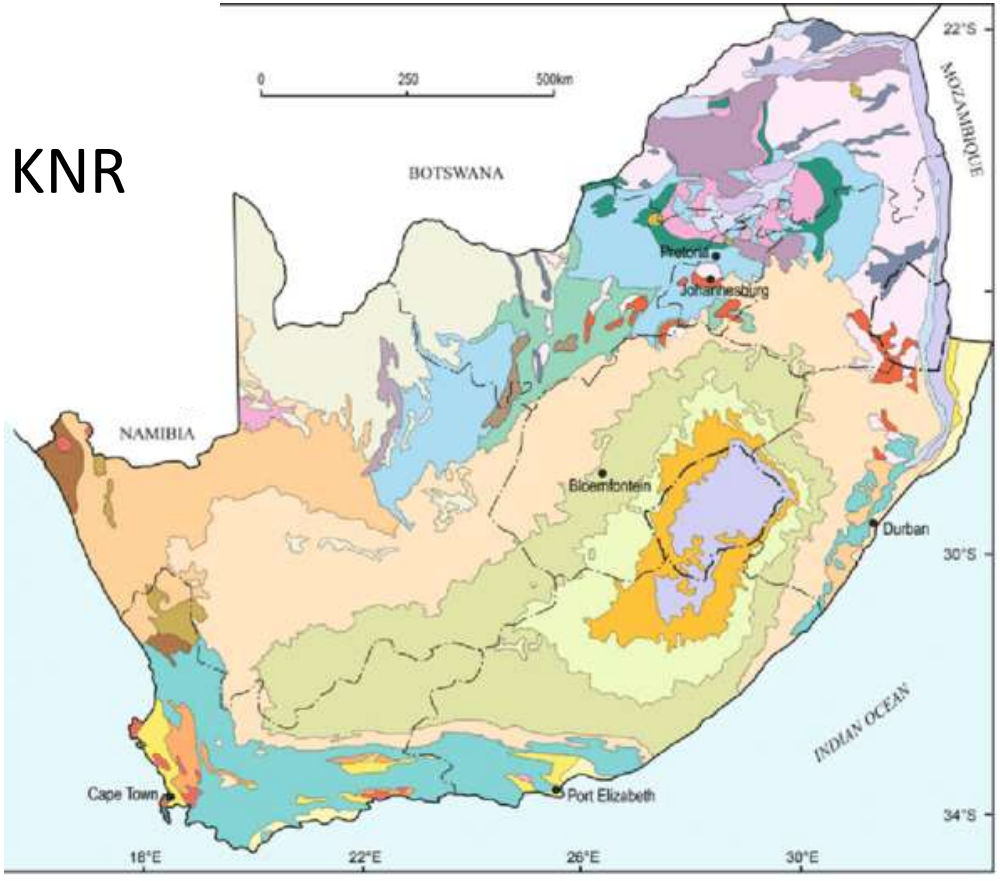
Geology of the Kloofendal Nature Reserve

Presentation for FroK guides

17th May 2022

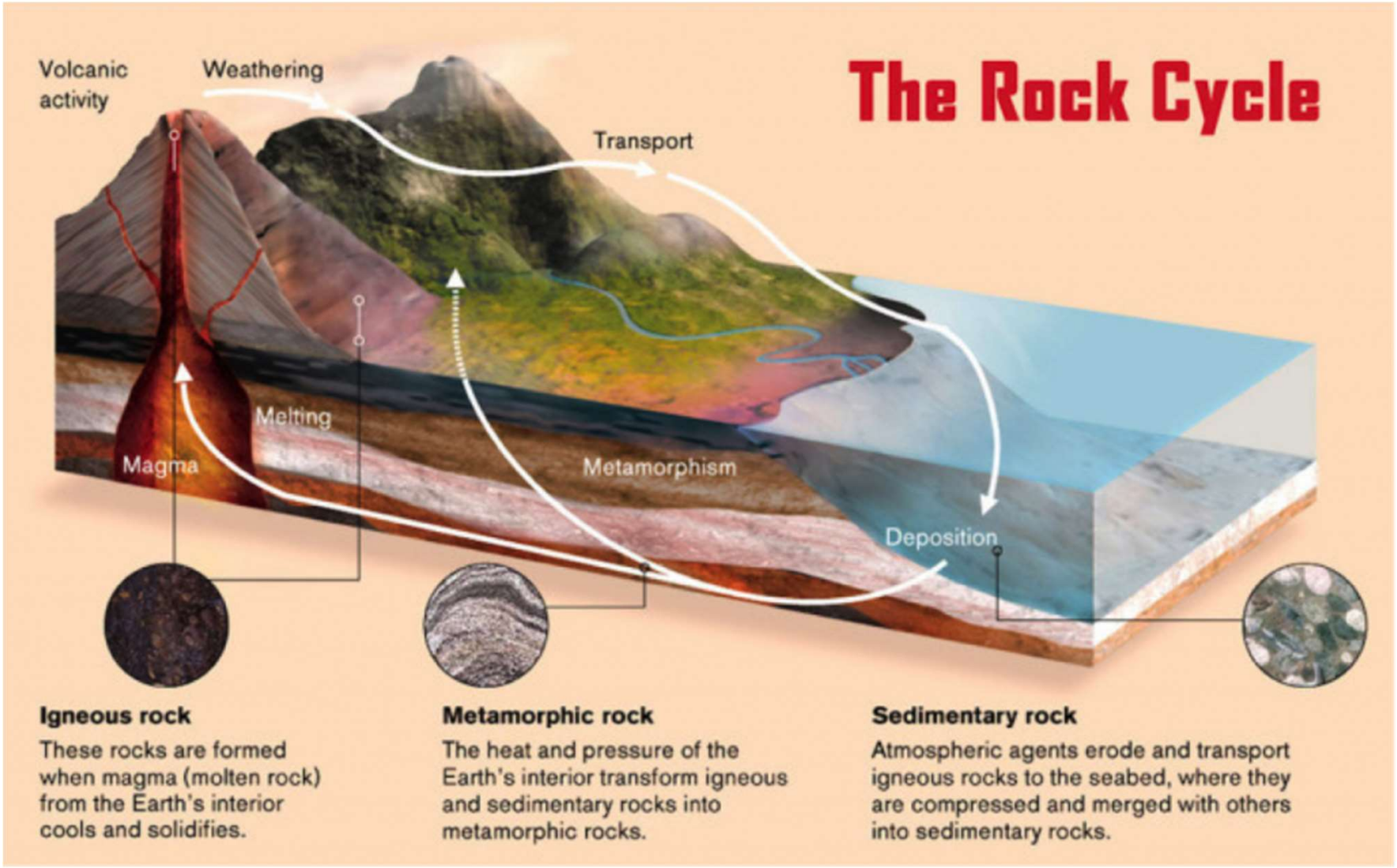
Steve Spottiswoode

- Simplified Geology of South Africa
- Gauteng geology
- Gold Reef deposits in the Witwatersrand
- Detailed geology around the KNR(Kloofendal Nature Reserve)
- Previous KNR resources
- Rock types in (and near) the KNR
- 13 types of Geological sites in the KNR
- Kloofendal Confidence “reef”



A quick reminder of rock types

Kloofendal is ~99% metamorphic with some recent sedimentary deposits in the valleys and <0.1% (?) igneous intrusion (dyke)



Origin of gold in the earth’s crust

Origin of gold

Gold production in the universe

Gold is thought to have been produced in supernova nucleosynthesis, and from the collision of neutron stars,[51] and to have been present in the dust from which the Solar System formed.[52]

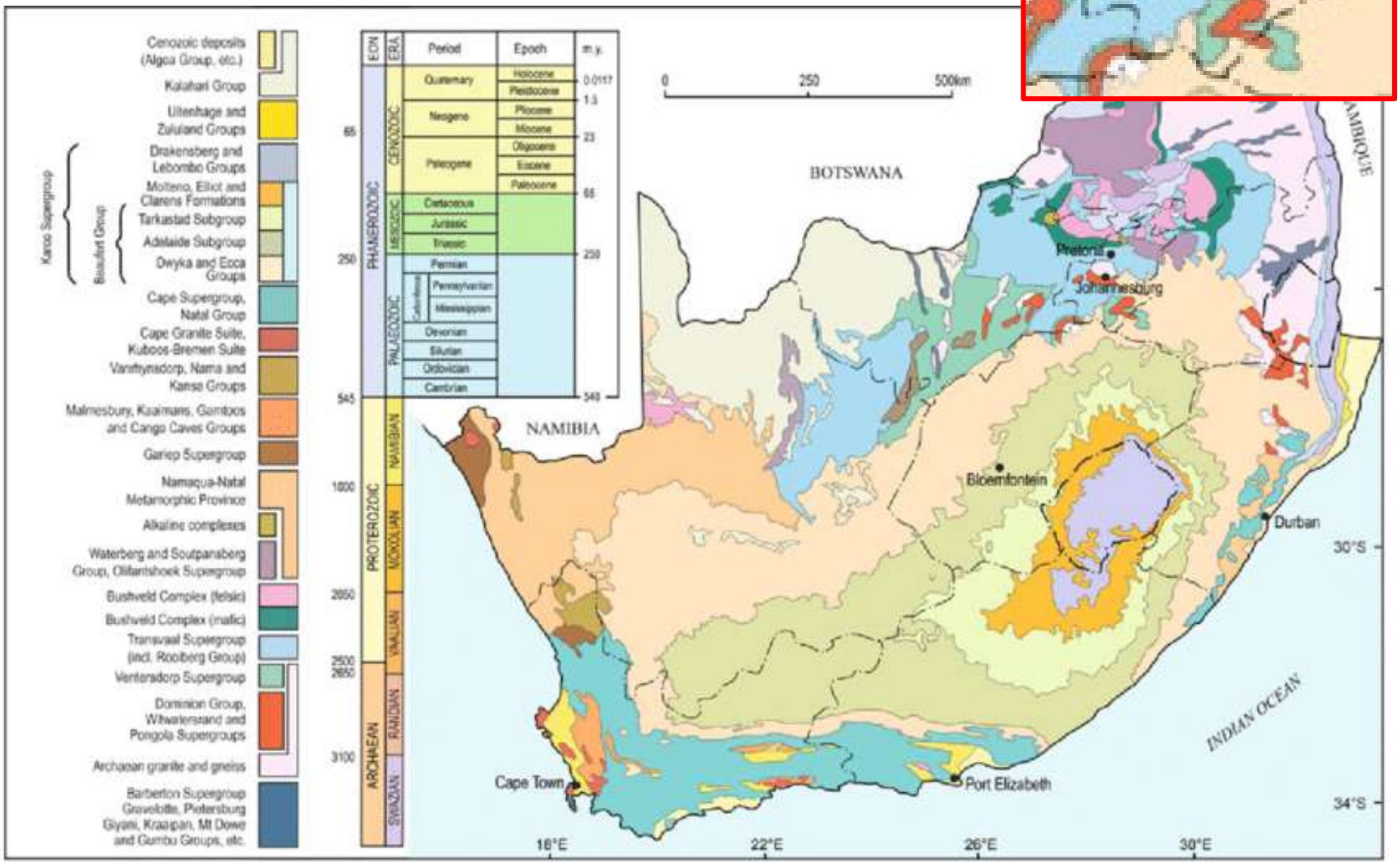
Asteroid origin theories

Because the Earth was molten when it was formed, almost all of the gold present in the early Earth probably sank into the planetary core. Therefore, most of the gold that is in the Earth's crust and mantle has in one model thought to have been delivered to Earth later, by asteroid impacts during the Late Heavy Bombardment, about 4 billion years ago.[58][59]

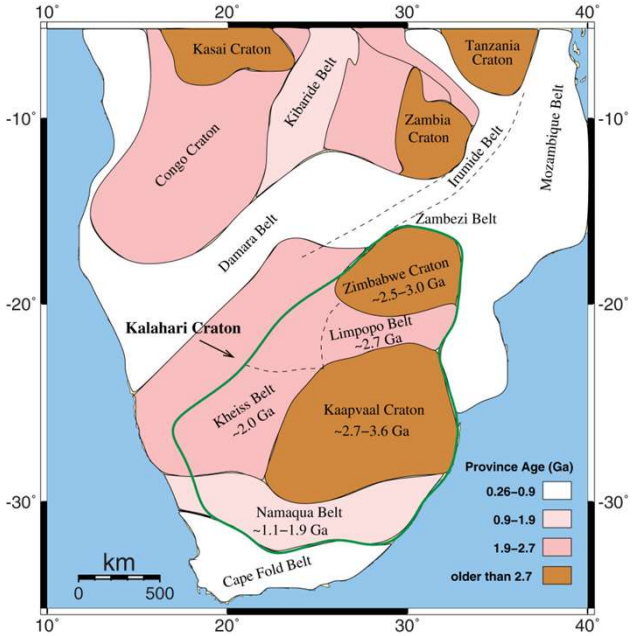
From: https://en.wikipedia.org/wiki/Gold

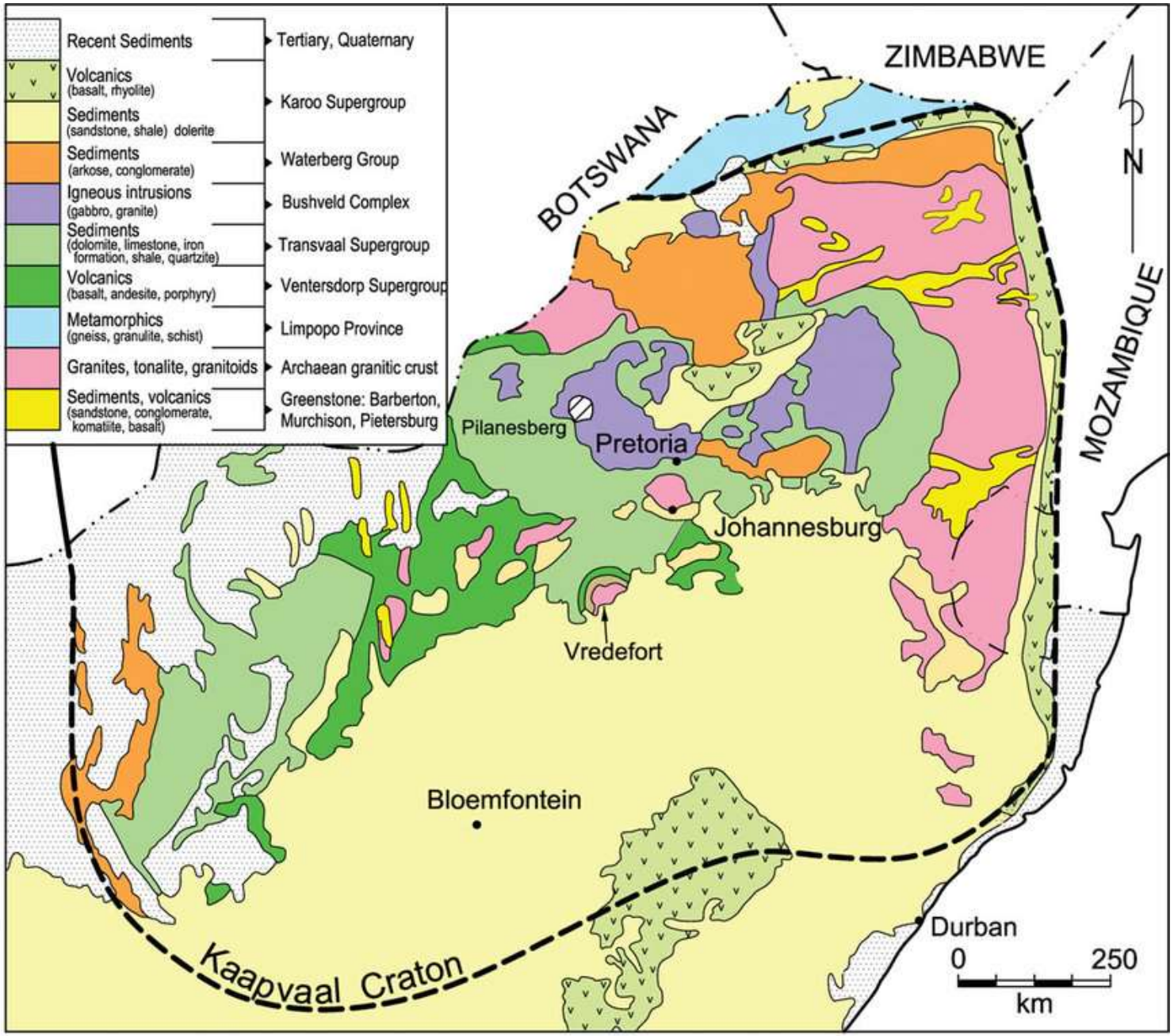
Simplified Geology of South Africa

➔ Kaapvaal Craton (ancient crust)



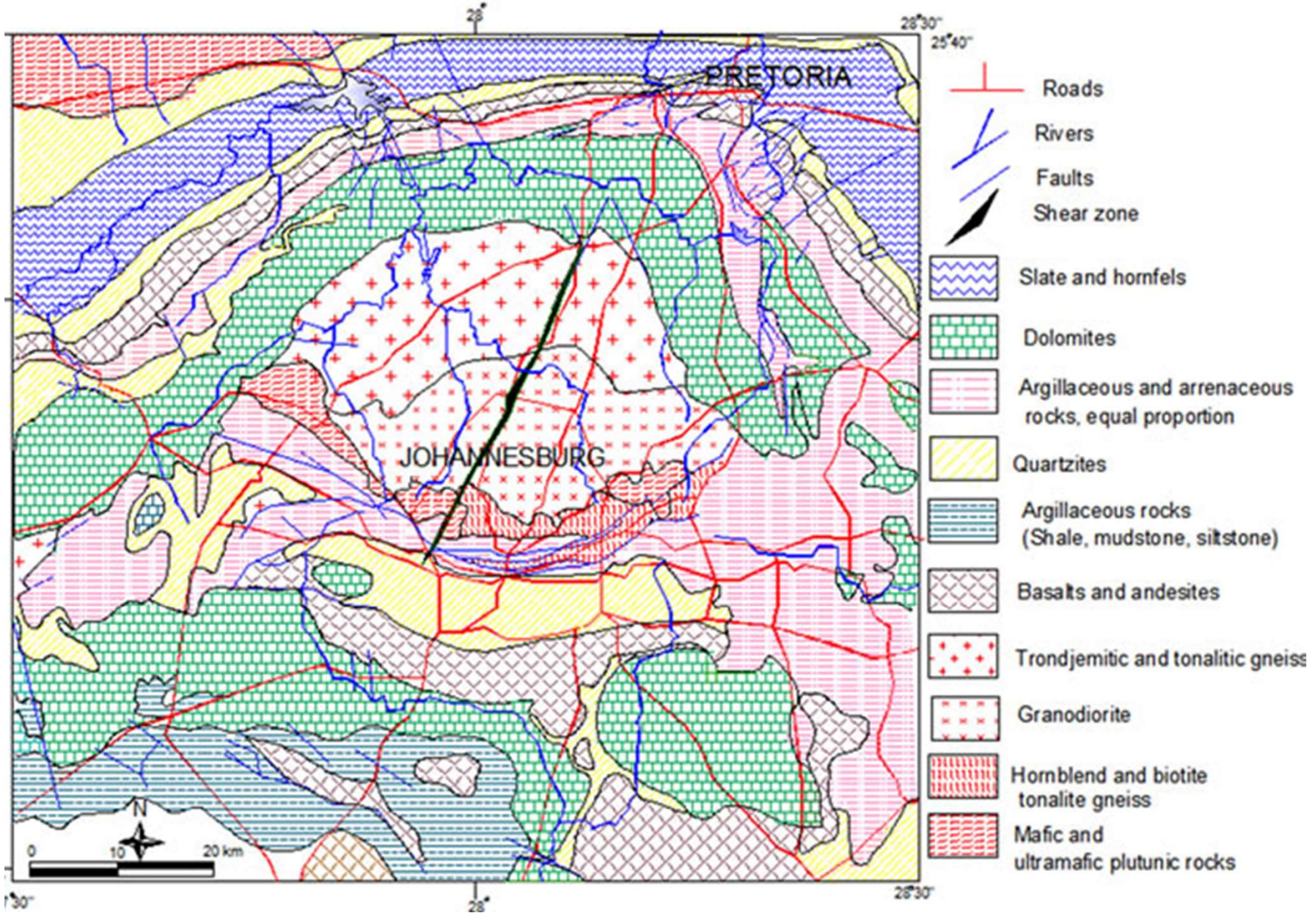
Kaapvaal Craton



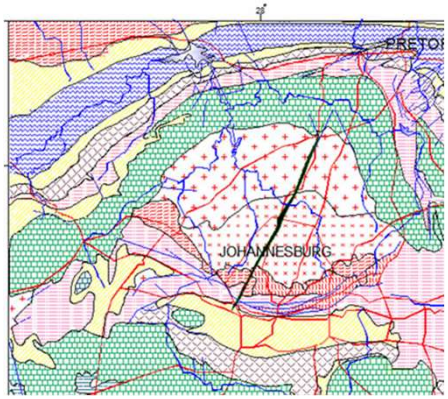


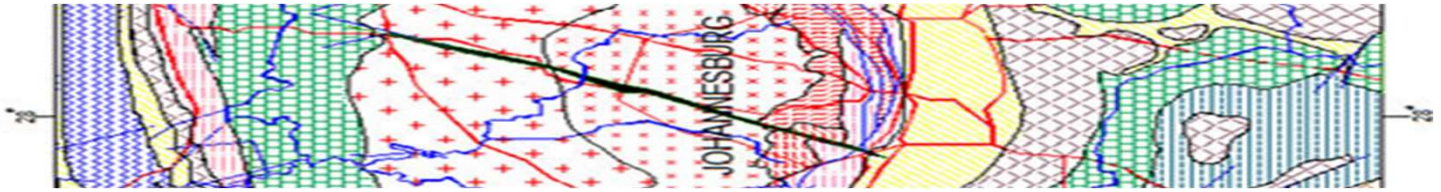
Gauteng geology

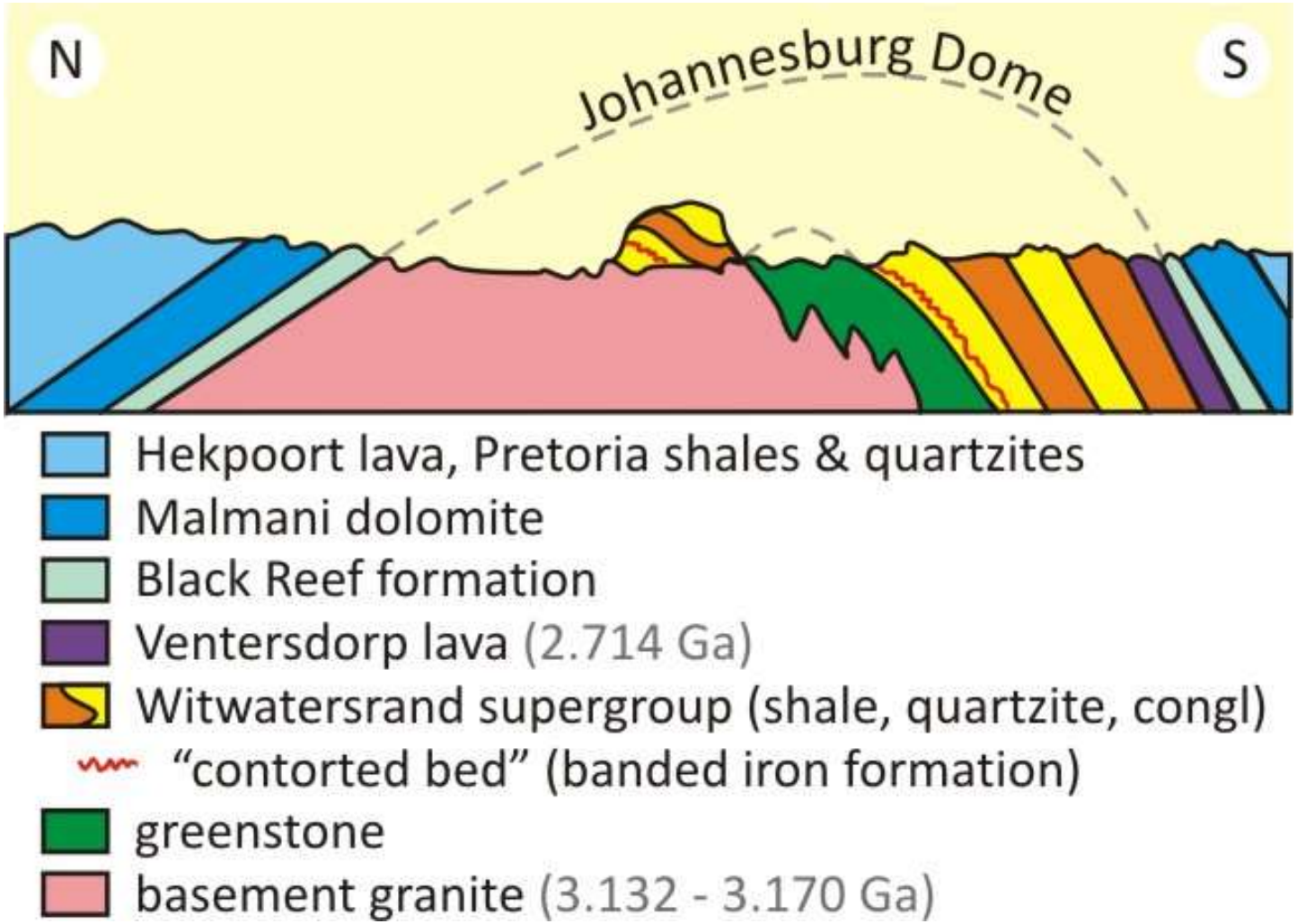
"Johannesburg Dome" in the middle



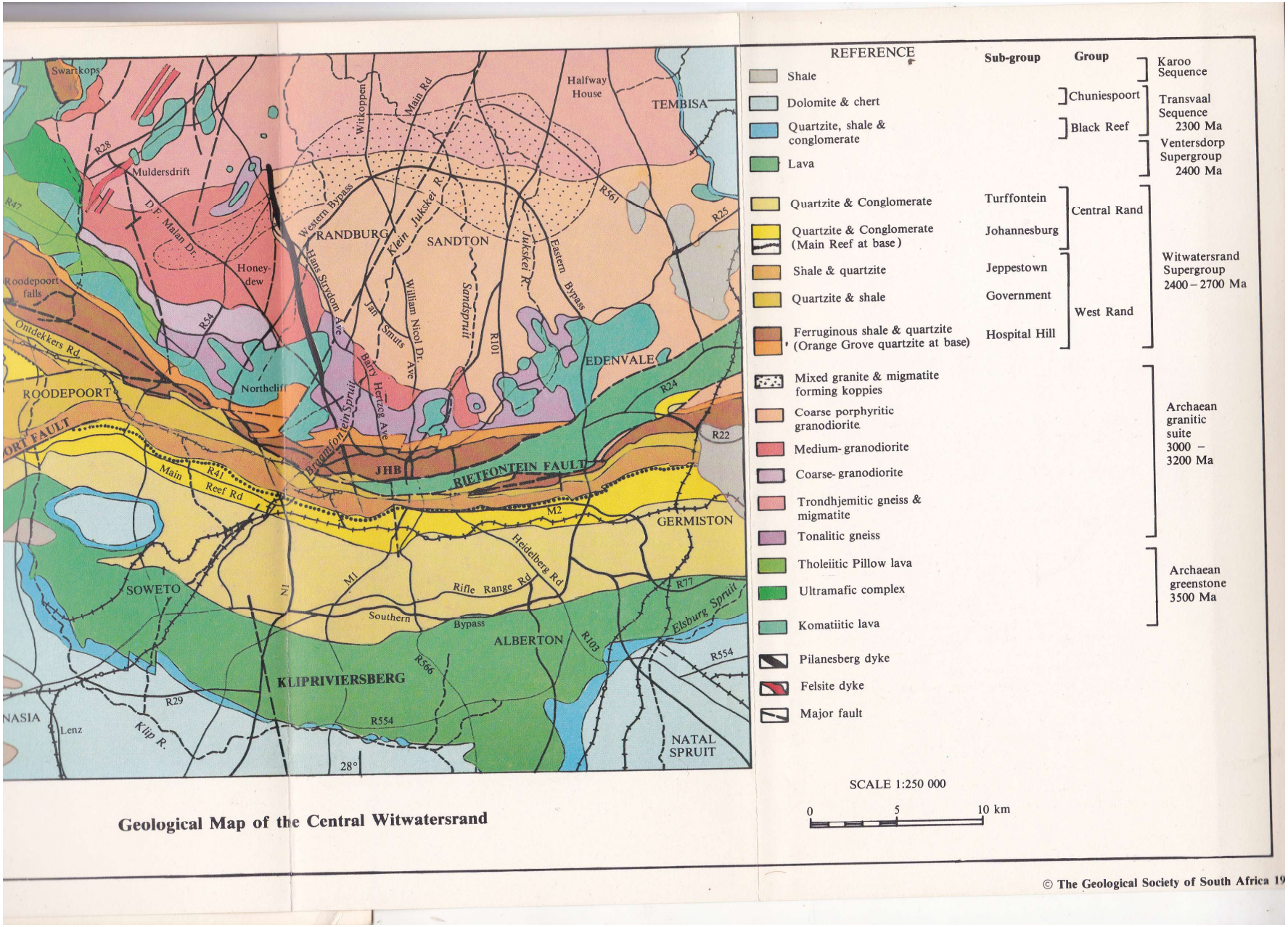
Section through the Johannesburg Dome



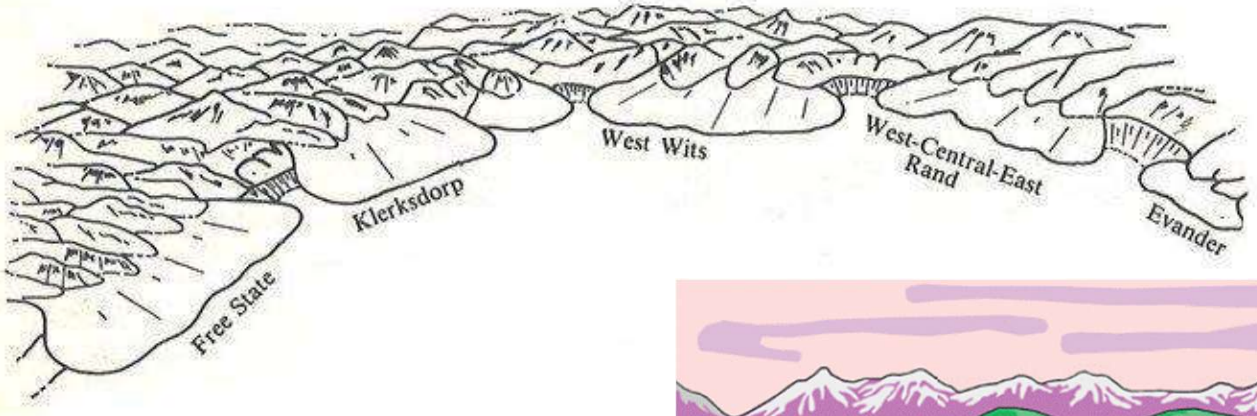


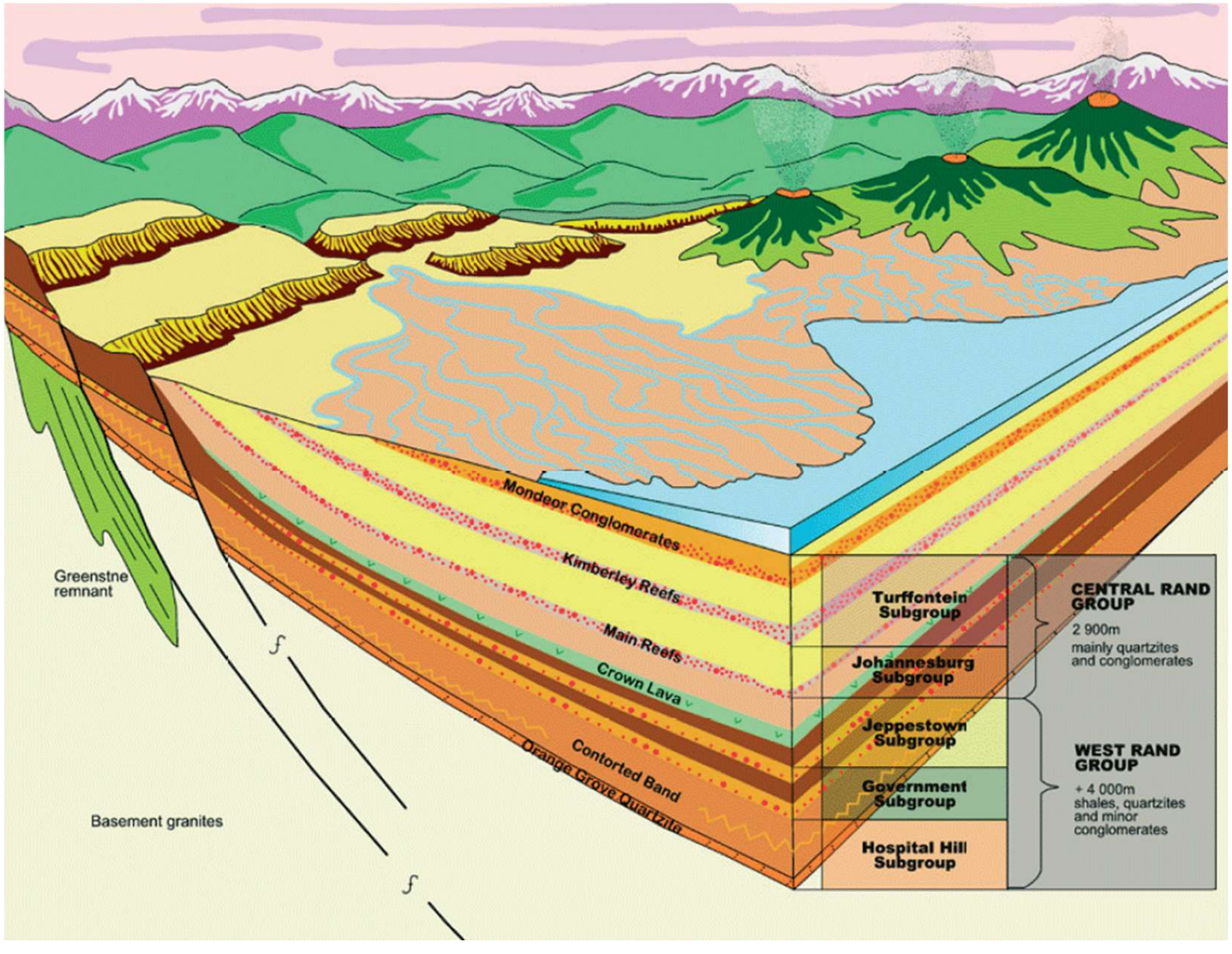


Map from Rod Kruger



Gold reef deposits in the Witwatersrand





Dates, from Tucker, Viljoen & Viljoen

Table 1. Summary of some important ages relating to the deposition, deformation and mineralisation in the Witwatersrand Basin and underlying and overlying formations.

Stratigraphic Unit	Age (Ga)	Author(s)
Vredefort Impact event	2.023	(Gibson & Reimold, 1999)
Bushveld Igneous Complex	2.054 - 2.059	(Walraven, et al., 1990)
Great Dyke (Zimbabwe)	2.575 - 2.586	(Oberthuer, et al., 2002)
Black Reef Formation (Approximate)	2.642 - 2.650	(Eriksson, et al., 2006)
Ventersdorp Platberg Group	2.709 - 2.643	(Robb & Meyer, 1995)
Ventersdorp Contact Reef (VCR)	2.714 - 2.780	(Robb & Meyer, 1995)
Central Rand Group (Upper Witwatersrand)	~2.714 - 2.894	(Robb & Meyer, 1995)
West Rand Group (Lower Witwatersrand)	~2.914 - 2.970	(Robb & Robb, 1998)
Dominion Reef Group	3.074 - 3.086	(Robb & Robb, 1998)
Detrital allogenic Au (in Vaal Reef)	3.016	(Kirk, et al., 2001)
Detrital uraninite grains (as for gold above)	3.065	(Kirk, et al., 2001)
Compact rounded pyrite	3.000	(Barton, et al., 1989)
Archaean Basement (Nelspruit batholith)	3.120 - 3.100	(Robb & Meyer, 1995); (Barton, et al., 1989)
Archaean Basement (Moodies Group)	3.230 - 3.220	
Archaean Basement (Onverwacht Group)	3.450	
Archaean Basement (TTG Gneisses)	3.640	

Gold deposits in the Witwatersrand Reefs
From Tucker, Viljoen & Viljoen

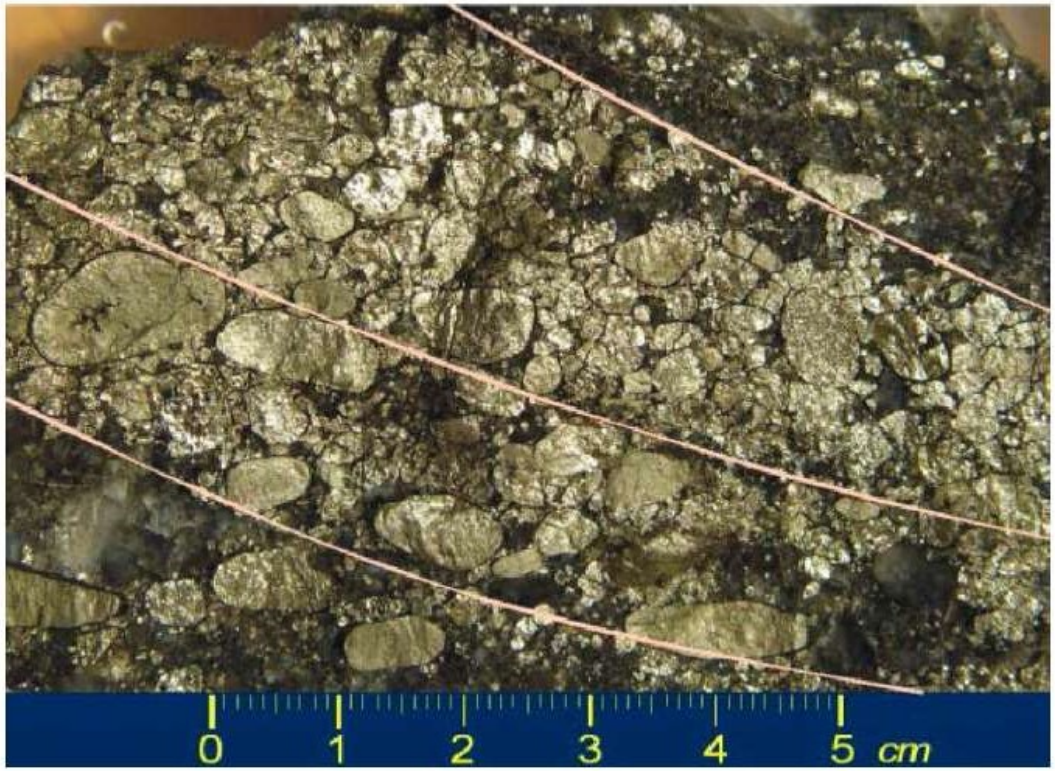


Figure 11: Coarse, dull rounded, porous pyrite ("buckshot") on foresets, interpreted as being syngenetic in origin. The gold grade is circa 200 g/t, E9G/d Reef (top of Kimberley Formation) on Cooke Section, Randfontein Estates Gold Mine (Tucker, 1980).

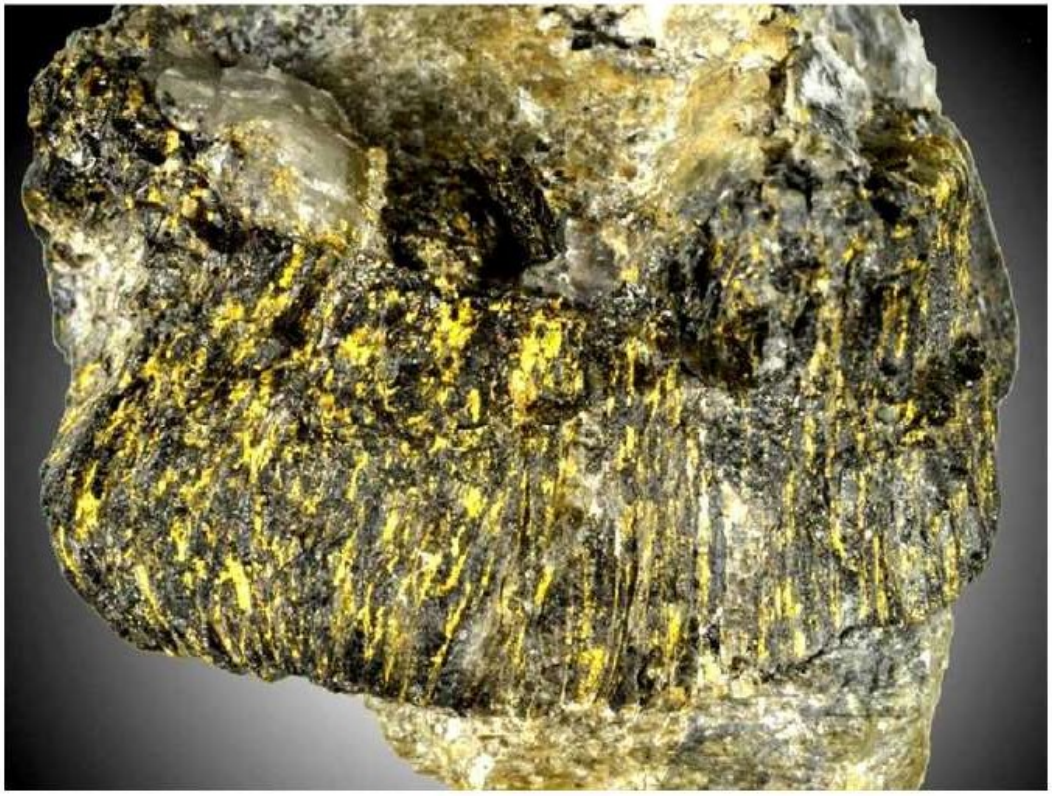
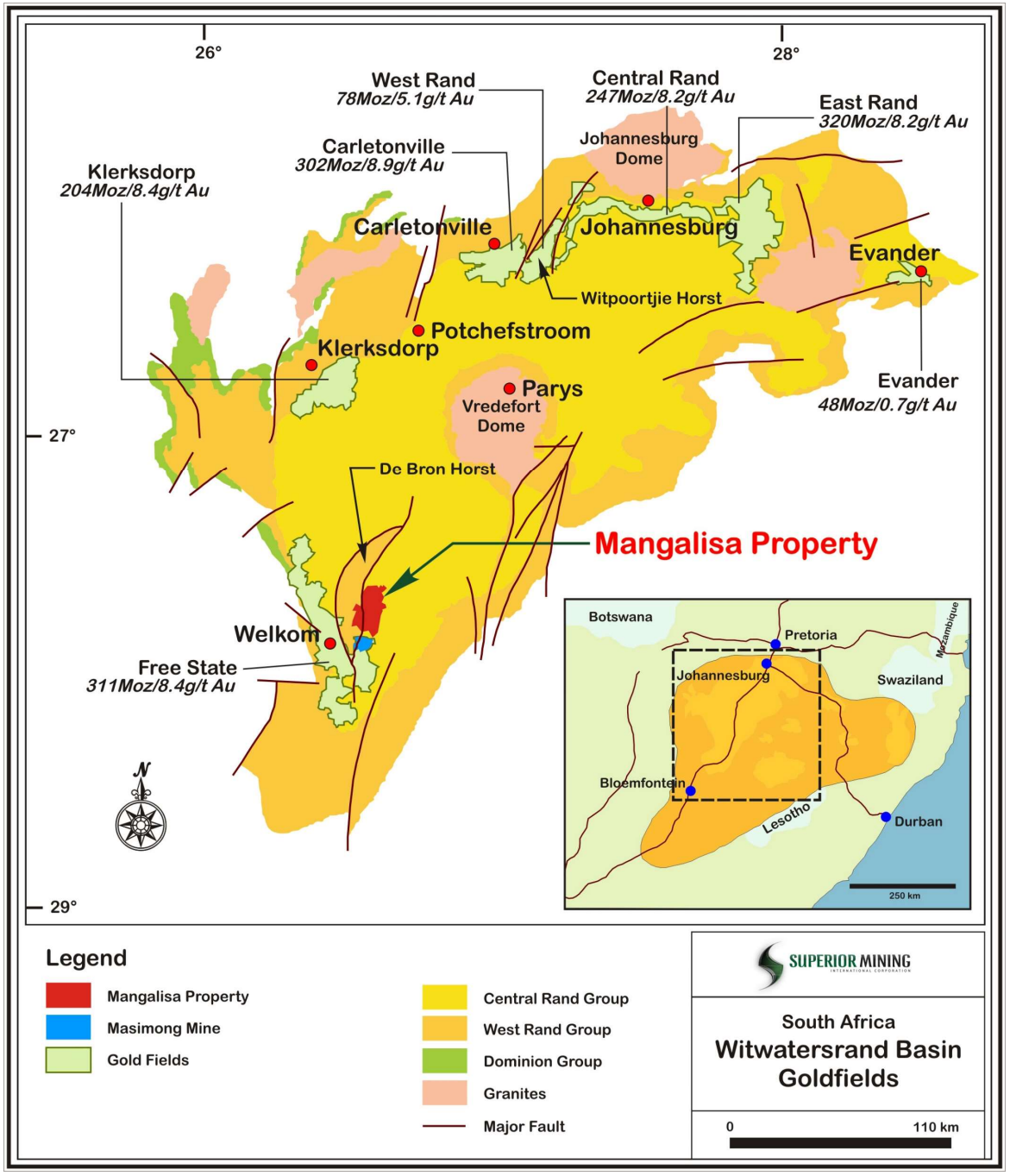


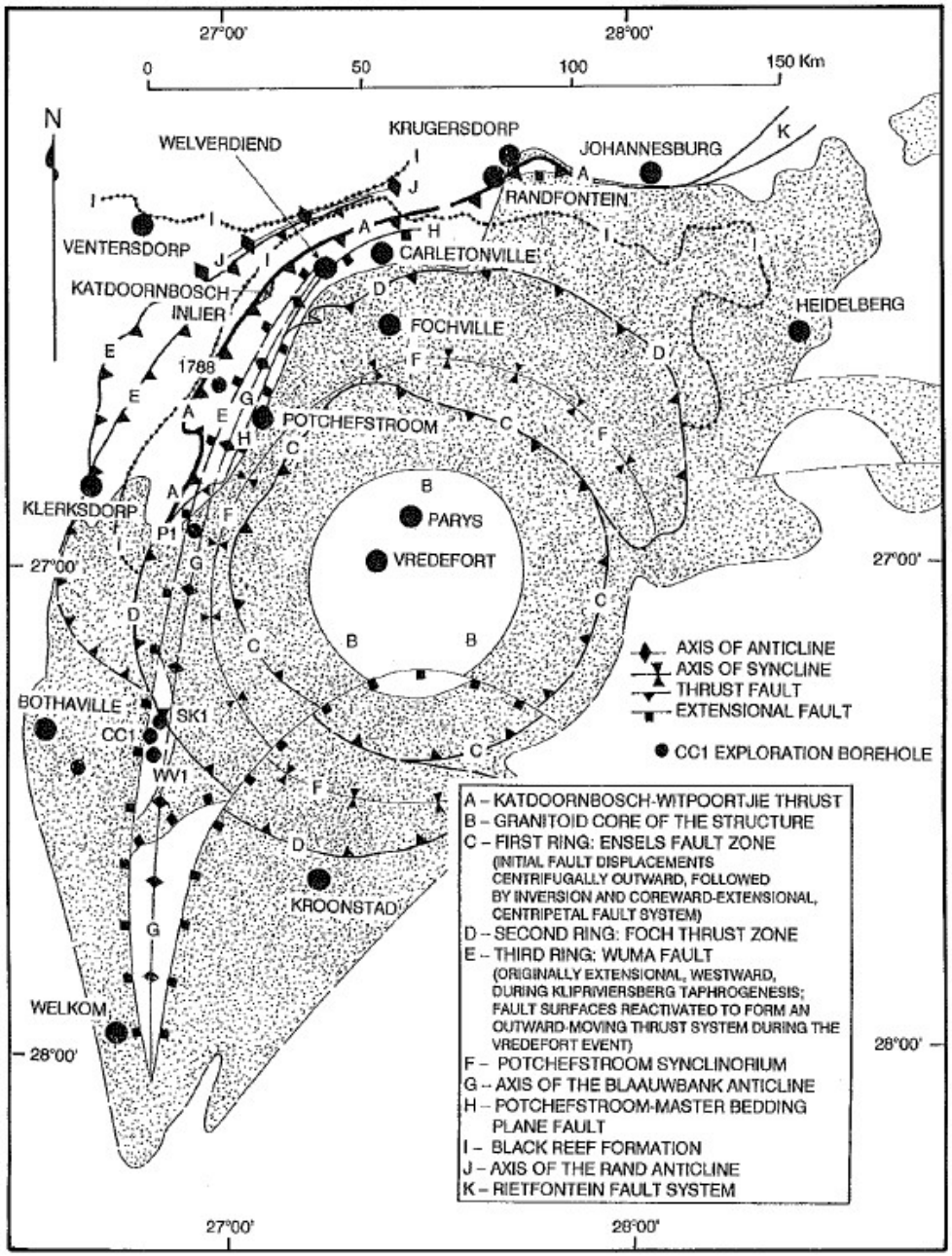
Figure 12: Carbon Seam on basal scour of Carbon Leader Reef with columnar carbon structure and abundant visible gold - West Wits Goldfield (Photograph by B. Cairncross).

Gold deposits in the Witwatersrand

Many such pictures have been produced by eager junior miners to attract investors.

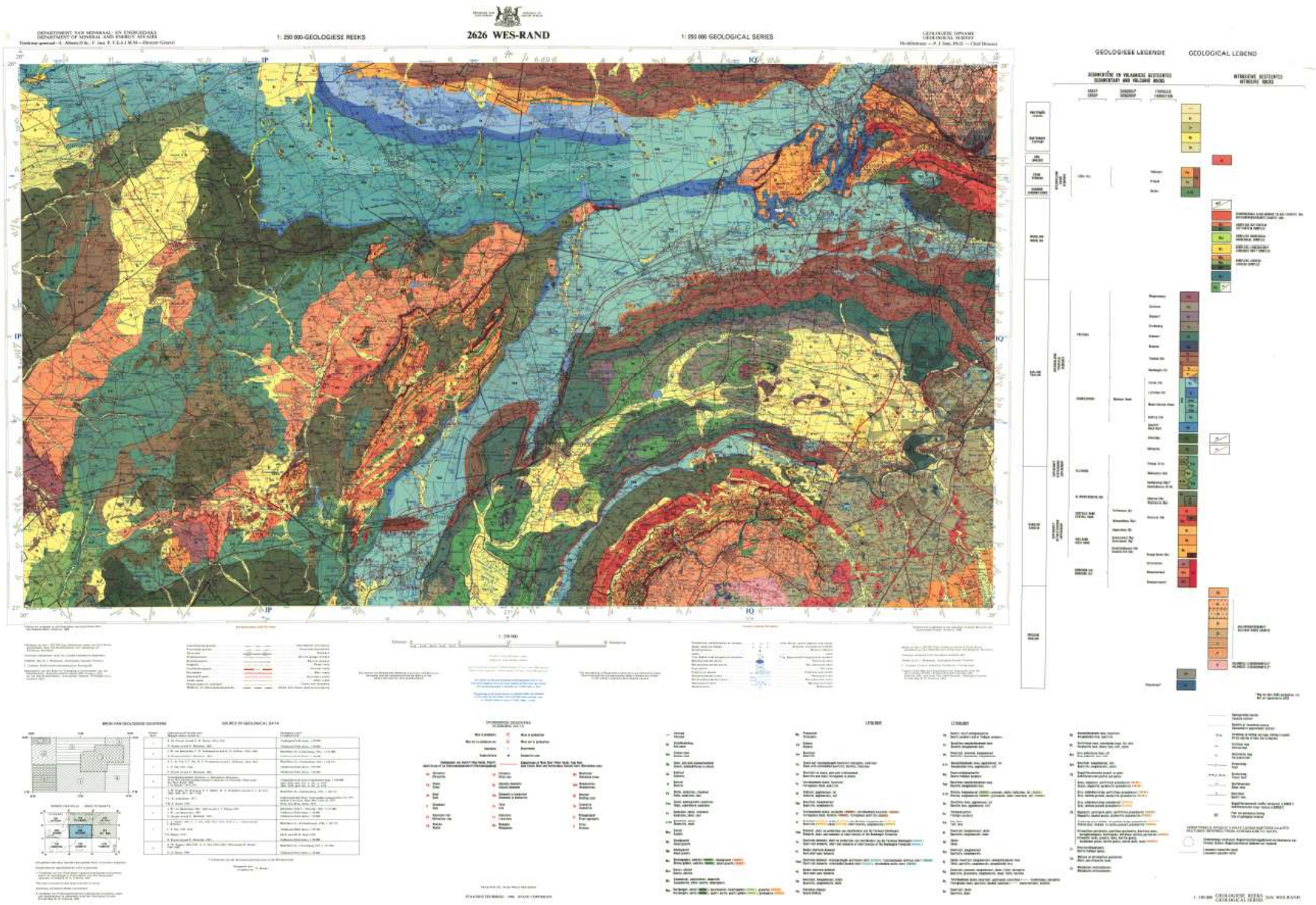


Large-scale faulting from the Vredefort impact

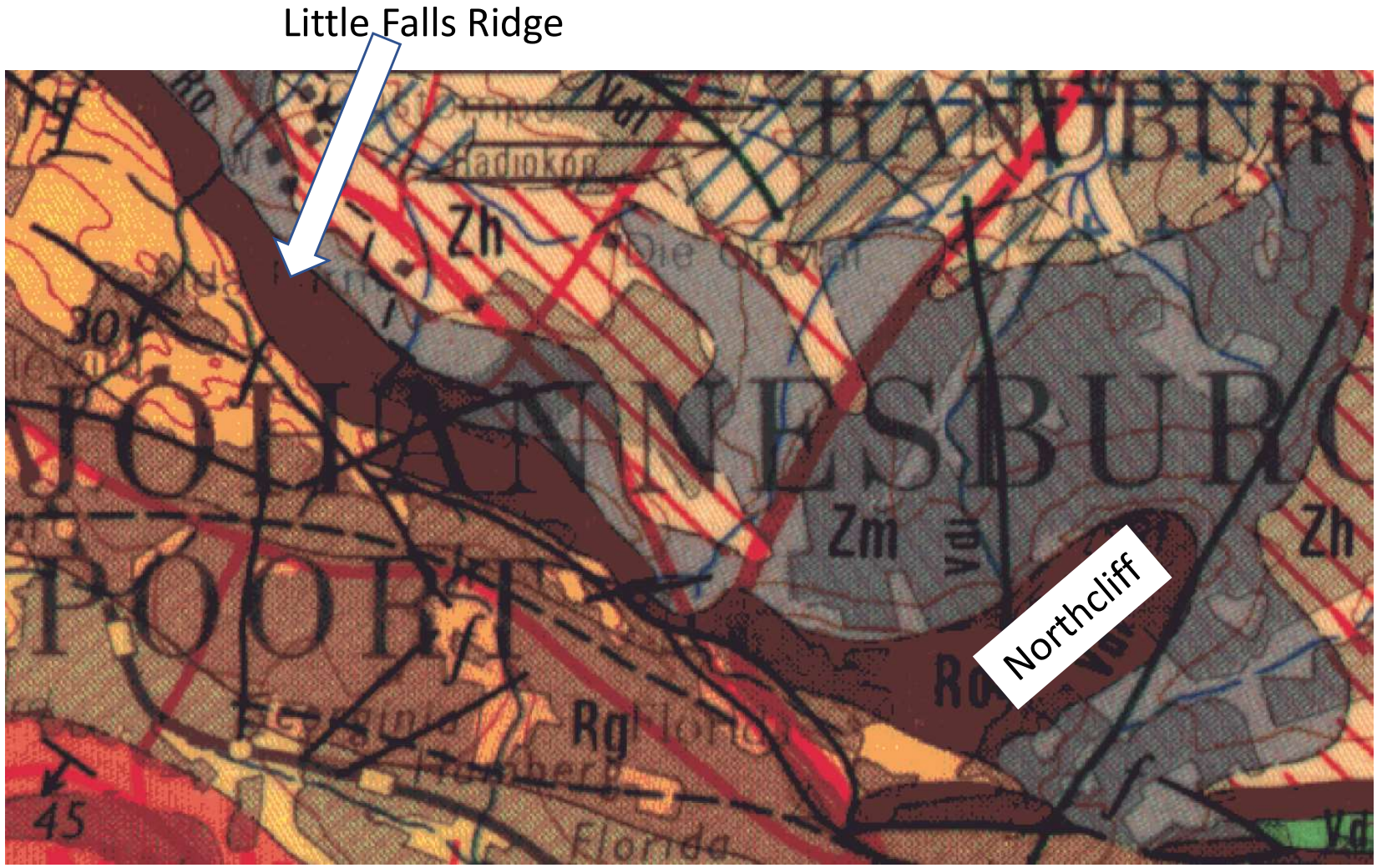


Brink et al, EGRU, 1999

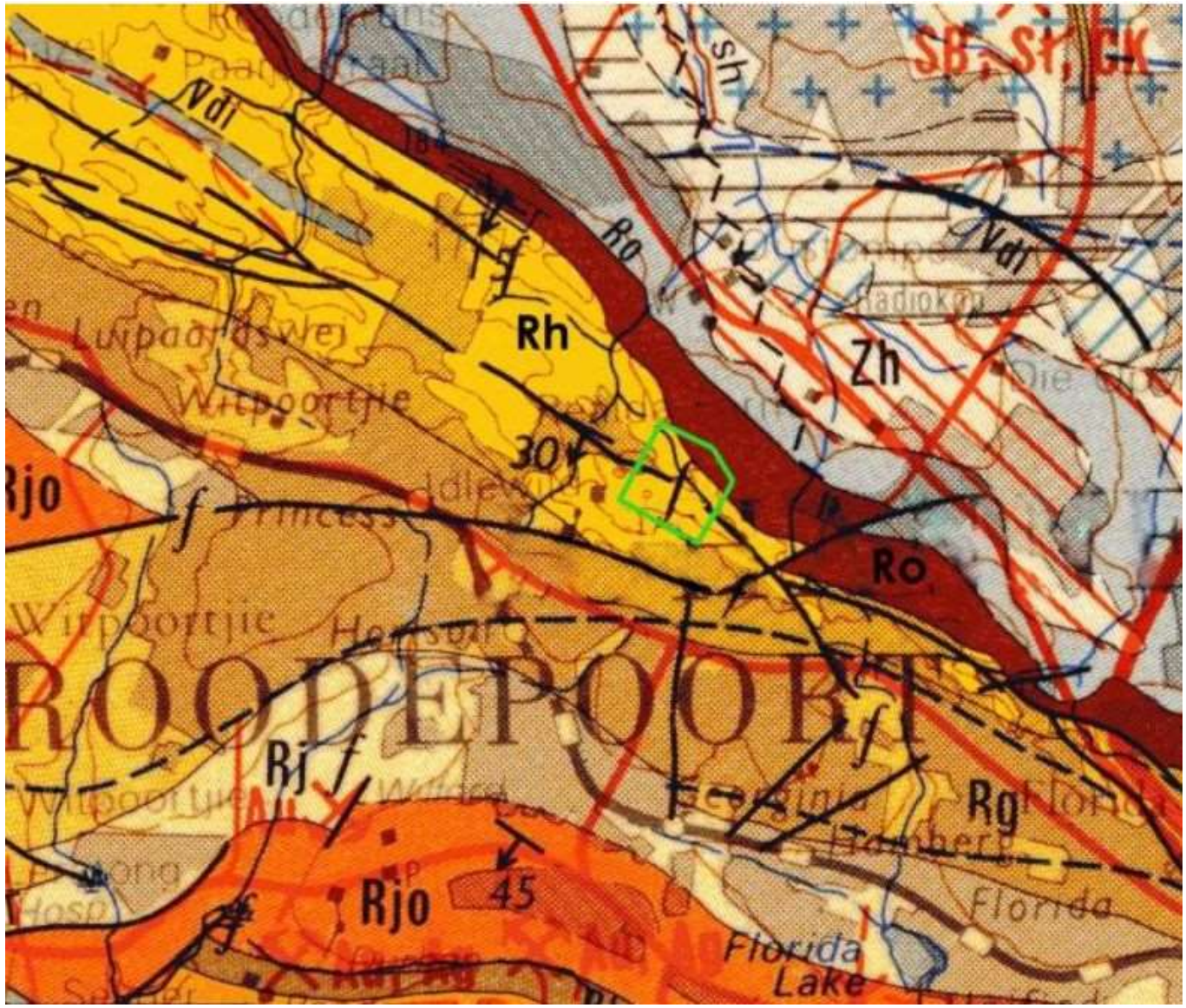
National 1:250 000 Map – West Rand

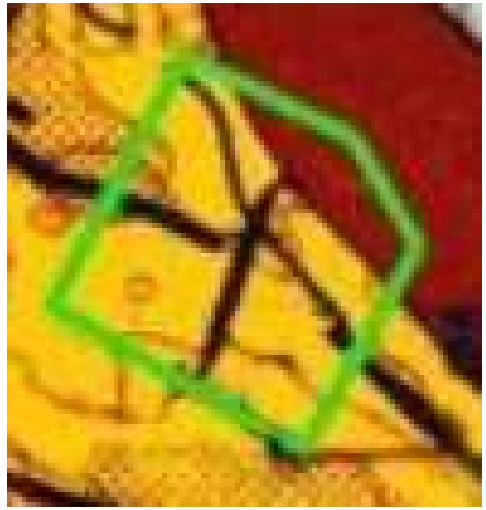


Portion of National 1:250 000 Map – West Rand



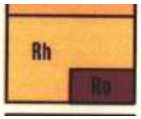
KND location, from R1 million JCPZ EIA report 2020





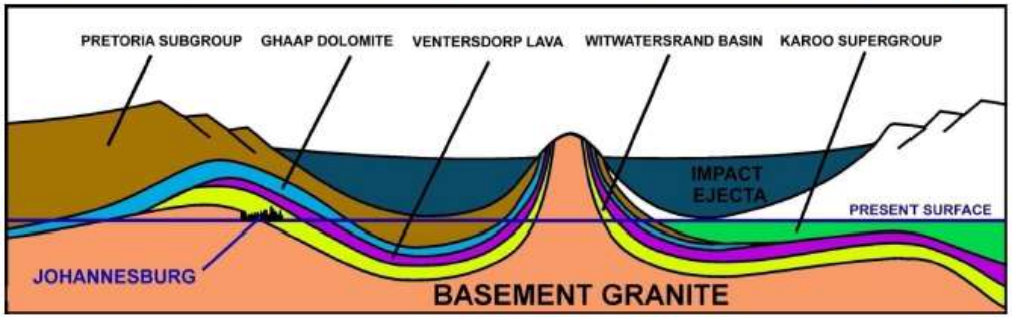
Hospitaalheuwel (Rh)
Hospital Hill (Rh)

Orange Grove (Ro)



Previous KNR resources

Schematic diagram showing warping of earth's crust by Vredefort meteorite impact



The Kloofendal Nature Reserve is embedded in a region with ancient and dramatic geological history, the KaapVaal Craton.

We are within 200 km of:

- The richest gold and platinum mines in the world;
- The world's largest and oldest meteorite impact at Vredefort;
- Evidence of the development of early life on earth in our shales and in the nearby dolomites; and
- Early man at the Cradle of Humankind

Age (in million years)

3340	3120	3000 to 2940		2710?	±2500	±2000?	Recent
Greenstone	Granite	Quartzite	Altered shale Phyllite Schist?	Lava	Dolomite	Quartz vein	Ferricrete

A SUMMARY: THE GEOLOGY AND STRUCTURE OF THE CENTRAL PART OF THE KLOOFENDAL NATURE RESERVE INCLUDING THE STRUBEN MINEWORKS.

The above geological map of the central portion of the Kloofendal Nature Reserve reveals a fascinating interplay of the Earth's forces and processes at work. These processes resulted in forming the richest field of gold mineralisation ever discovered. The key discovery happened here in Kloofendal in 1884, when Fred and Harry Struben found a rich pocket of gold in a tensional shear vein within a quartzite fragment in the Rietfontein Fault zone cutting through the Lower Witwatersrand beds.

The "Mine Area" is in the centre of the map a few metres west of the Dam. It lies in the central portion of sigmoidal lenses of Brixton quartzite beds (coloured in yellow) surrounded by the sheared reddish zones of fault rock comprising the Rietfontein Fault Zone (RFZ) which, like toothpaste, envelop the broken up fragments of quartzite and slate. The mine excavation consists of a cutting and shafts into the minor gold bearing wall rock of a sheared, weathered, vertical basic igneous intrusion lying within a tensional gash vein.

The gold has two probable sources;

- From remobilised sedimentary mineralization in the arenites and magnetic slates of the Witwatersrand beds and the Proterozoic basement greenstones.
- Thermal fluids penetrating upwards in a major fault system.

Both these mobile fluids seek tensional areas where pressure and temperature drop resulting in deposition of mineralization.

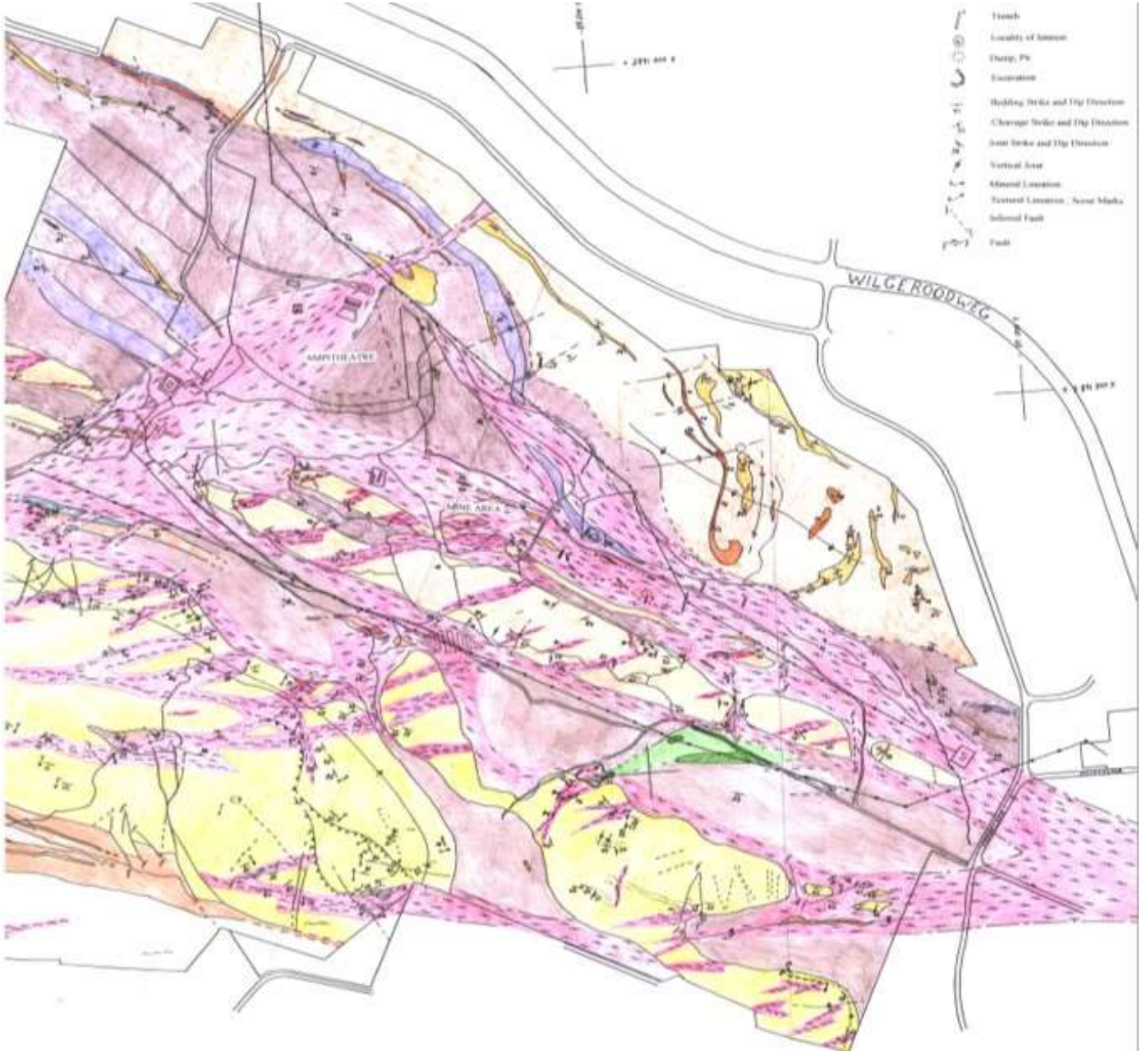
North of the RFZ,(which follows the stream valley and Dam), lies a hillside slope with numerous folded and contorted shards and lenses of Lower Witwatersrand units of quartzite and slate representing the magnetic Contorted bed, the Ripple Marked Quartzite and other silty and slaty units. A north-westerly splay can also be seen breaking out of the RFZ just west of the dam....all features that are characteristic of Left Lateral Wrench Faulting.

South of the Rietfontein Fault Zones lie the hills and cliffs of the Promise Formation of the Hospital Hill Quartzites, where cross-bedded quartzites and pebble layers are folded and crisscrossed by tensional veins. These fold and fracture structures are related to the junction of the Witpoortjie and Rietfontein fault systems occurring east of the Kloofendal Nature Reserve.

The filling of the Rietfontein Fault Zone is found to consist of a reddish iron-rich earthy clay containing numerous fragments of surrounding rocks from minute wisps and shards up to partially disrupted and rotated blocks of quartzite, slate, shale and igneous material. It can be traced for hundreds of kilometres in a west-north-westerly direction from the Rietfontein Mine in the East Rand to at least as far west as Swartruggens as a major Wrench Fault System coincident with the northern margin of the Witwatersrand Basin.

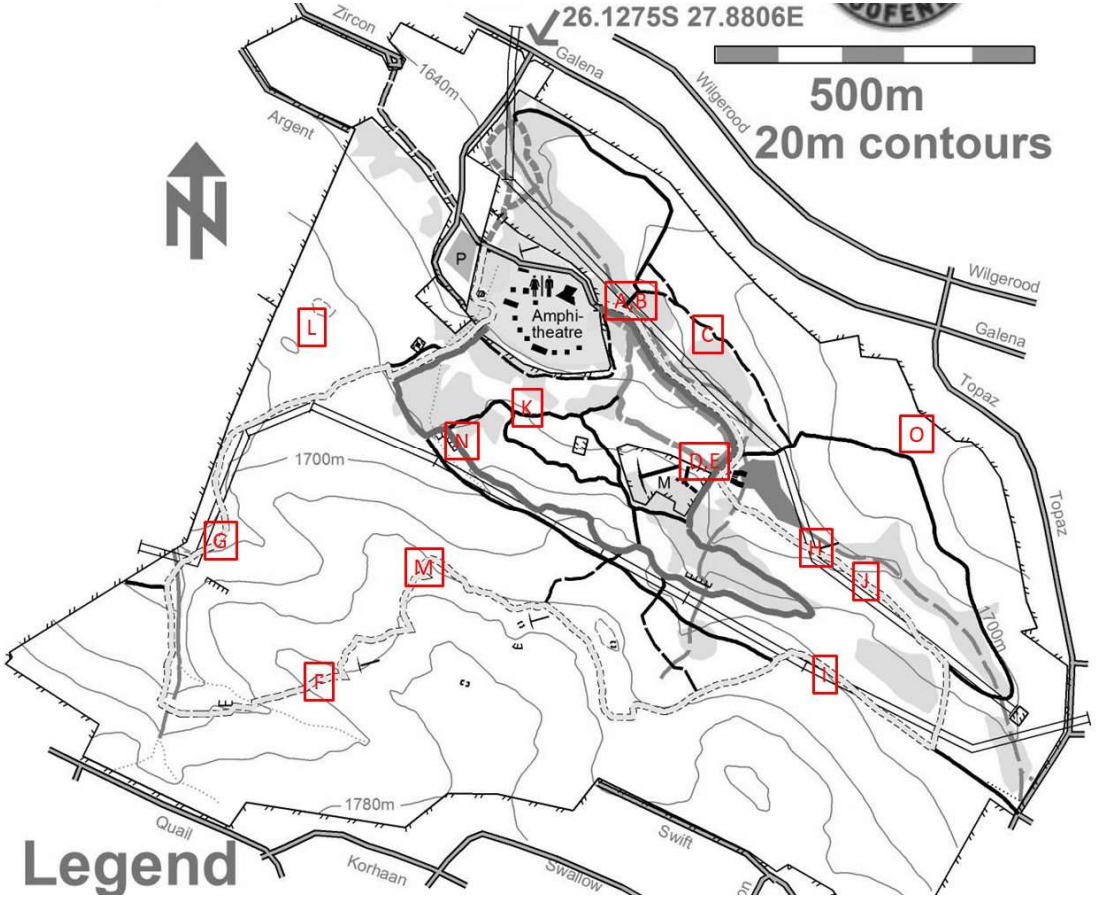
Tony Jamison. 2016-05-17

Geological map from Tony Jameson



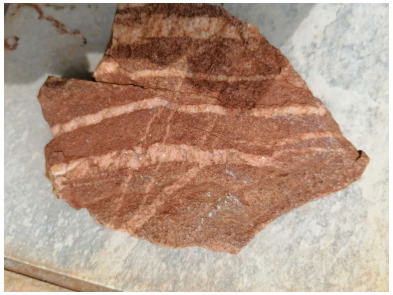
Current map for geological sites

Code	Desciption
A	Quartzite block in fault gouge
B	Multiple continuous quartz veins at different angles
C	Tough in-filled veins
D	Phyllite outcrop on Struben Trail
E	Mine
F	Cross-bedding in vertically-dipping quartzites
G	Multiple faulted quartz veins
H	Lenses of quartzite in fault gouge
I	Weathered outcrop of dyke
J	Small intersecting faults on track and underground in Shirley's tunnel
K	Minor fold in Phyllite
L	Syncline ?
M	Small cave (site of stone or iron tools?)
N	Schist on trail below Dassie Rocks
O	Small abandoned slate quarry



- Rock types in the KNR (Kloofendal Nature Reserve)

Quartzite



Shale

Schist

Dyke

Ferricrete

- Rock types near the KNR

Granite

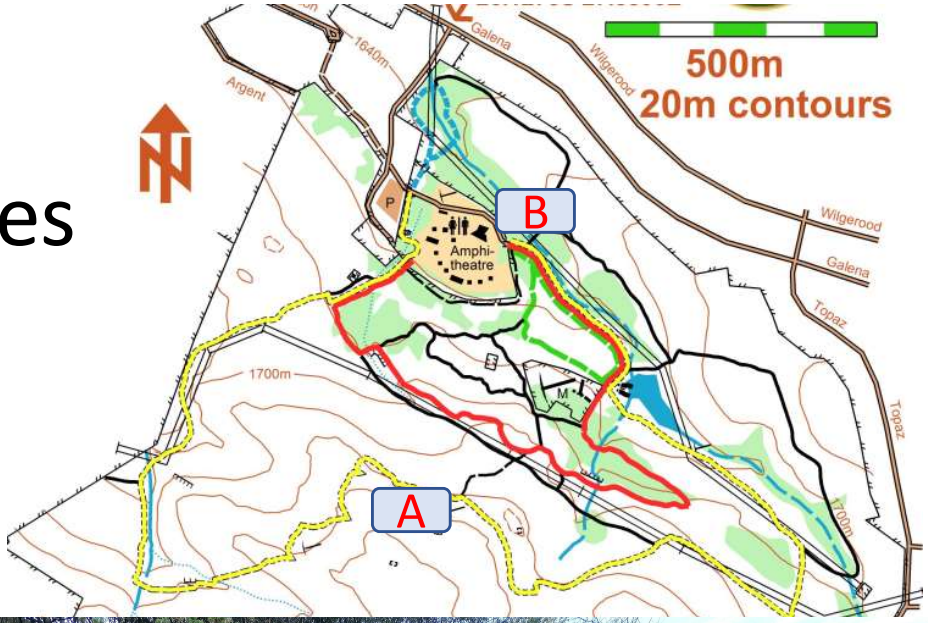
Conglomerate

Dolomite

Lava

Crystalline quartz

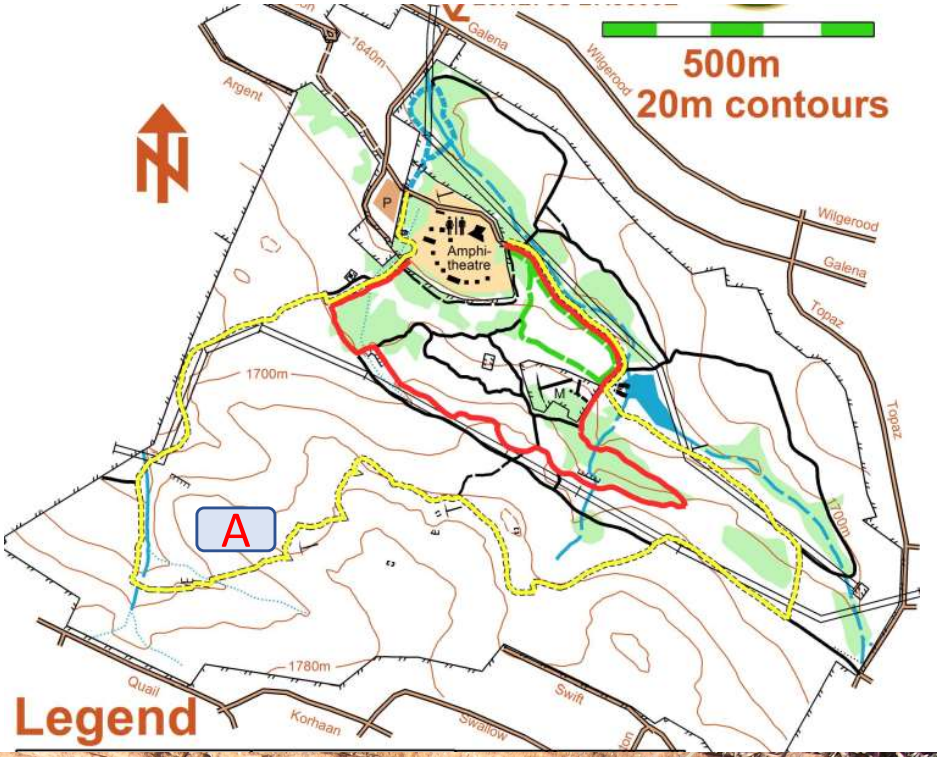
Geological sites in the KNR
Dipping strata & bedding planes



A

B

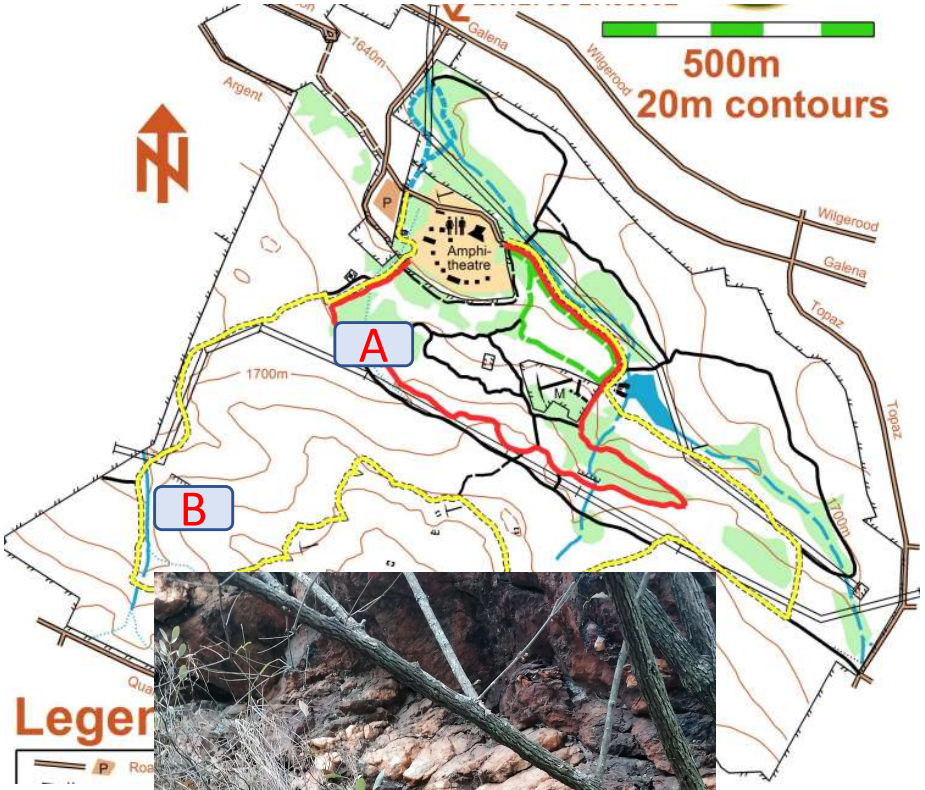
Geological sites in the KNR
Crossbedding



A

Geological sites in the KNR
Fault planes

A

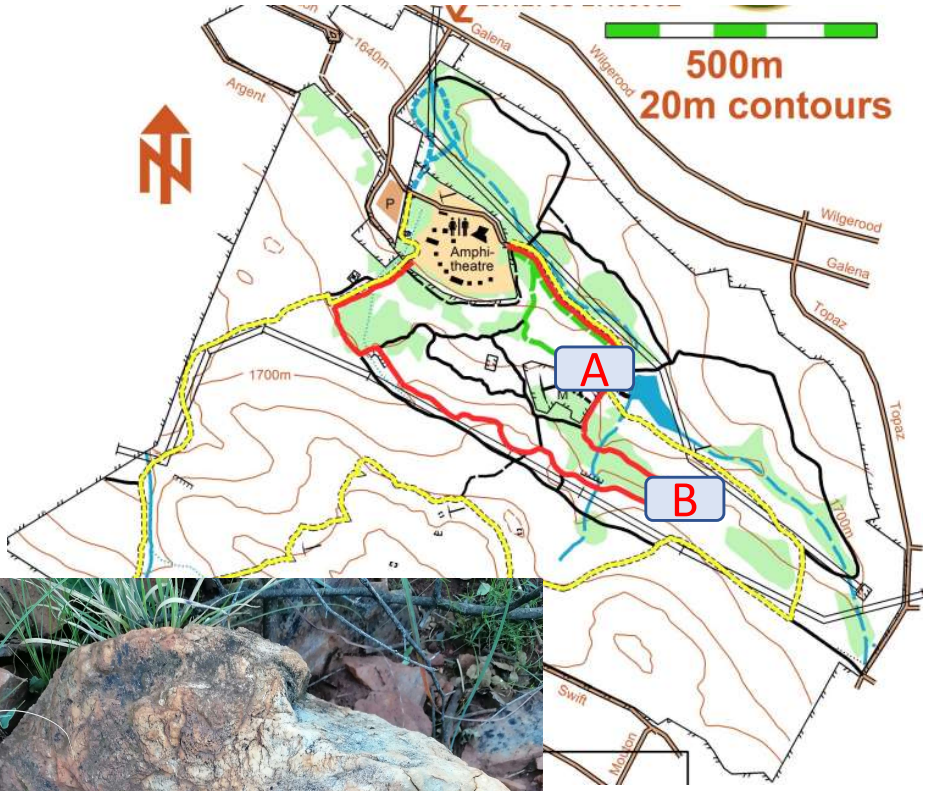


B

Geological sites in the KNR

Slickensides

A

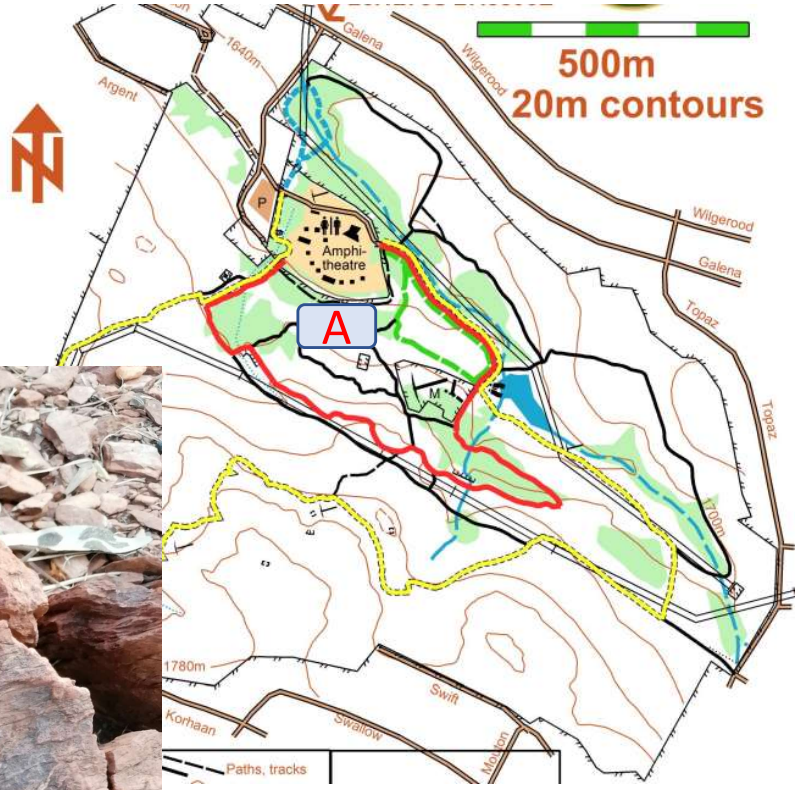


B

Geological sites in the KNR

Folding in Shale

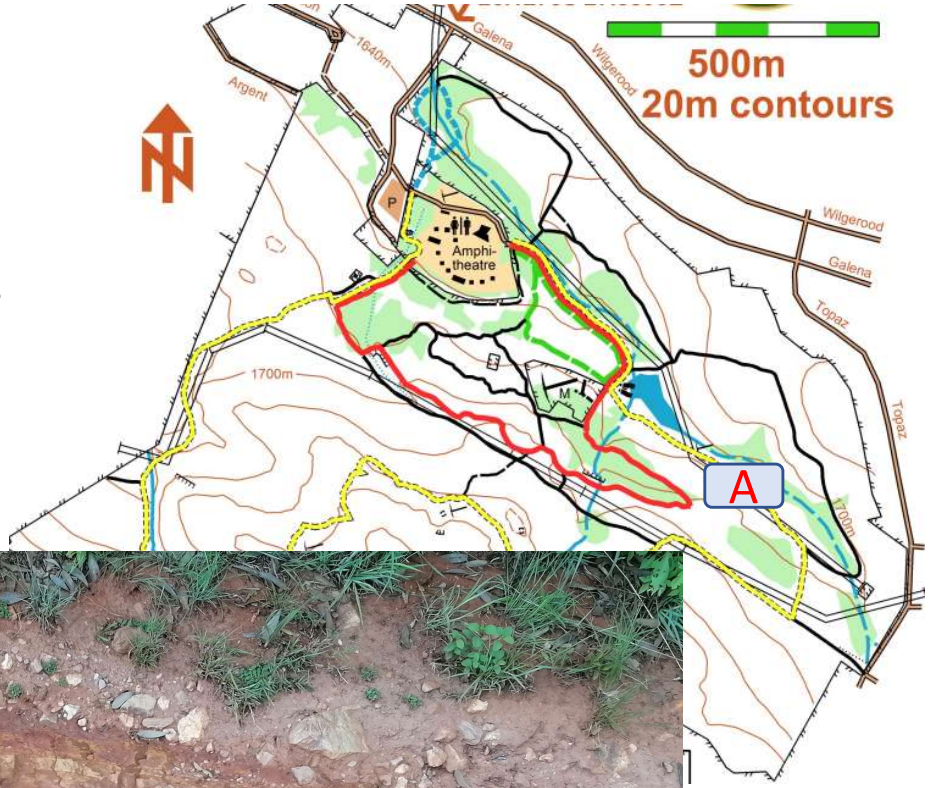
A



Geological sites in the KNR

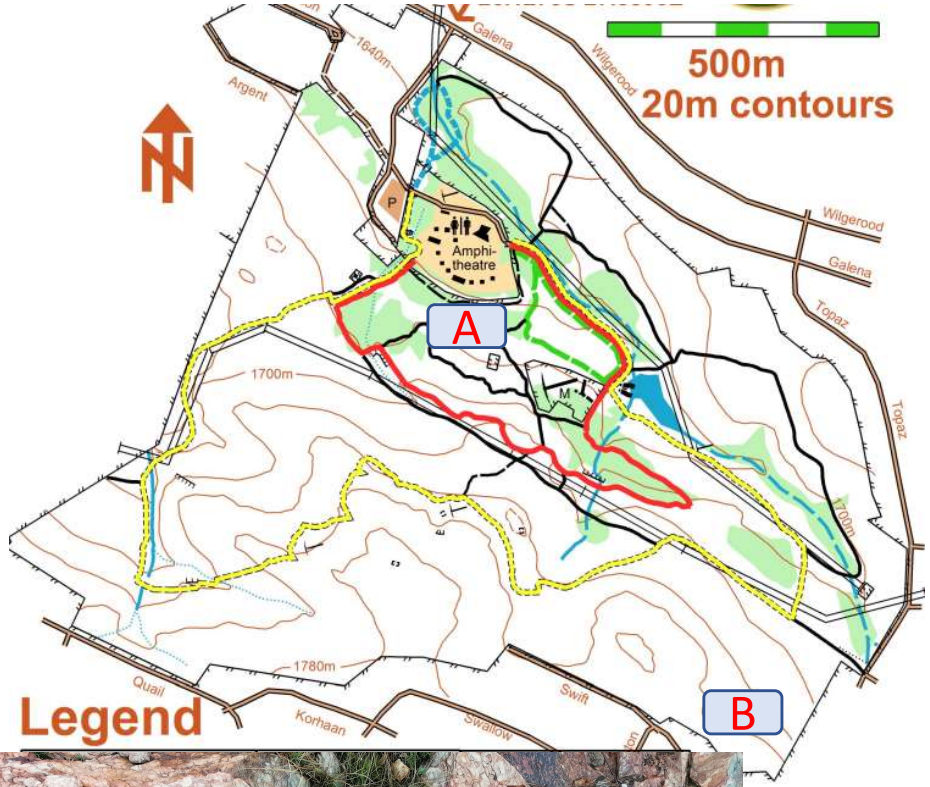
Boudinage

= Pinching in quartzite & folding in shale



A

Geological sites in the KNR
Quartz veins



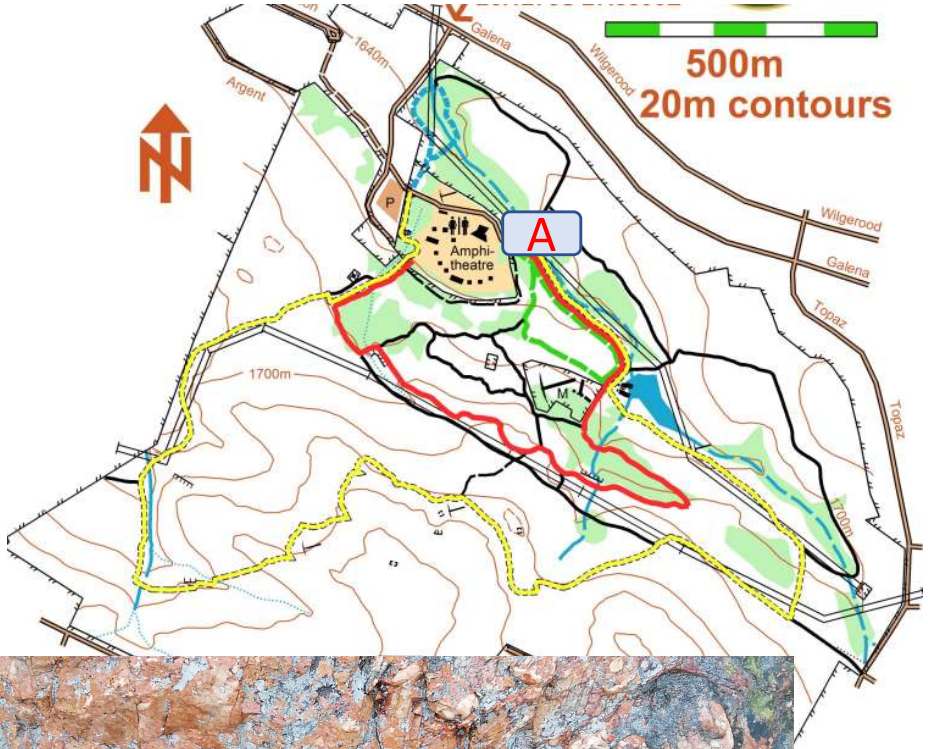
A

B

Geological sites in the KNR
Breccia

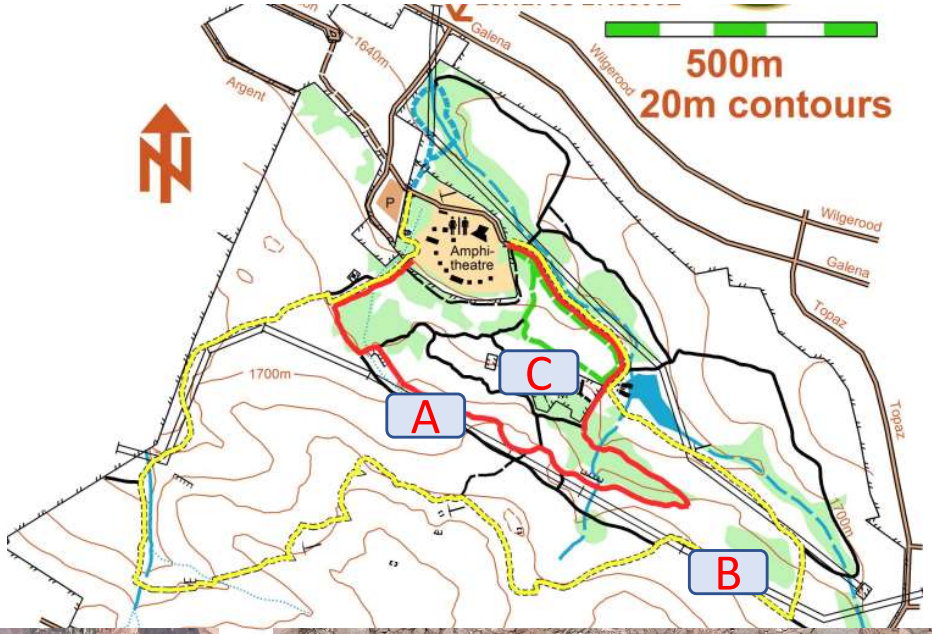
A

?



?

Geological sites in the KNR Dyke



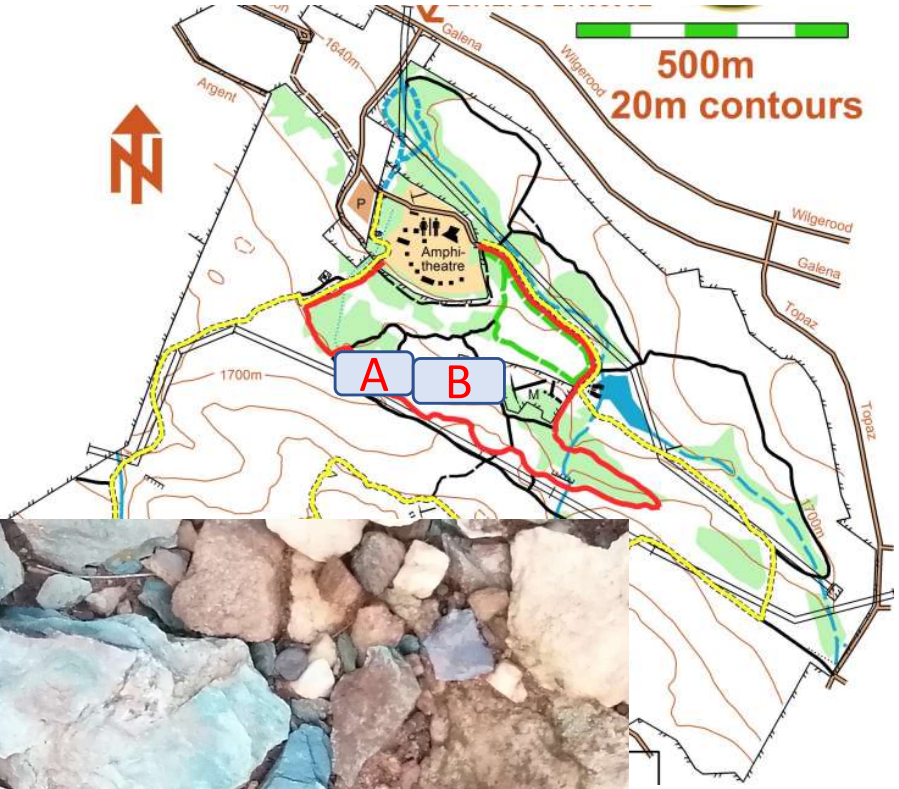
A

B

C

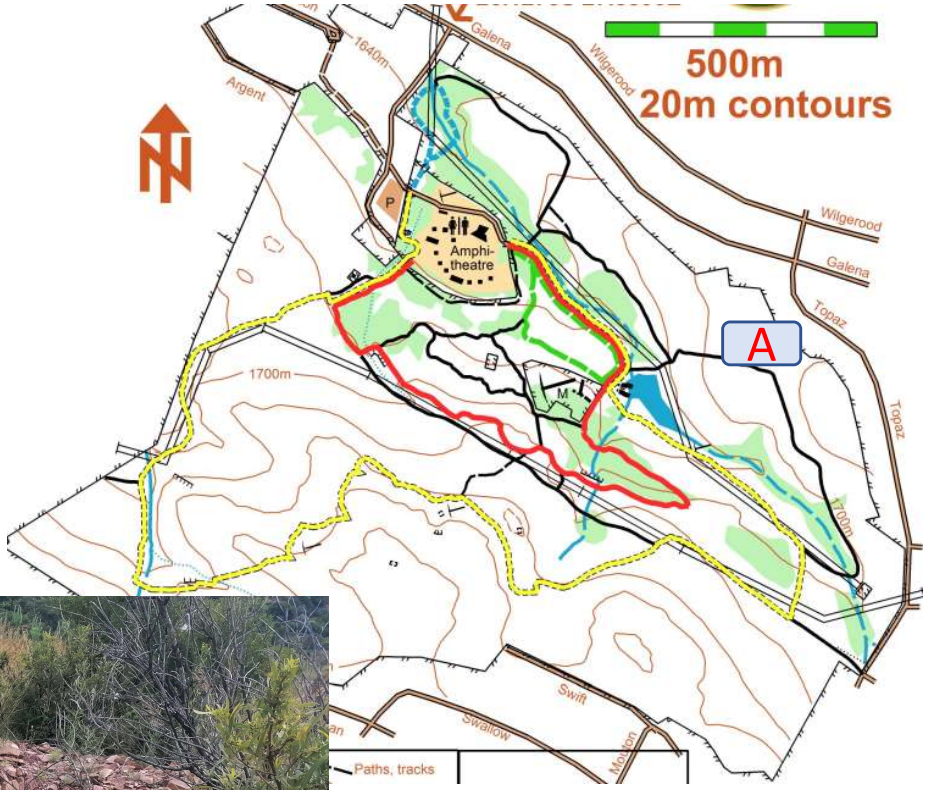
Geological sites in the KNR Schist

A



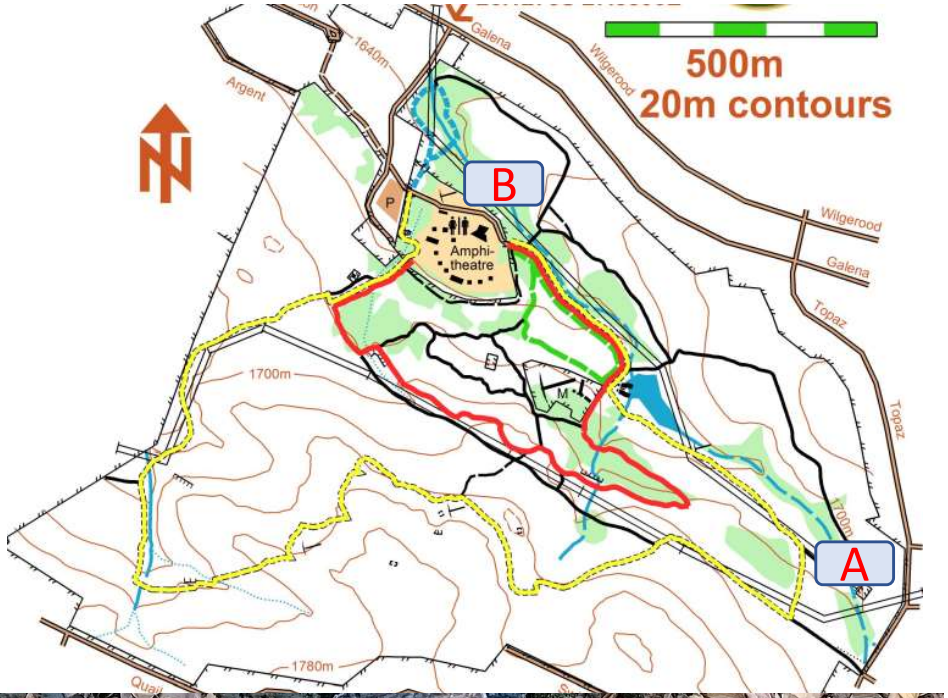
B

Geological sites in the KNR
Slate quarry



A

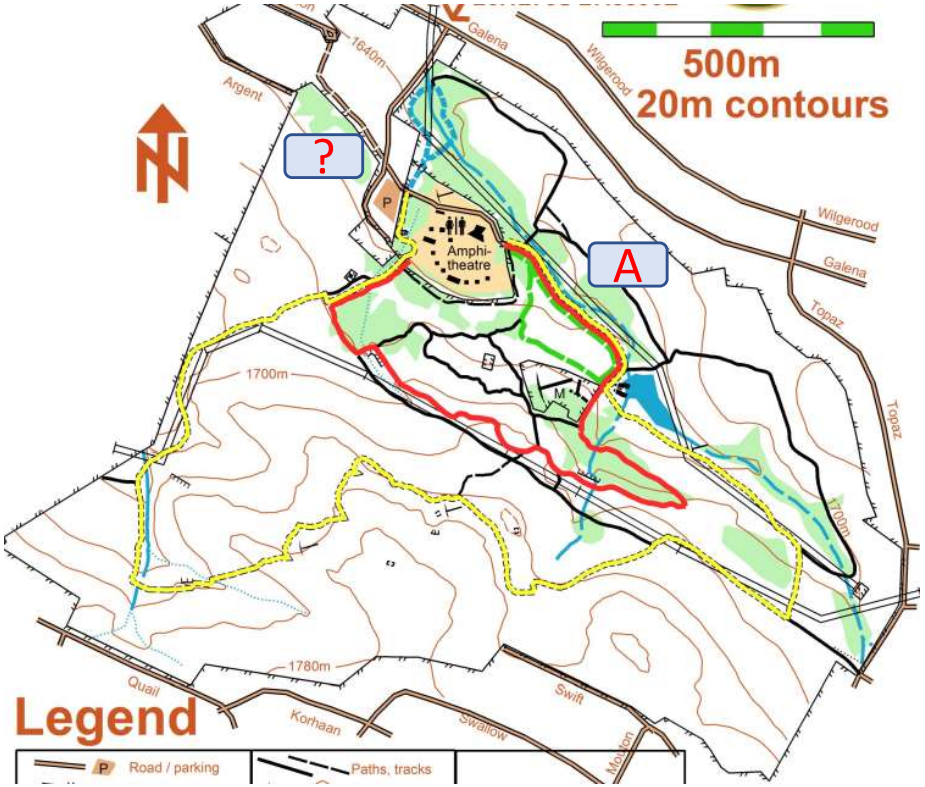
Geological sites in the KNR
Ferricrete



A

B

Geological sites in the KNR
Boxwork structures



?

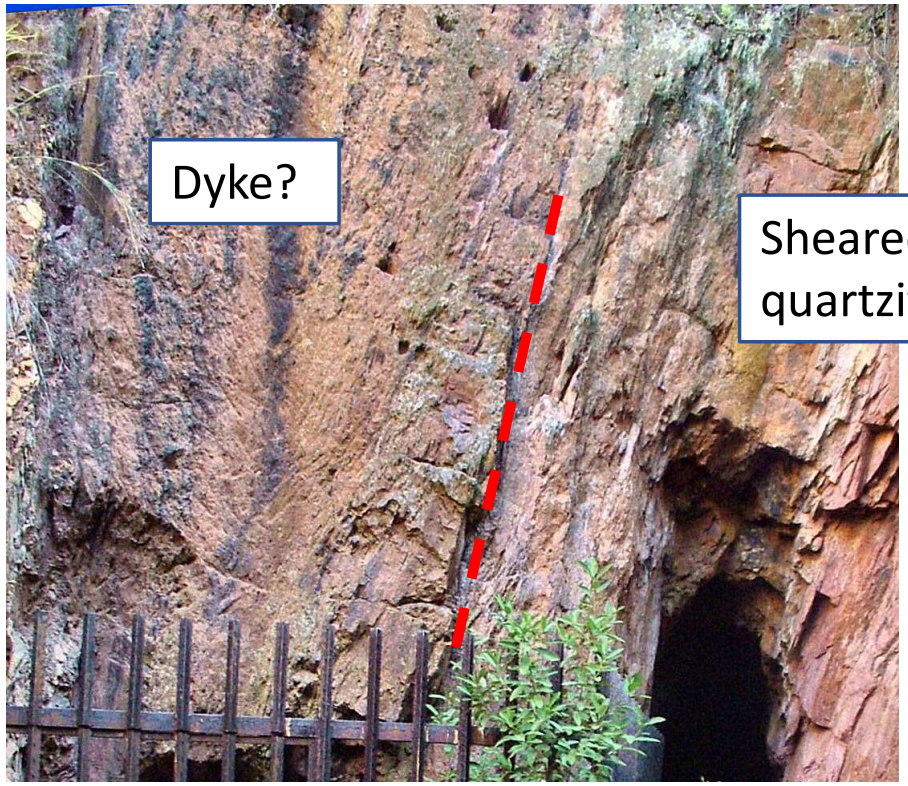
B

Magnetic

Kloofendal Confidence “Reef”

Miners chased quartz veins

Miners chased fractures



That’s all
Thank you

Struben family visiting