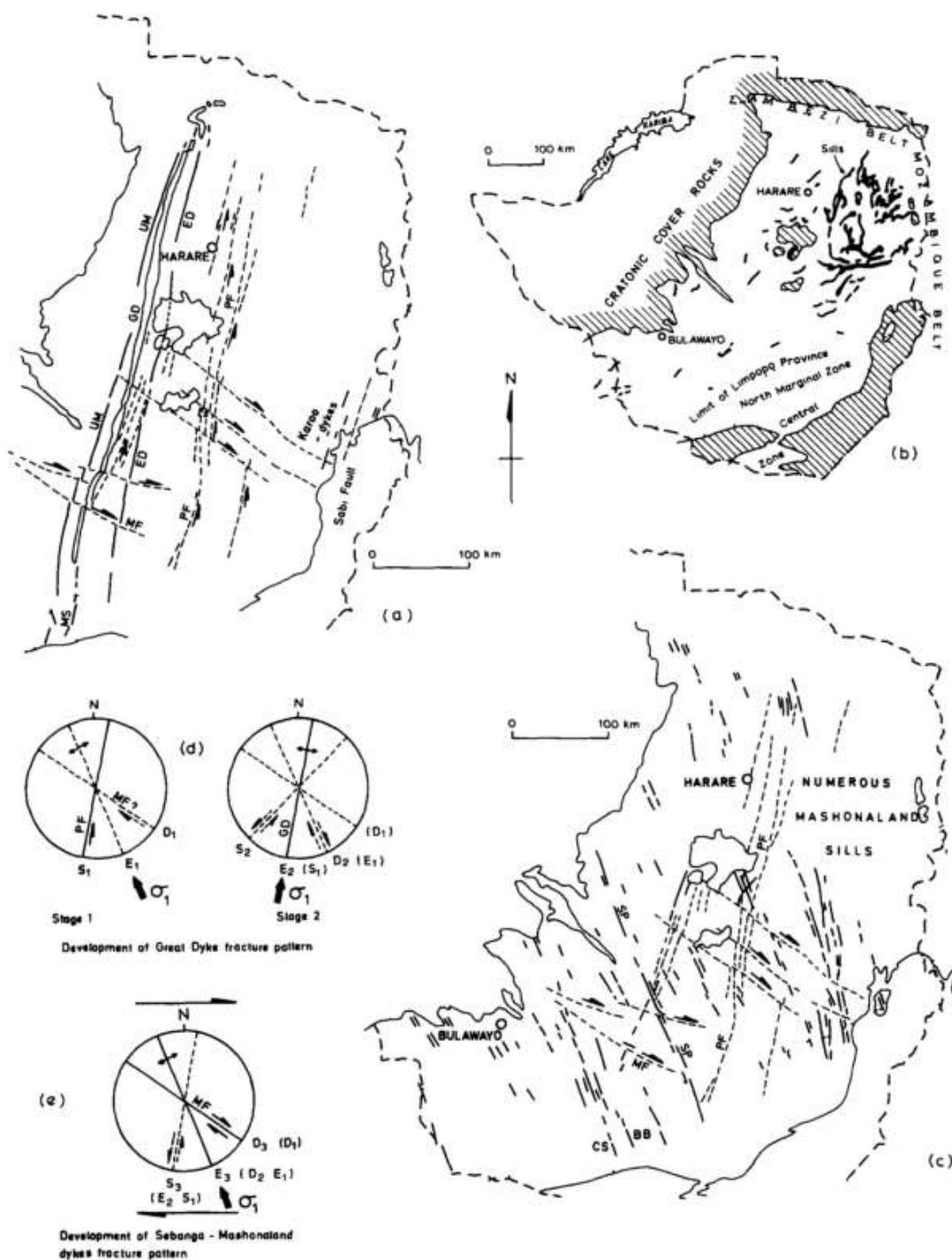


Area $\sim 6 \text{ km}^2$

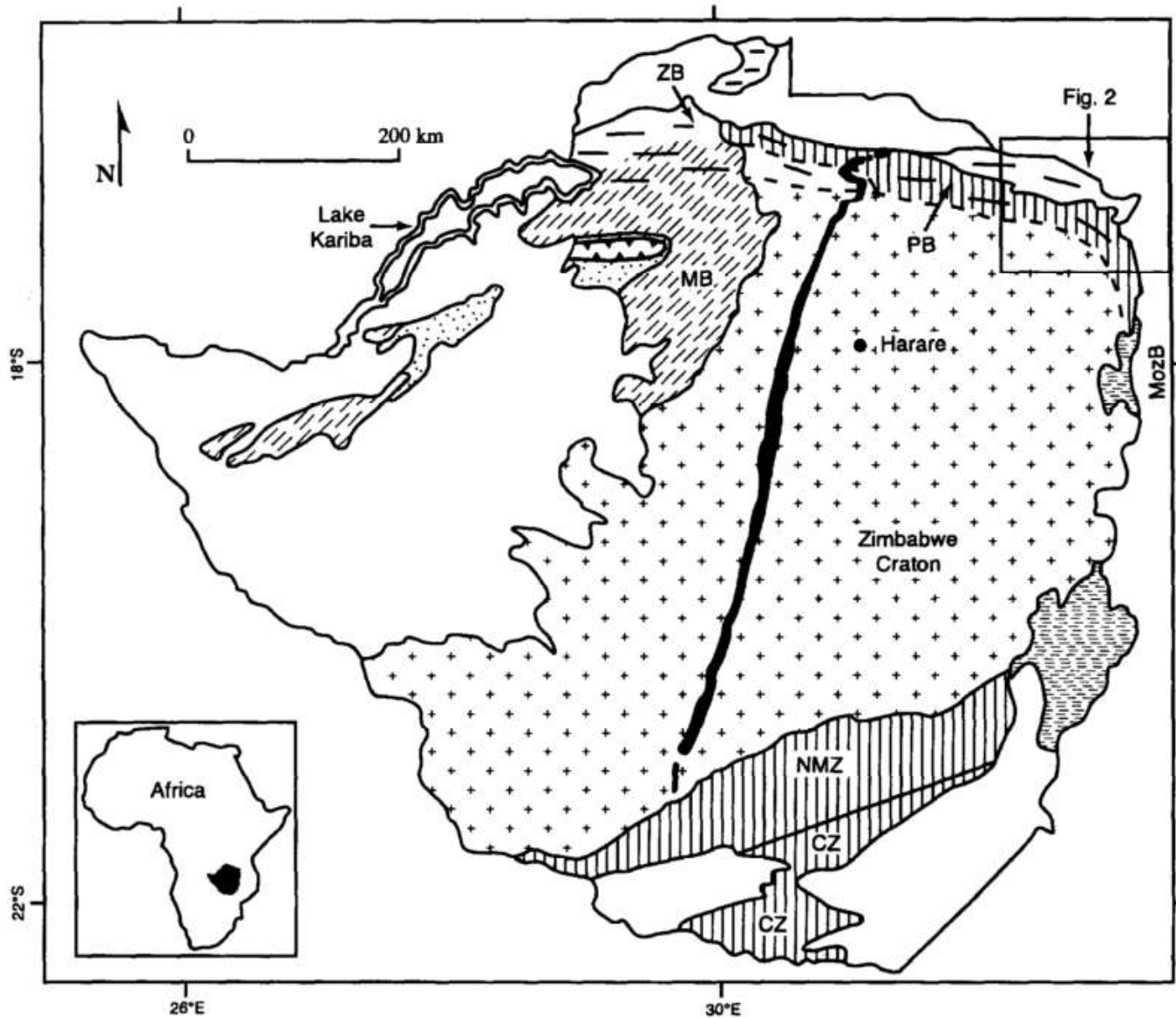
Length $\sim 550 \text{ km}$

Volume $\sim 33000 \text{ km}^3$

Podmore 1970

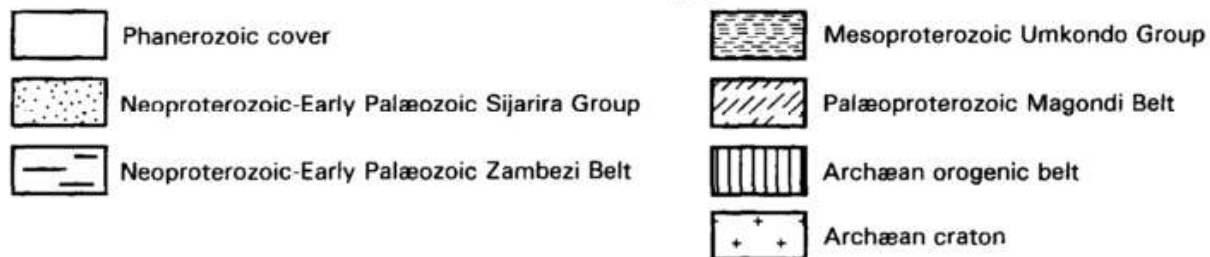


J. F. Wilson 1990:
A craton and its cracks



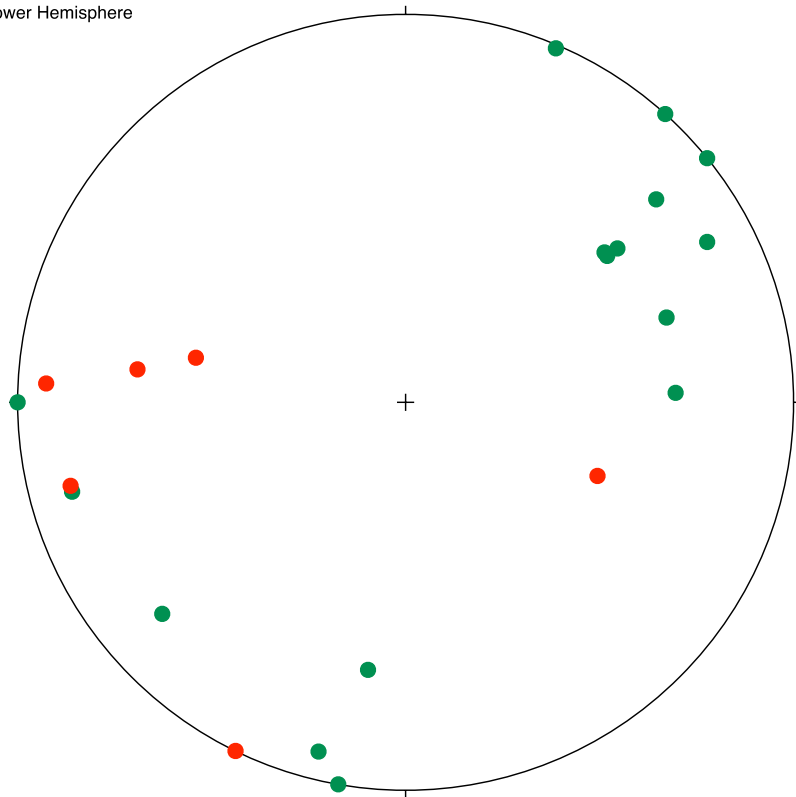
Pfunzi belt,
Ngarwe Orogeny
Ca. 2.62 Ga

Vinyu et al. 2001;
Barton et al. 1991

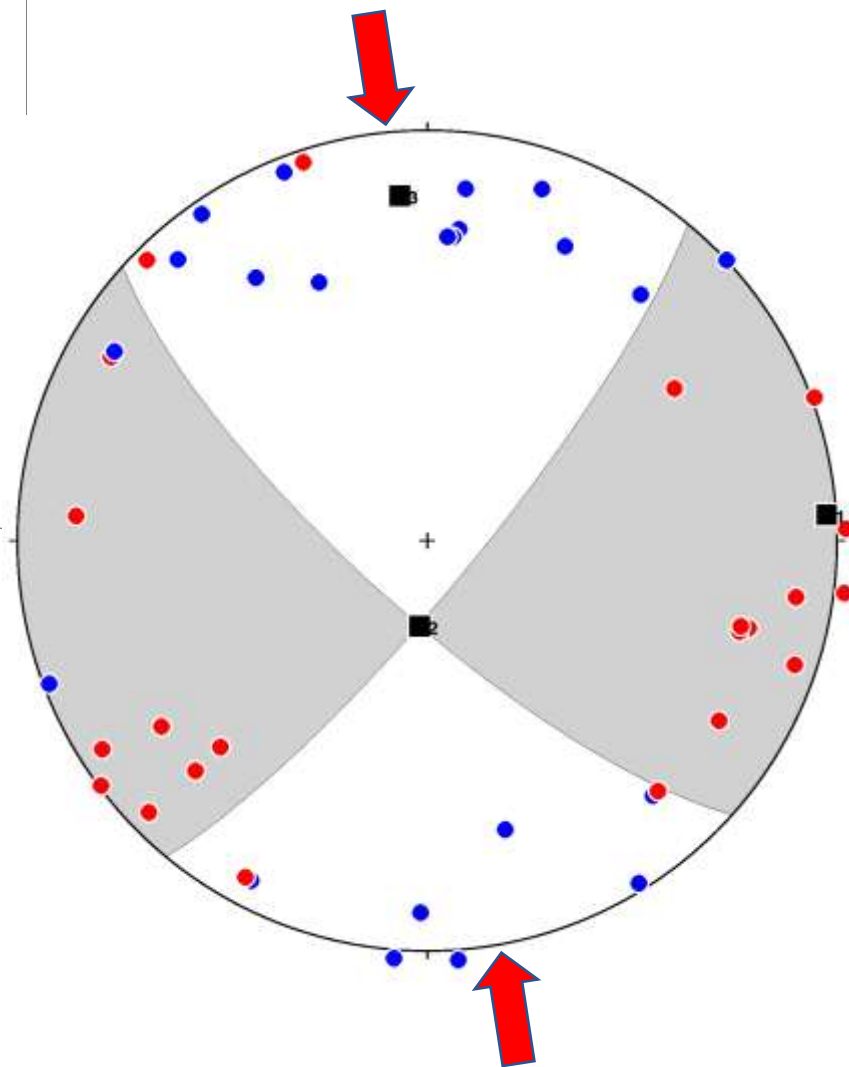


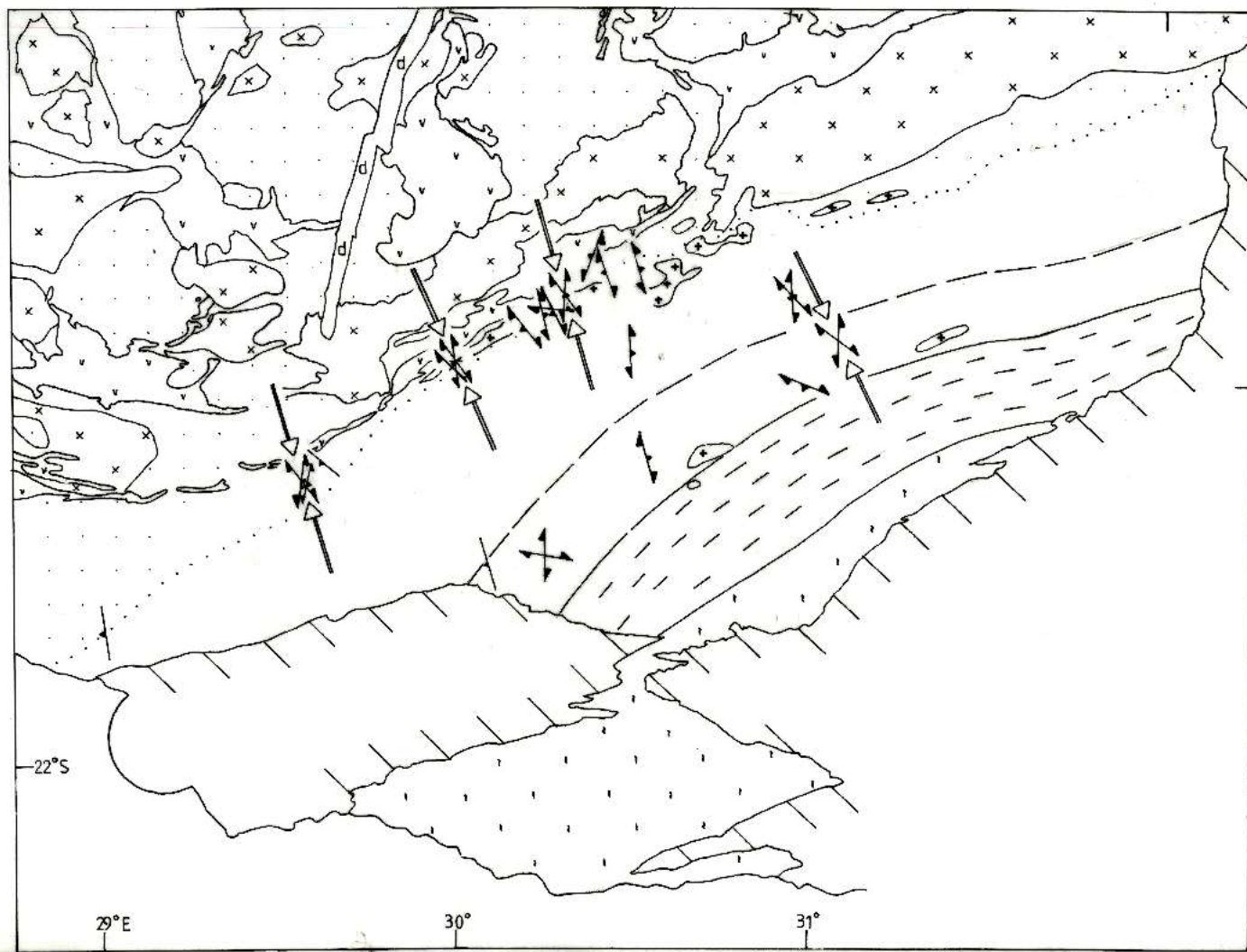


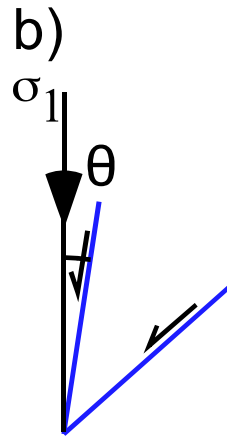
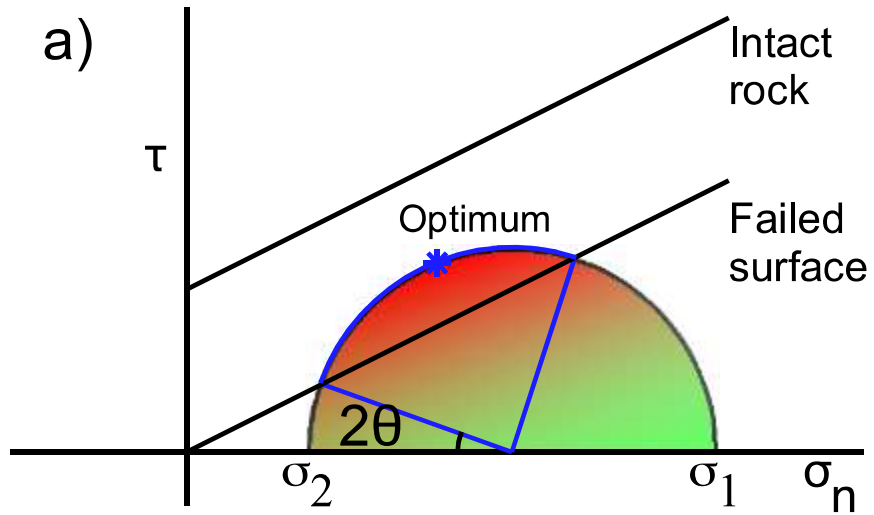
Equal Area
Lower Hemisphere



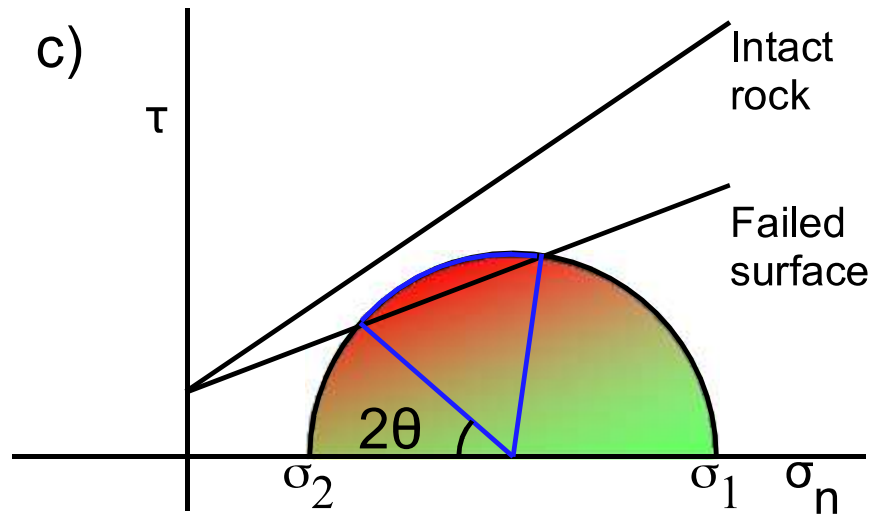
N = 22



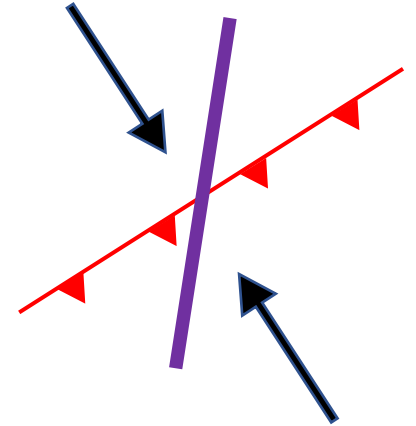
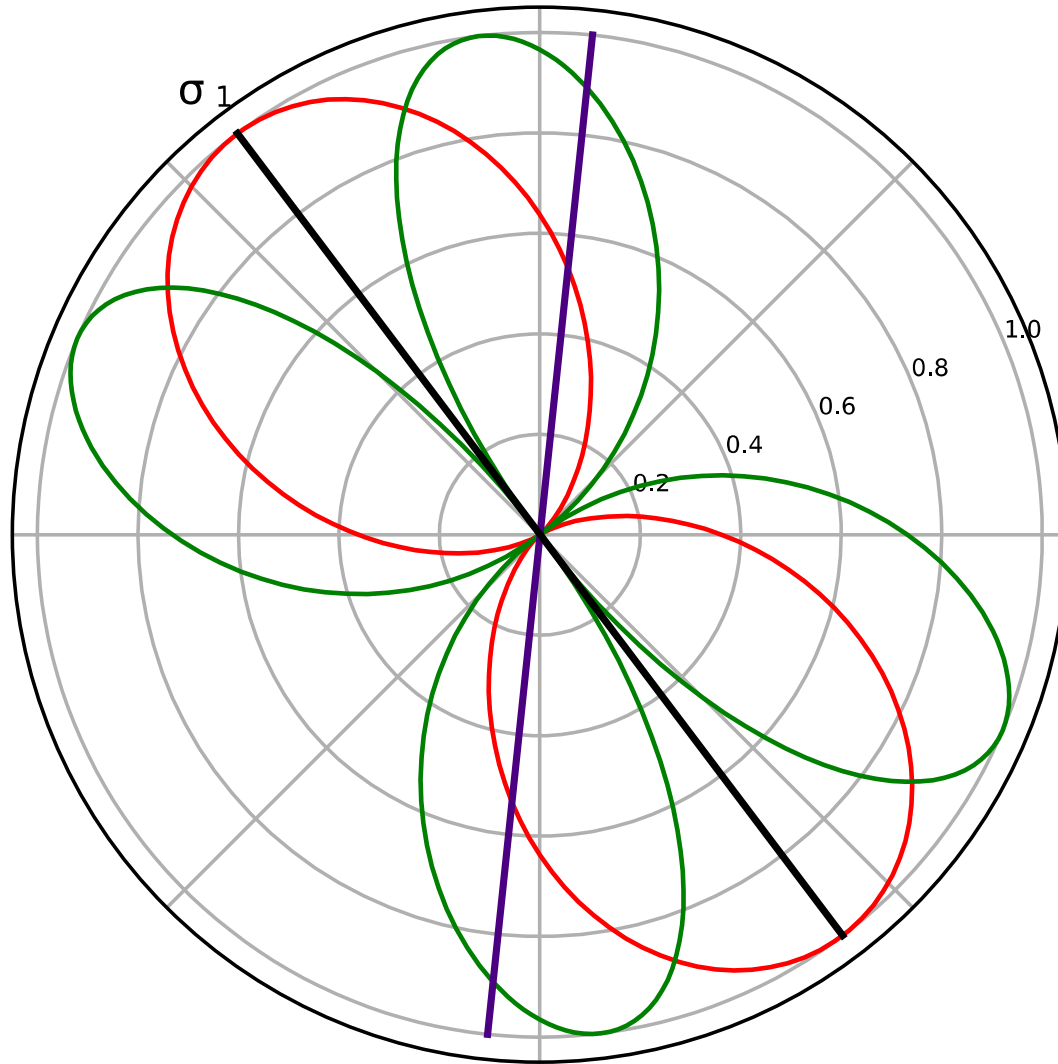


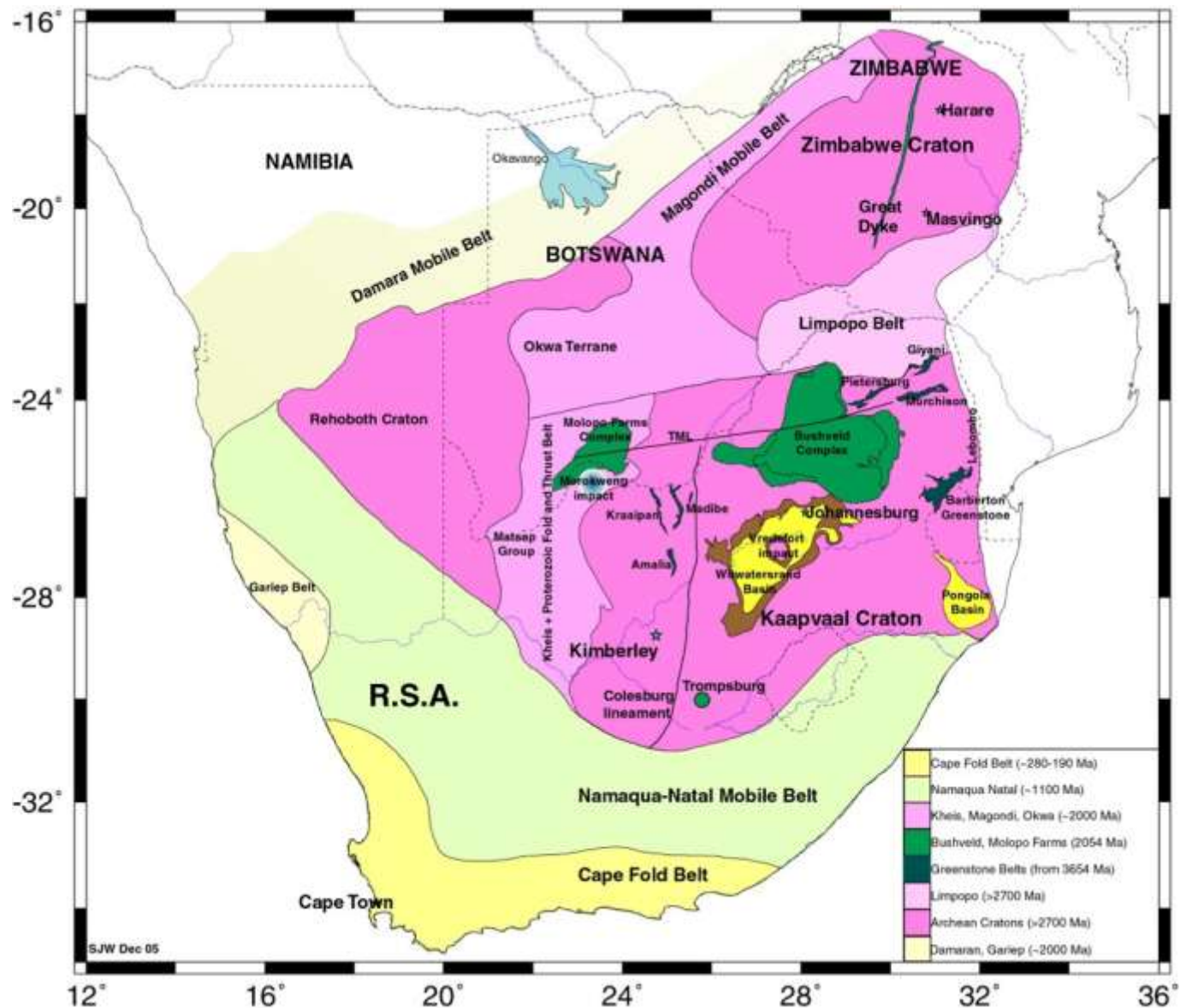


On a pre-existing weak structure,
reactivation is possible
for a range of orientations

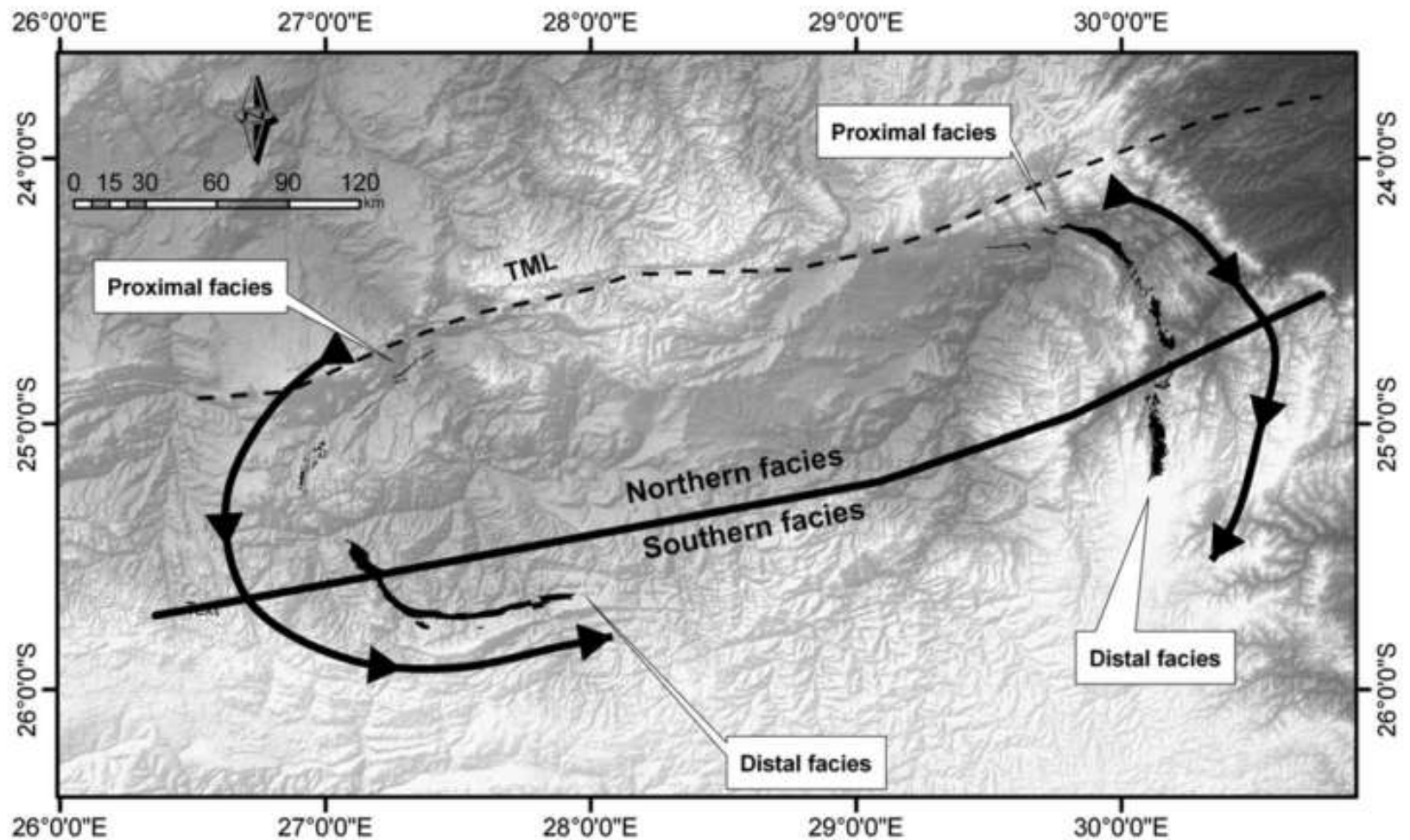


Polar plot of Slip and Dilation Tendencies

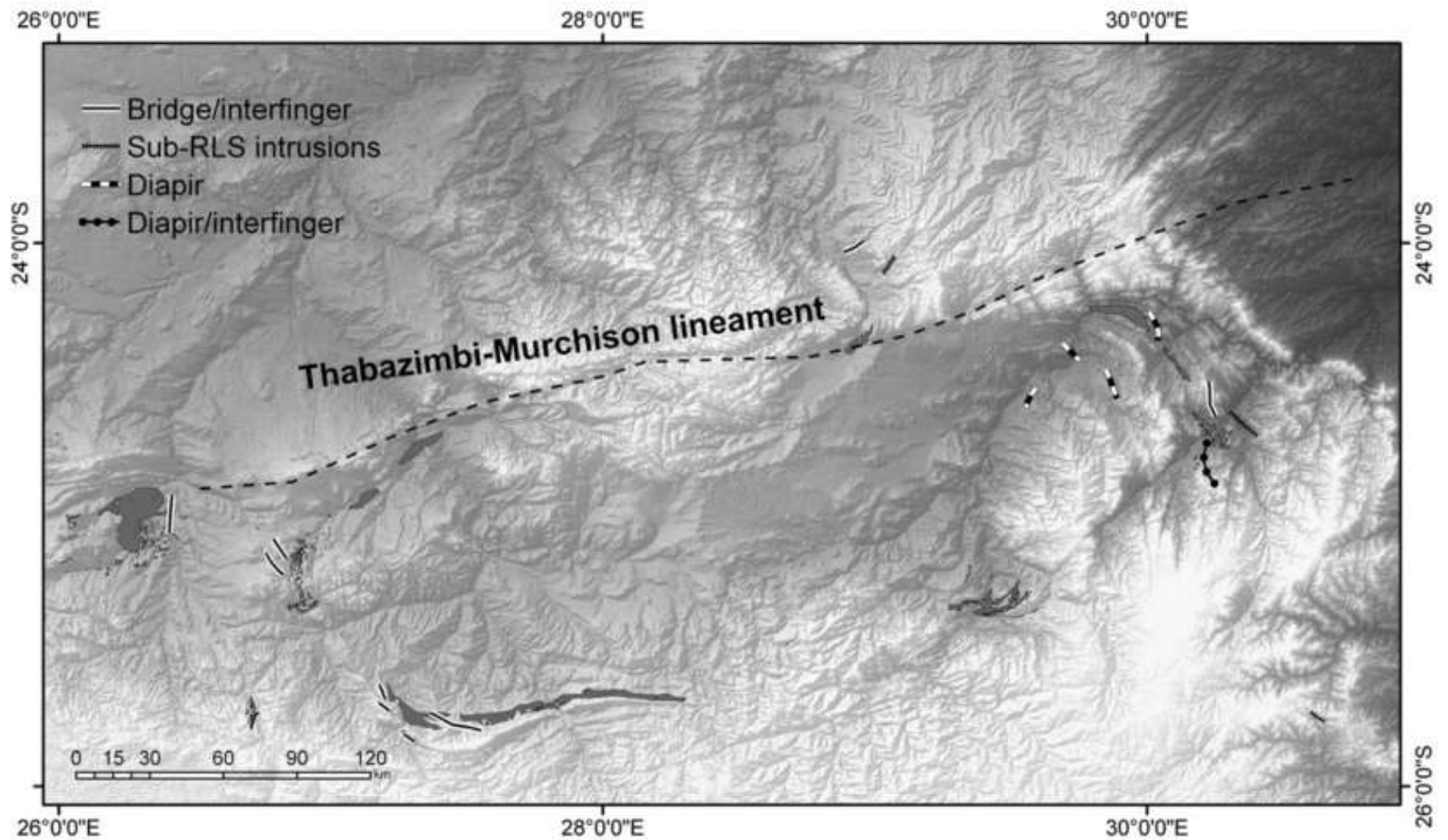




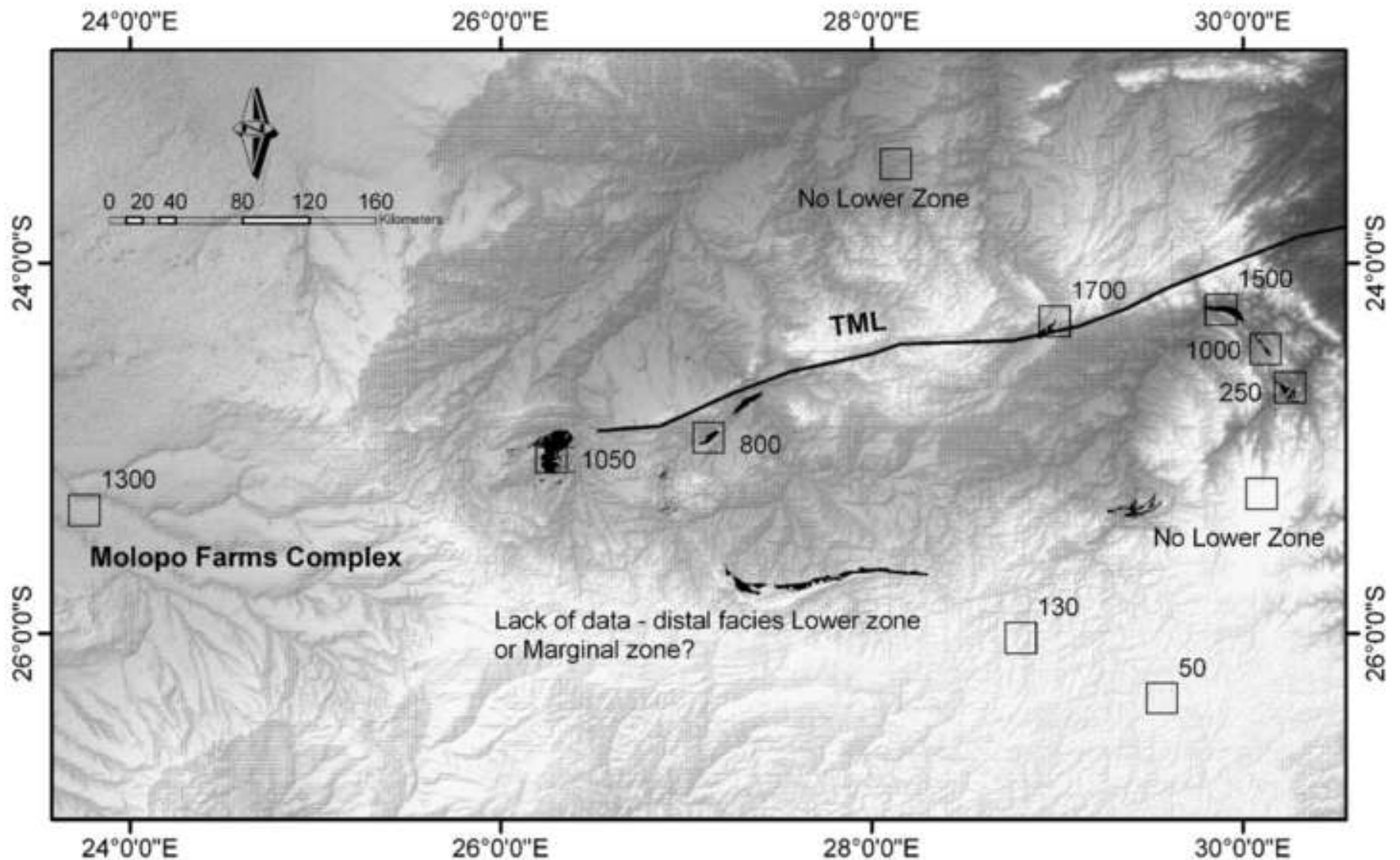
From Lew Ashwal



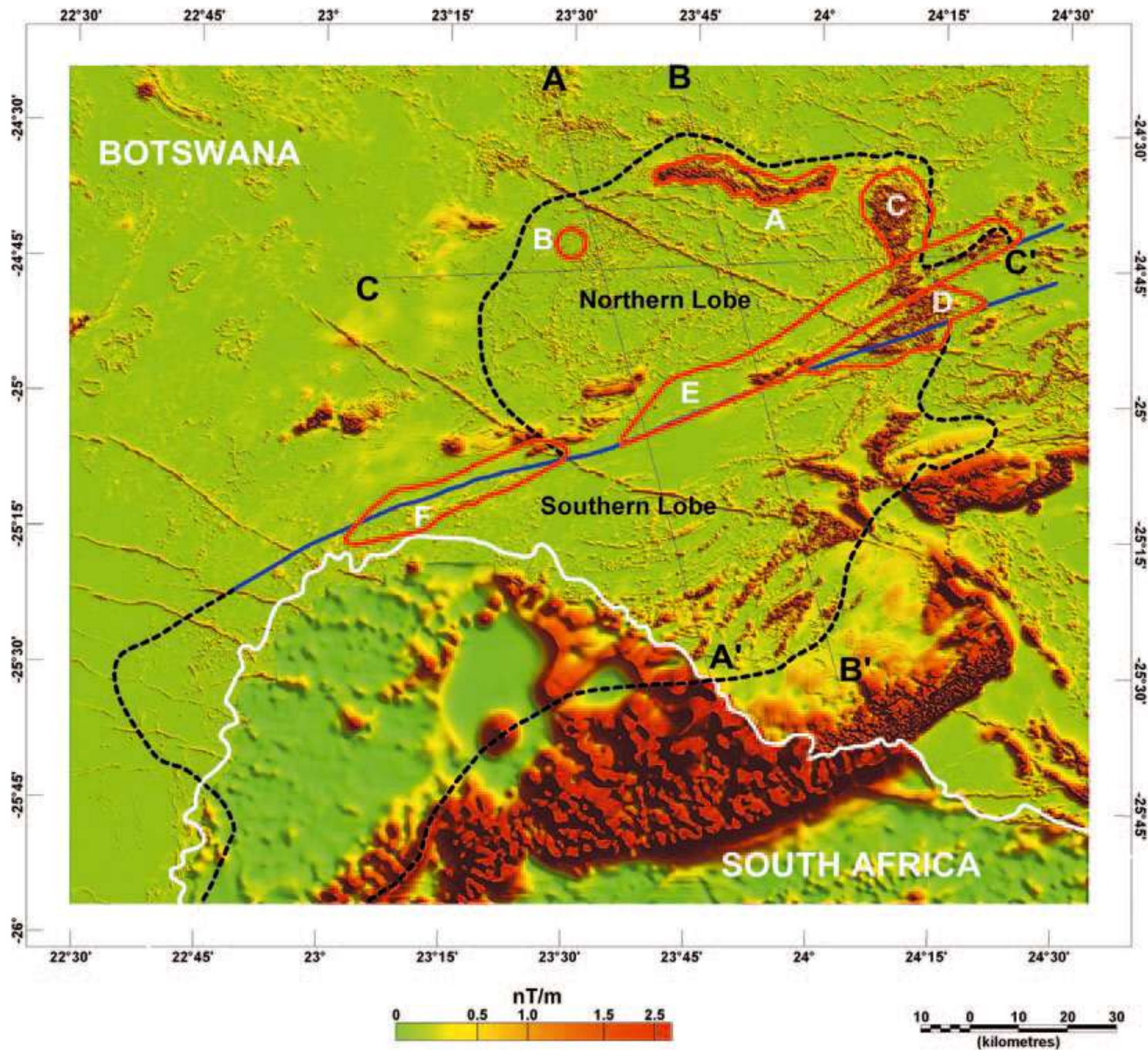
Clarke et al. 2009: Facies trends in the Critical Zone, showing SE directed magma transport



Clarke et al. 2009: Structural features showing NW-SE magma flow directions



Clarke et al. 2009: Thickness of the Lower Zone, showing SE thinning

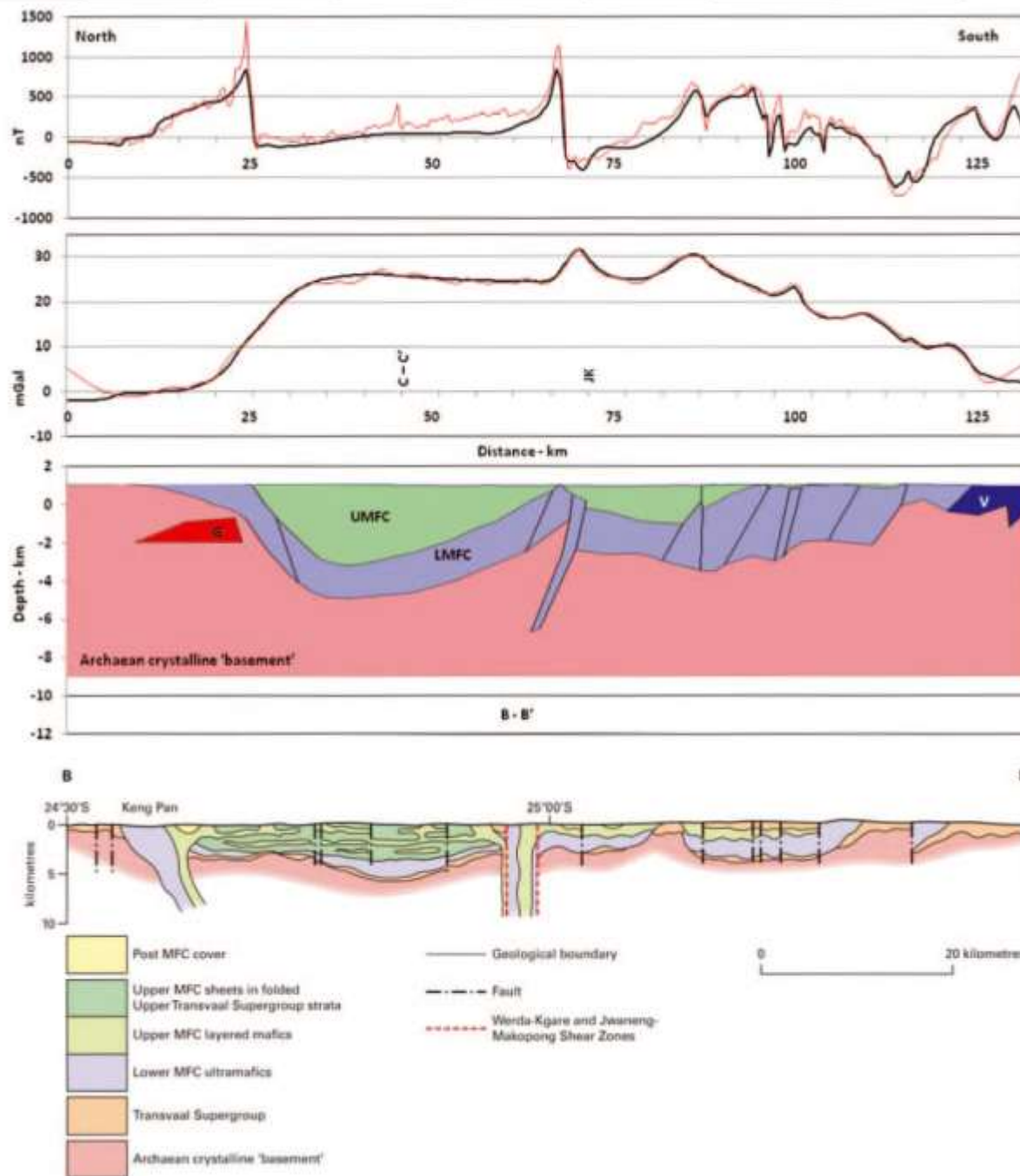


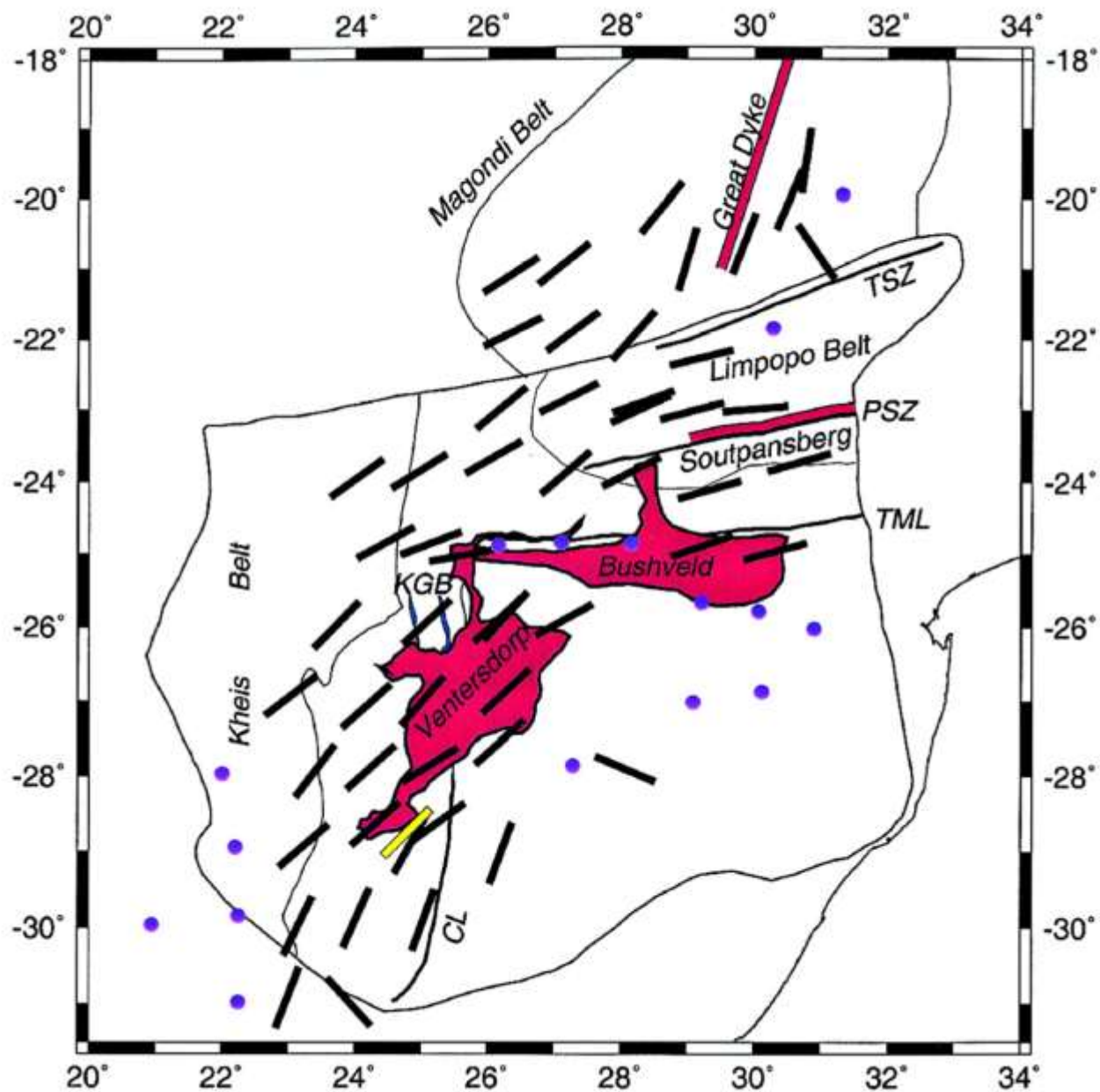
Molope Farms
Complex
Analytical
Signal

Walker et al.
2010

Molope Farms Complex Geophysical Modelling

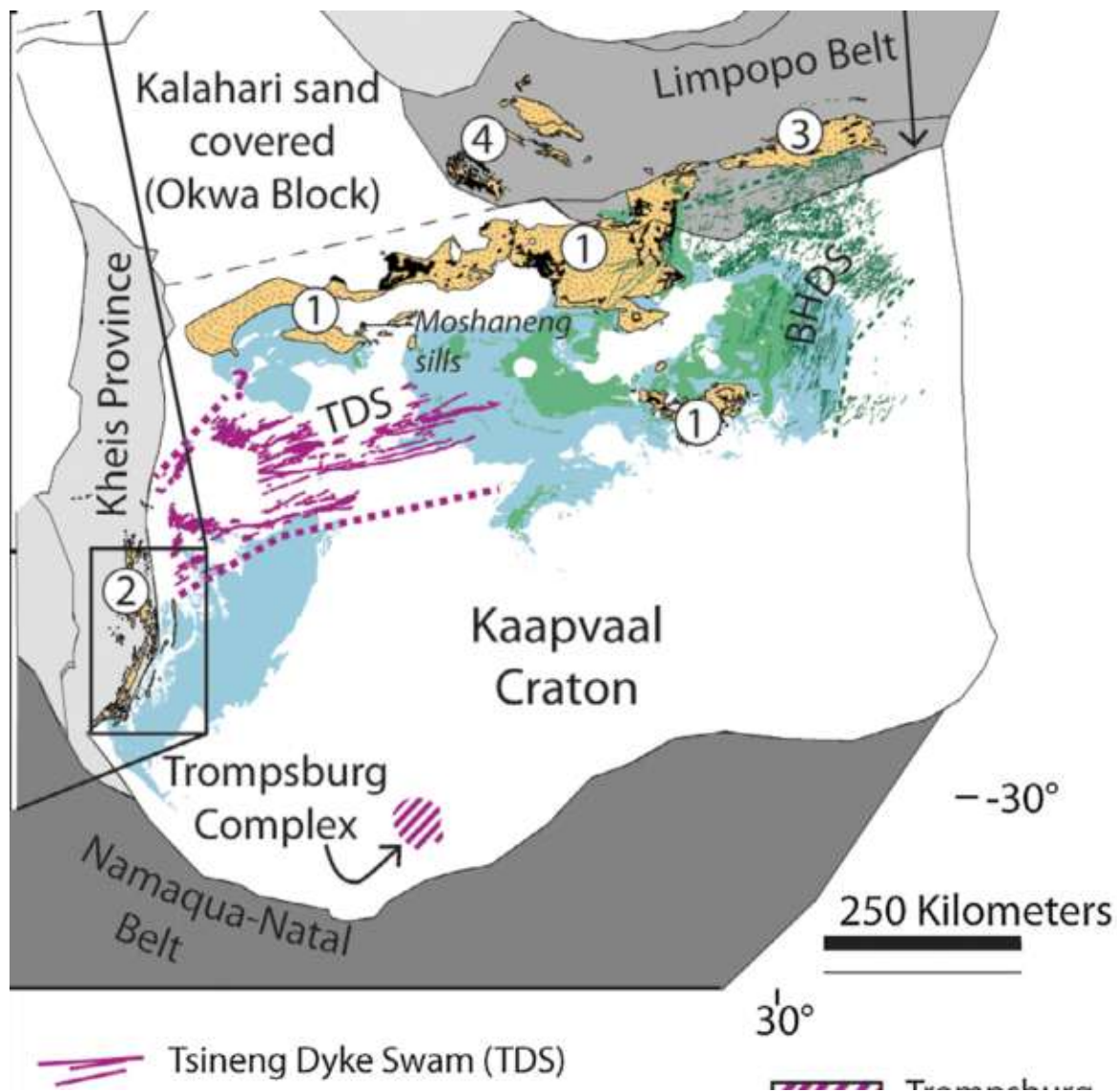
Walker et al.
2010



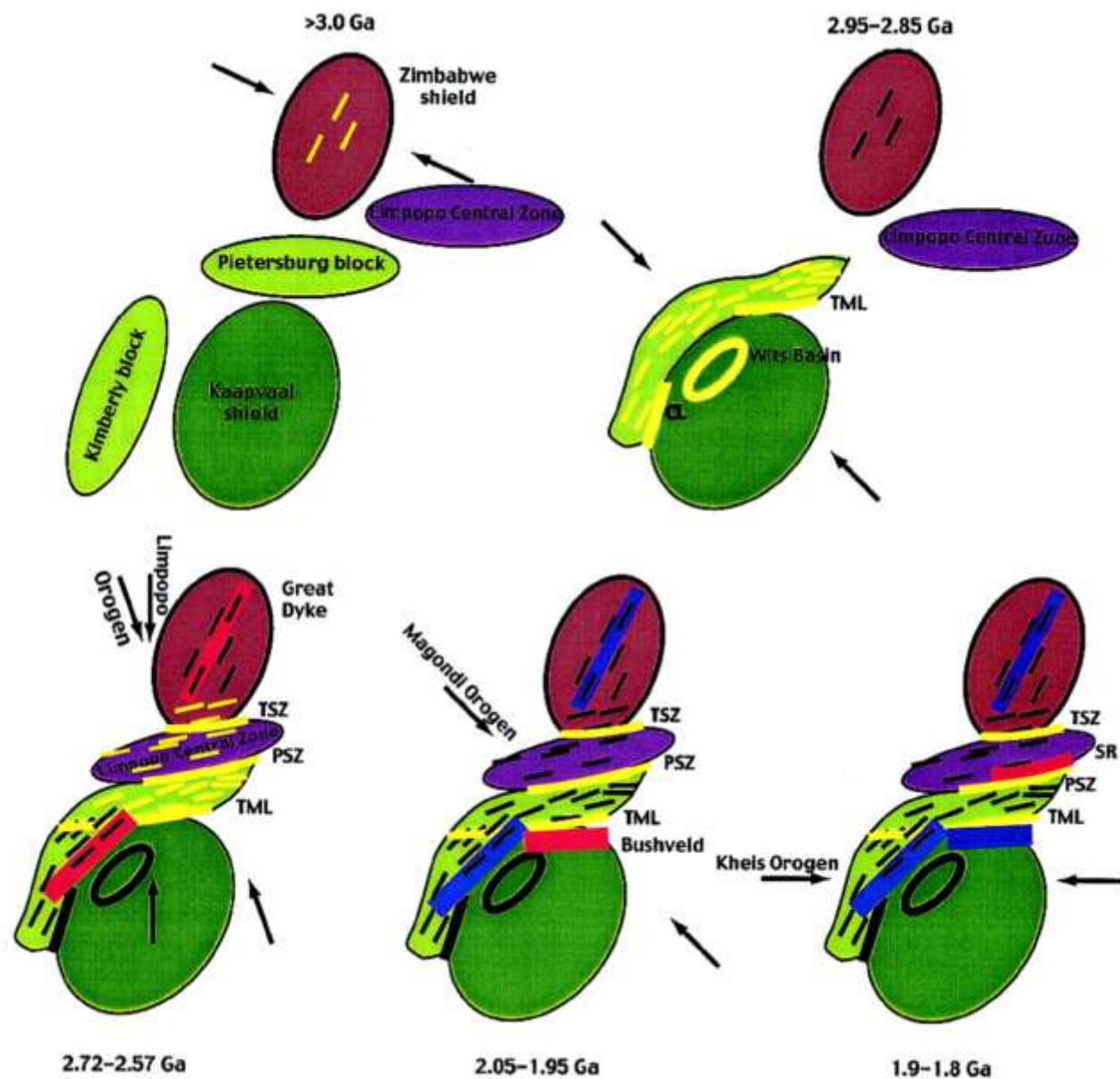


Seismic Anisotropy

Silver et al. 2004



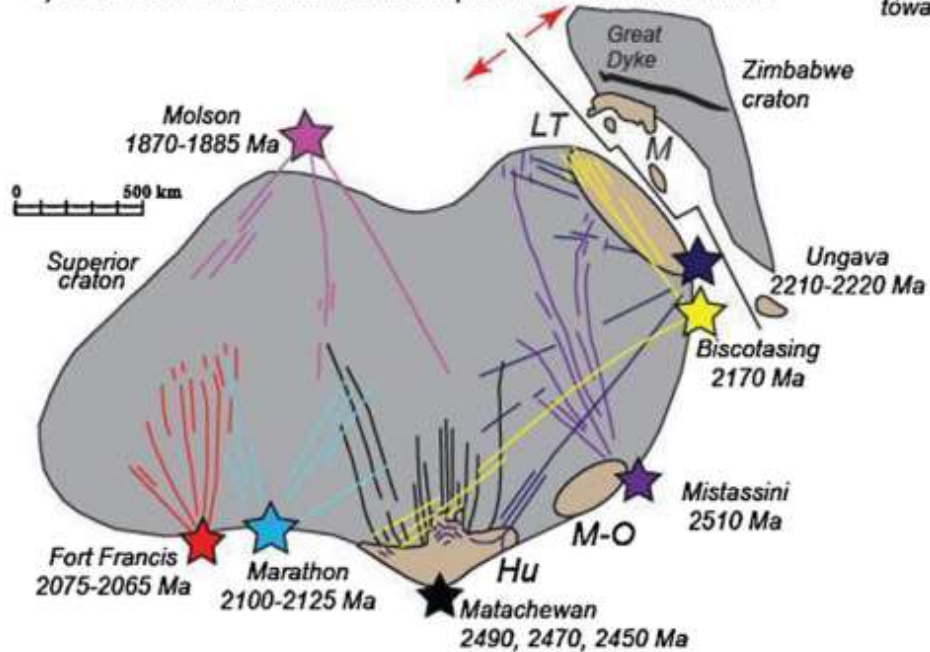
Semami et al 2016
Tsineng Dyke swarm
 $\sim 1923 \pm 6$ Ma



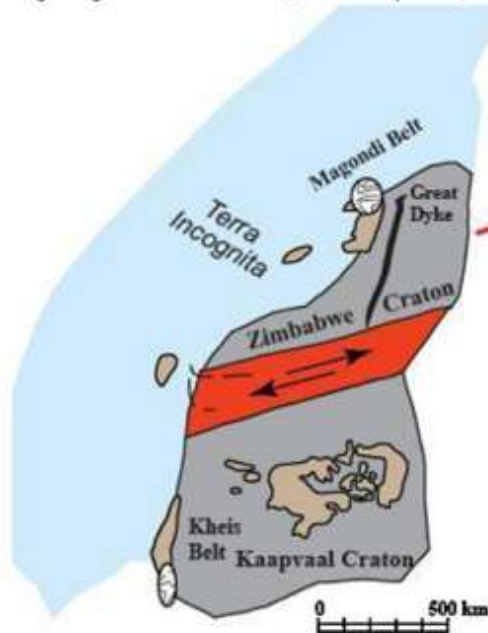
Silver et al.
2004

“Collisional
Rifts”

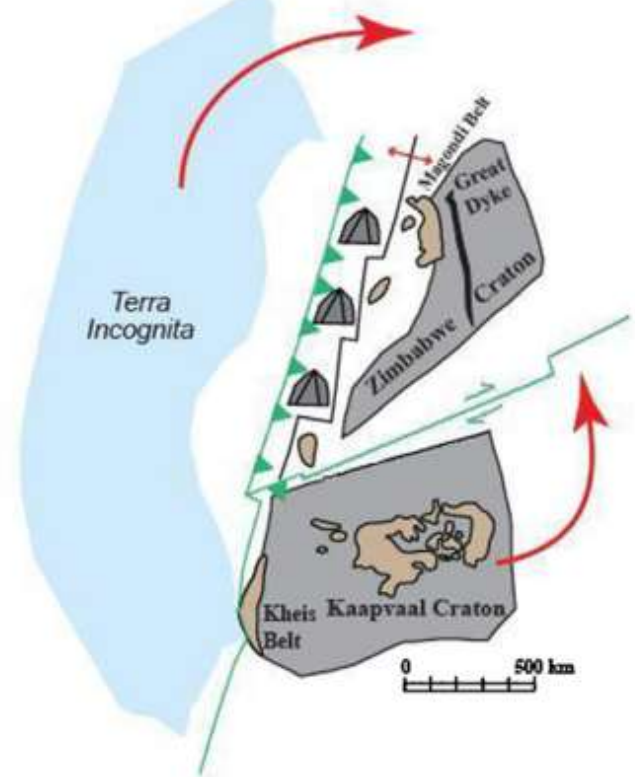
a) c. 2.2 Ga rift-drift transition on the Superior and Zimbabwe cratons



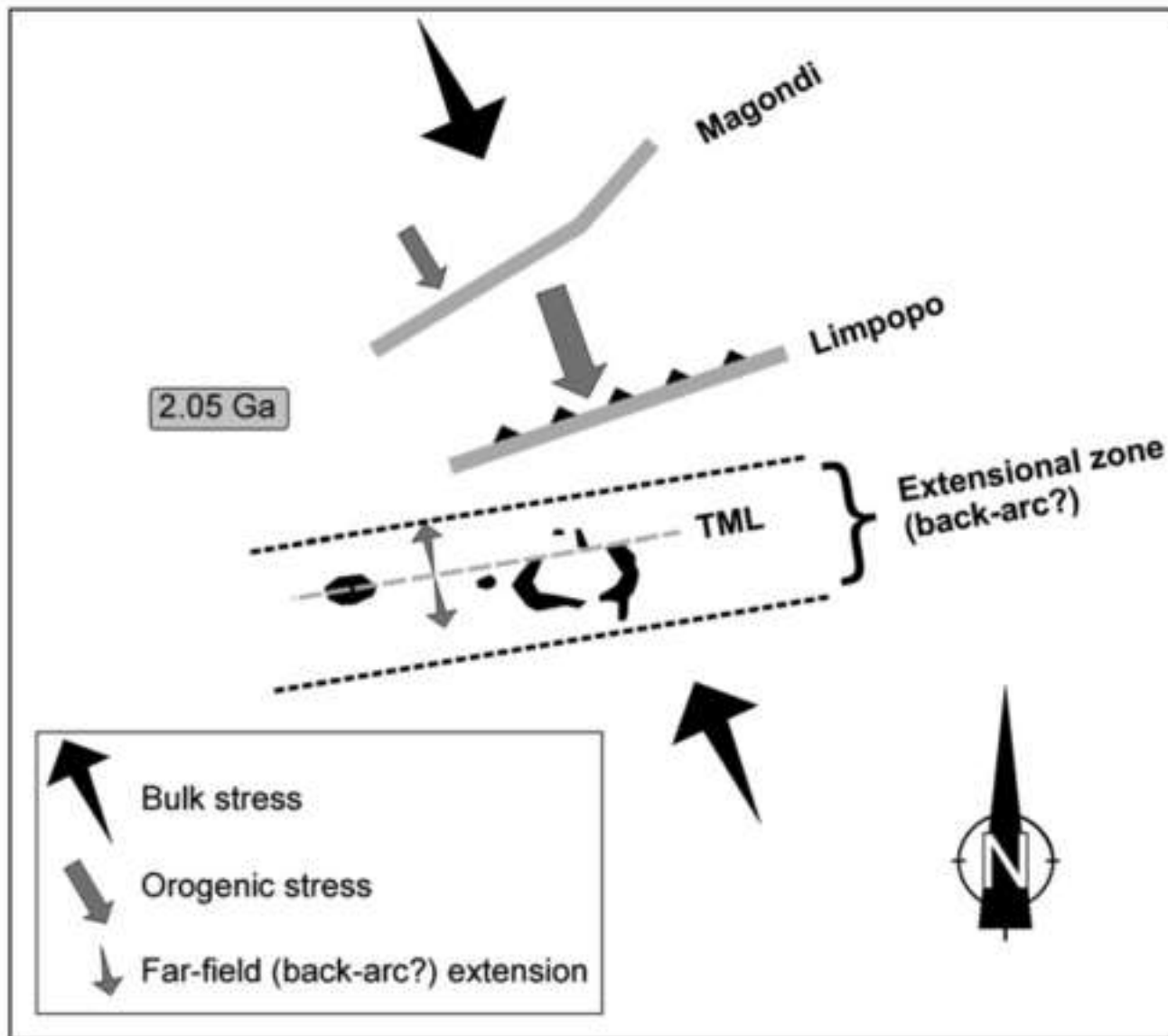
c) Assembly of the Kaapvaal, Zimbabwe, and unknown terrane associated with dextral shearing in the Limpopo Belt, escape tectonics, and higher grade deformation, metamorphism, and uplift at promontories



b) c. 2.1 Ga oblique collision of the Kaapvaal craton and unknown terrane, rotation towards the Zimbabwe craton with subduction zones and back-arc basin developed

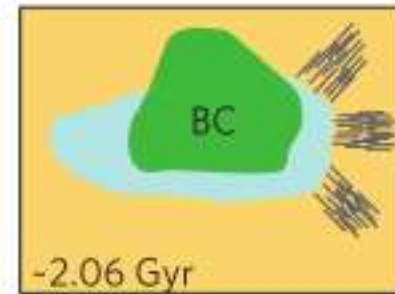
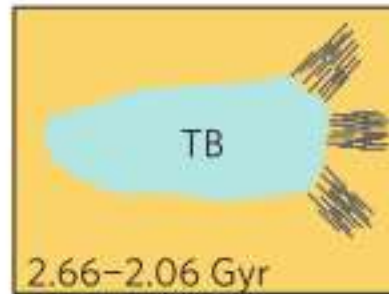
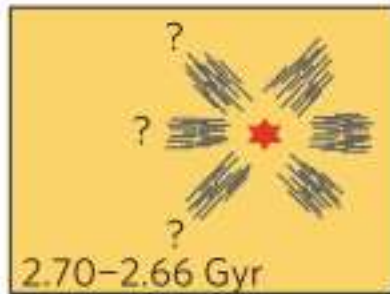


- Paleoproterozoic basins (Hu - Huronian, M-O - Mistassini and Otish, LT - Labrador Trough, M - Magondi)
- Areas with high grade deformation, metamorphism, and uplift

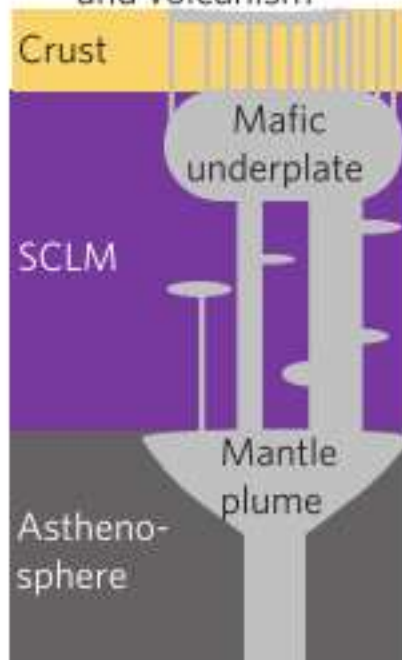


Proposed emplacement model for the RLS and satellite Molopo Farms Complex, showing the Bushveld Complex sill emplaced from a dyke-like feeder that utilised the TML into an extensional (back-arc) zone within the overall compressive (subduction) regime at 2.05 Ga. Clarke et al. 2009

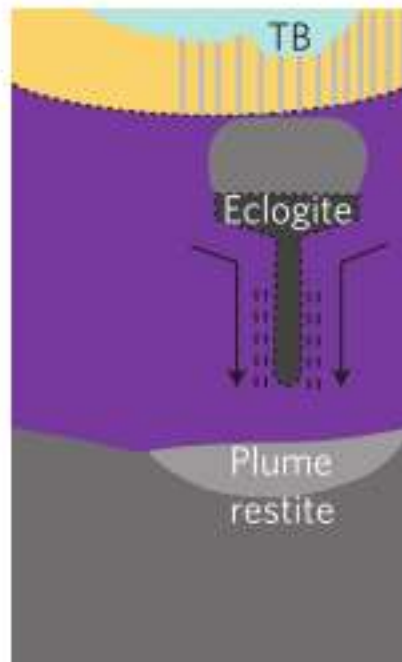
Map view



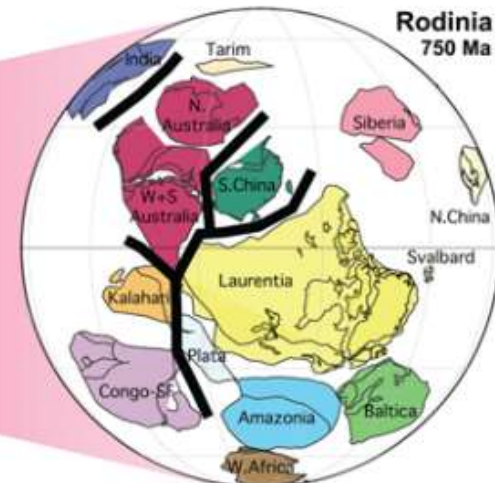
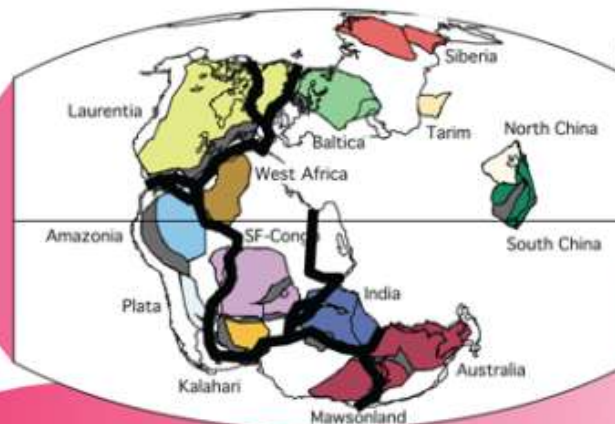
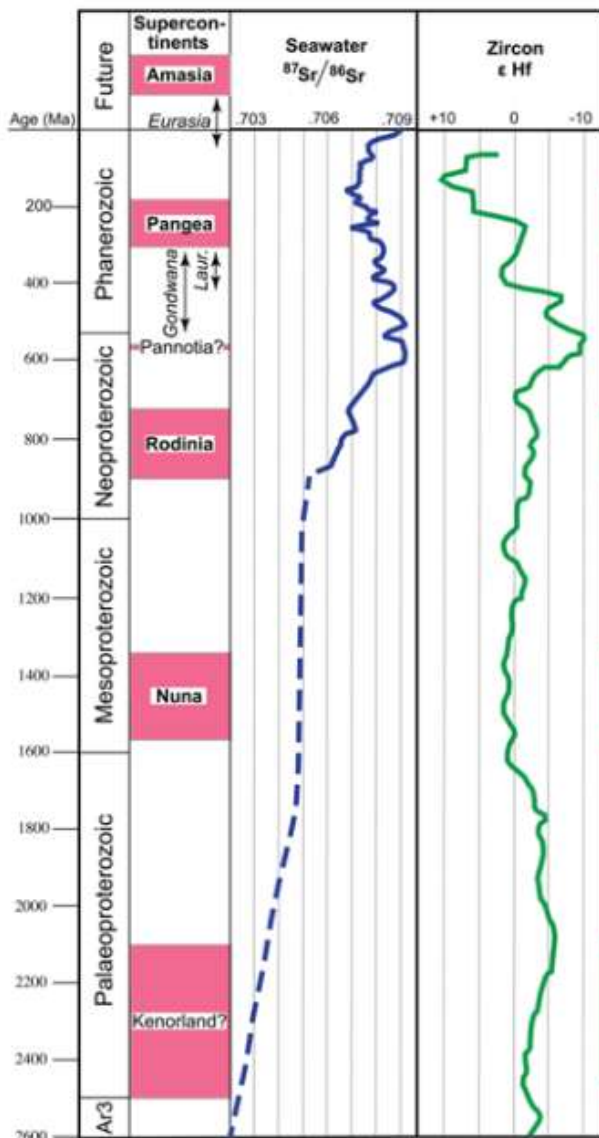
Initial rifting
and volcanism



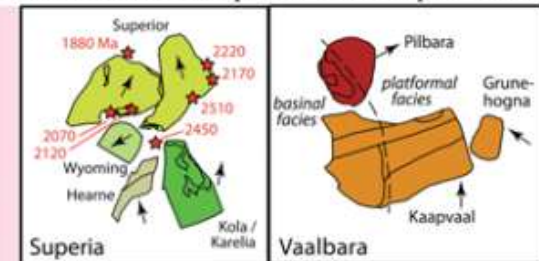
Cross-section

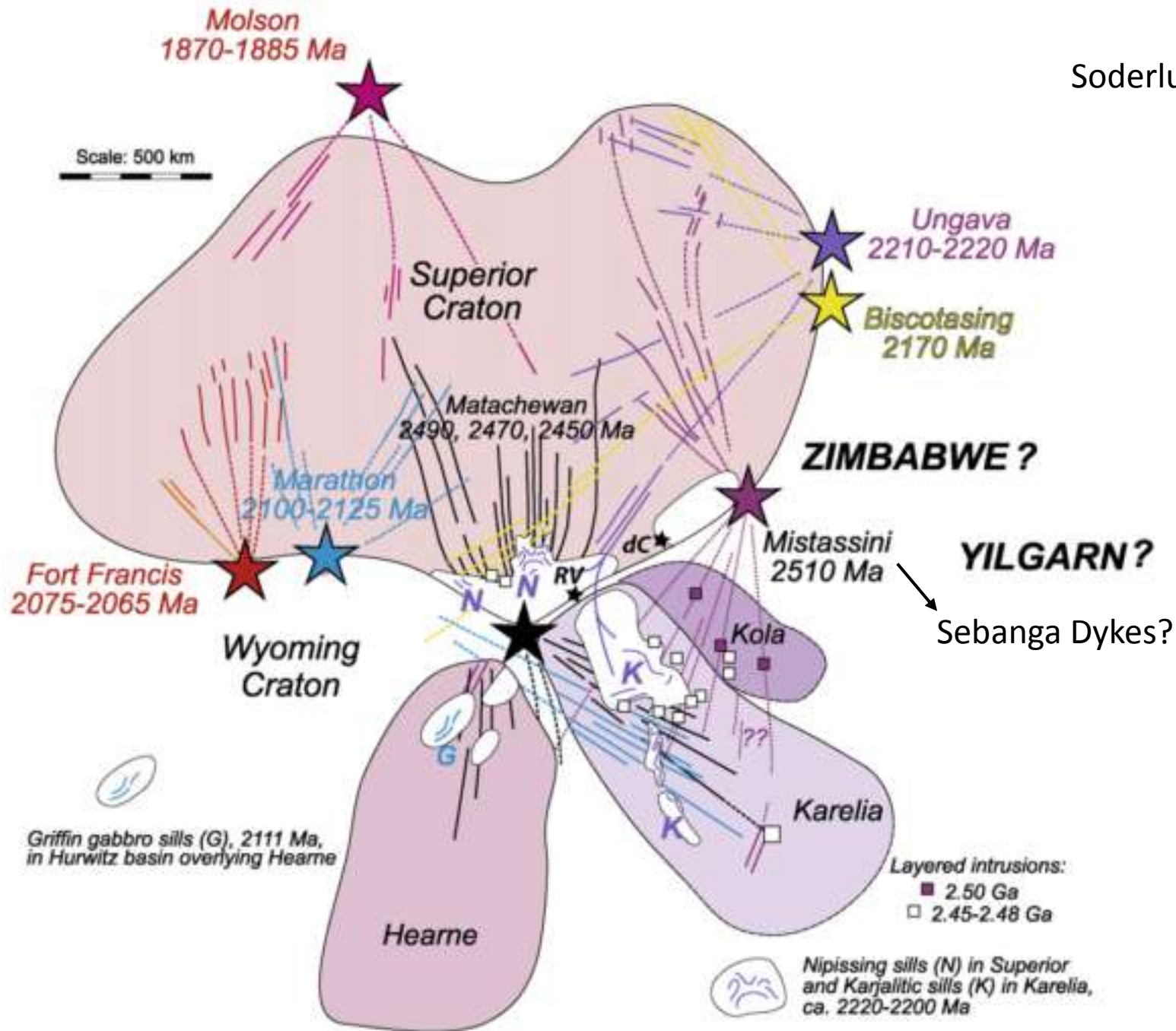


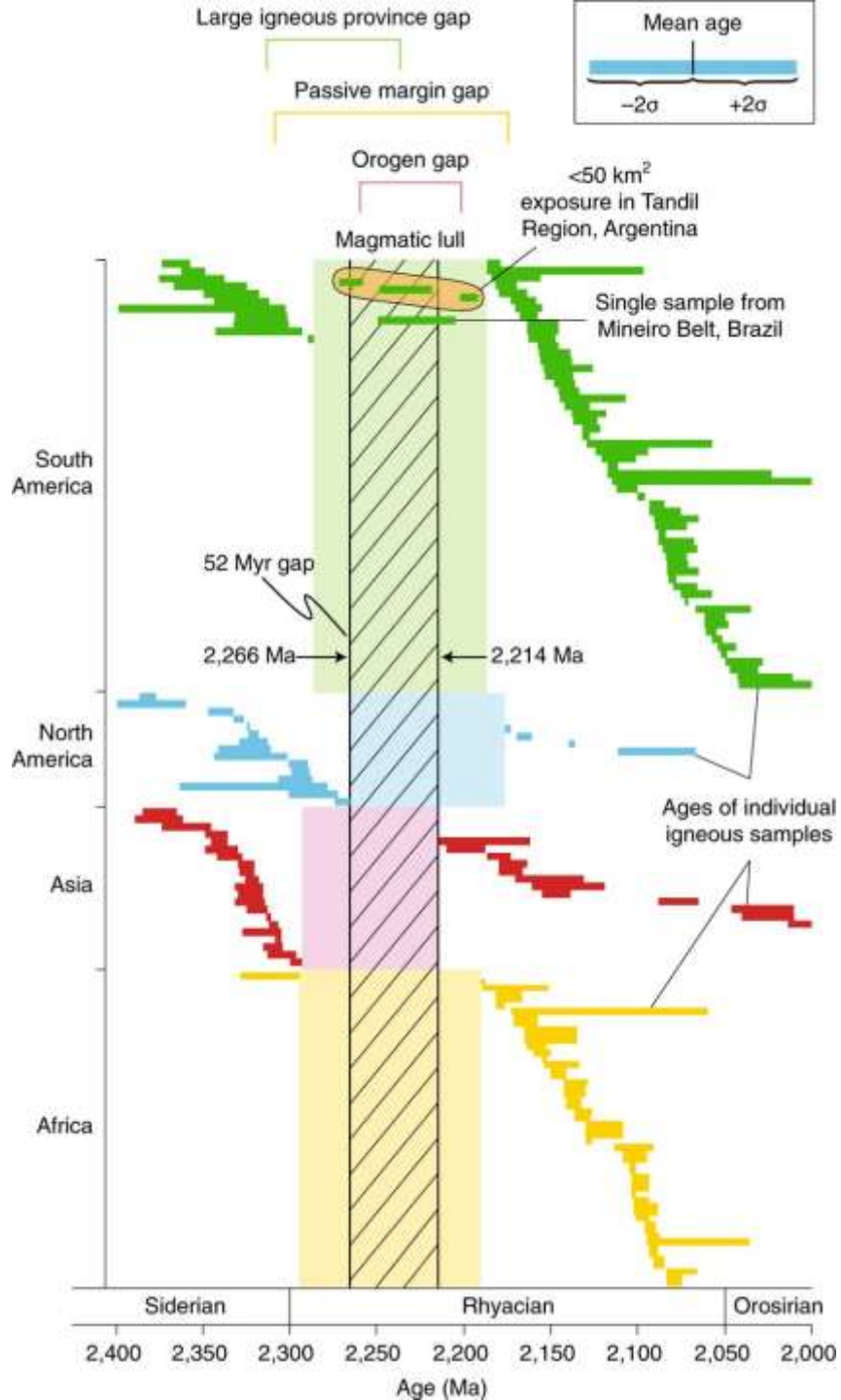
Summary of the Supercontinent Cycle



Neoproterozoic-Paleoproterozoic supercratons



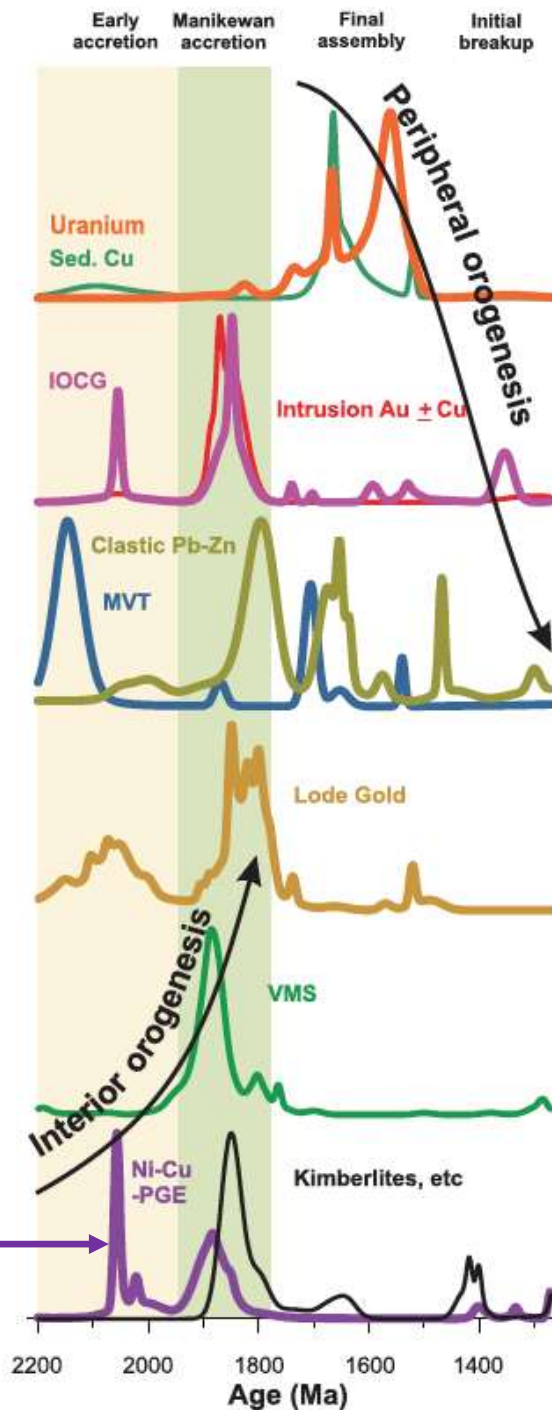




A Palaeoproterozoic tectono-magmatic lull as a potential trigger for the supercontinent cycle
Spencer et al. 2018

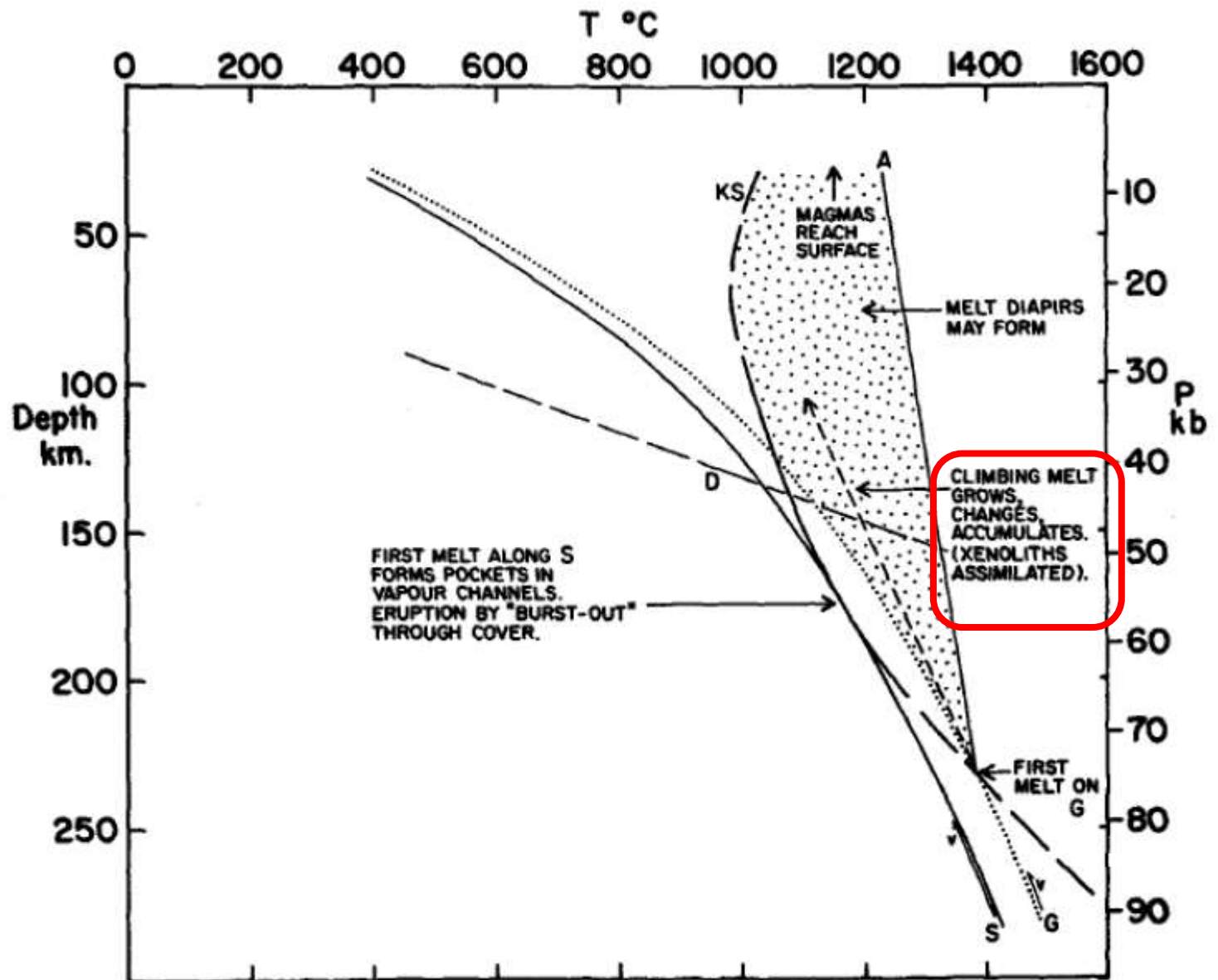
Paleoproterozoic magmatism following a “lull”

Bushveld Complex

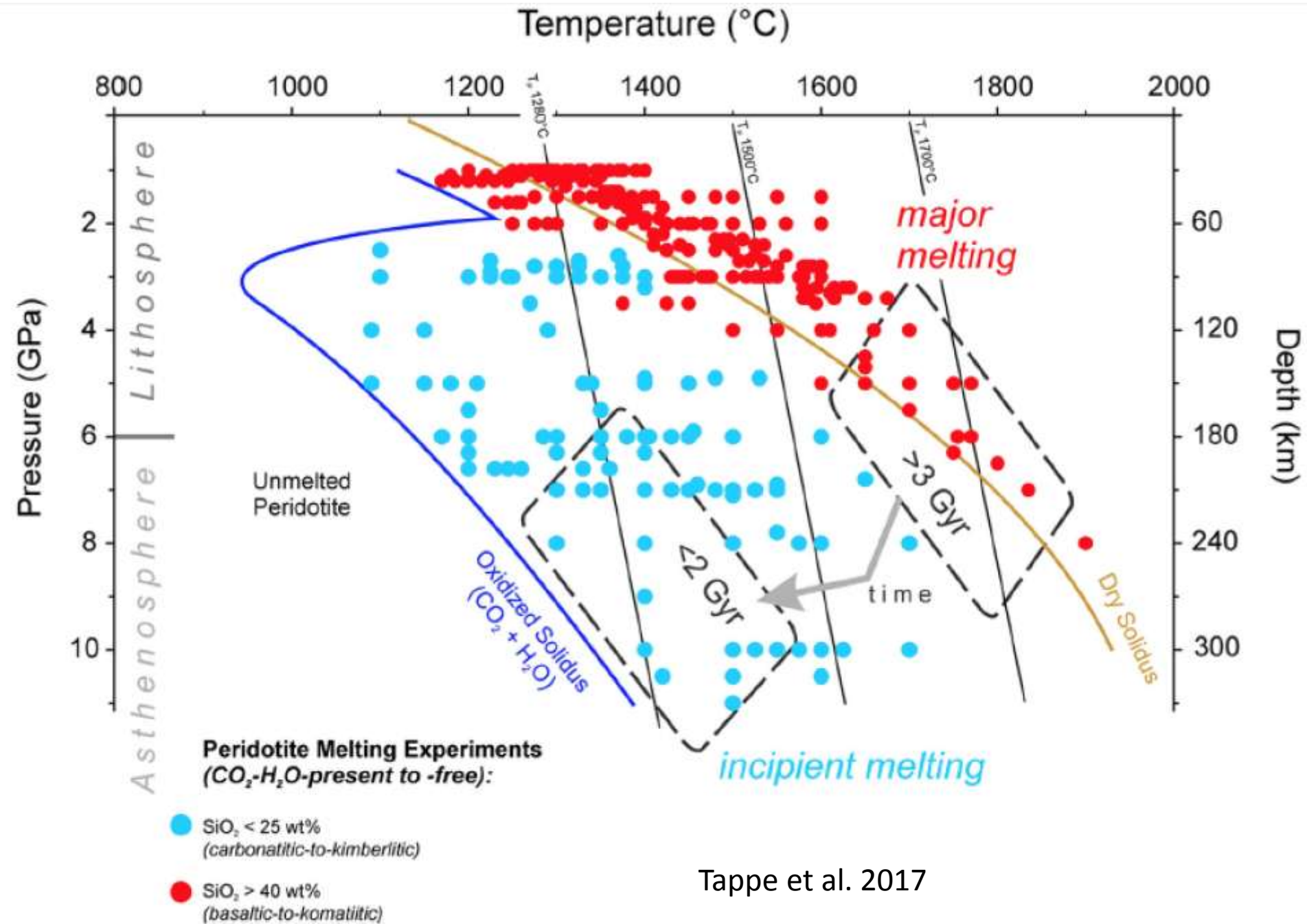


Magmatism during “interior Orogenesis” in Nuna
N.B. Kalahari craton
not part of Nuna

Pehrsson et al. 2015



Bailey 1980



Tappe et al. 2017

Conclusions

- The Great Dyke and the Bushveld Complex/Molopo Farms Complex intruded pre-existing crustal structures which transected the whole of the Zimbabwe and Kaapvaal cratons respectively
- Convergent tectonic settings at high/oblique angles to these structures would have created high dilation and slip tendencies on these structures
- The Zimbabwe craton may have been part of a supercraton 75 Ma after the intrusion of the Great Dyke
- The Kaapvaal craton may have assembled into Nuna 400 Ma after intrusion of the Bushveld Complex
- Both intrusions had tectonic triggers, and may not be related to deep mantle circulation patterns