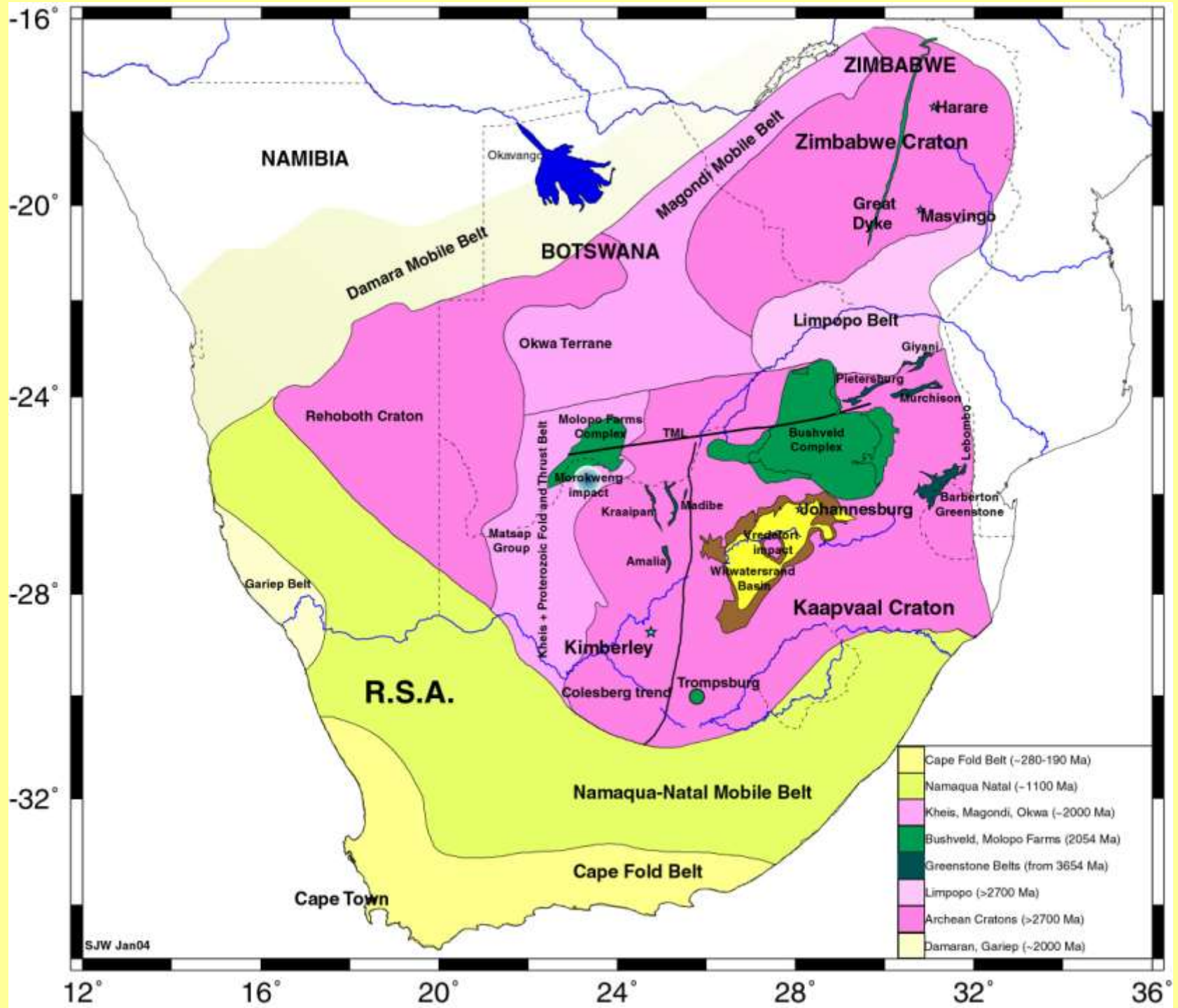


# Magnetic studies of the Bushveld Complex

Susan Webb, Janine Cole, Carol Finn, Trond Torsvik,  
Lewis Ashwal, Gordon Cooper, Madeline Lee  
School of Geosciences, University of the Witwatersrand

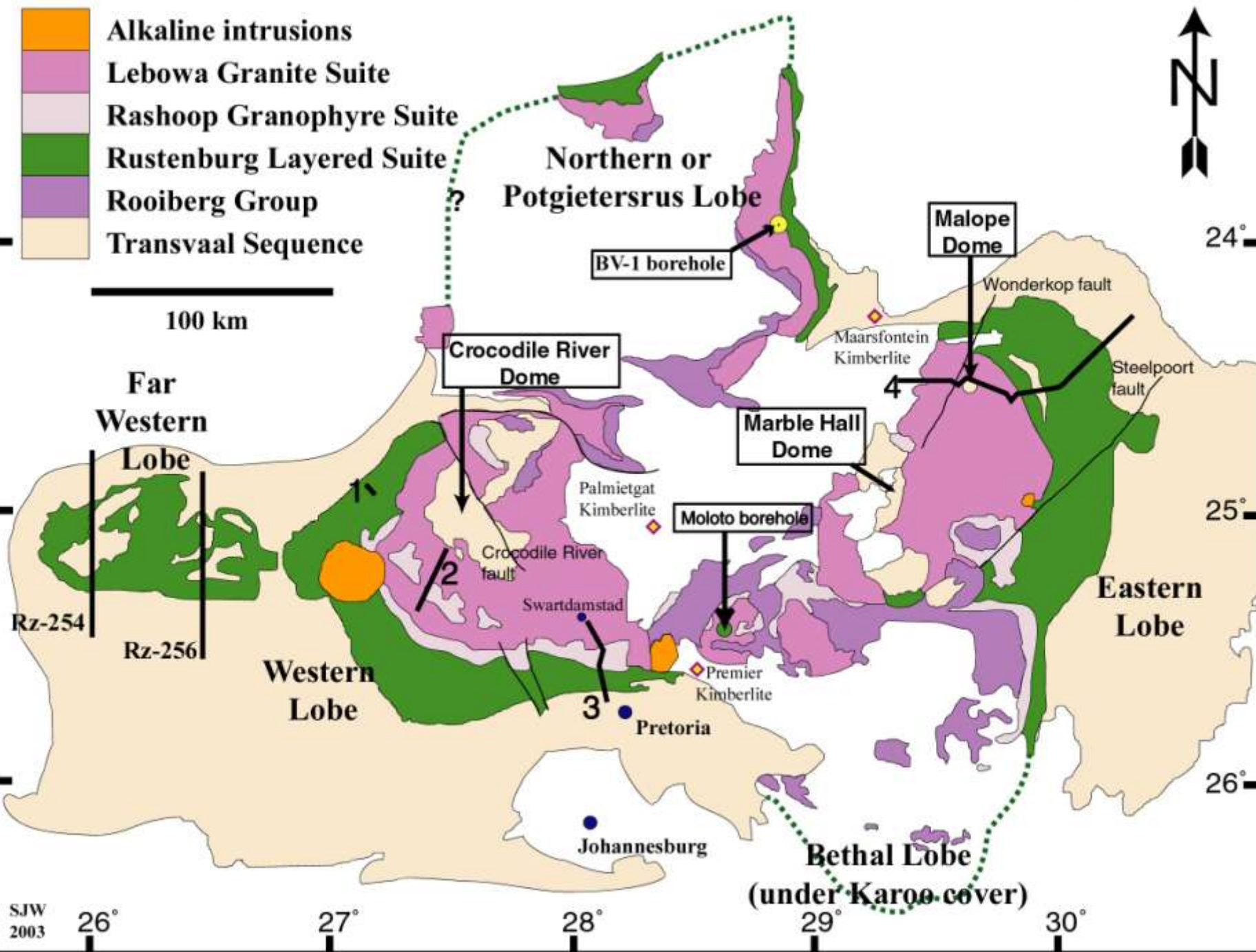




- Alkaline intrusions
- Lebowa Granite Suite
- Rashoop Granophyre Suite
- Rustenburg Layered Suite
- Rooiberg Group
- Transvaal Sequence



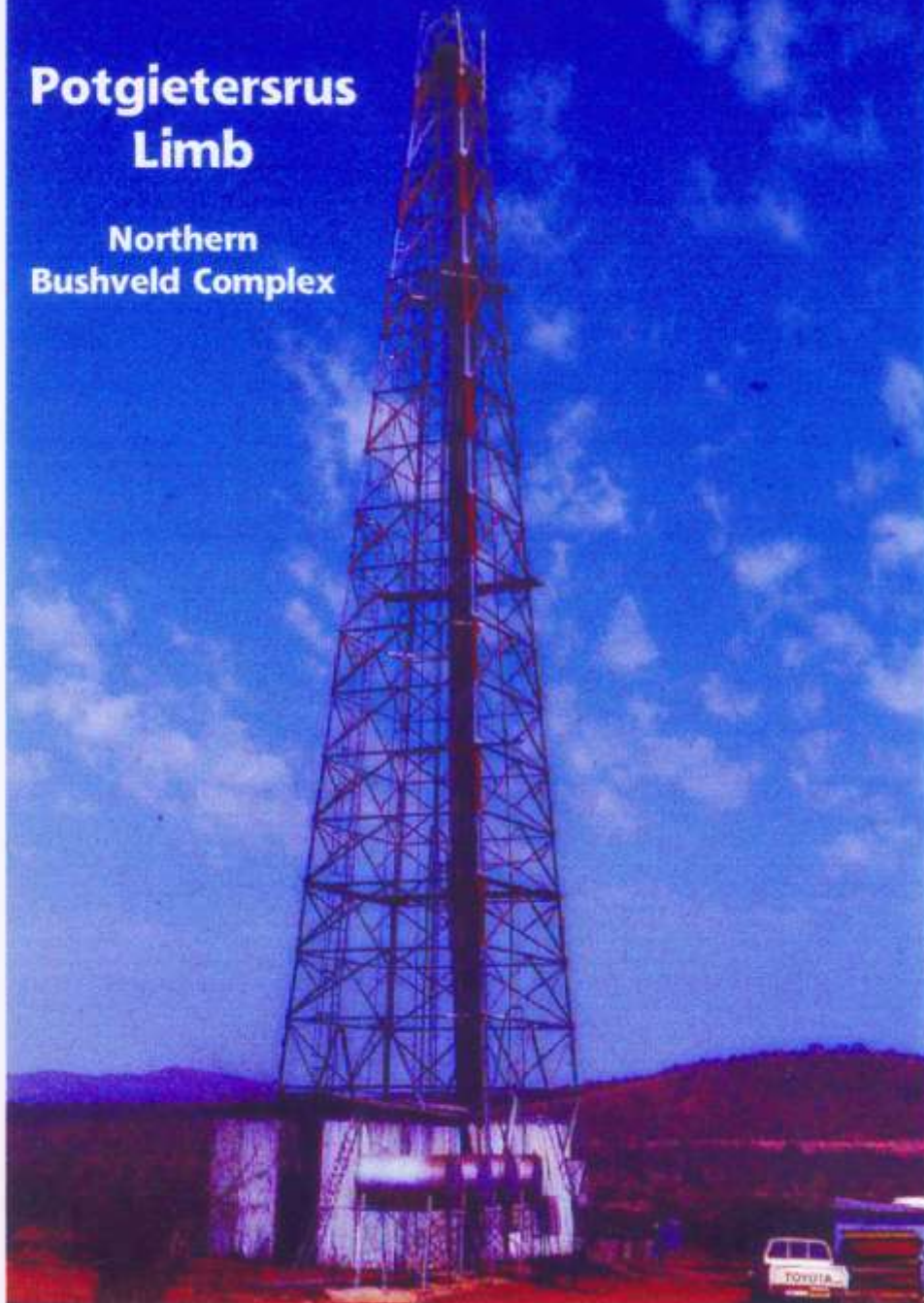
100 km

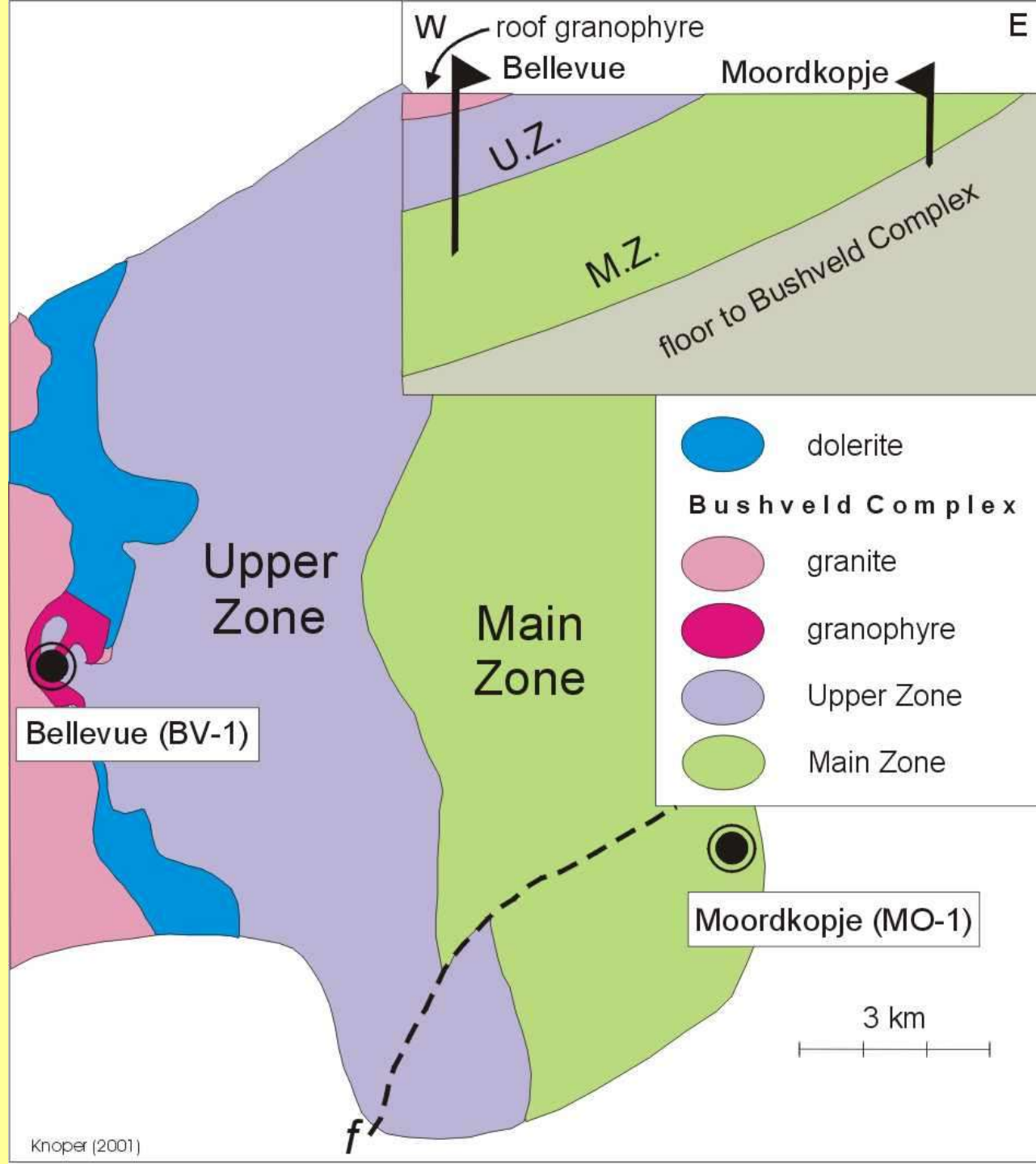


# Deep Stratigraphic Borehole

**Potgietersrus  
Limb**

**Northern  
Bushveld Complex**





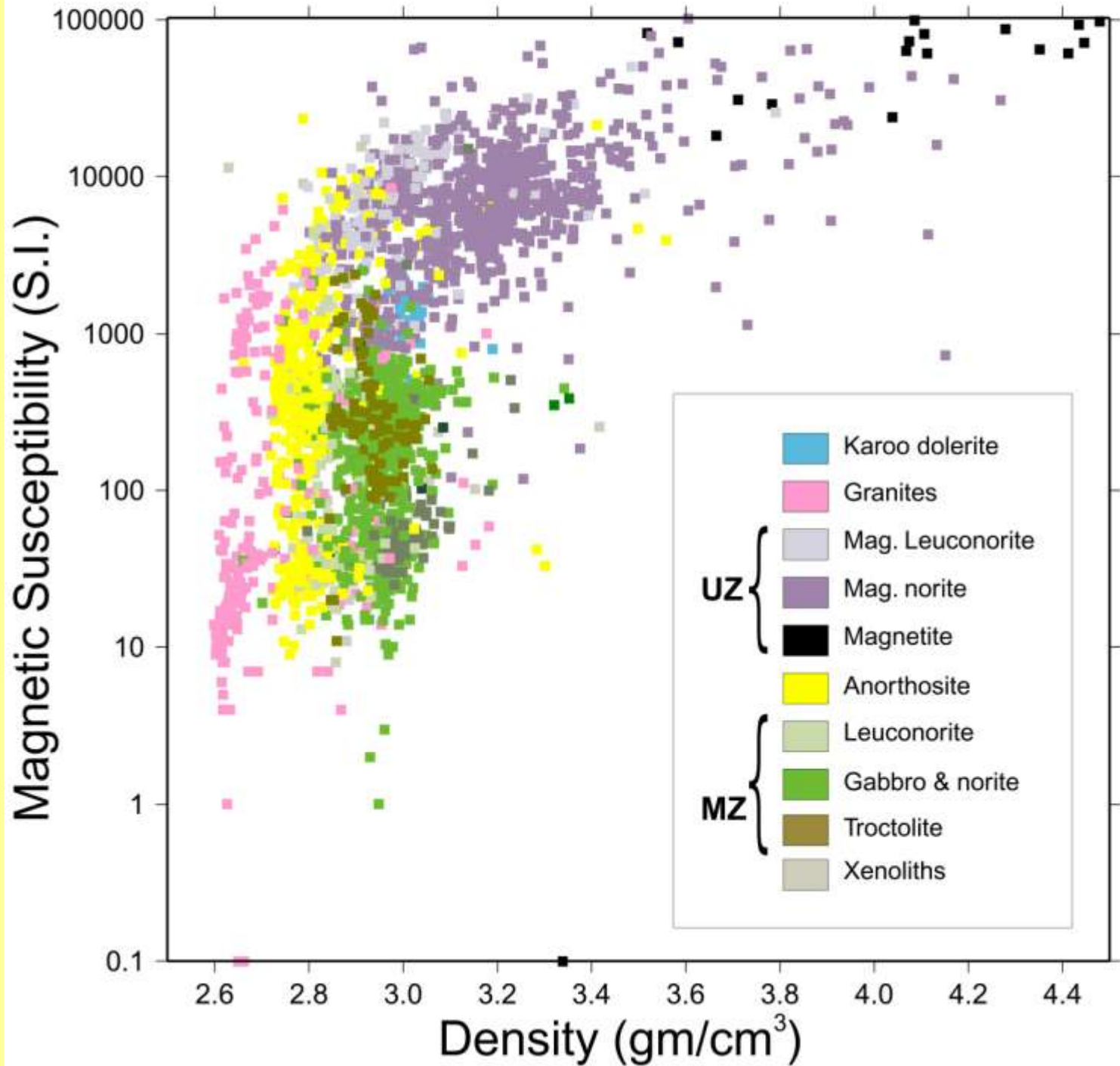
Knoper,  
2001

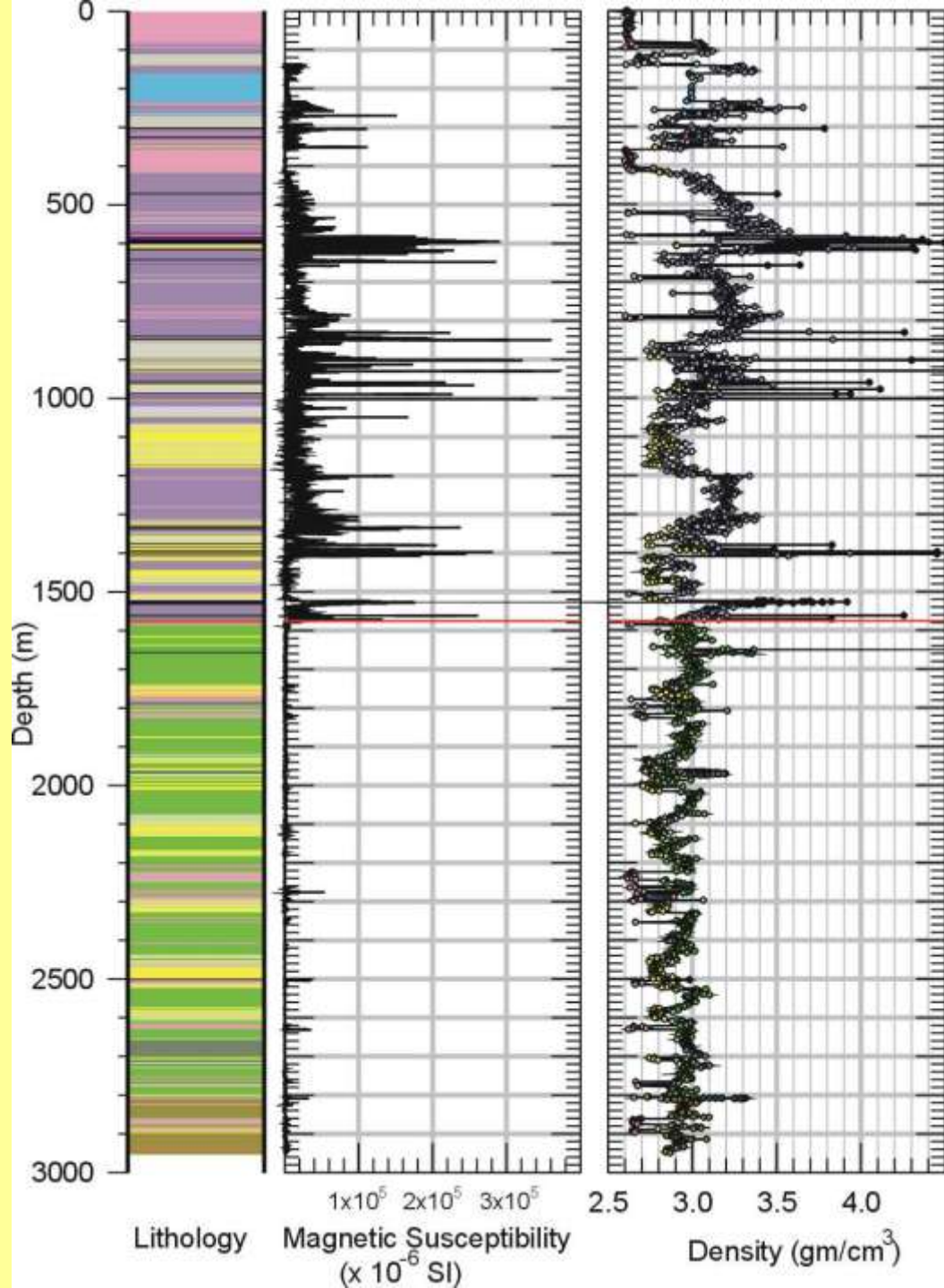


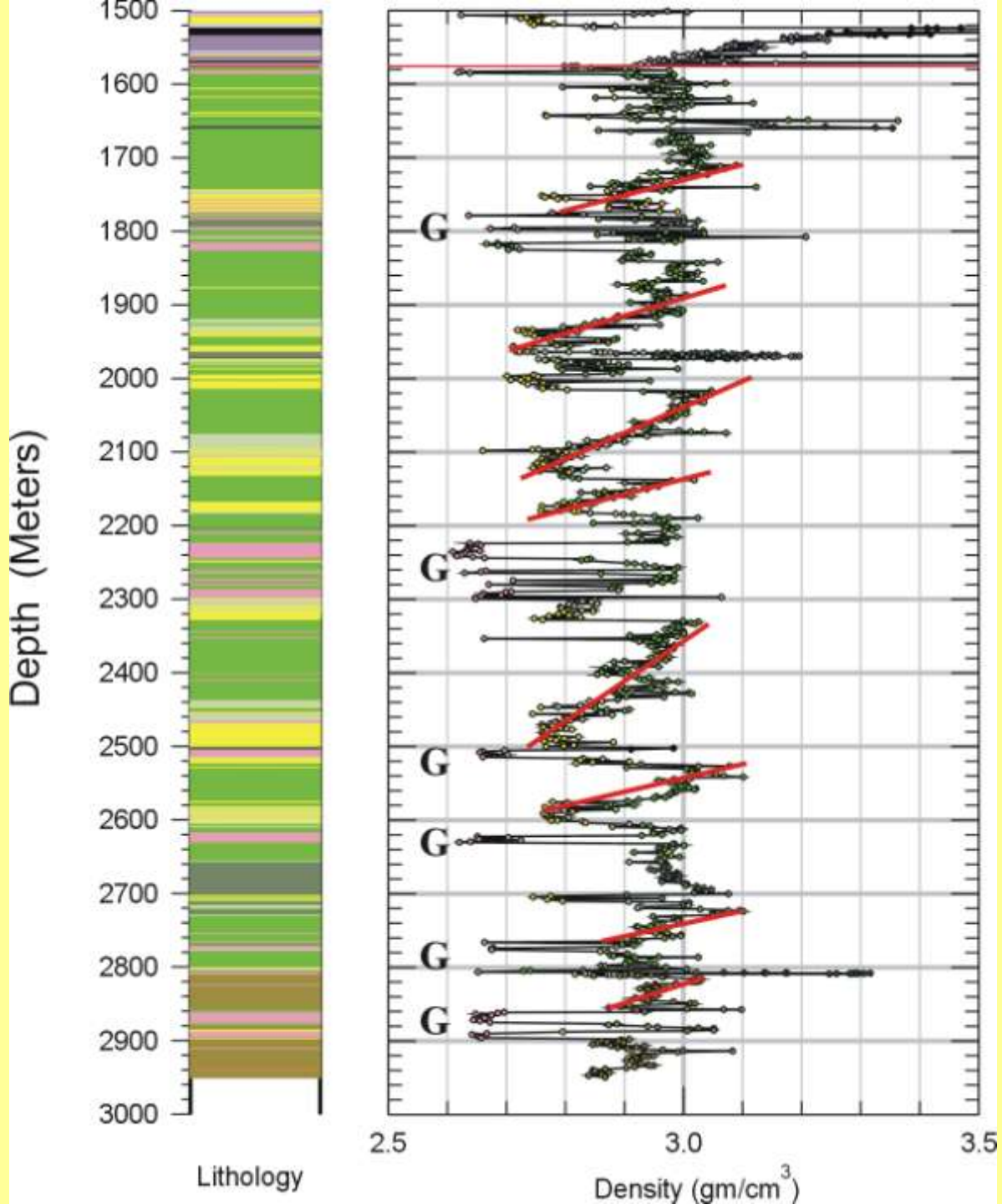


**Magnetic susceptibility:**  
**n = 109,360**

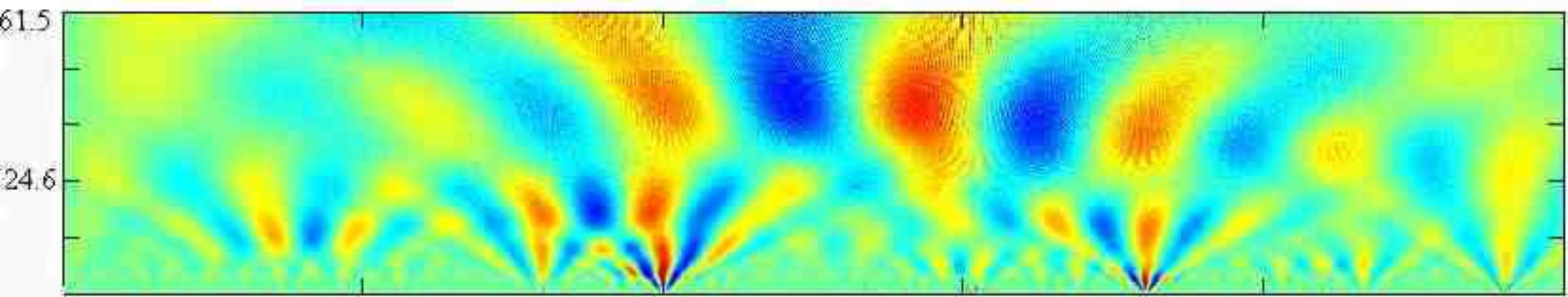
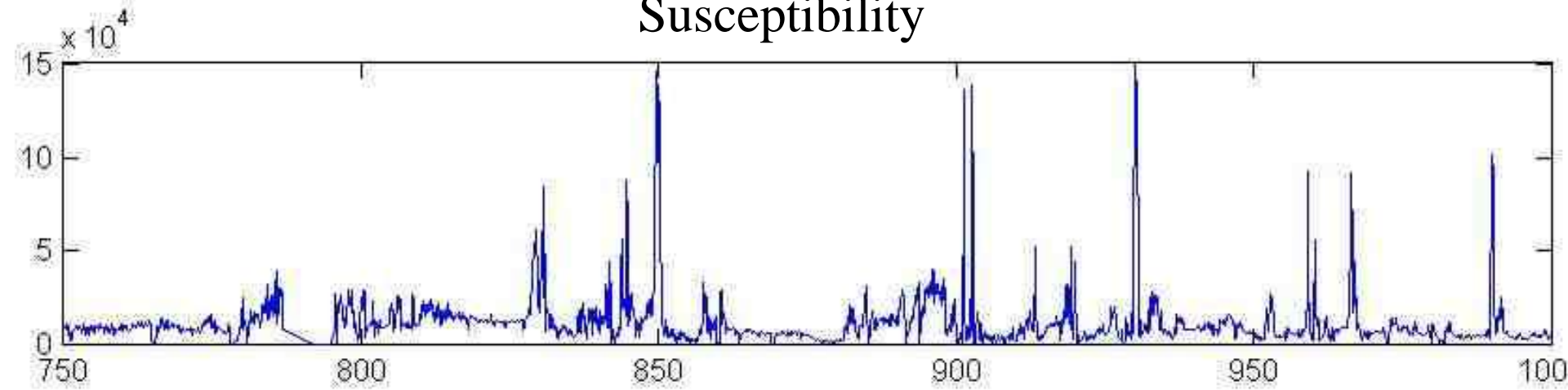
**Density: n = 2,252**



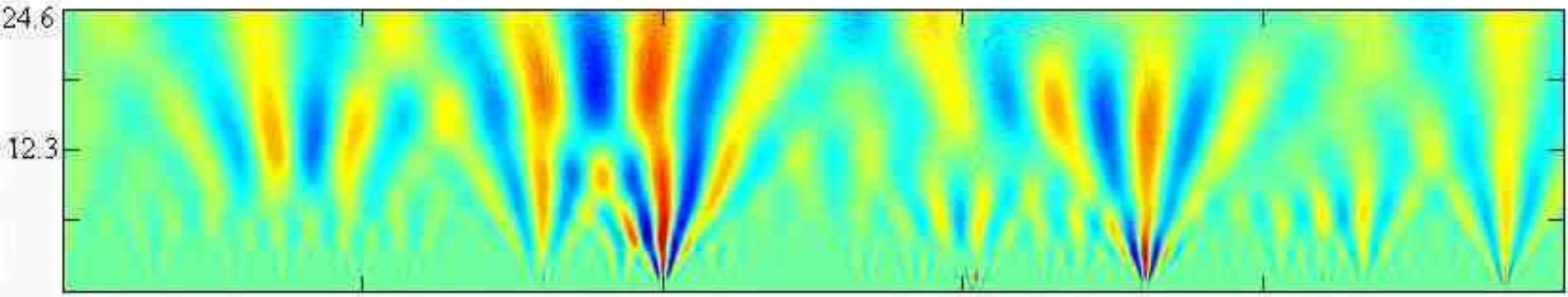




# Susceptibility



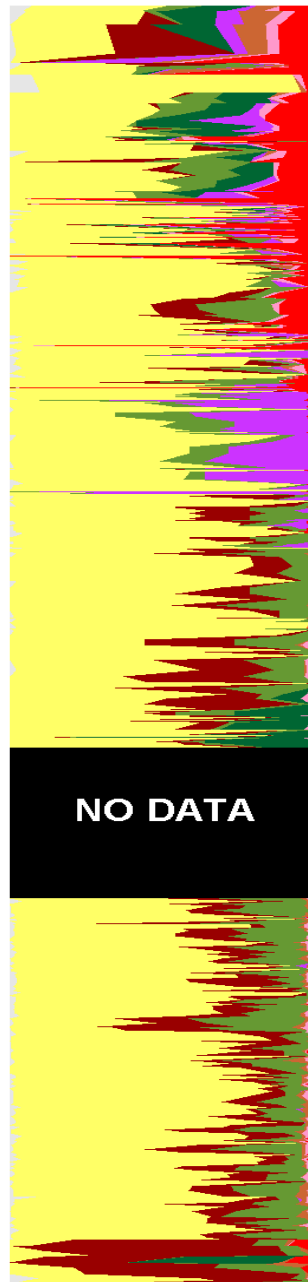
Y axis labelled in wavelength (m)



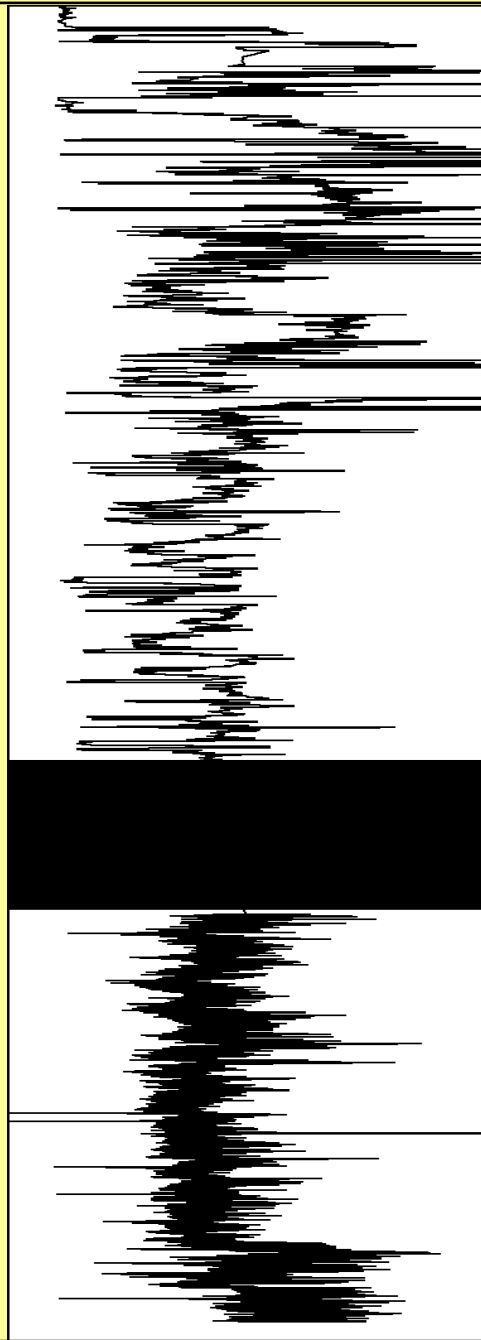
# Conclusions from BV1 and Further Work

- Scale of layering not previously documented
  - (~150-170 m)
- Susceptibility increasing prior to MZ/UZ boundary
- MZ/UZ boundary appears staggered
- Density increasing upwards – implications for emplacement
- Statistics change significantly along the core – wavelets are useful for analysis
- Regions of intense sub-layering observed
  
- Identifying Magnetic reversals
- Looking for more layering (Moordkopjie and other boreholes)
- Geophysical modelling

0  
200  
400  
600  
800  
1000  
1200  
1400  
1600  
1800  
2000  
2200  
2400  
2600  
2800  
3000  
3200  
3400  
3600  
3800  
4000  
4200  
4400  
4600  
4800  
5000  
5200

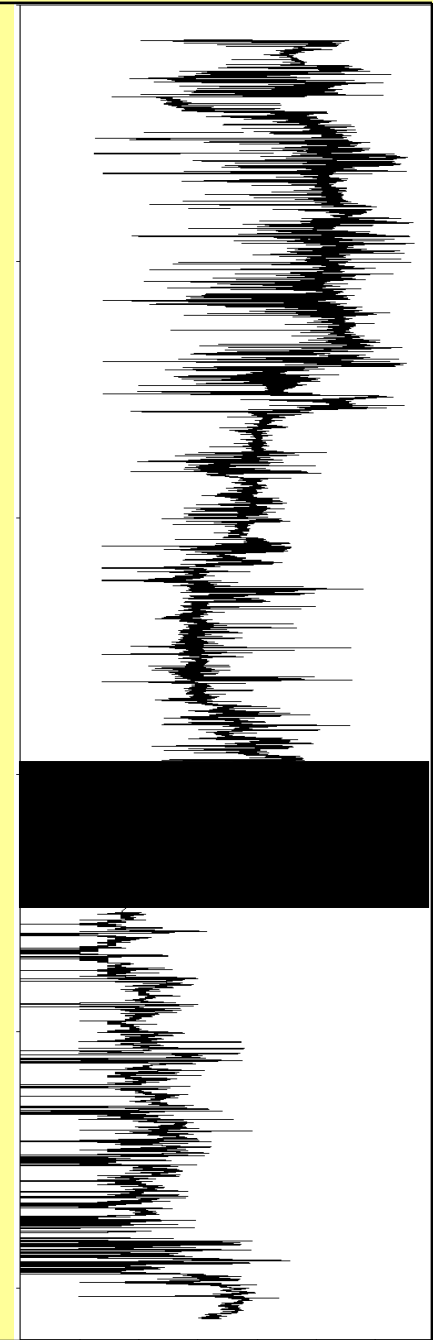


Quartz  
Plagioclase  
Orthopyroxene  
Clinopyroxene  
Olivine  
Other  
Biotite  
Amphibole  
Opaques



2.6 2.8 3.0 3.2 3.4

Density

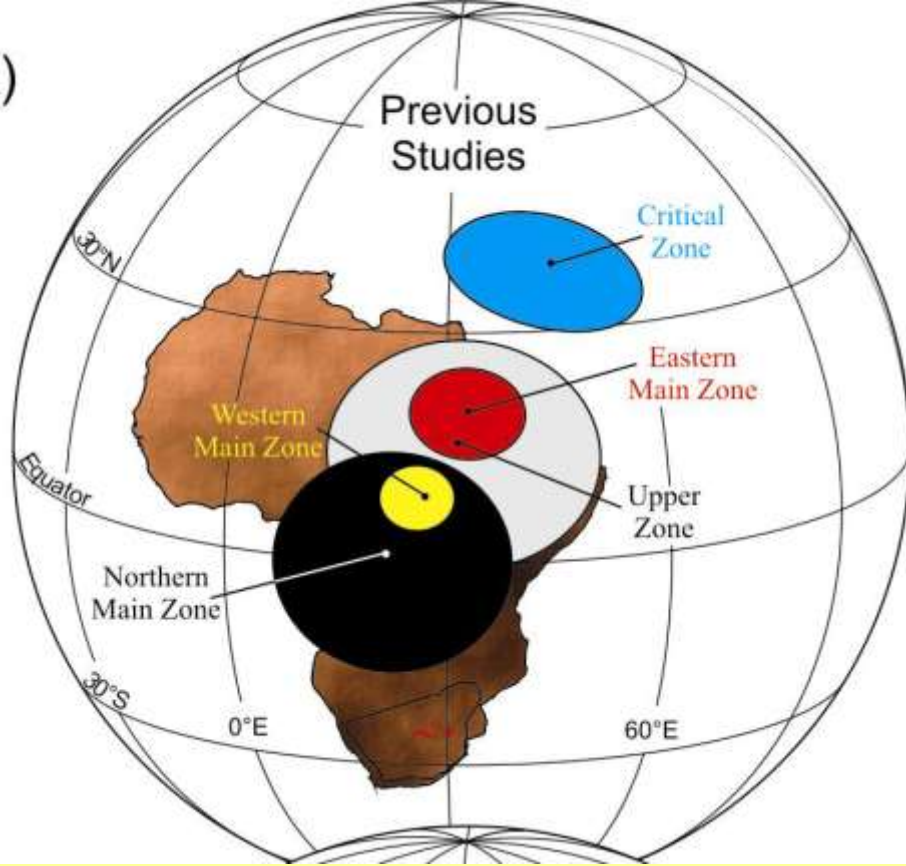


-6 -5 -4 -3 -2 -1 0 1

Log Magnetic susceptibility

Roelofse (2007)

A)

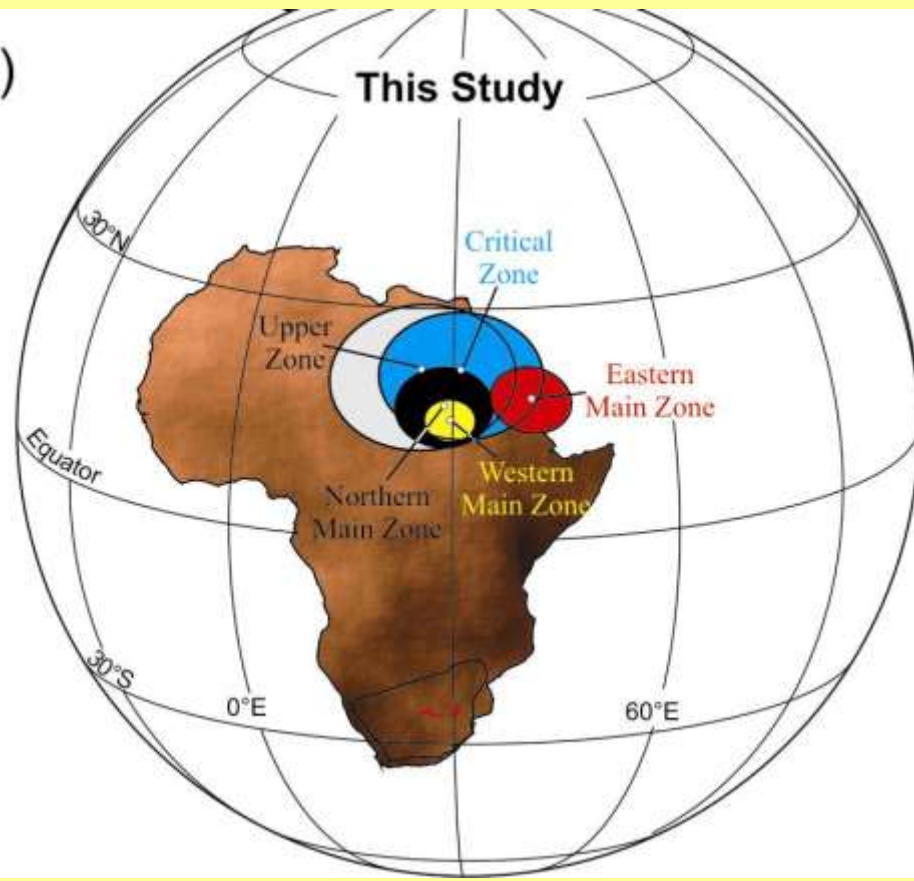


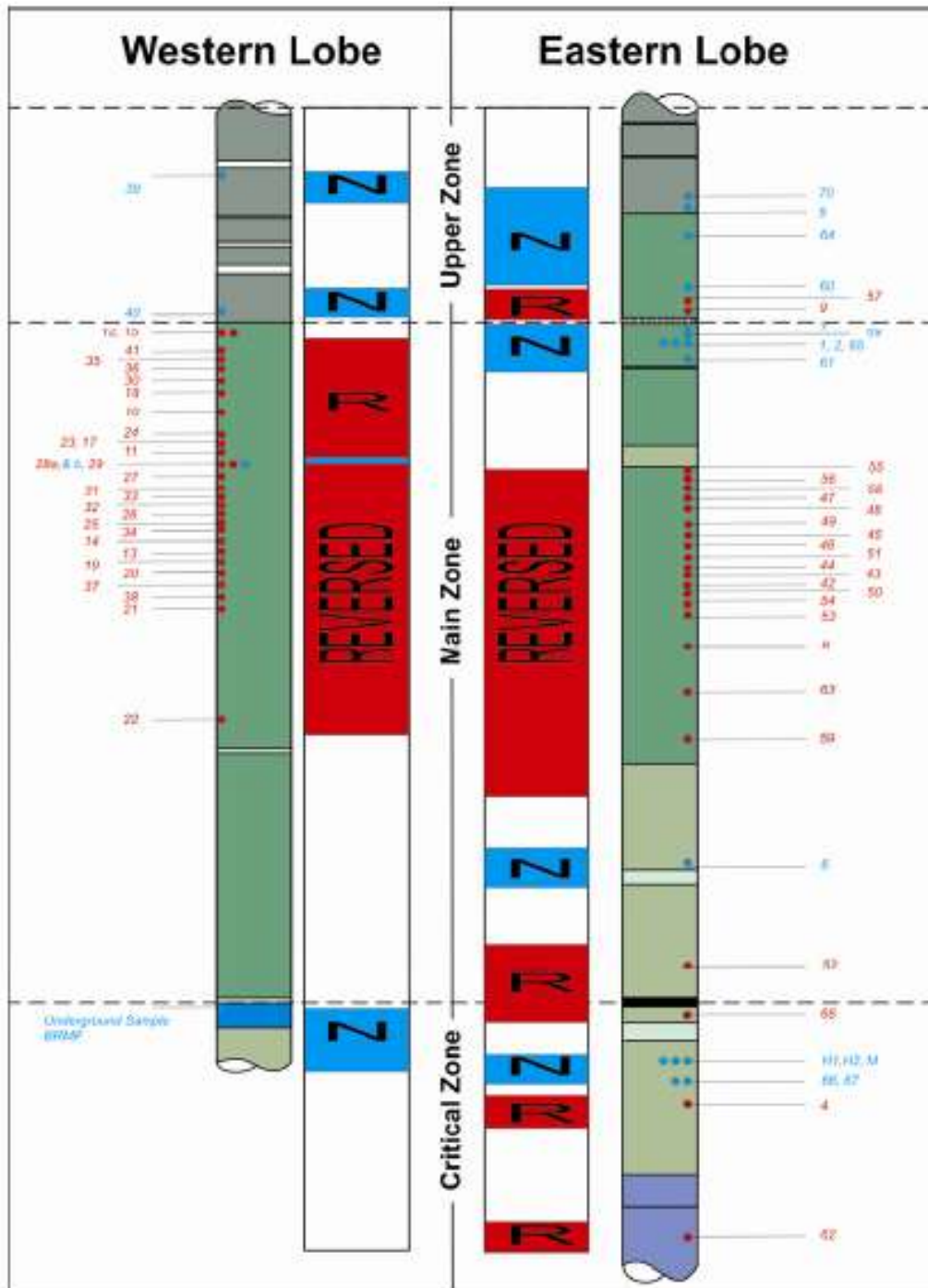
Letts, 2007

Palaeomagnetic studies in the Bushveld Complex

(No polar wander path for the Bushveld Complex)

B)





Letts, 2007

Reversals in the Bushveld Complex

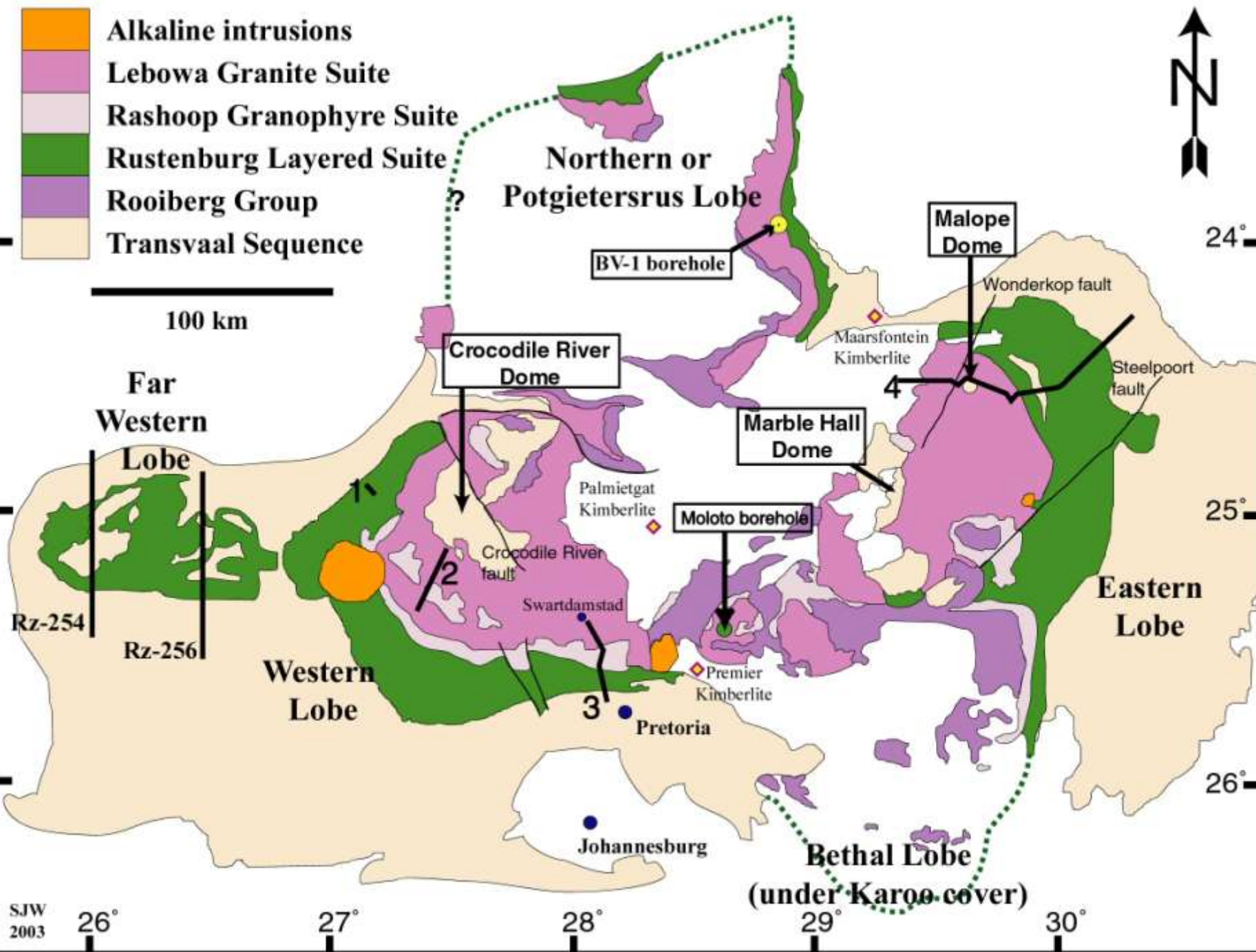
But how do they correlate between the western and eastern limbs? Can we build up a detailed magnetostratigraphy?

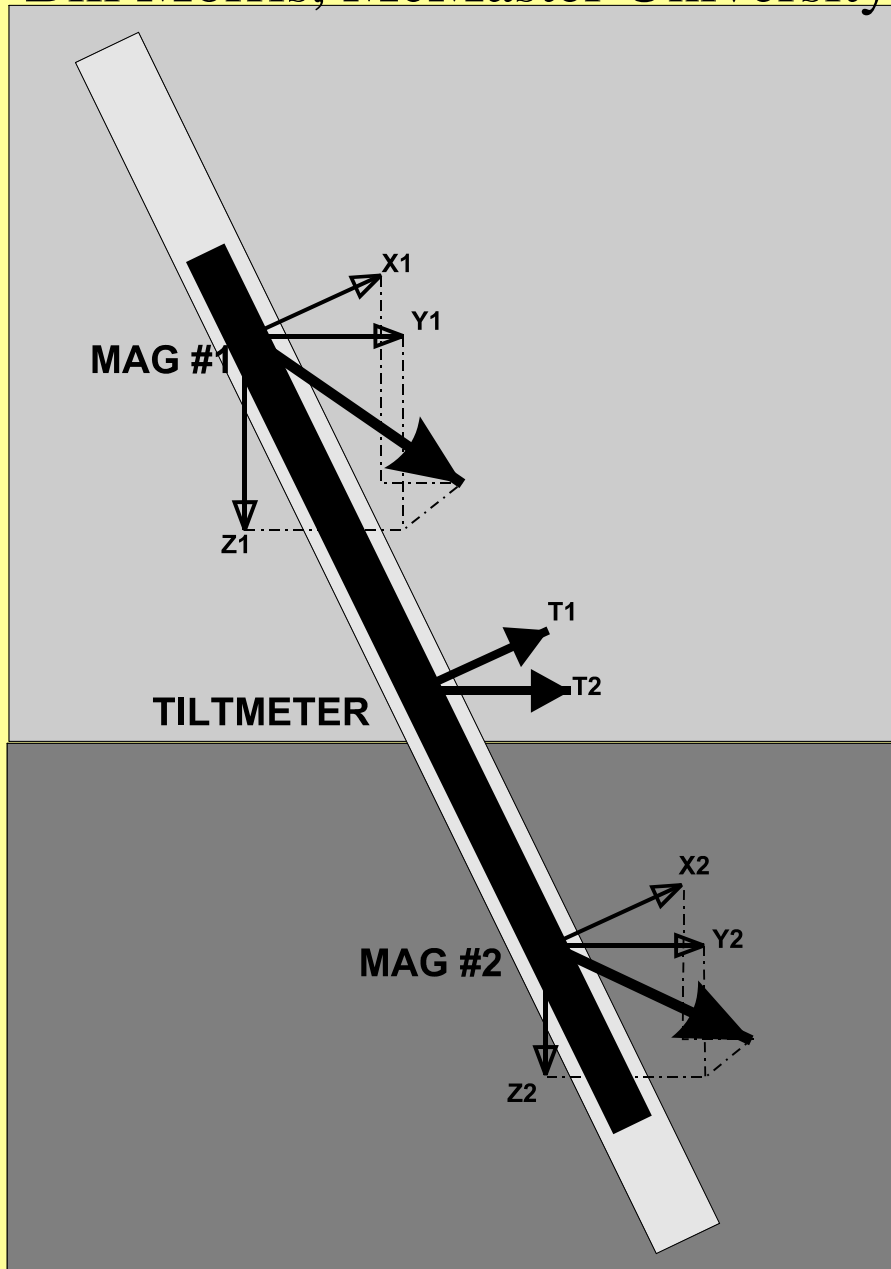
Shaft holes for mines...

- Alkaline intrusions
- Lebowa Granite Suite
- Rashoop Granophyre Suite
- Rustenburg Layered Suite
- Rooiberg Group
- Transvaal Sequence



100 km



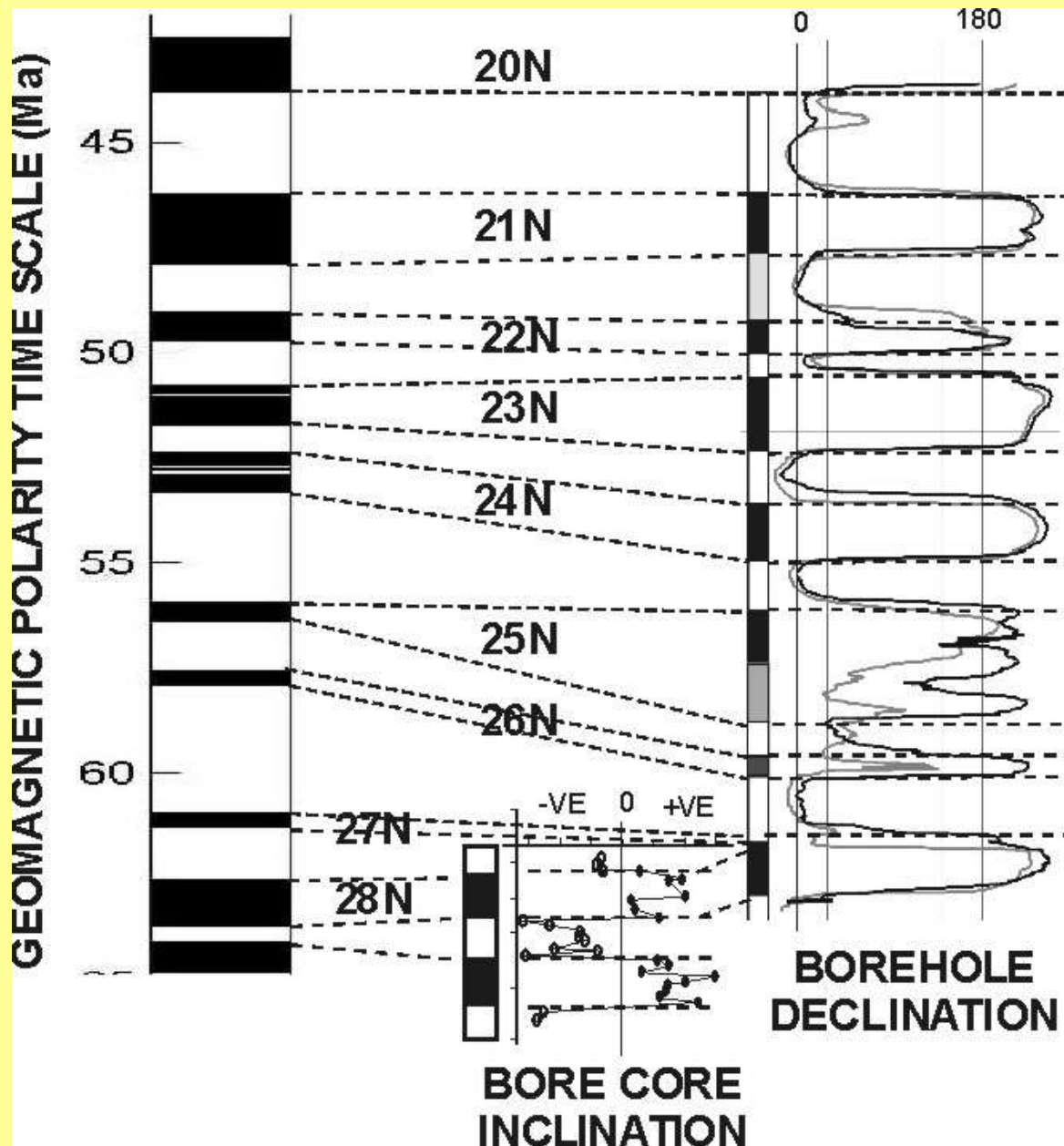


Probe rotation versus magnetic field rotation

If hole is inclined then may have sufficient signal in tilt-meters.

If hole is near vertical then may need to use special probe which contains two sets of triaxial fluxgate magnetometers rigidly fixed inside the probe.

Sequential vector difference between fluxgates provides a direct measure of magnetic field rotation irrespective of probe rotation.

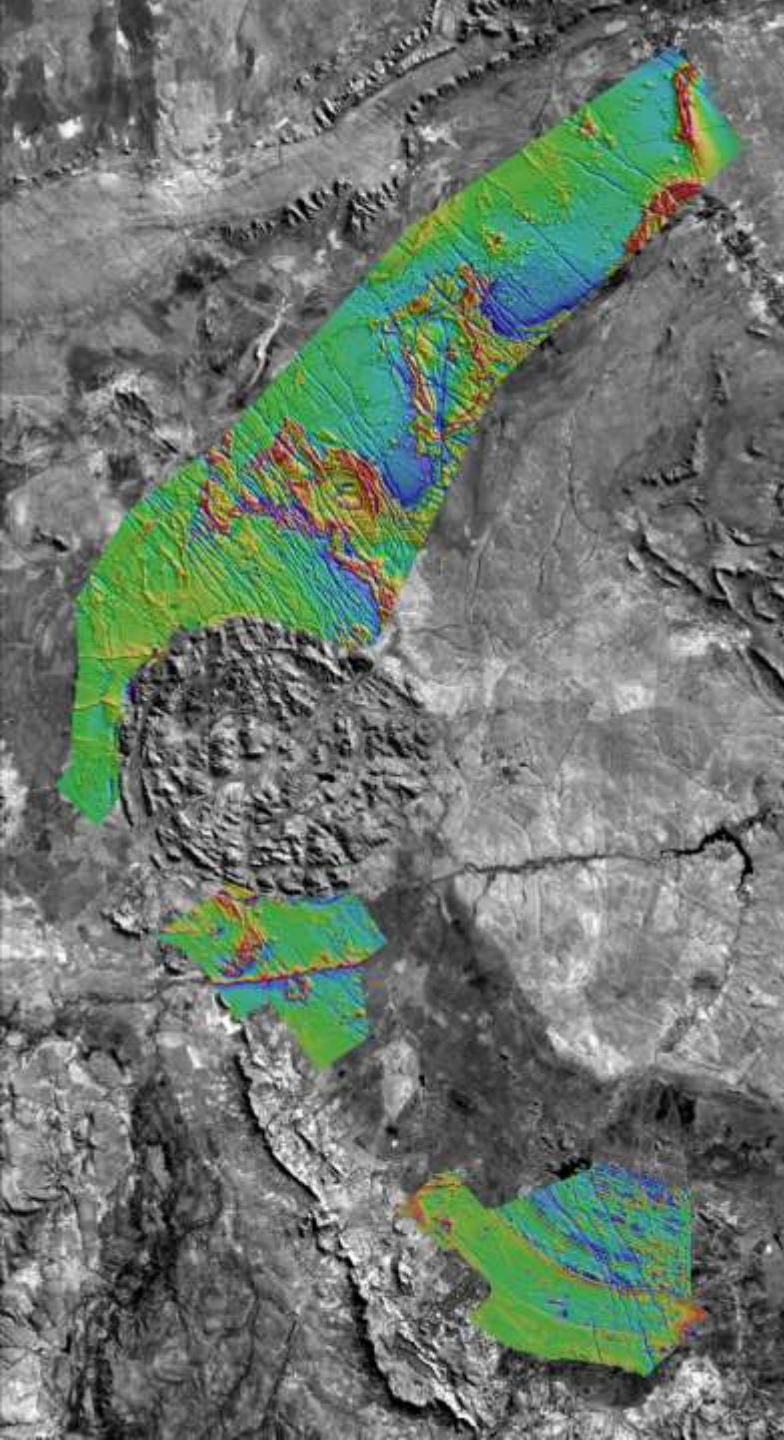


Does the observed pattern make sense in terms of magnetic reversal stratigraphy?

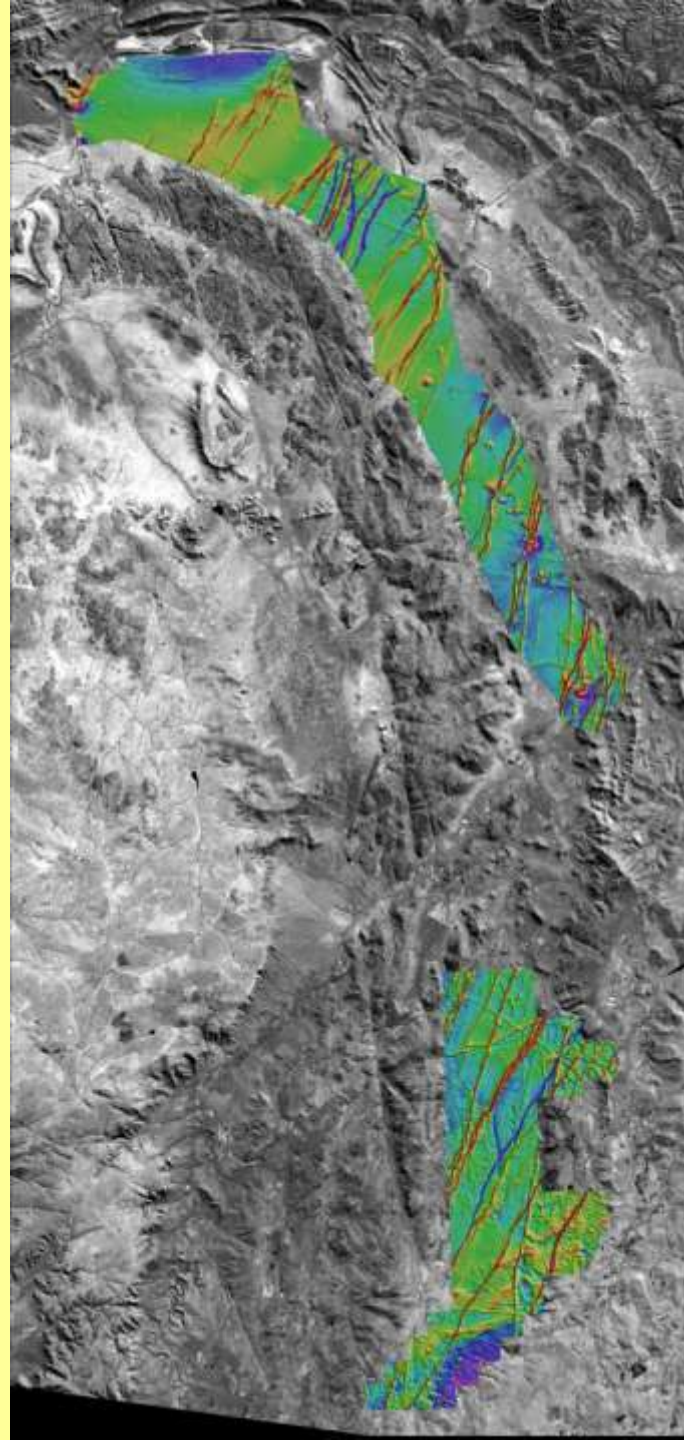
It fits with available paleomagnetic data which has limited depth coverage.

Magnetostratigraphy .....

Maybe, yes



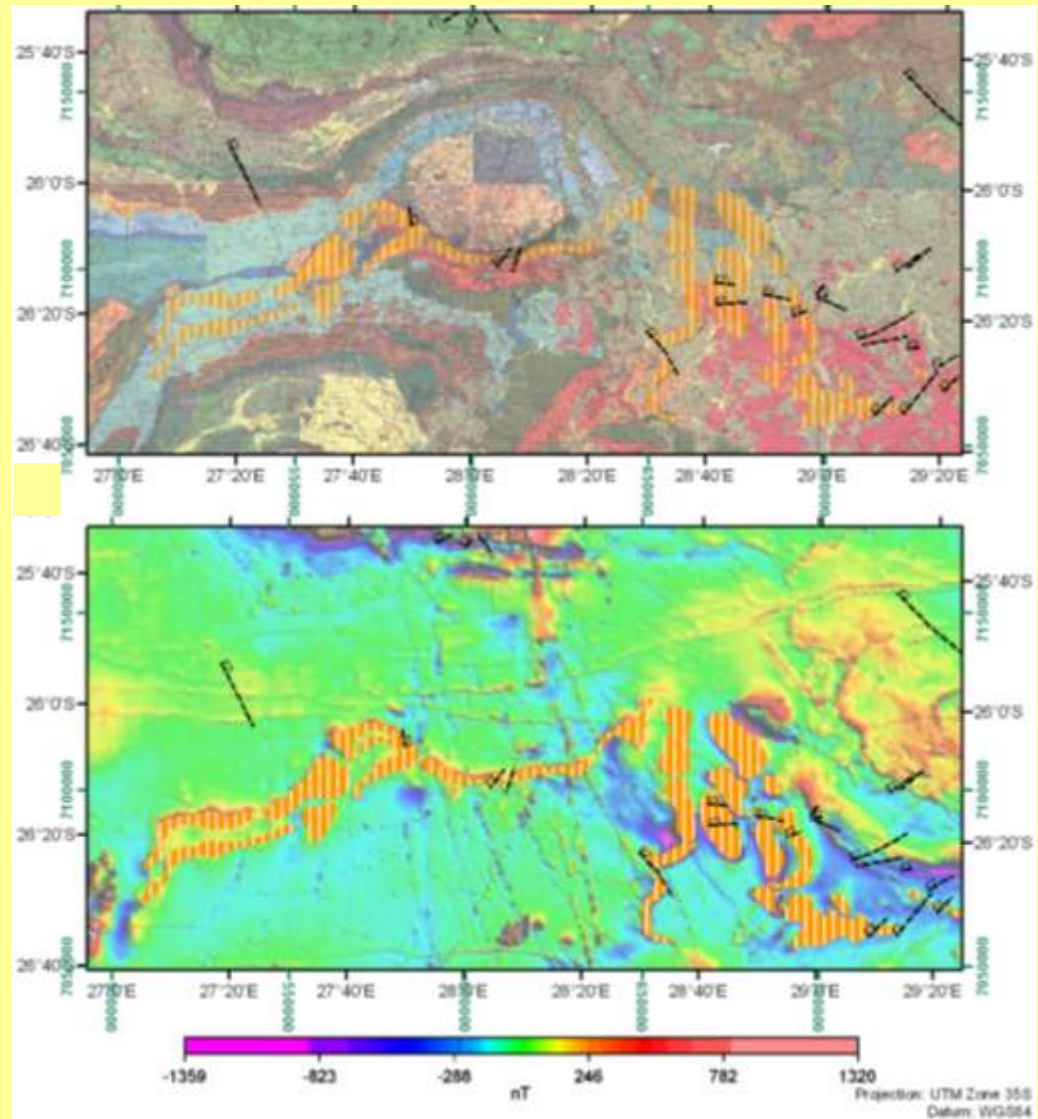
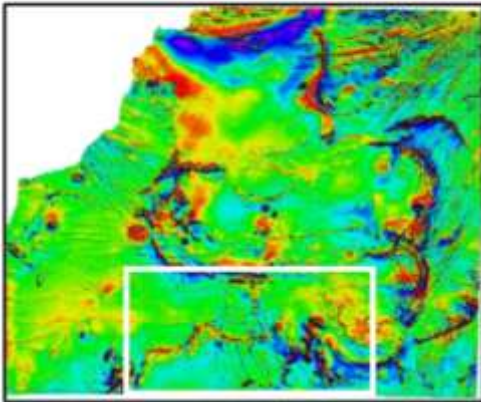
Courtesy  
Anglo  
Platinum



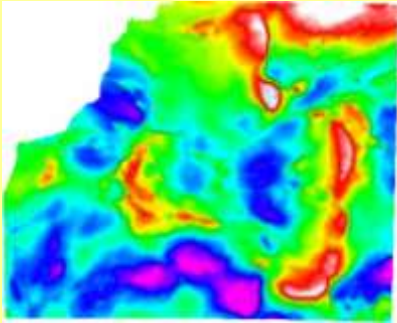
# FIRST INTERPRETATION RESULTS : NON-BUSHVELD ROCKS

Witwatersrand Supergroup  
Magnetic shales

Locality of the area wrt the whole BIC

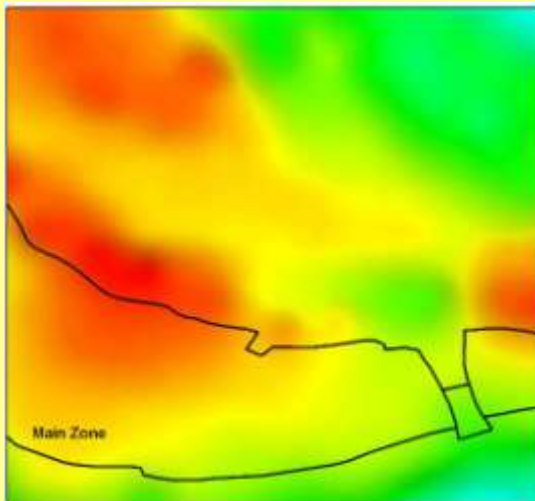


**FIRST INTERPRETATION RESULTS : BUSHVELD ROCKS**

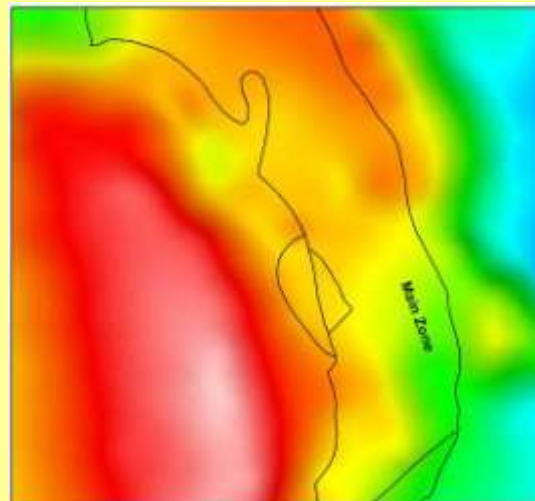


**Main Zone : Gravity**

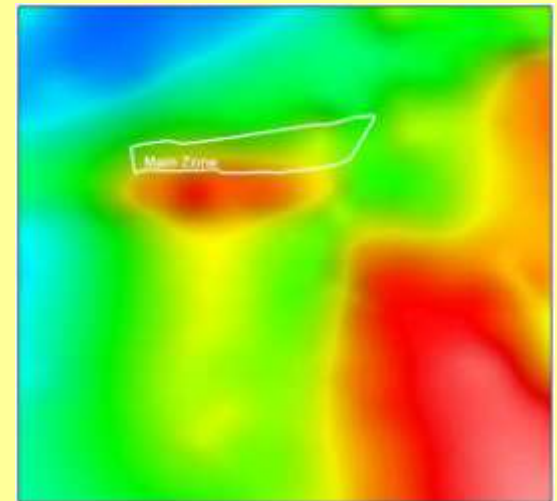
**Western Lobe**



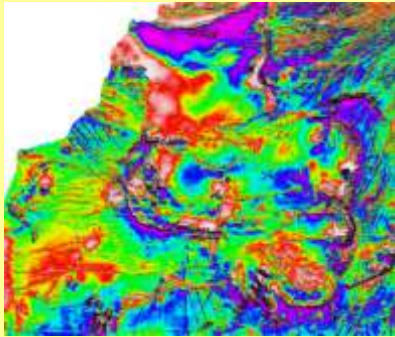
**Eastern Lobe**



**Eastern Lobe (Northeast)**

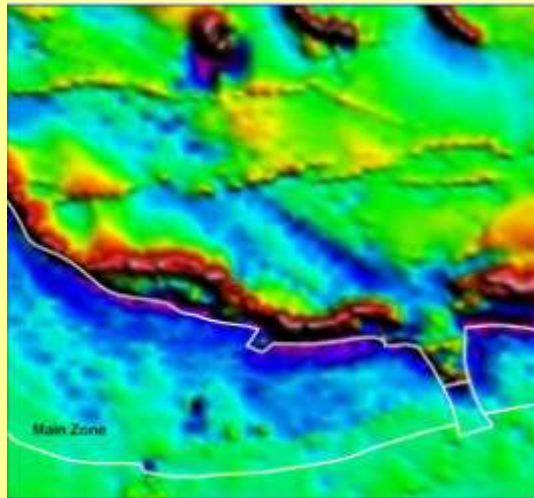


**FIRST INTERPRETATION RESULTS : BUSHVELD ROCKS**

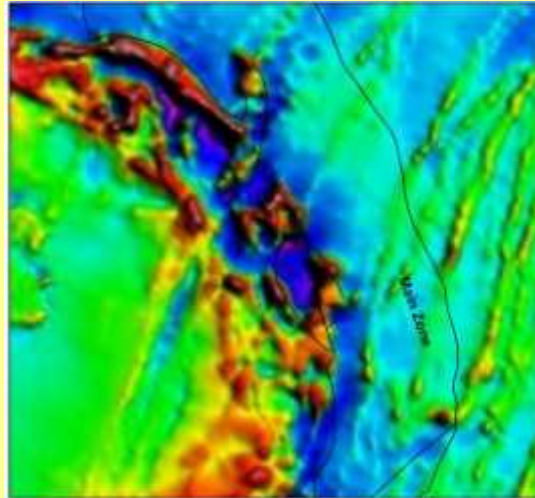


**Main Zone : Magnetics**

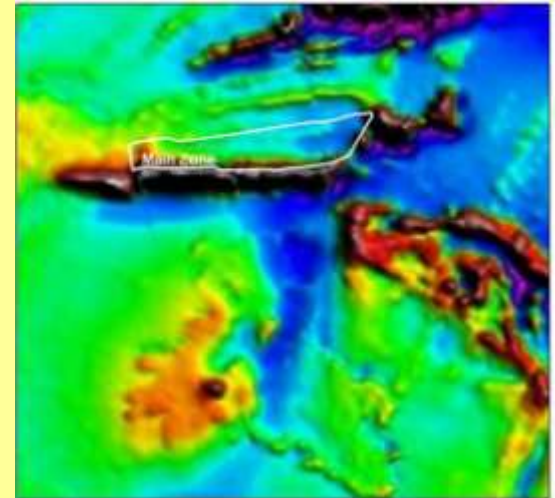
**Western Lobe**



**Eastern Lobe**



**Eastern Lobe (Northeast)**



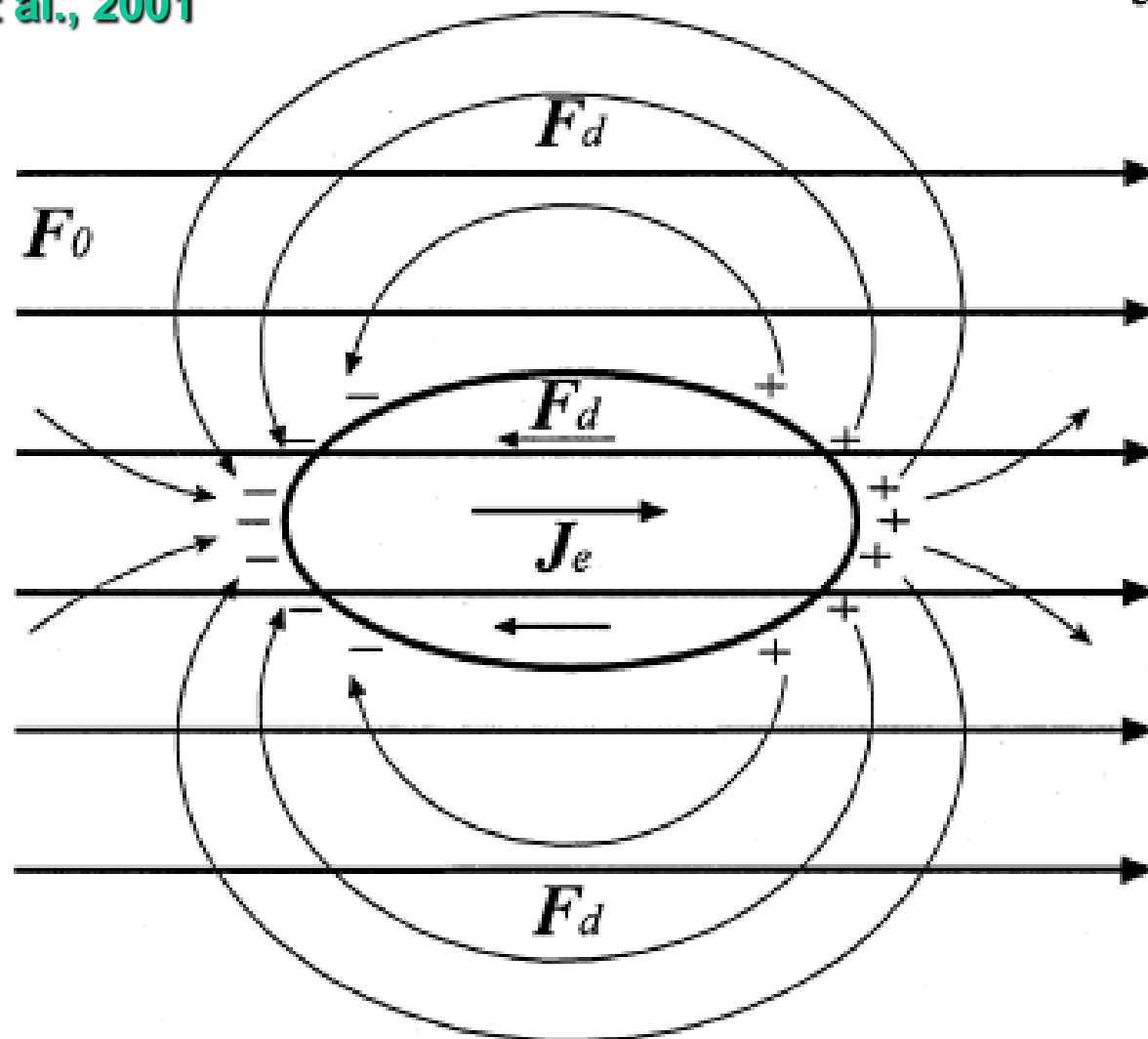


FIG. 1. (a) Demagnetization phenomenon of an ellipsoid magnetized along a principal axis:  $F_0$  is the inducing magnetic field,  $F_d$  is the demagnetization field, and  $J_e$  is the internal or the effective magnetization of the ellipsoid. (b) The modeling pa-

# Demagnetization Project

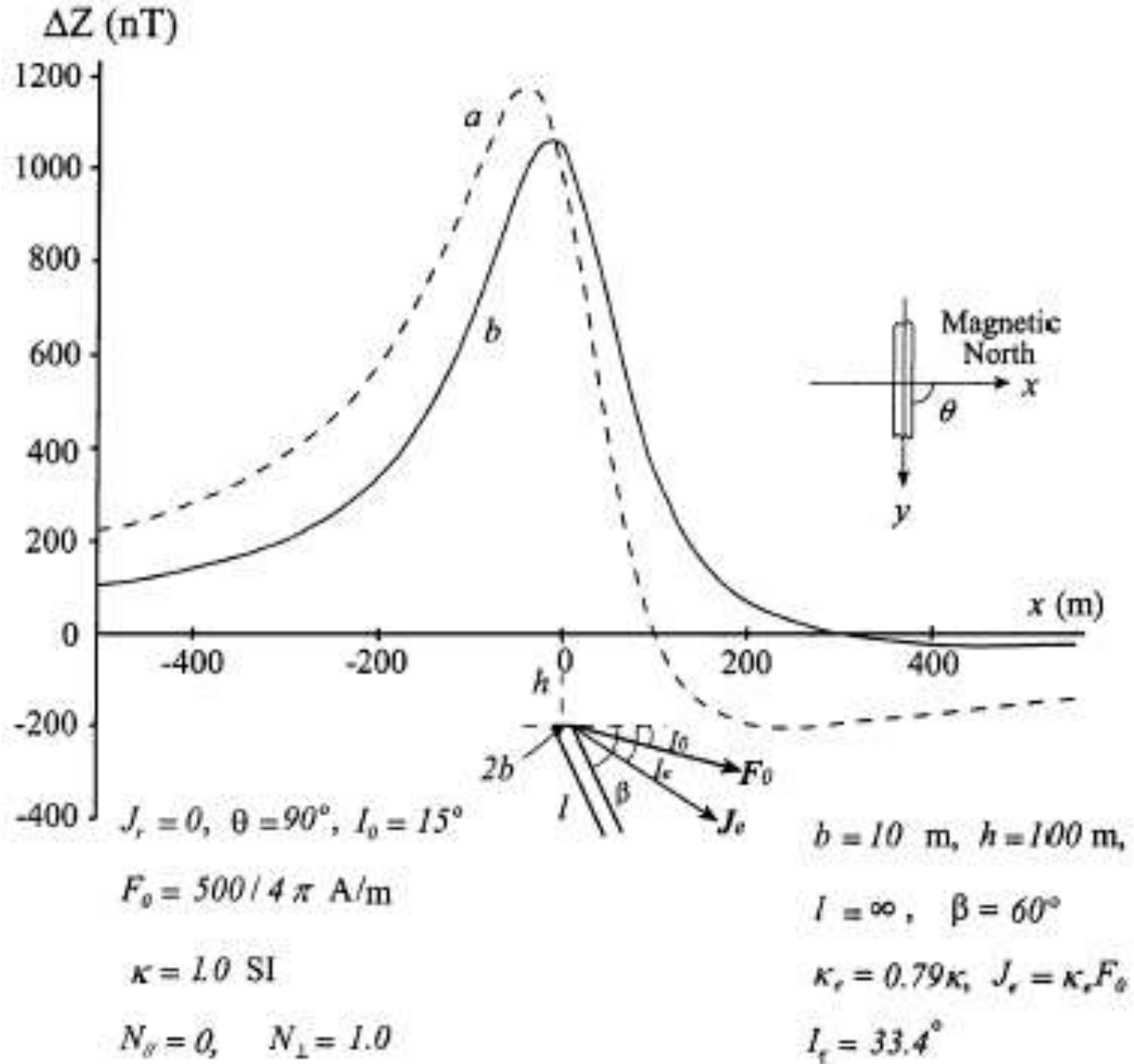
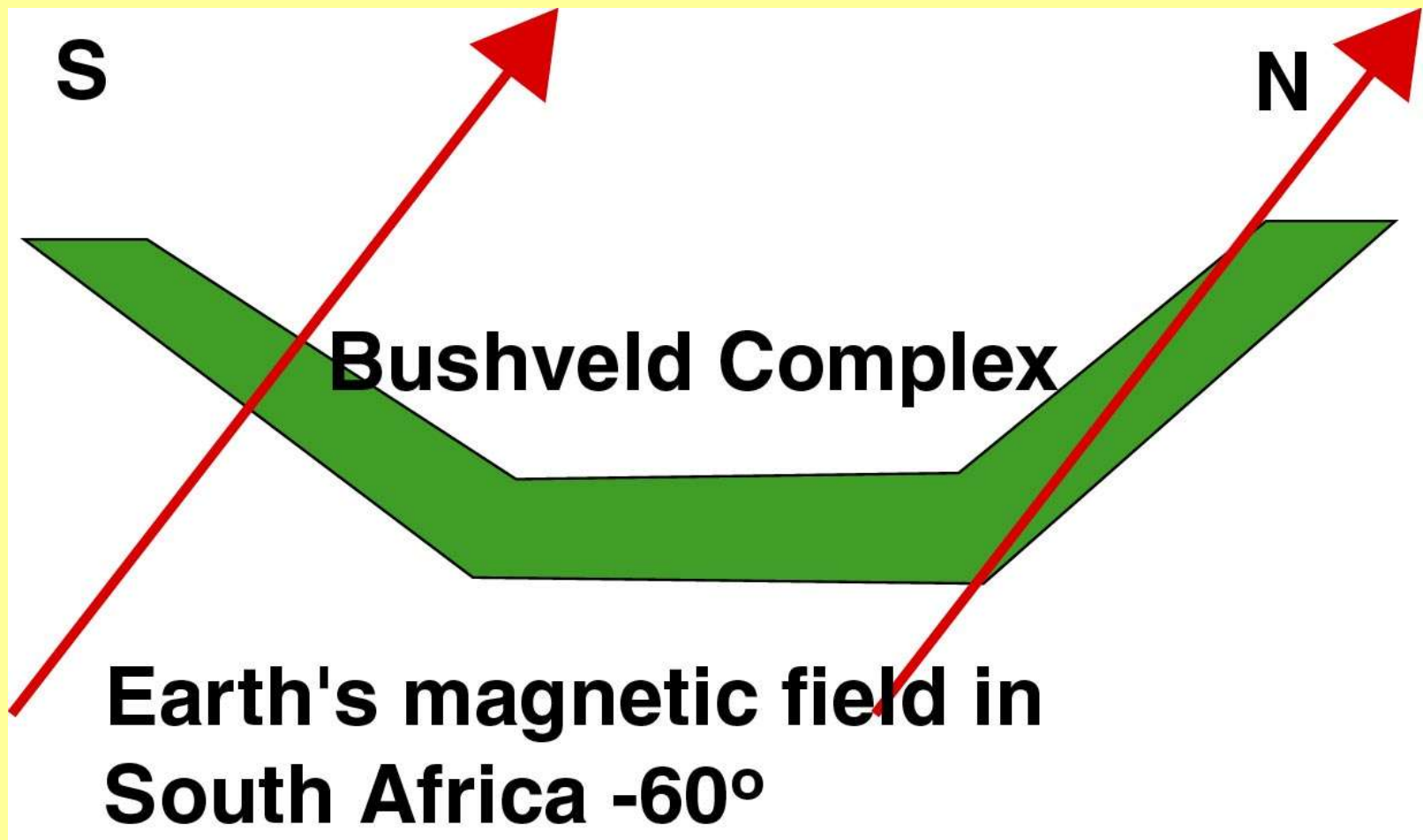


FIG. 7. Theoretical vertical magnetic anomalies of a 2-D sheet. Curve *a* is the anomaly without considering the demagnetization effect. Curve *b* is the anomaly after applying the demagnetization correction.

Guo et al.,  
2001

Demagnetization should be significant in the Upper Zone where there are layers of magnetite up to 6 meters thick ( $k \gg 0.1$  SI).

The effect will depend very strongly on the location within the Bushveld Complex and the relationship between the orientation of the Earth's magnetic field and the dipping layers. These results can then be applied to the Witwatersrand Basin, which contains thick layers of Banded Iron Formations.



Thanks to Council for  
Geoscience, Donkerhoek  
national core library, NRF  
special research grant for  
the Bushveld Complex  
Anglo Platinum, Anglo  
American  
(Gordon Chunnett,  
Andy Rompel), Mike  
Knoper, Bill Morris

