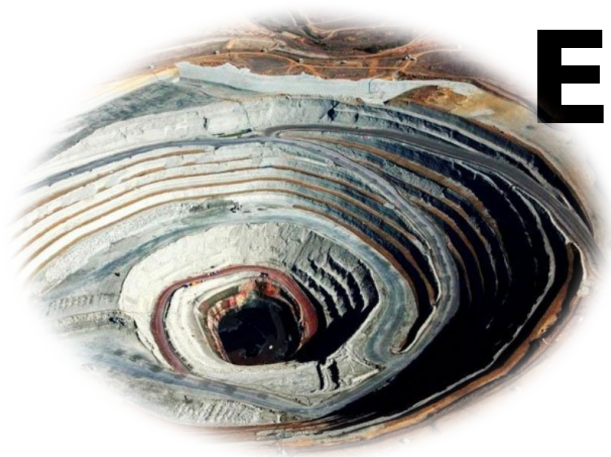




Chapter two

Basic principles of Exploration, Development and Exploitation



Session topic:

Basic principles of exploration and exploitation

Objectives:

By the end of the lesson students will be able to:-

- Define exploration.
- Differentiate exploration and exploitation.
- Identify the principal steps of exploration and exploitation.

Exploration and Exploitation

- *Mineral exploration is the process of finding **ore** (commercially viable concentrations of minerals) to **mine**.*
- *Mineral exploration **is a much more intensive, organized and professional form of mineral prospecting** and, though it frequently uses the services of prospecting, the process of mineral exploration on the whole is much more involved*

- Exploration field activities take place as part of a strategy (often called a “play”) ***to locate and define a particular economically mineable mineral commodity (ore) in a mineral province.***
- Large exploration plays are often broken down into individual projects (often a particular tenement group) and each project may contain one or more prospects.

- The prospect could be ***outcropping mineralization, an old mine, an area selected on the basis of some geological idea, or perhaps some anomalous feature of the environment*** (usually a geophysical or geochemical measurement) that can be interpreted as having a close spatial link with ore.
- The exploration geologist job ***is to generate new prospects and then to explore them in order to locate and define any ore body that might lie within them.***

Province scale - area selection

- Area selection is based on *applying the theories behind **ore genesis**, the knowledge of known ore occurrences and the method of their formation*, to known geological regions via the study of geological maps, to determine potential areas where the particular

Political, sovereign and other associated risks

- Any area selected for mineral exploration also carries various forms of sovereign and other associated risks; that is, ***the risk that even if a commercially viable deposit is present, political, environmental and social factors may make the discovery and development of the mineral resource unviable.***
- The ultimate result of an area selection process is the pegging or notification of exploration licenses, known as ***tenements***.

Target generation - Regional Scale

- The target generation phase involves investigations of the geology via *mapping, geophysics* and *conducting geochemical* or intensive *geophysical testing* of the surface and subsurface geology.
- In some cases, for instance in areas covered by soil, alluvium and **platform cover**, drilling may be performed directly as a mechanism for generating targets.

The proceeding steps are

Geophysical methods

Remote sensing

Geochemical methods

Resource evaluation

Reserve

definition

Extraction

• **Geophysical methods**

- Geophysics, is the study of the physical properties of the Earth. ("Geo" means Earth).
The main geophysical surveys undertaken as part of modern geological surveying include
 - Radiometrics
 - Magnetism
 - Gravity
- Radiometrics, Magnetism and Gravity data give us information about different sections of the Earth's crust.

- **Geochemical methods**

- Geochemical methods involve the measurement of the chemistry of the **rock, soil, stream sediments or plants** to determine abnormal chemical patterns which may point to areas of mineralization.

Exploitation

- *The ultimate goal of mineral exploration is the extraction, beneficiation and profitable and beneficial sale of mineral commodities.*
- Extraction methods may vary considerably and it is the discipline of *engineers* trained in *mining engineering* to determine the most safe, cost effective and efficient method of *mining* the ore body.

- enough exploration and development are done prior to exploitation to ensure that production, once started, can continue uninterrupted throughout the life of the mine.
- exploitation is the work of recovering mineral from the earth in economic amounts and delivering it to shipping or processing facilities.
- exploitation or production phase are associated with the daily activities of obtaining (extracting) a profitable product from the mineral reserve on a commercial scale, including any processing before sale.













Geostratigraphy of the Witwatersrand and surroundings:

K2 } Karoo
 K1 } Supergroup

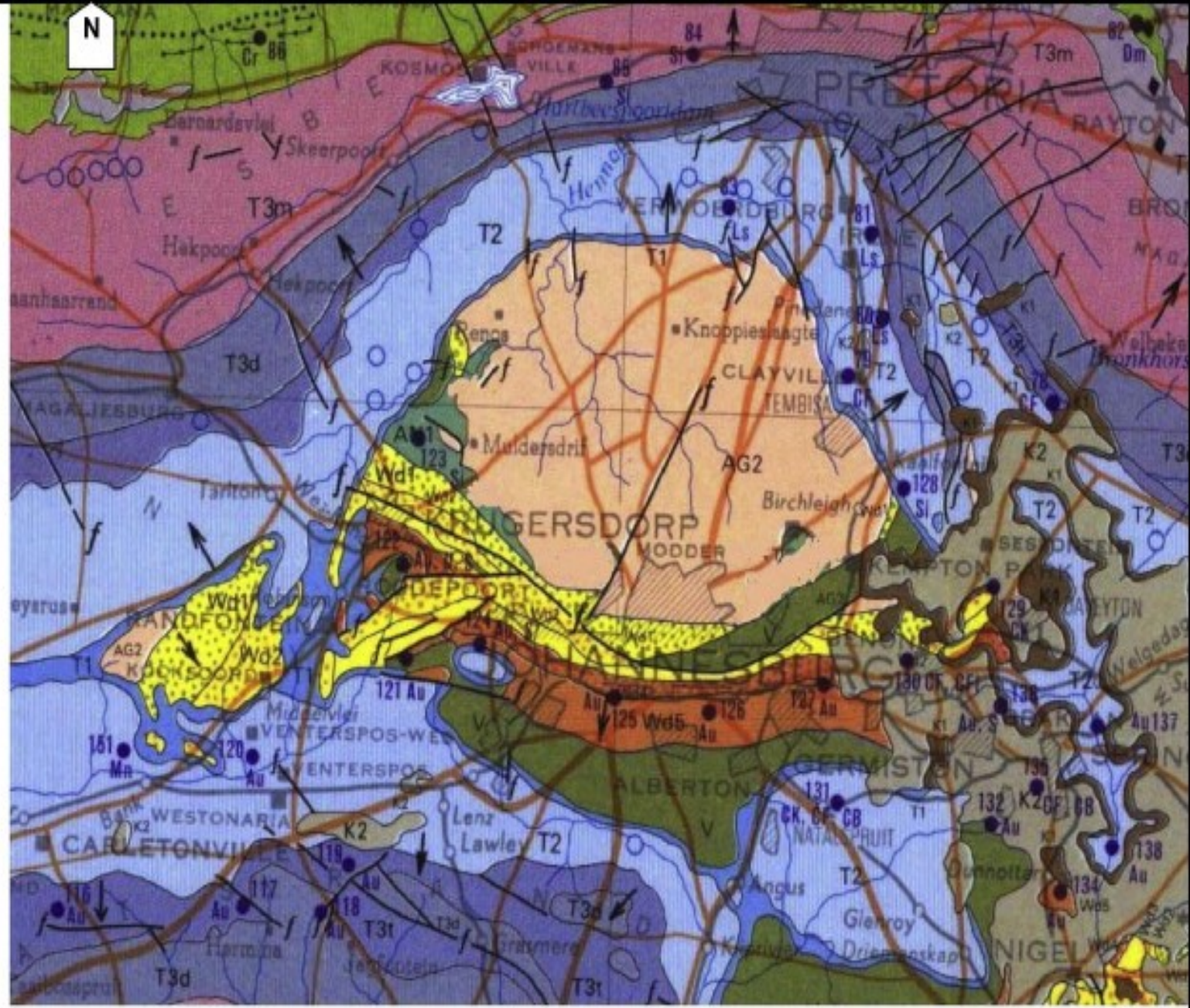
T3a } Transvaal
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 T2
 T1

Ventersdorp
 Supergroup

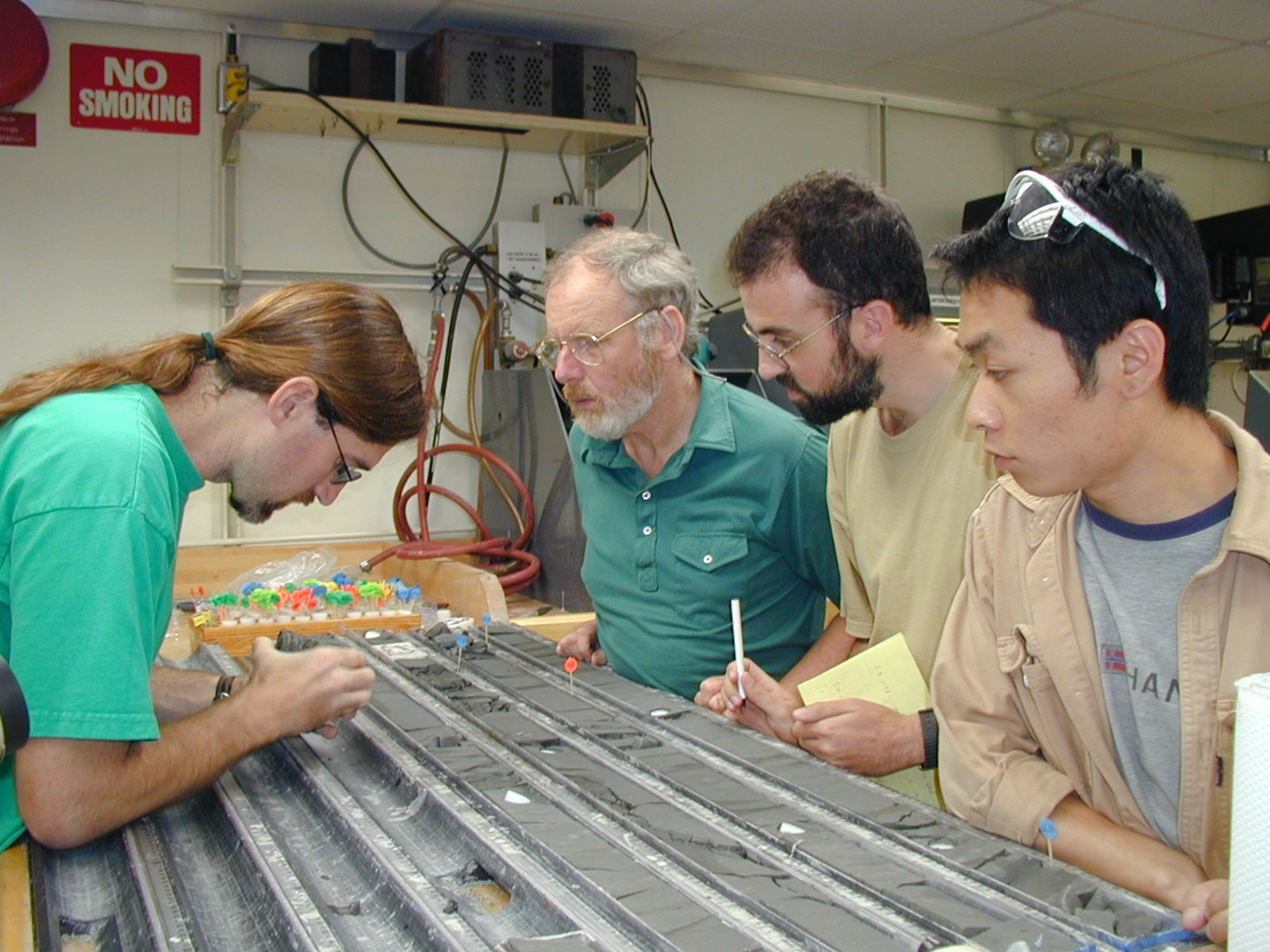
Wd5 } Witwatersrand
 Wd4 } Supergroup
 Wd3 }
 Wd2 }
 Wd1 }

AG2 } Archaean
 AN1 } Basement

Legend:
 — f — Fault
 — — — Railway line
 — — — Road
 — — — River
 [Hatched Box] Major urbanised area



10km
 Scale









exploration and exploitation of mineral deposits

1. **Mineral exploration:** to discover a mineral deposit.
2. **Feasibility study:** to prove its commercial viability.
3. **Mine development:** establishment of the entire infrastructure.
4. **Mining:** extraction of ore from the ground.
5. **Mineral processing:** milling of the ore, separation of ore minerals from gangue material, separation of the ore minerals into concentrates, e.g. copper concentrate; separation and refinement of industrial mineral products.

- 6 *Smelting:*** recovering metals from the mineral concentrates.
- 7 *Refining:*** purifying the metal.
- 8 *Marketing:*** shipping the product (or metal concentrate if not smelted and refined at the mine) to the buyer, e.g. custom smelter, manufacturer.
- 9 *Closure:*** before a mine has reached the end of its life, there has to be a closure management plan in place that details and costs the proposed closure strategies.

Geology in the exploration sequence

- We can't think exploration without geology. Exploration ideas can be raised based on the geological knowledge that we might have about the area. therefore, ***the initial point for exploration is knowledge about the regional geology.***
- ***geological mapping is required from regional scale to very detail***

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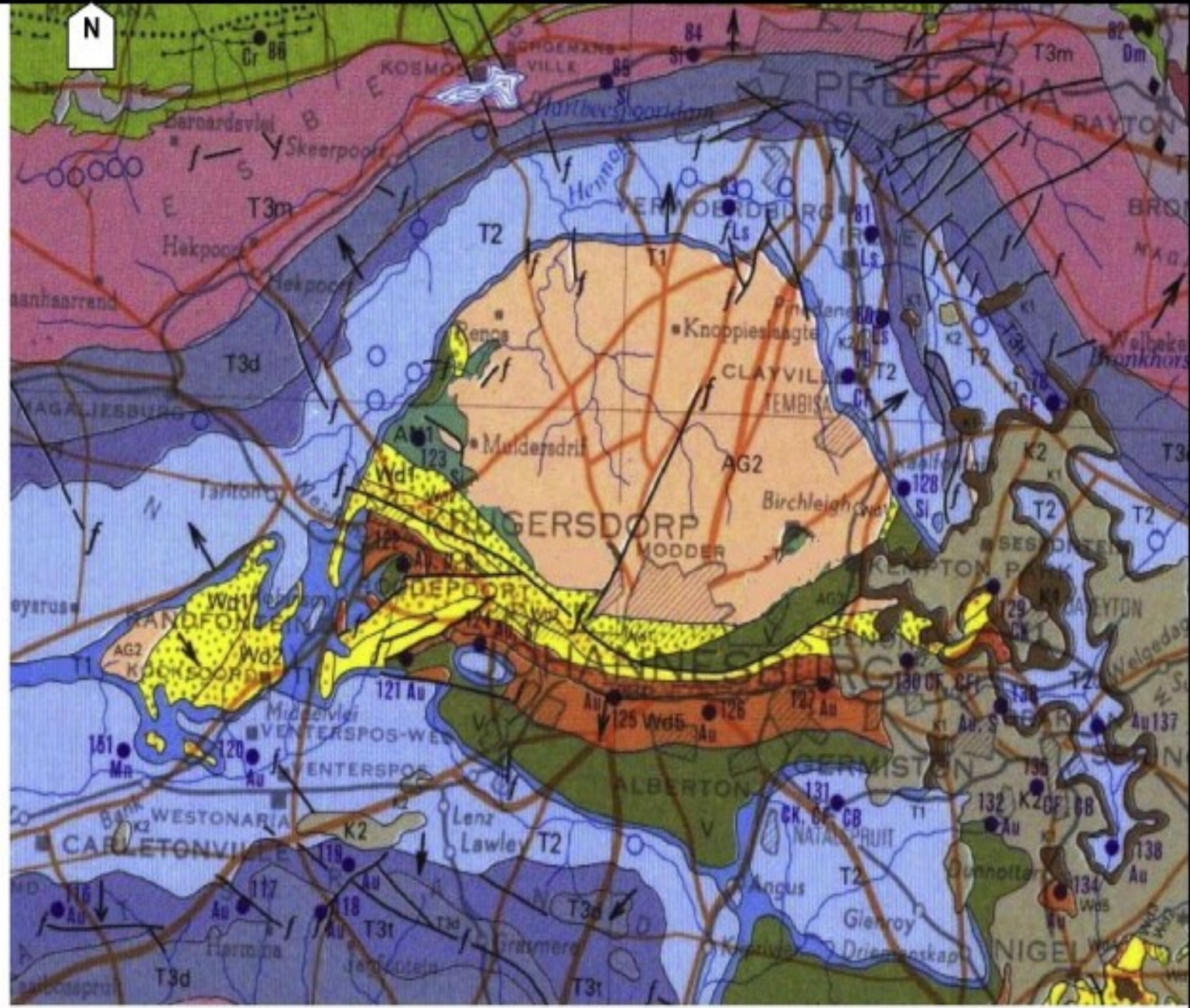
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10km
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- Geological mapping can be of different scale, based on how detail it is required up on the exploration sequence.
- It becomes detail as the exploration advances from a prospect in to target generation and target drilling stages.
- Before extraction and throughout, geological structural studies are very crucial, on the other hand geology controls the quality of the mineral being extracted in all stages.

Exploration Program Design

- Obviously not all prospects that are generated will make it through to a mine. ***Most will be discarded at the target generation or target drilling stages.***
- The large number of prospects ***initially generated decline through the exploration stages*** in an exponential manner.
- Success of exploration program ***depends on the number of initial prospects and the prospect wastage.***

➤ There are only two ways to turn an unsuccessful exploration program into a successful one; ***the exploration program either has to get bigger*** (i.e. increase the starting number of prospects generated) or ***the explorationist has to get smarter.***

- Some regional exploration methods involve widespread systematic collection of geophysical or geochemical measurements and typically result in the production of large numbers of anomalies.
- This is an ***empirical exploration style***. Generally little will be known about any of these anomalies other than the fact of their existence, but any one anomaly could reflect an ore body and must be regarded as a prospect to be followed up with a preliminary assessment usually a field visit.

- The opposite type of prospect generation involves applying the theories of ore forming processes to the known geology and mineralization of a region, so as to predict where ore might be found. This is a **conceptual exploration approach**.
- Conceptual exploration will generally lead to only a small number of prospects being defined. These are much more likely to be “quality” prospects, in the sense that the chances are higher that any one of these prospects will contain an ore body compared to prospects generated by empirical methods.

- Empirical and conceptual generation and targeting are two end members of a spectrum of exploration techniques, and few actual exploration programs would be characterized as purely one or the other
- Conceptual generation and targeting tends to play a major role ***where there are high levels of regional geological knowledge and the style of mineralization wanted is relatively well understood***. Such conditions usually apply in established and well-known mining camps such as (for example) the Bushveld region of South Africa.

- Empirical techniques tend to play a greater role in greenfield exploration programs, ***where the levels of regional geological knowledge are much lower and applicable mineralization models less well defined.***