

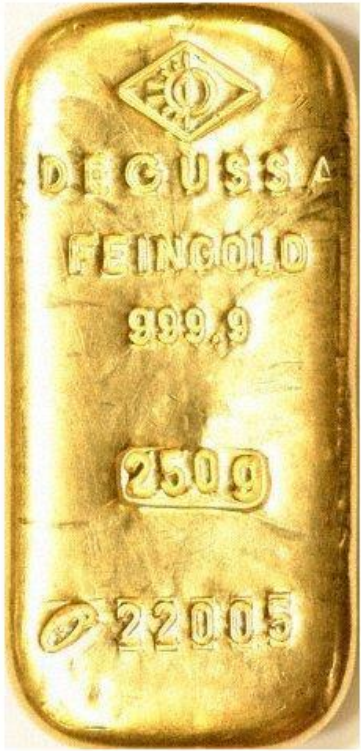
Witwatersrand Gold: where it originated and why it is important?

Presentation by Dr Linda Iaccheri
School of Geosciences
University of the Witwatersrand

<https://thumbs.dreamstime.com/b/gold-nugget-map-south-africa-close-up-top-239935623.jpg>



Geology is the history of the Earth, the formation of rocks and minerals.
Reflect on the 2 minerals that you see here:

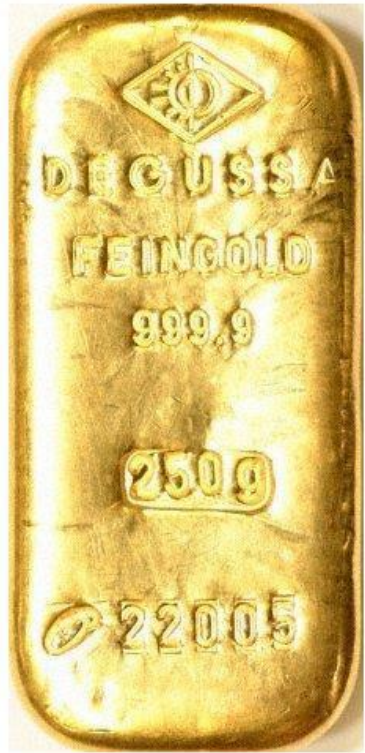


GOLD



COAL

- Which is more important for your daily life?
- Which one is more expensive?



GOLD BAR

143.95 USD per ton



COAL

3 991.40 USD per ounce (31 grams)

- Why is gold more valuable?
- Why do we love gold so much?

.... Why do we like gold so much??

1. Jewellery
2. Money and Financial trade
3. Investment
4. Electronics
5. In teeth for dentistry
6. In medicine
7. Space technology
8. Beautifying buildings (churches), in cosmetics, trophies
and even exotic food



**The symbolic meaning =
WEALTH**

GOLD = WEALTH

- We love it because we believe it makes us wealthy;
- Solid investment in times of global uncertainty and wars

- **GOLD HUNTERS experience GOLD FEVER**
- **New discovery of GOLD always attracted attention and migration of people in search of their luck, GOLD RUSH**
- **When was the GOLD RUSH that caused the establishment of EGOLI, the city of gold (Johannesburg)?**



*George Walker, Harrison's partner,
who held a claim on Langlaagte.*

The map displays the Ranges Land area, which is outlined in thick black. Surrounding farms and their areas (in hectares) are as follows:

- Waterval**: 79
- Paardekraai**: 42
- Paarl Camp**: 258
- Mooifontein**: 14
- Diepskloof**: 63
- Vierfontein**: 133
- Miscund**: 96
- Braamfontein**: 479
- Klipfontein**: 342
- Cyferfontein**: 180
- Rietfontein**: 17
- Doornfontein**: 323
- Turfontein**: 198
- Klipriviersberg**: 222
- Elandsfontein**: 236
- Rietvlei**: 126
- Olifantsvlei**: 86
- Bergvlei**: 199

Other geographical features include the Orange River, Sand Spruit, and the Ranges Land area itself, which is the central focus of the map.

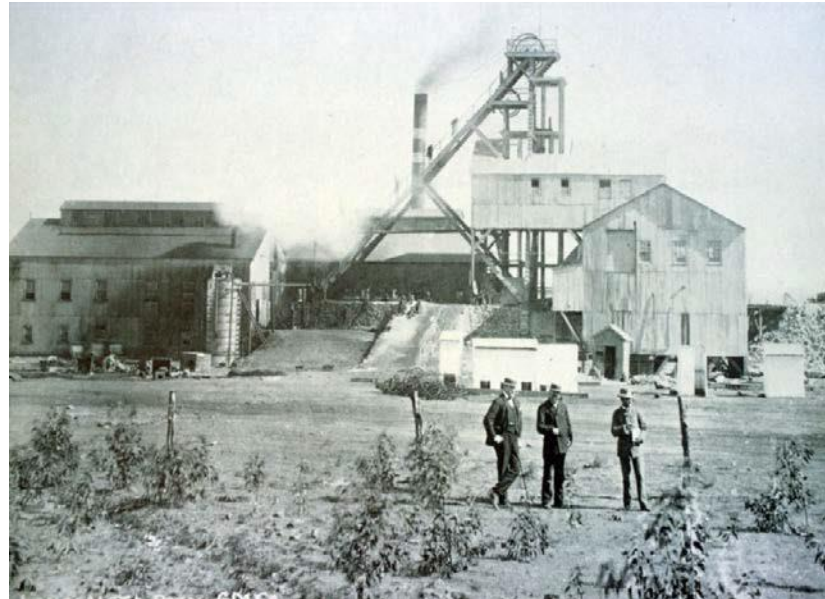
- In **Dec. 1885** **George Walker and George Harrison**, who had been in the goldfields of Australia, sailed into Durban, and made their way to Barberton.
- **Walker went to work on farm Langlaate** and on weekends panned streams for gold. In **June 1886** he identified a **conglomerate** and panned it
- Discovered substantial gold, was awarded a discovery claim, which was bought by diamond magnates from Kimberley.

The discovery of gold brought to the foundation of our city in June 1886 (now it is a 140 years anniversary)

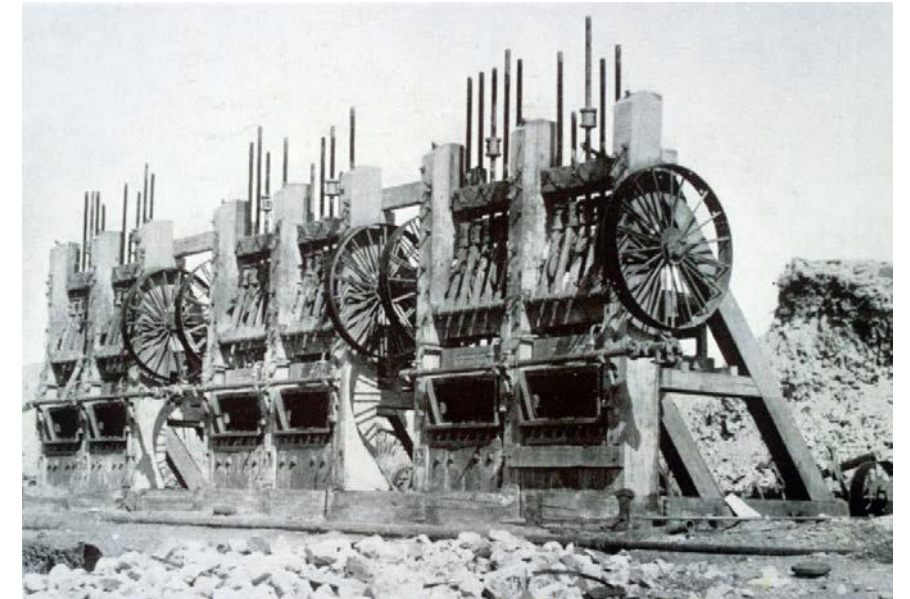


Tents and huts, Johannesburg in 1886

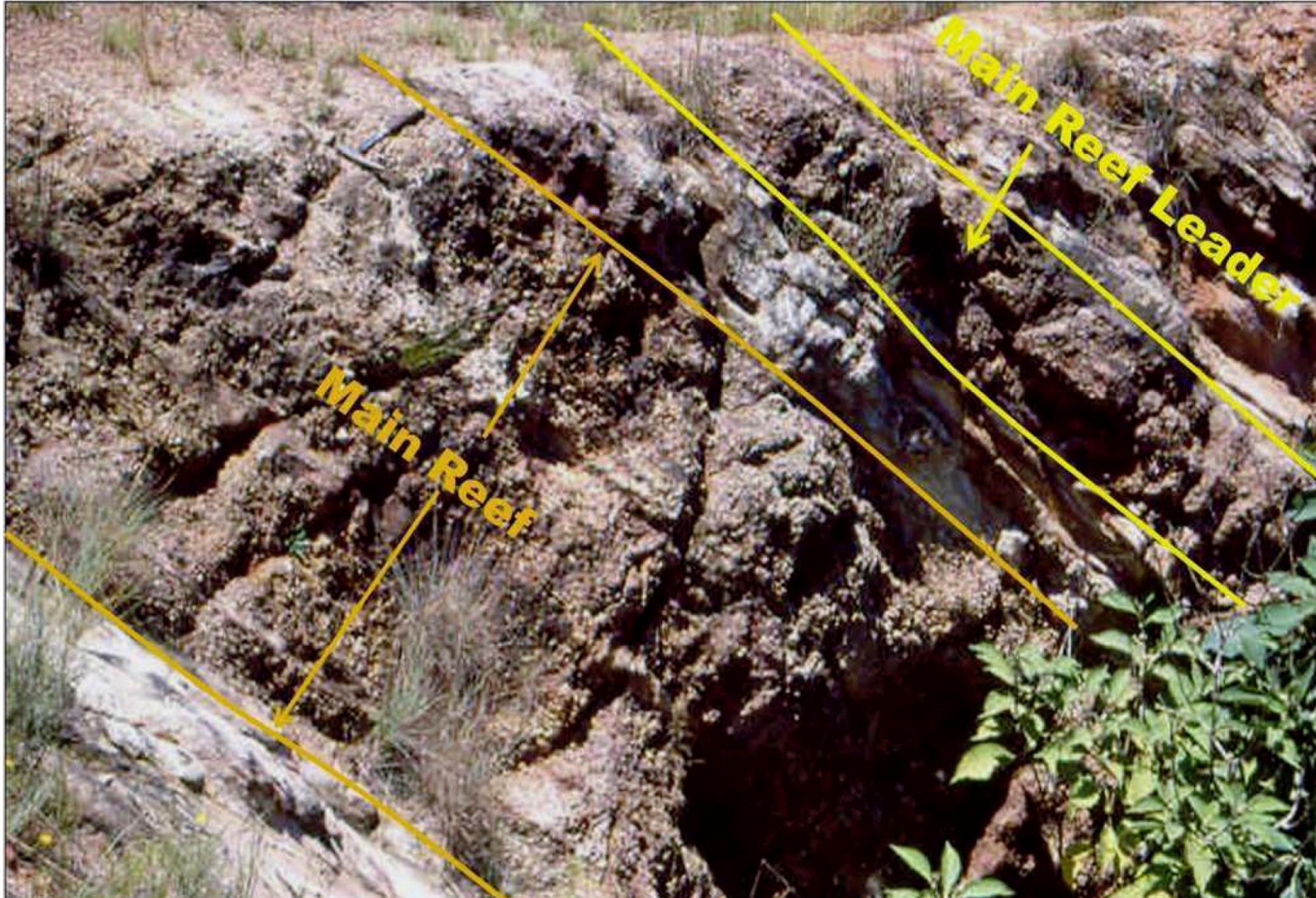
Rissik Street



Johannesburg around
1890 Ferreira's camp

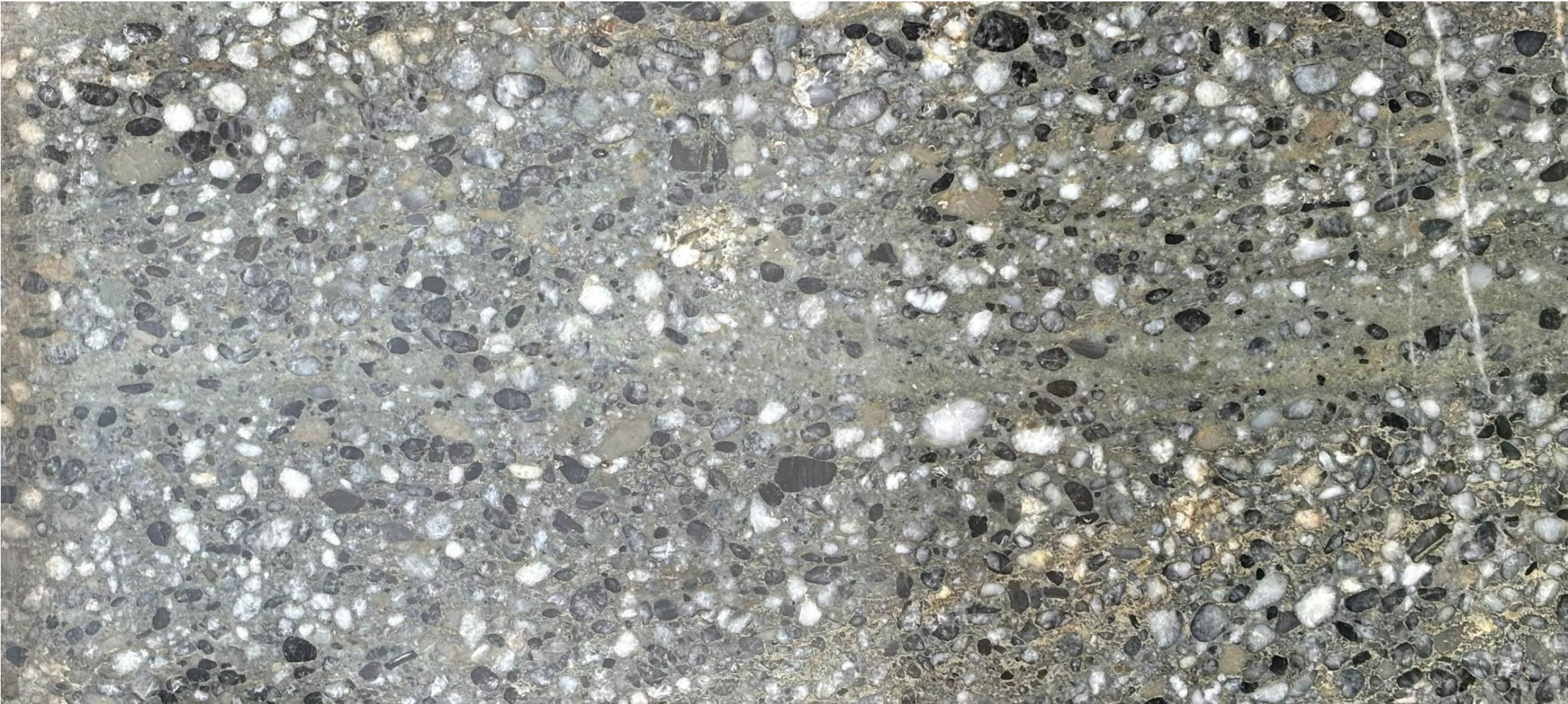


The gold in Joburg is hosted in flat lying layers of conglomerates, called Reefs.

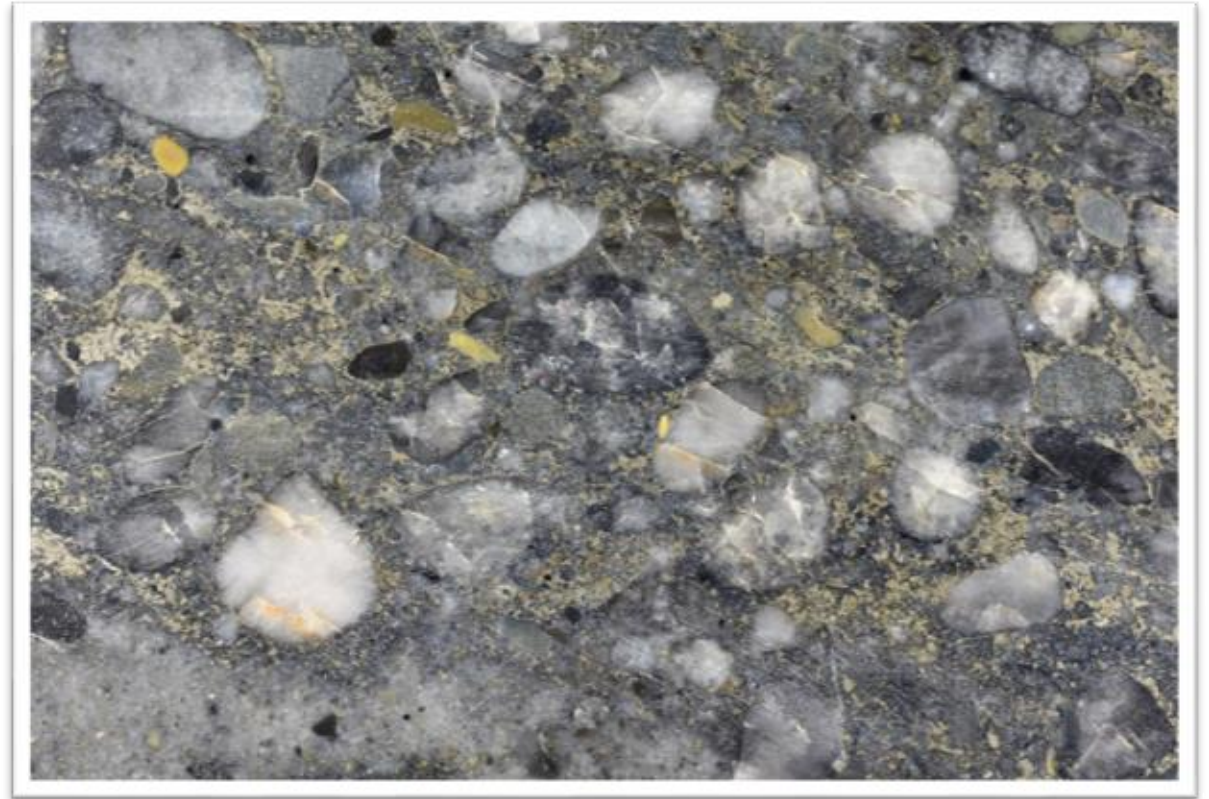
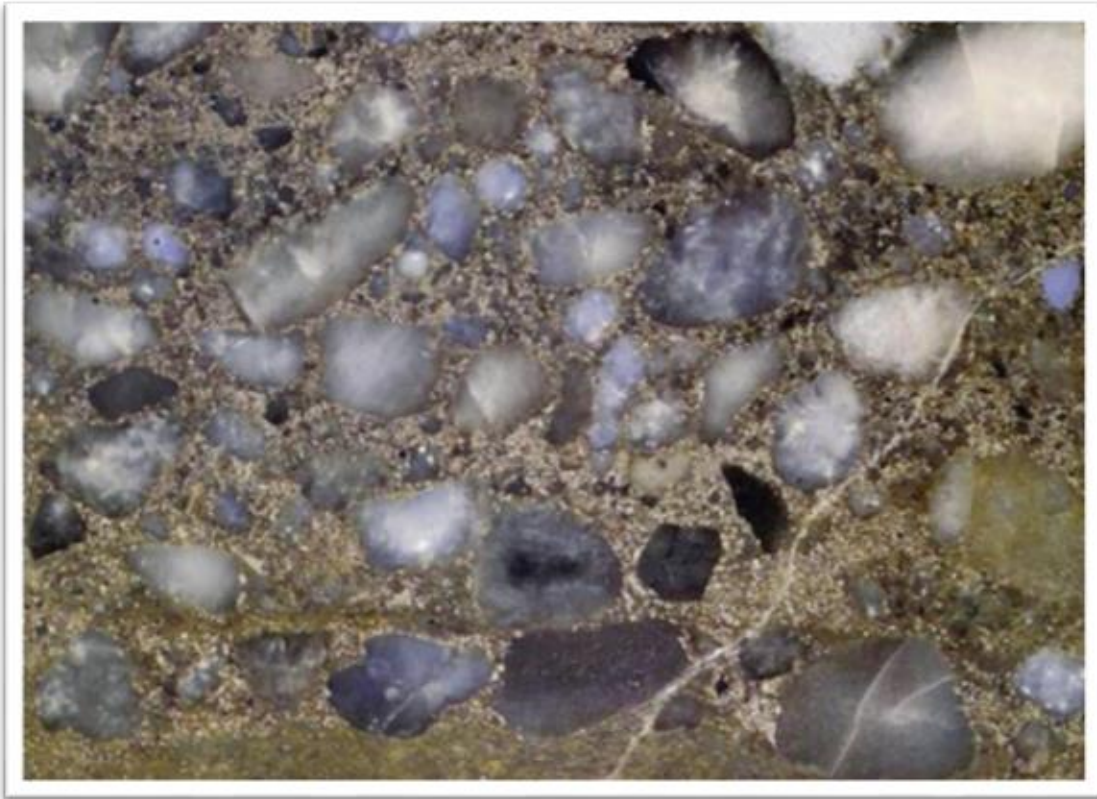


Outcrop of the Main Reef and Main Reef Leader conglomerates at the Langlaagte Discovery Site on the Central Rand Goldfield (see previous figure for location (M.J. Viljoen).

A **Conglomerate** is a coarse-grained sedimentary rock composed of **rounded clasts** cemented together by finer sediments and **mineral cements**.

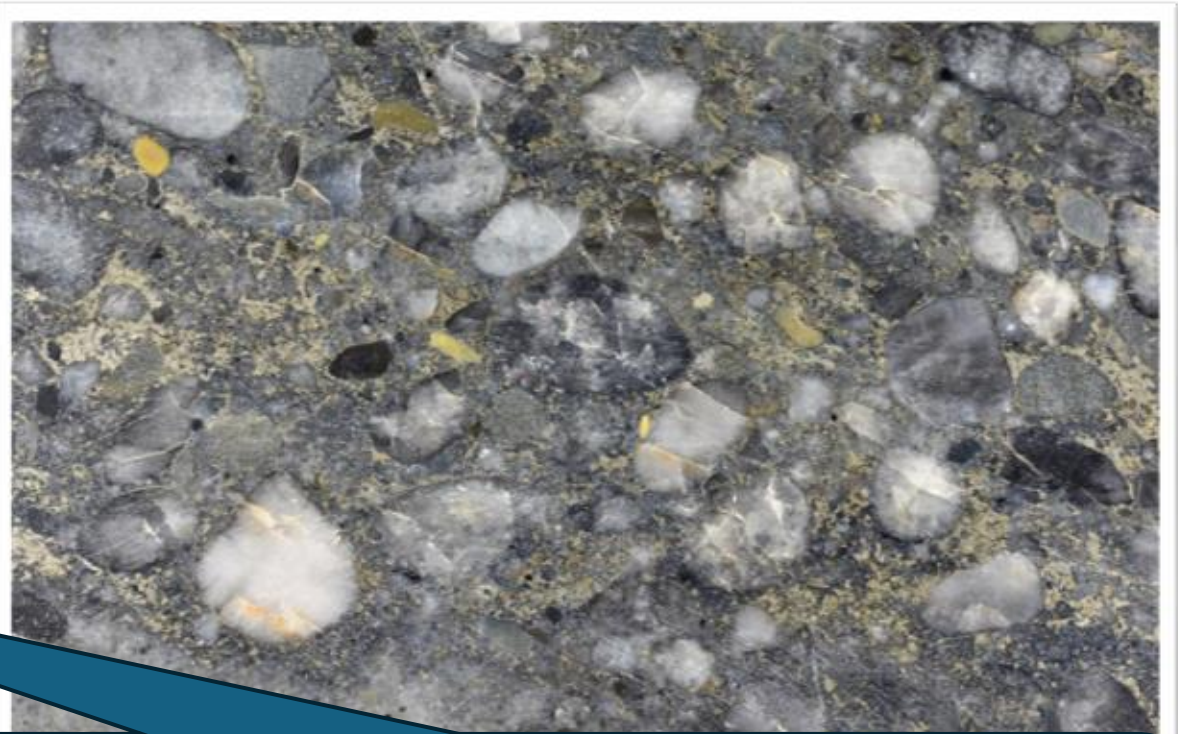
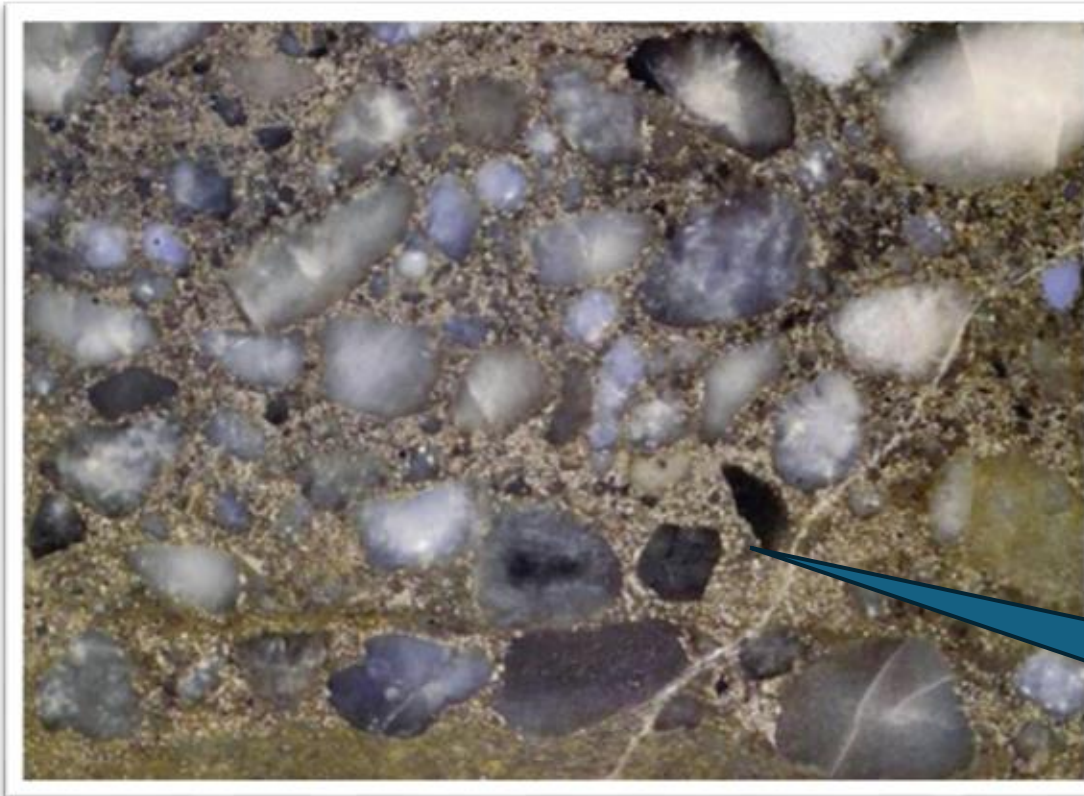


In the **conglomeratic reefs**, the rounded clasts are **quartz** and the cementing fine-grained mineral is **pyrite**



Where is the gold?

In the **conglomeratic reefs**, the rounded clasts are **quartz** and the cementing fine-grained mineral is **pyrite**



Where is the gold?

The gold is inside the pyrite in minute quantities (called invisible gold), it requires processing for extraction

The conglomeratic reefs are a sedimentary rock due to the accumulation of sediments in a shallow marine ocean



Underground mine image of water-cut reef channel containing gold-bearing conglomerate and cross-bedded quartzite in the Middle Elsburg Composite Reef at Randfontein estates gold mine.

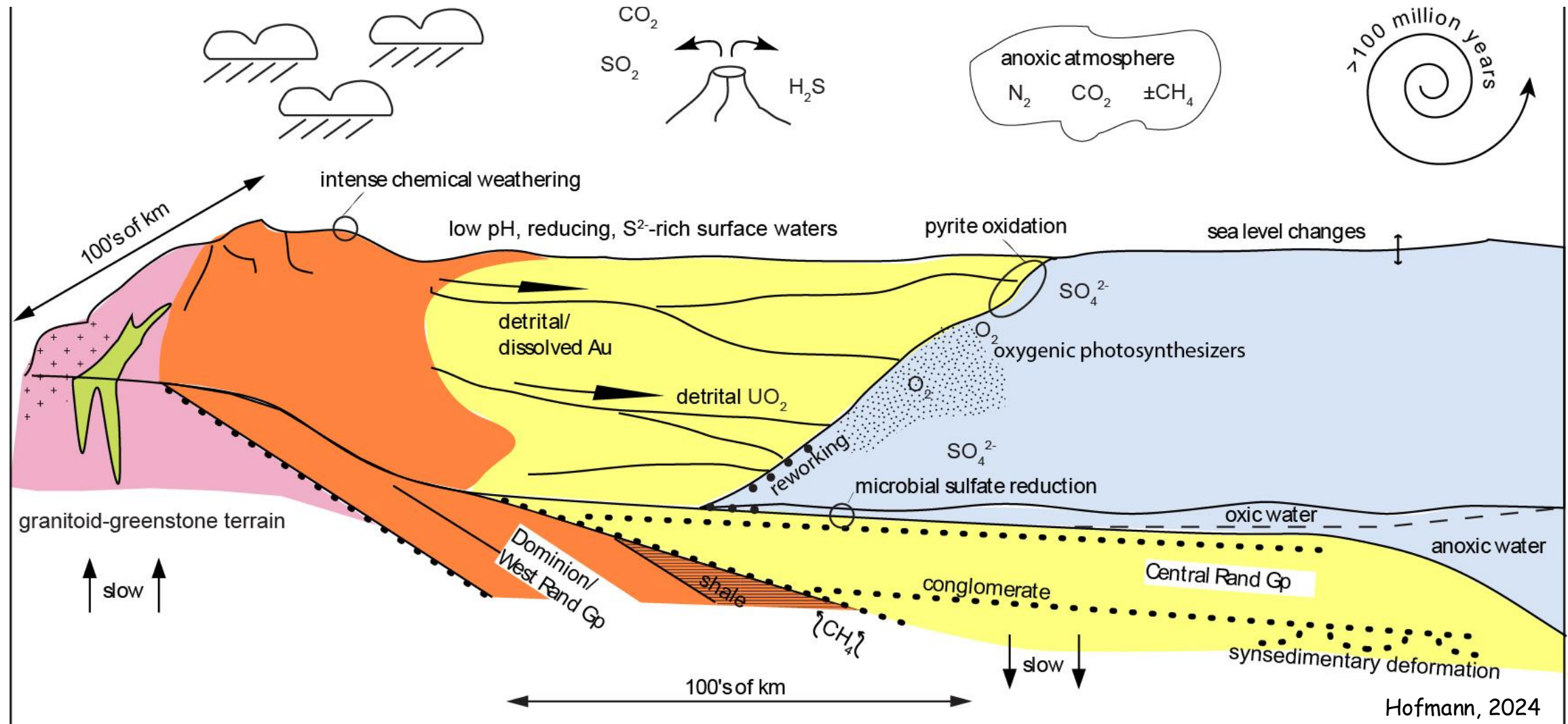
The conglomeratic reefs are a sedimentary rock due to the accumulation of detritus in a shallow marine ocean

- *Which ocean?*
- *And when did it happen?*
- *How old are the rocks in and around Joburg?*



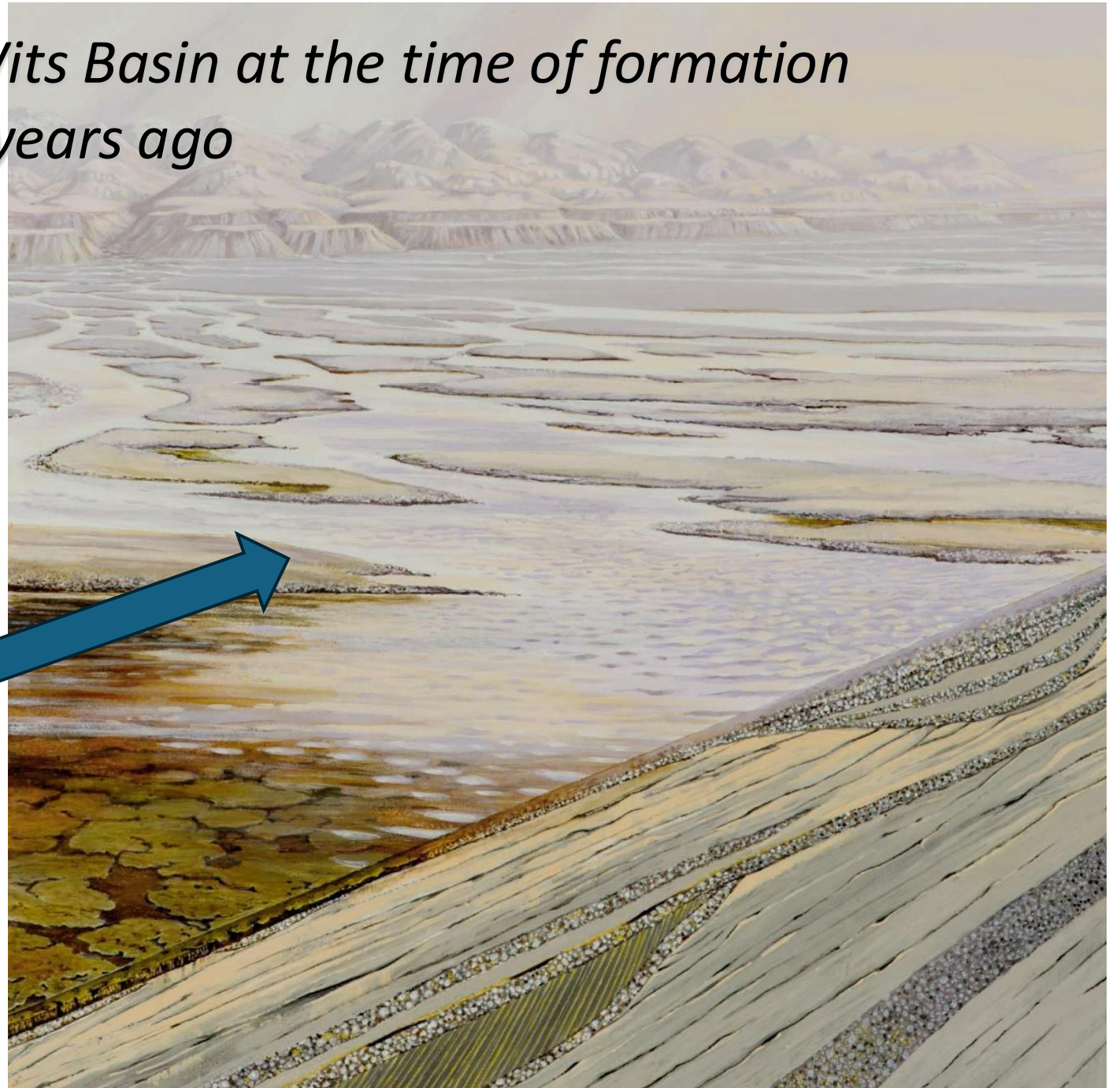
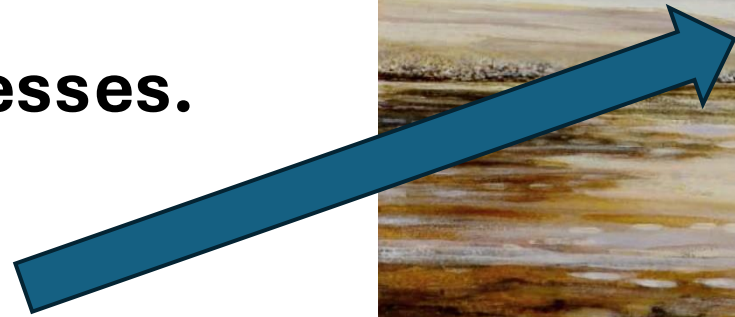
Witwatersrand Basin gold mineralization formed circa 2900 Million years ago

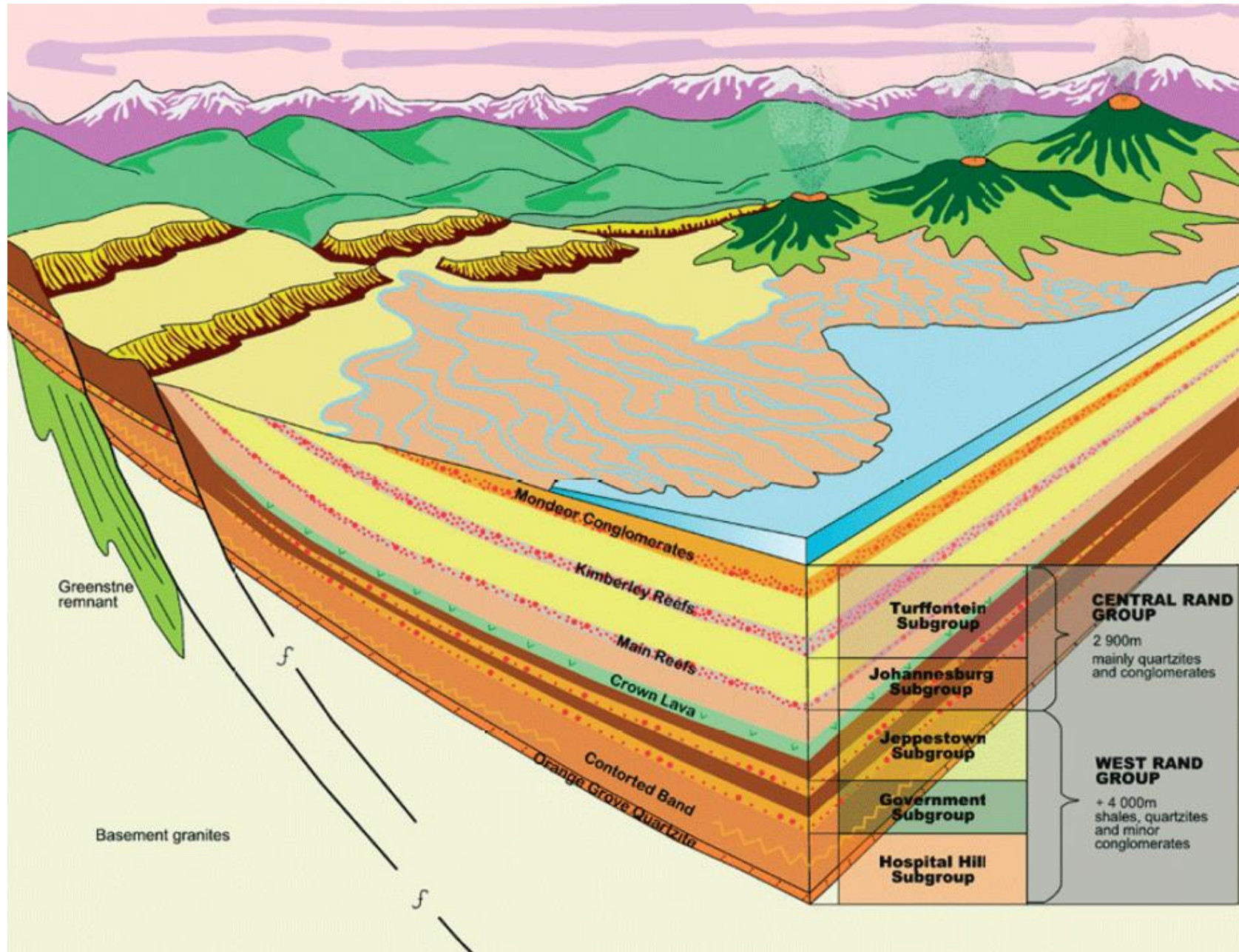
Layers record basin evolution, sedimentary processes, atmospheric/biological evolution, diagenetic/post-diagenetic modifications)



Conceptual landscape of the Wits Basin at the time of formation of the reefs circa 2900 Million years ago

Identification of braided fluvial patterns and paleocurrents for locating the accumulation of heavy minerals during sedimentary processes.

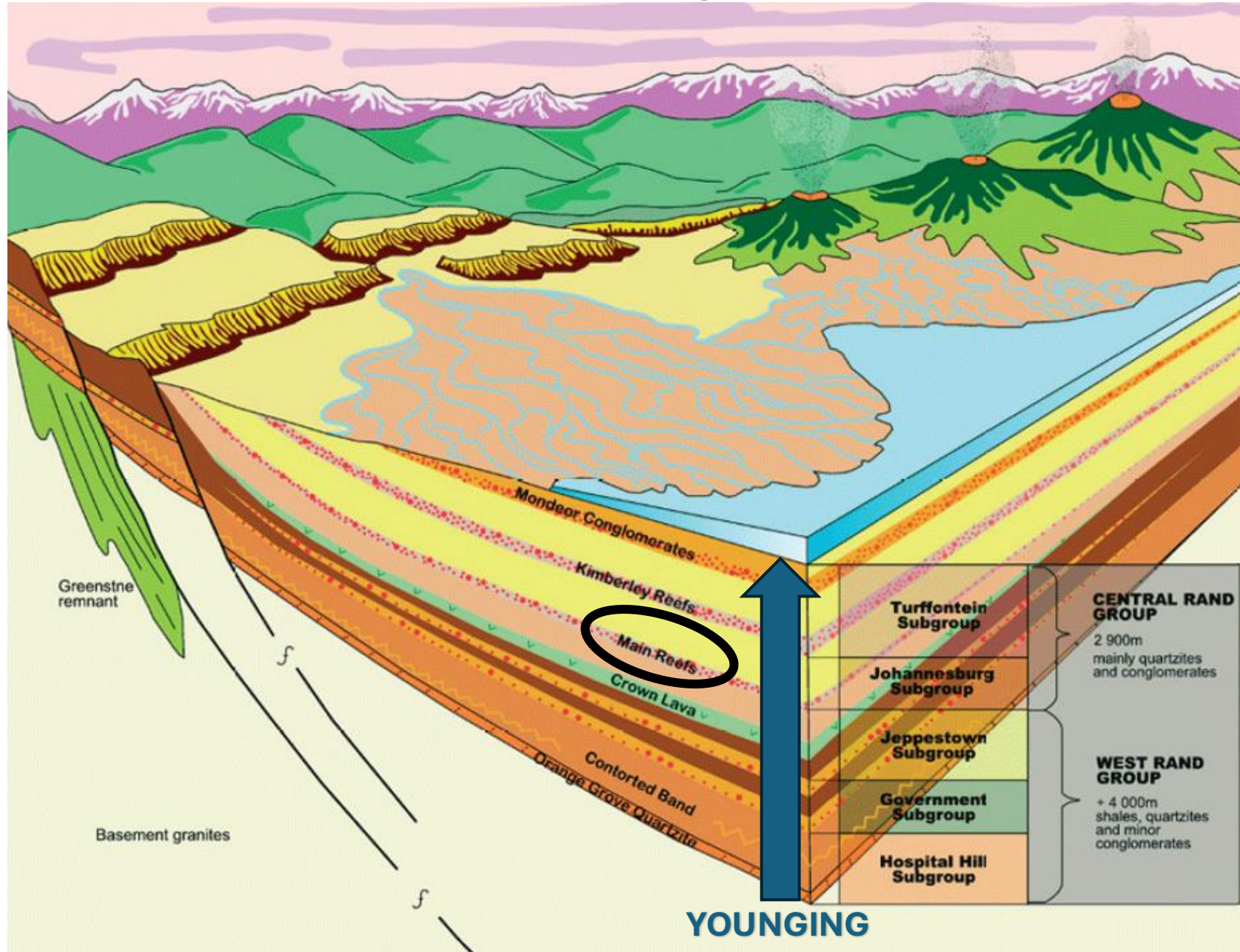




Weathering and erosion of highland areas towards the North, infilling basin towards the South.

Accumulated a thick sequence of quartzites and conglomerates that we know as **the Witwatersrand Supergroup: West Rand + Central Rand Groups**

The Witwatersrand Supergroup



**Upper Wits = Central
Rand Groups: GOLD!**

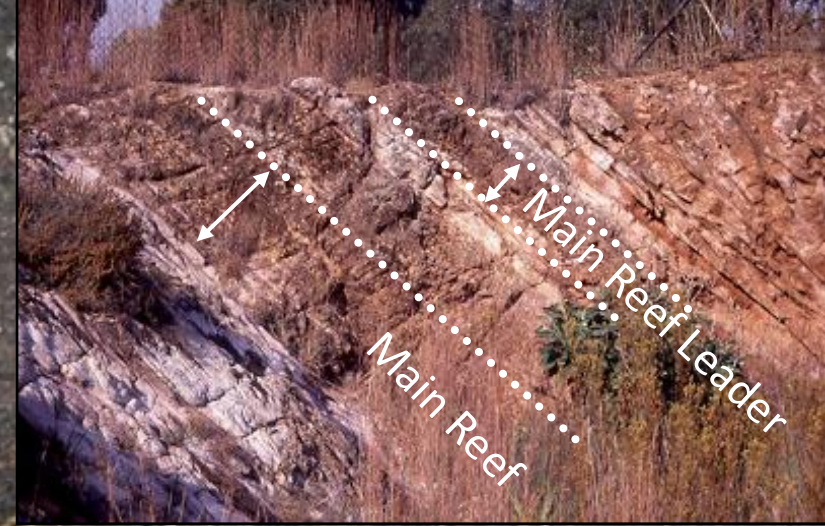
Main Reef

**Lower Wits = West
Rand Group: no Gold**

Witwatersrand Supergroup

the world's largest gold deposit

53 000 t of gold produced since 1886



This is a
map in
plan view



Younging of
rocks direction

Soweto

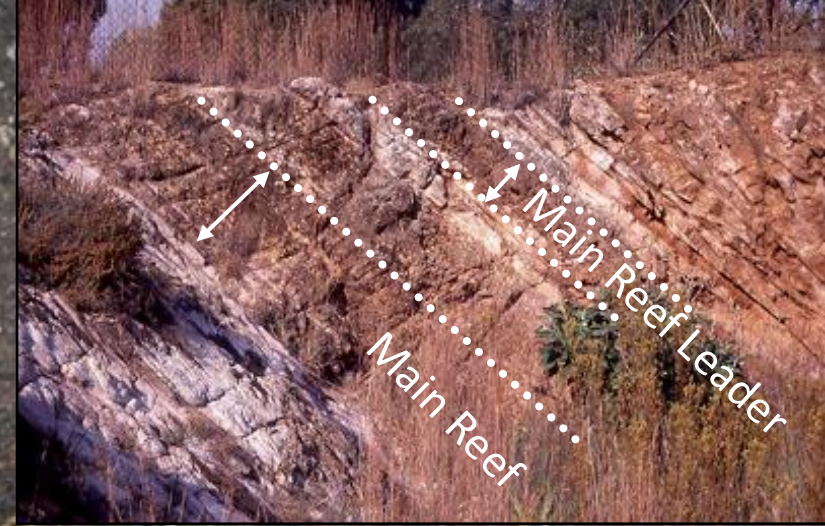
Slice the earth here: North to South

Sandton



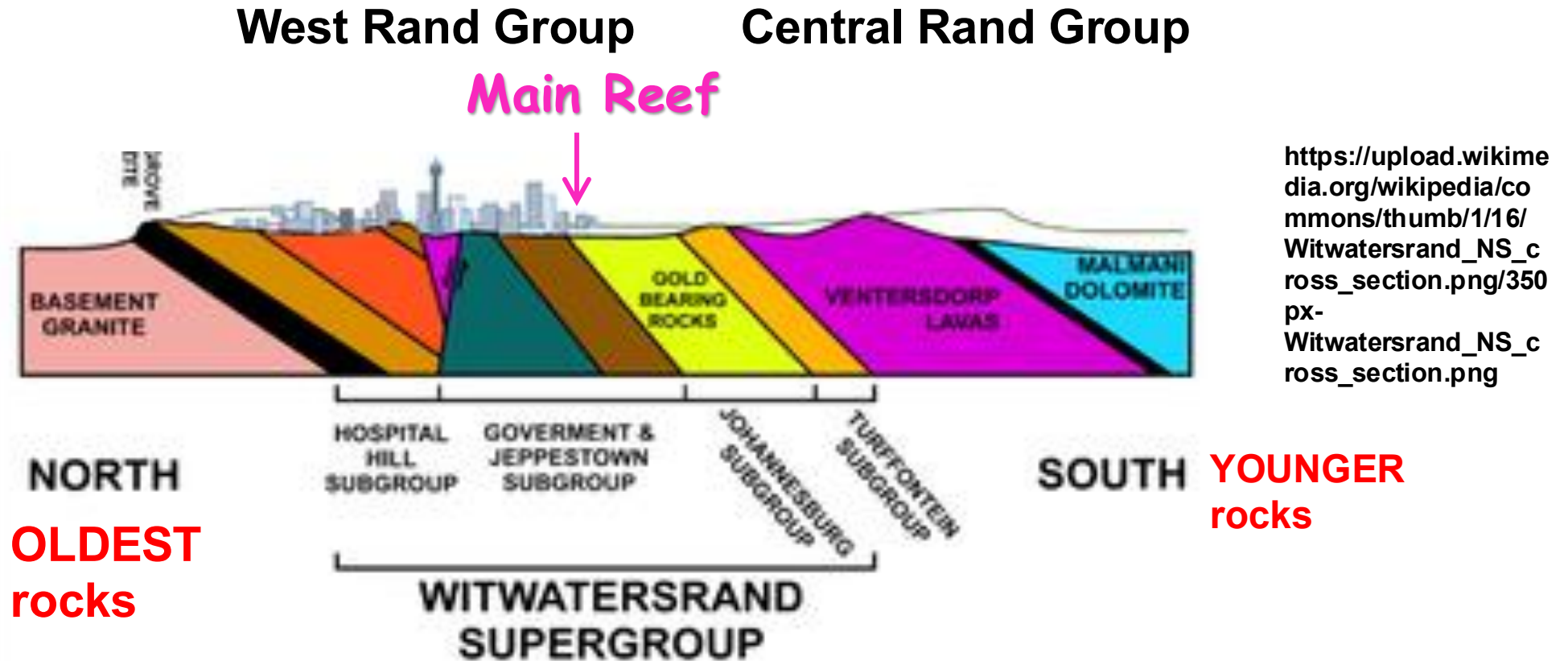
Johannesburg
City Centre

Main Reef



Cross- section from North to South of the geology of Johannesburg

This is a cross section



- The rocks of the Wits Supergroup were deposited in layers on top of an ancient granitic basement (visible in the Northern Suburbs)
- The layers are not horizontal, but they dip about 20 degrees toward the South

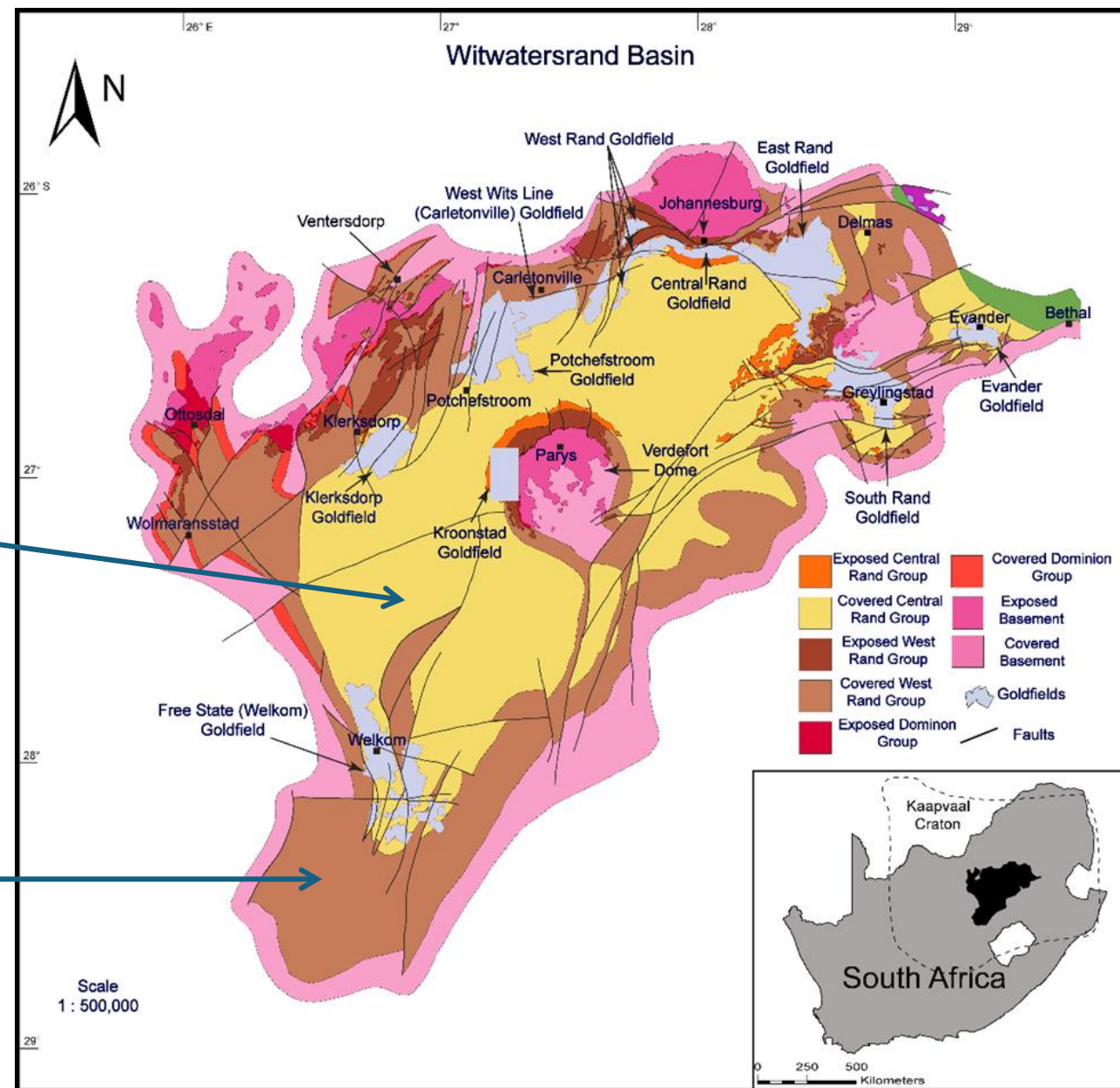
In the Wits Basin:

- Primary GOLD is found within the sedimentary rocks of the WITWATERSRAND Supergroup
- The Wits Supergroup represents the accumulation of sediments into inland sea / basin on top of the Kaapvaal Craton
- The basin gets deeper southwards into the basin
- The basin was active in the late Archaean in age – 2.8 – 2.3 Ga
- The Wits Supergroup is divided into 2 Groups - West Rand & Central Rand Groups
- The lower part of the sedimentary sequence (the West Rand Group) is gold poor
- The upper part of the sedimentary sequence (the Central Rand Group) has conglomeratic layers, called reefs, which contain gold associated with pyrite.

The Witwatersrand Basin is not only in Joburg, but consists of 10 goldfields, defining an arc which more than 300 km.

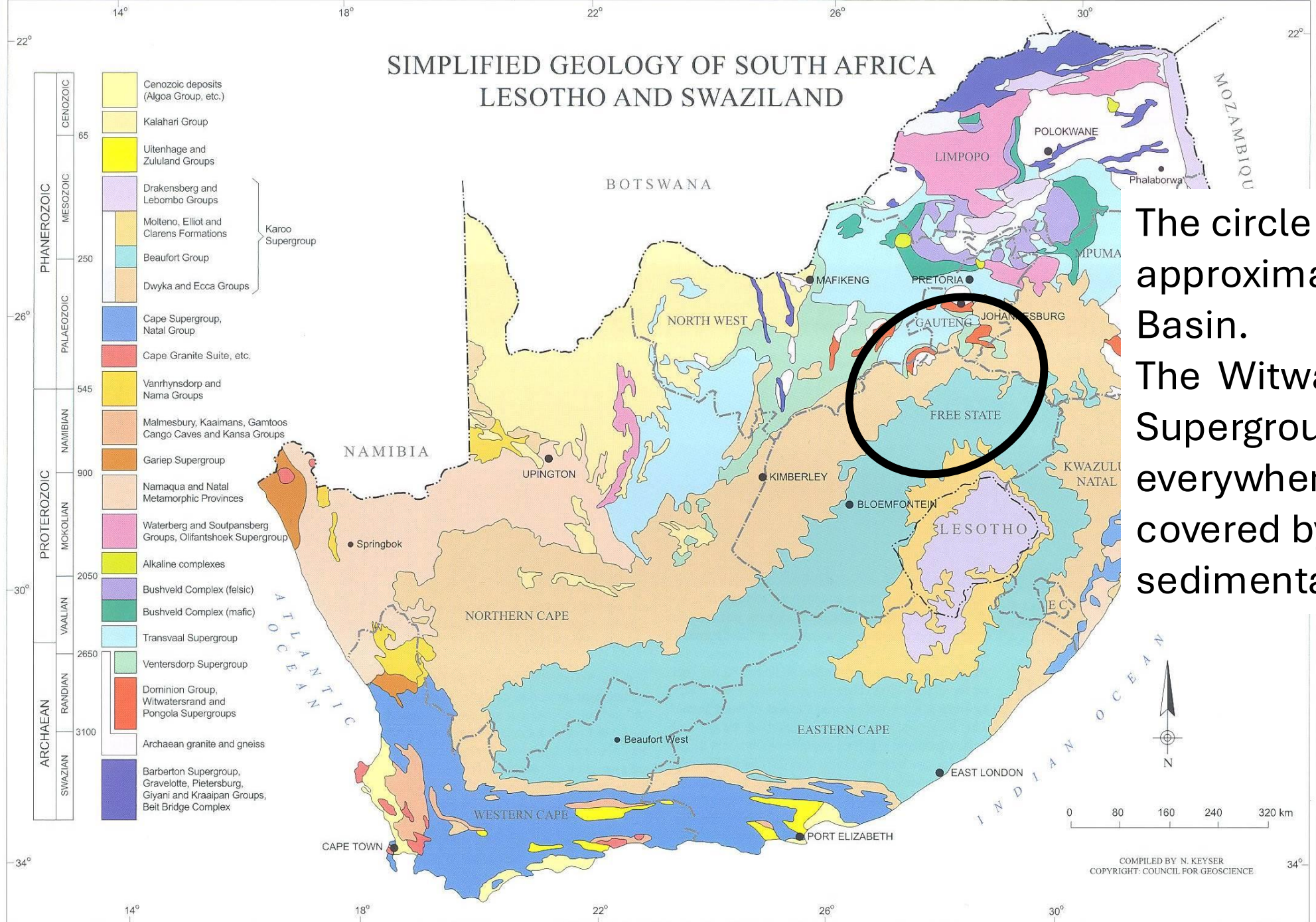
Central Rand Group:
shale, quartzite & minor conglomerate; **rich in gold**

West Rand Group: mainly shale and quartzite; **poor in gold**



Geological Map of the Witwatersrand Basin, showing the outline of the Basin and its position relative to the Kaapvaal Craton in South Africa (Modified after Pretorius et al., 1986)

SIMPLIFIED GEOLOGY OF SOUTH AFRICA LESOTHO AND SWAZILAND



The circle shows the approximate extent of Wits Basin.

The Witwatersrand Supergroup is not everywhere exposed, but covered by younger sedimentary rocks.

The Wits Basin is the world's largest gold deposit: about 53 000 t of gold produced since 1886

Let's reflect on these points:

- 1. *Average Grade* of a gold mine in the Wits Basin is around 6 grams per ton of rock**
- 2. Gold in the Wits mines is not visible, it is inside Pyrite and requires physical and chemical processing for *liberation* and**
- 3. The processing to extract gold leaves behind large tailings facilities**
- 4. *Pyrite* is a Fe sulfide (FeS_2) and in contact with surface water can produce acidic drainage, which is dangerous to the environment.**
- 5. The layers are not horizontal but dip toward the South, therefore mine are going deeper and deeper, and more expensive**

1. Grade of Mine: around 6 gram of gold per ton of rock



Mining requires a lot of rock breaking, moving, and processing to gain the commodity

→ Gold is rare

→ There is a lot of underground workings in the Wits Basin (generations of miners)

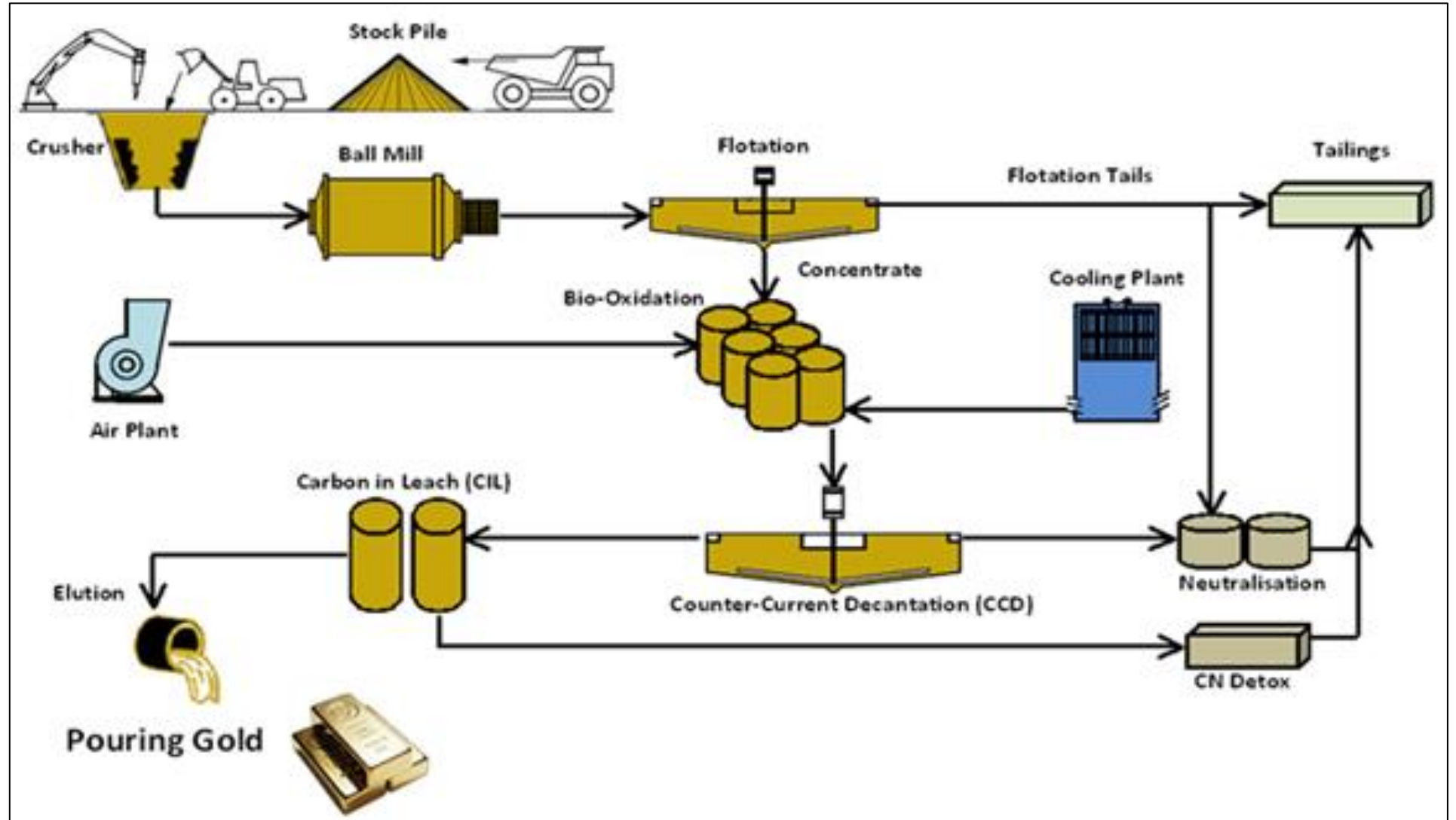
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2. Gold in the Wits mines is not visible, the liberation of gold from pyrite requires physical (milling) and chemical processing (cyanide solution)

Example of
processing plant for
gold



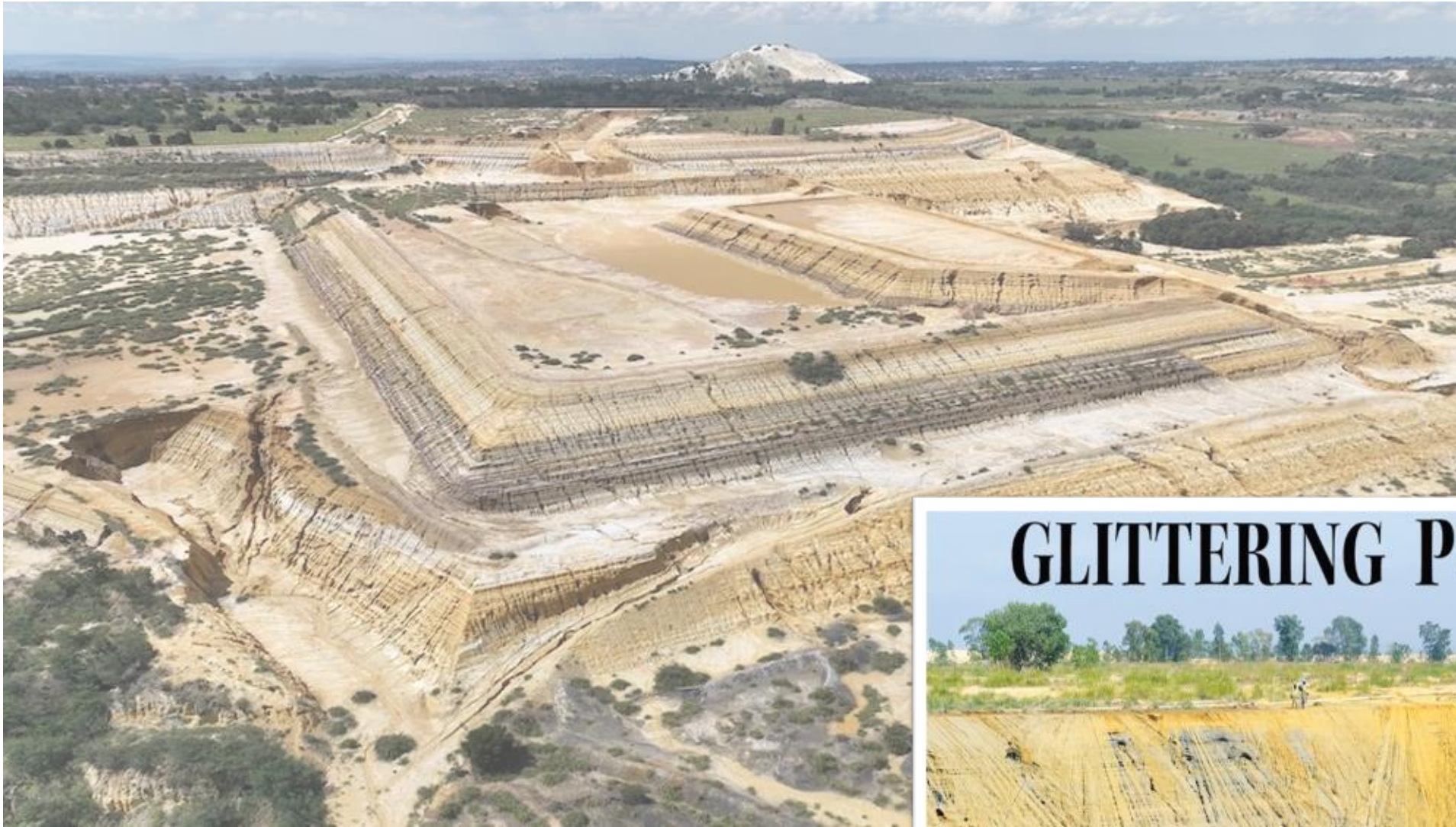
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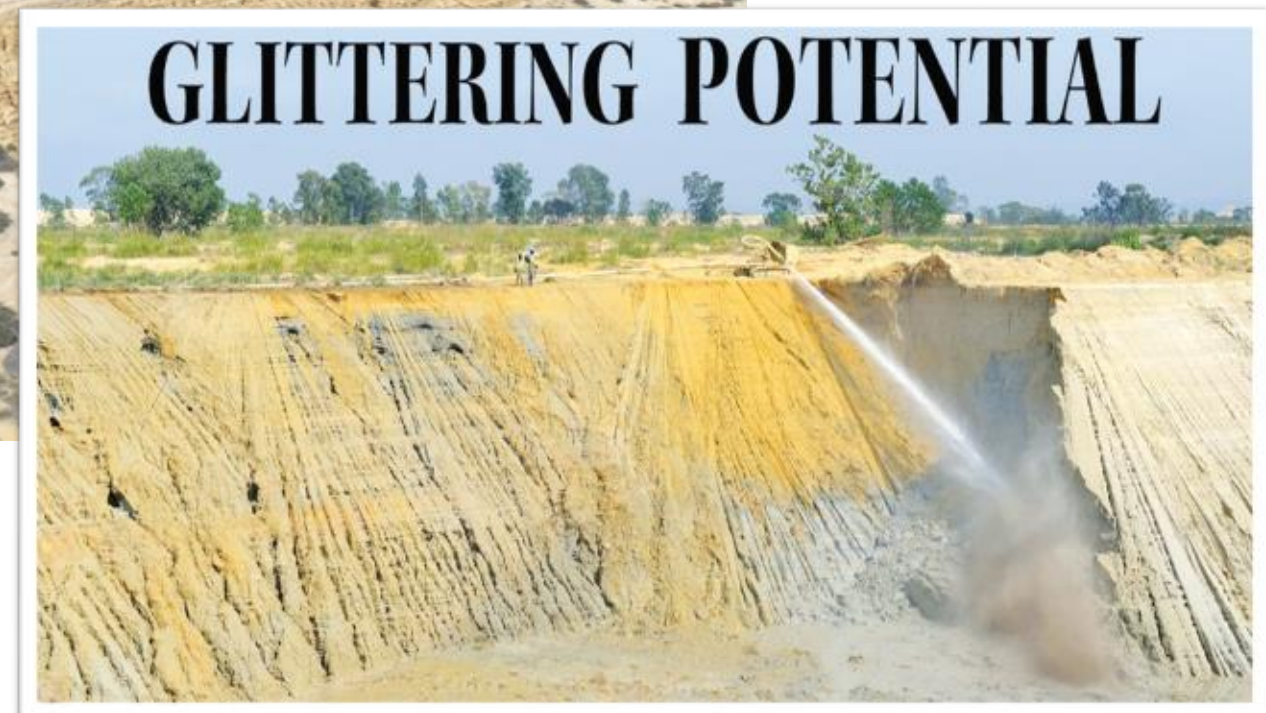
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Old tailings are reprocessed to extract the gold left behind also by artisanal miners



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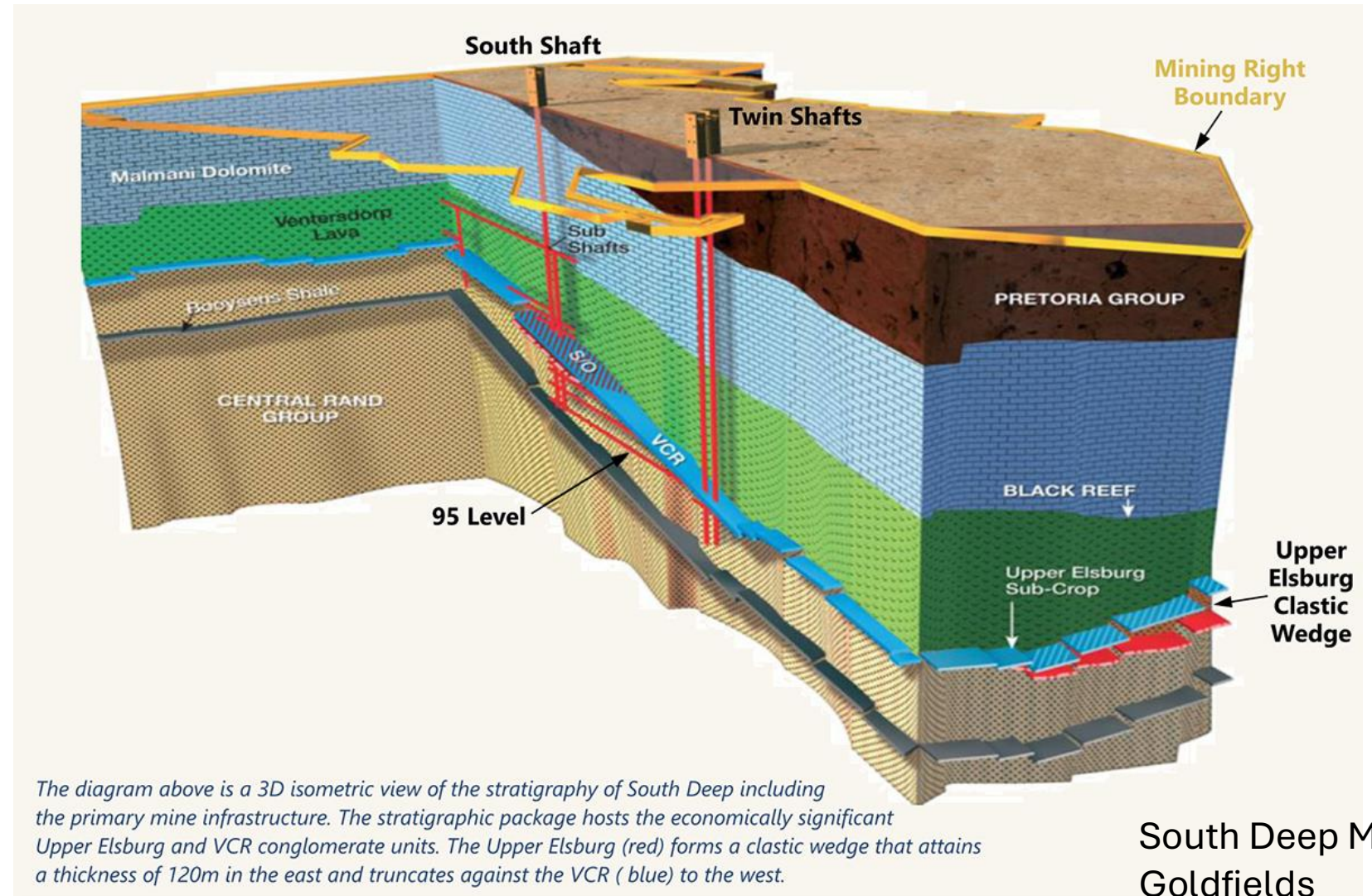
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- Mines are getting deeper and more expensive
- In the deepest mine in the Carletonville area miners work at about 4 km depth



Production in gold mining sector declined 17.4% year-on-year: Stats SA

13 October 2022, 12:30 PM |



SABC |

[@SABCNews](#)



Image: Reuters

Miners work deep underground at Sibanye Gold's Masimthembe shaft in Westonaria, South Africa, April 3, 2017

- Increase costs of production for conventional mining is making the mine not economic and mines are closing down
- Gold is still there and attractive for artisanal, informal miners

