



URBAN HYDROLOGY: WATER IN THE CITY OF TSHWANE  
Plant Sciences Auditorium, University of Pretoria  
23 – 24 January 2014

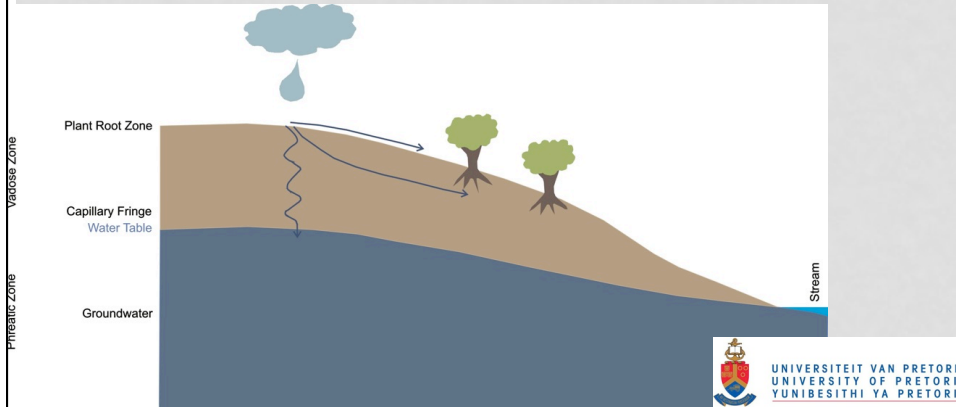
# URBAN HYDROGEOLOGY

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# HYDROGEOLOGY

- Classically groundwater; recently also:
  - Importance of vadose zone
  - Importance of interaction with surface water



The diagram illustrates the vertical profile of the ground. At the top, a cloud with a raindrop is shown. Below it, the Plant Root Zone is depicted with two trees. The Vadose Zone is the layer below the root zone, containing the Capillary Fringe and the Water Table. The Phreatic Zone is the saturated zone below the water table, containing Groundwater. A Stream is shown on the right side of the diagram, with an arrow indicating the interaction between the stream and the groundwater.



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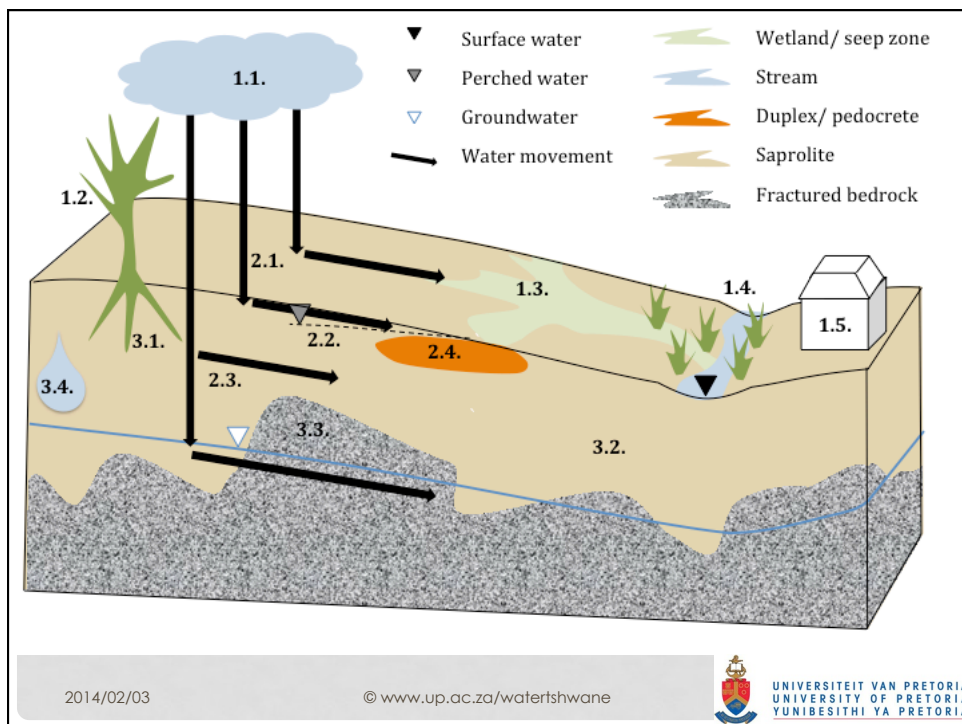


## URBAN HYDROGEOLOGY

- System more intricate due to, e.g.:
  - Uncontrolled groundwater abstraction
  - More different and denser distribution of sources of contamination
  - More impact of contaminated water to the residents and the environment
  - Less groundwater recharge due to surface sealing and stormwater removal
  - More localised and concentrated influx due to irrigation and water diversion (e.g. golf estates)
  - More impact on deep excavations, slopes and other engineering structures given interruption of flow paths

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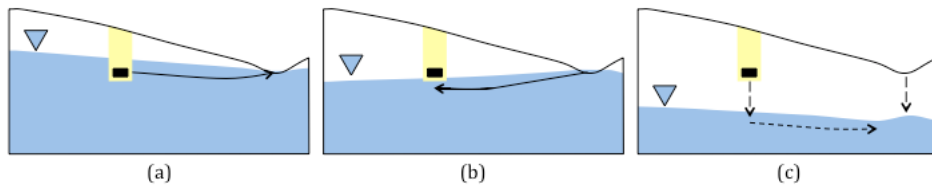
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## URBAN HYDROGEOLOGY

- Surface/ shallow subsurface contaminant sources
  - USTs, cemeteries, waste disposal sites
  - Alter soil hydrology through disruption of natural materials and flow paths (backfill)
  - Increase potential contaminant load
  - → need to understand hydrological interaction in detail



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## HYDROSTRATIGRAPHY

- Classification based on:
  - Stratigraphy – age, formation, composition
  - Hydrology – behaviour related to water
- Includes, for this purpose, details on:
  - Geomorphological development
  - Quaternary geology and soils
  - Structural geology and deformation
  - Recent and present influences (e.g. climate, soil profile development)

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## INFLUENCE OF GEOLOGY

- Aquifers
  - Occurrence of groundwater, including their yield, the source of springs, origins of rivers, supply to industry and communities in and downstream of municipality
  
- Seepage
  - Governs groundwater recharge, plant water availability, groundwater dependent ecosystems, SW-GW interaction and riparian habitats
  - Influences construction materials and construction per se
  
- Soil and rock
  - Defines appropriate land use

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## INFLUENCES OF WATER ON GEOLOGY

- Engineering (Geology):
  - Dissolution resulting in loss of material in soluble rocks and karstification, causing cavities, subsidence and/ or collapse
  - Erosion or piping resulting in loss of material, sheetwash, internal erosion and gully erosion, causing subsidence, collapse, settlement, piping and/ or silting
  - Chemical reactions resulting in changes in chemical composition, attacking cement, aggregates, metals and rocks
  - Weathering resulting in changes in the chemical and physical properties of the materials, causing decrease in strength and increasing deformability and permeability.

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## INFLUENCES OF GEOLOGY ON WATER

- Hydro(geo)logy:
  - Alignment of surface drainage
  - Aquifer vulnerability
    - USTs
    - Sanitation
    - Cemeteries
    - Waste disposal and landfills
  - Groundwater recharge
  - Water supply

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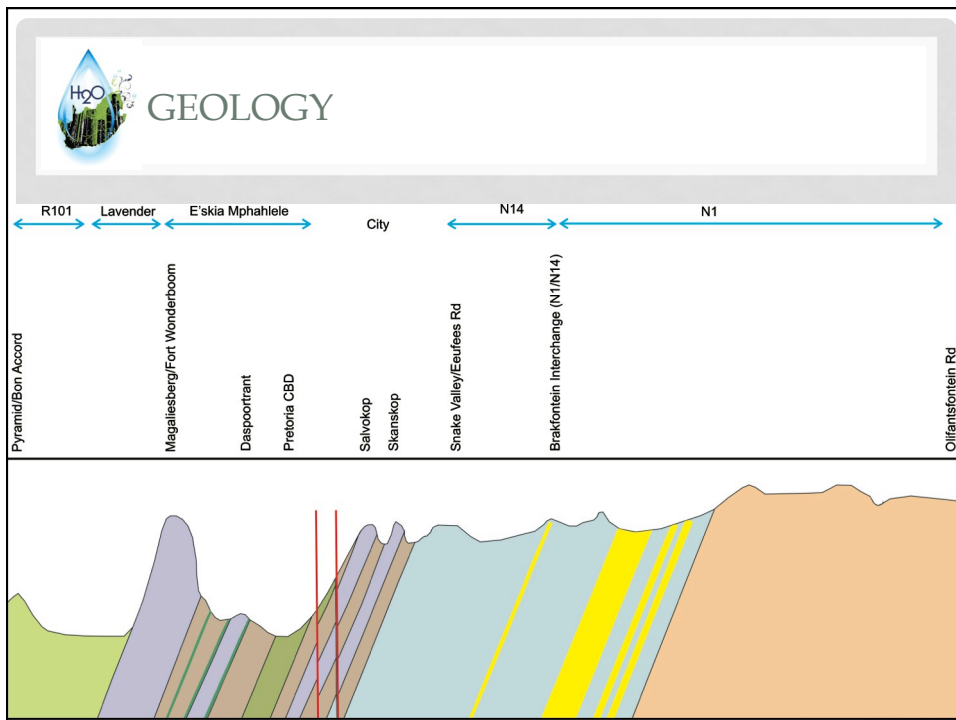
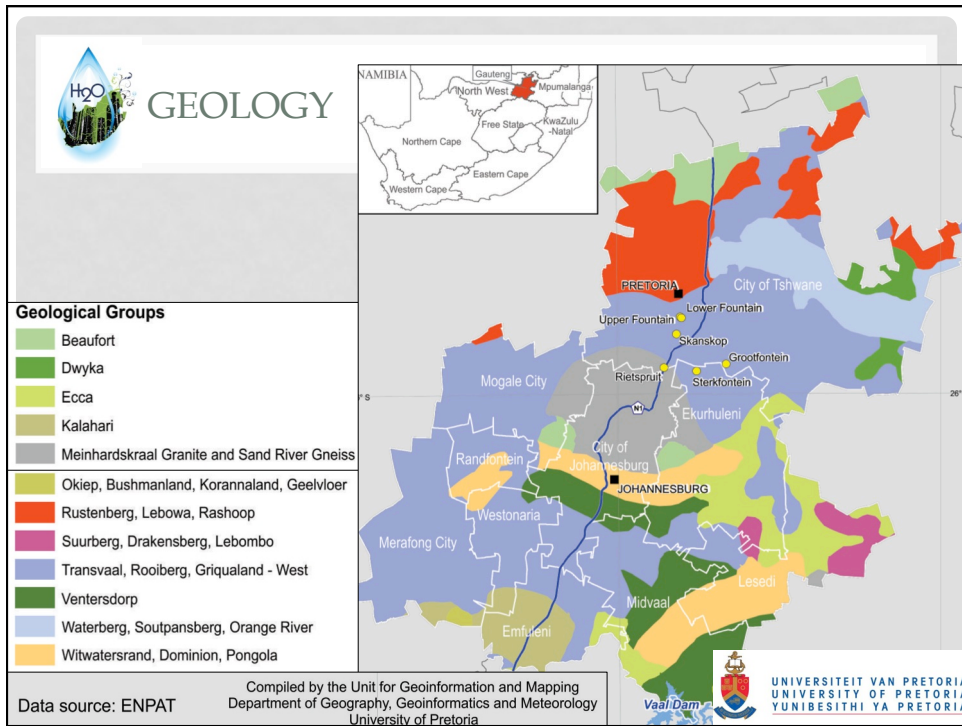
## INFLUENCES OF GEOLOGY

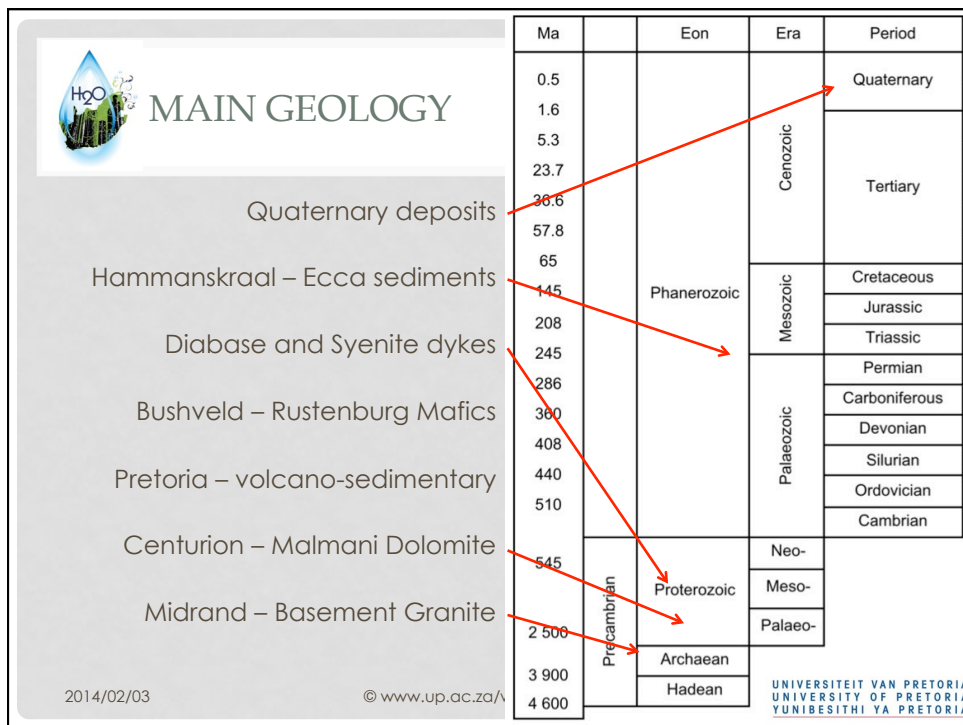
- Environmental and Biological Science:
  - Creates the habitat or growth medium
  - Direct influence in biodiversity
- Becomes a function of Soil Science:
  - Nutrients
  - Water retention and plant water availability

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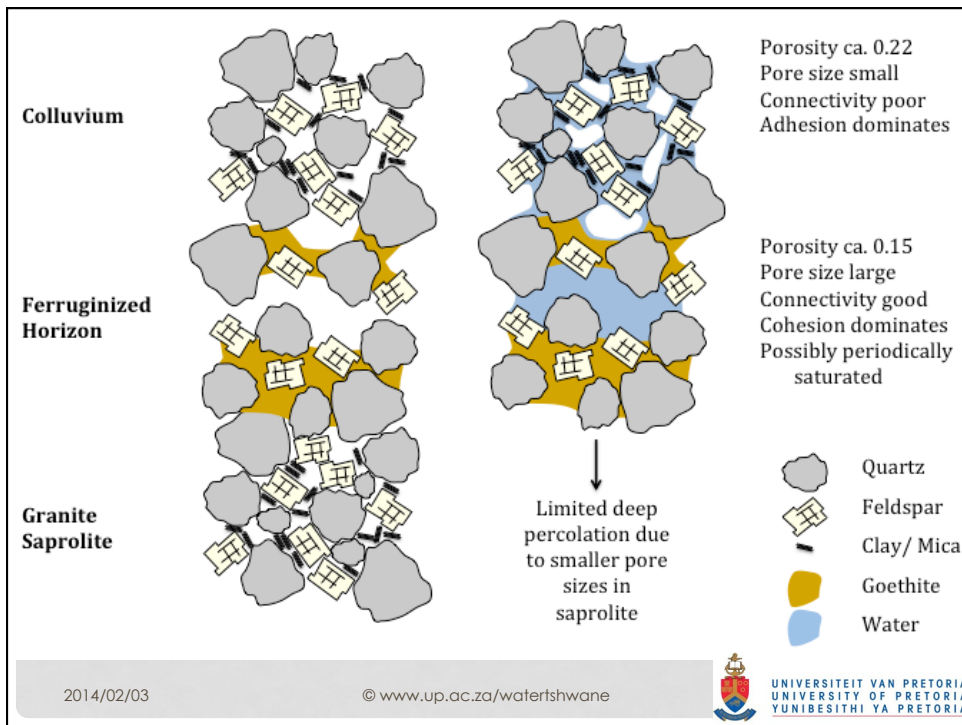
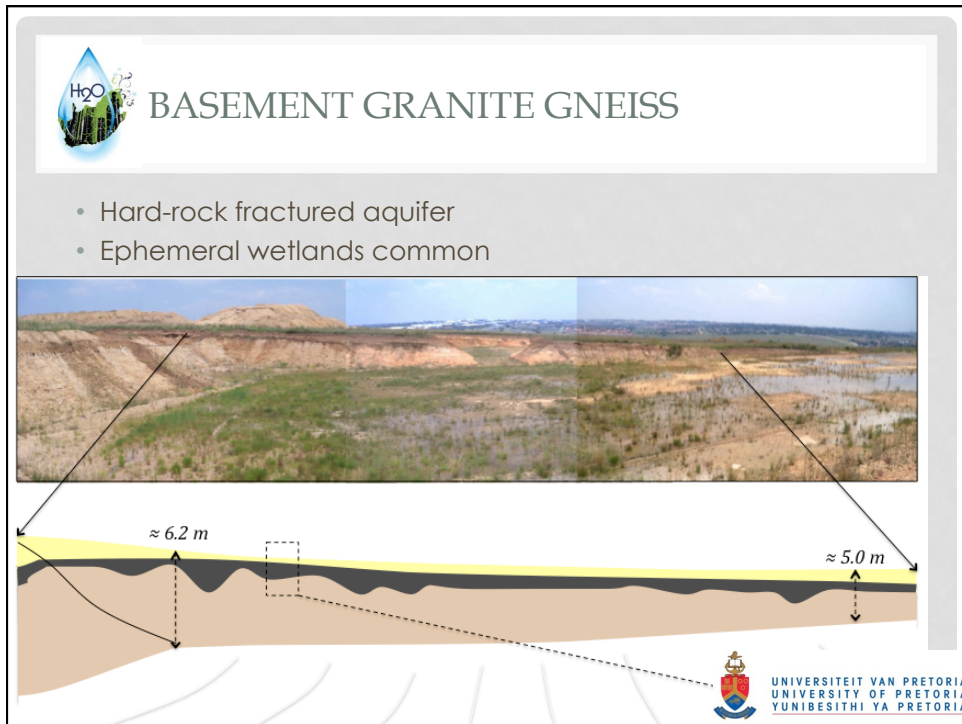


### BASEMENT GRANITE GNEISS

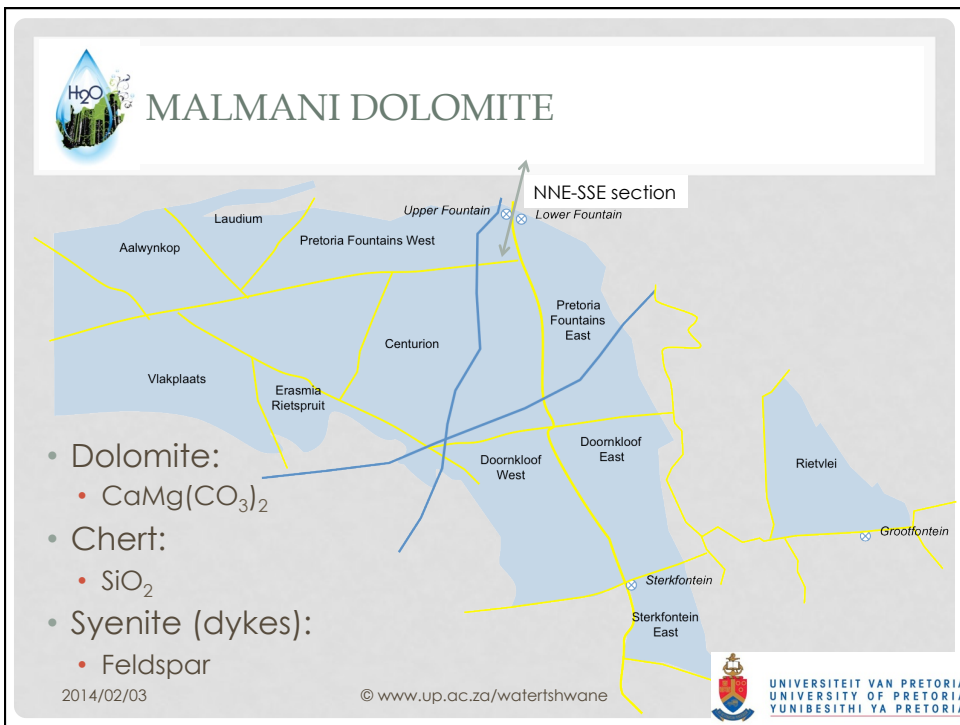
- Tonalite:
  - Trondjemite-tonalite (plag ≥ qtz >> kfs)
  - Collapsible
  - Possibly dispersive; erodible
- Migmatite:
  - Coarse-grained felsic granite with dark gneiss bands
  - Fe-precipitation and clay translocation
  - Possible localised expansive soils


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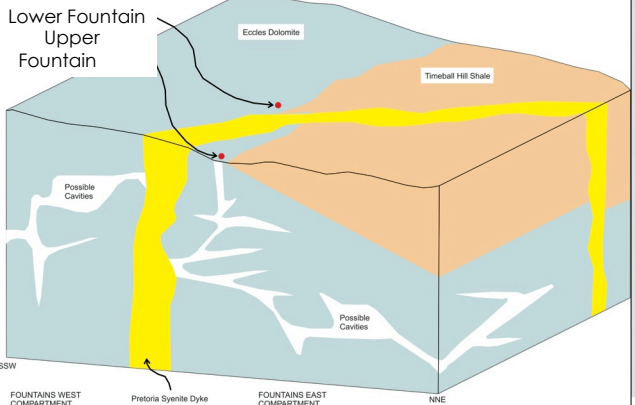





## MALMANI DOLOMITE

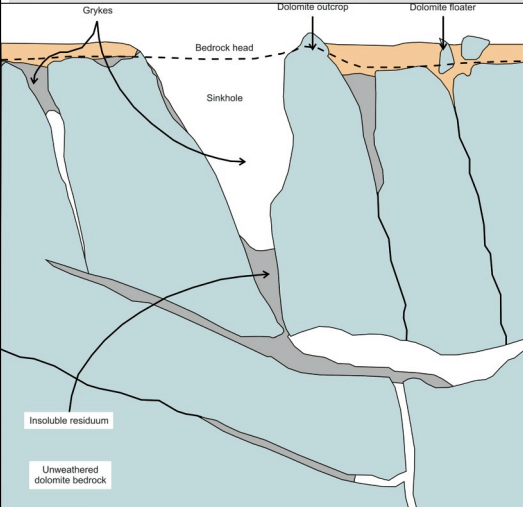
- Aquifer:
  - Karst (large cavities ("underground caves"))
  - And/or fractured









## MALMANI DOLOMITE



- Main concerns:
  - Sinkholes
  - Dolines



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## PRETORIA VOLCANO-SEDIMENTS



Magaliesberg Quartzite


Silverton Shale

Daspoort Quartzite

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## PRETORIA VOLCANO-SEDIMENTS

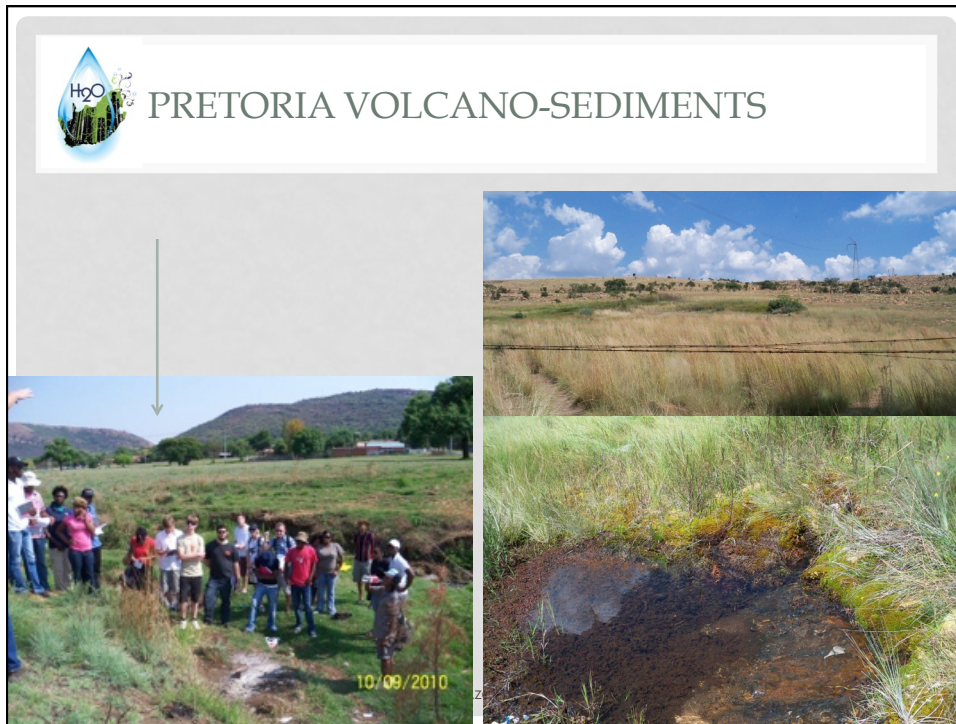
- Sandstone (often metamorphosed to quartzite)
  - Generally sandy soils
  - Fractured if serving as an aquifer

Daspoort Fm

Magaliesberg Fm








**PRETORIA**


- Shale
  - Shallow bedrock
  - Clayey soils
- Andesite
  - Deep weathering
  - Clayey soils
- Both possibly expansive

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## BUSHVELD MAFICS

- Gabbronorite
  - Subject to forming highly active clays
  - North of Pretoria
  - Most typical topographical feature: Pyramid and Bon Accord Quarry
- Major impact on water
  - Bushveld mining




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## HAMMANSKRAAL SEDIMENTS


- Sandstone/ siltstone/ shale
  - Ecca Group correlation in Springbok Flats Basin



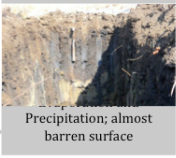
Waterlogged land



Duplex soils and grass veldt




Waterlogged land



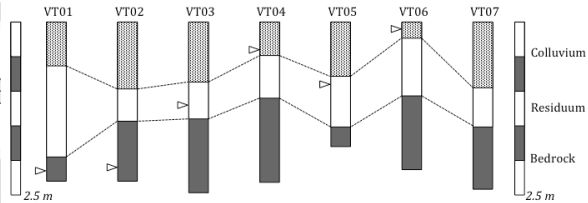
Precipitation; almost barren surface

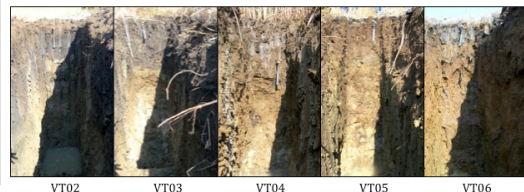
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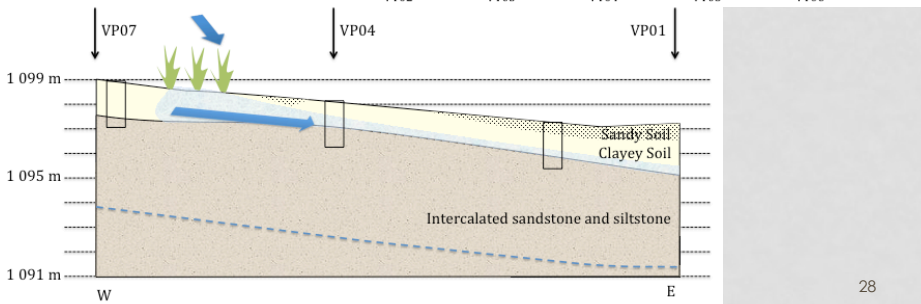


## HAMMANSI

- Water
  - Shallow seepage and SW-GW interaction through wetland







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## MADE GROUND



## SUMMARY

- Geology closely related to
  - Soils forming
  - Geomorphology
  - Surface hydrology
- Lithology determines
  - Behaviour of problem soils
  - Seepage
  - Ability to store and transmit water
  - Alignment of surface drainage



## SUMMARY

- Risk minimised through
  - Detailed investigation dependent on purpose
  - Geotechnical/ engineering geological
  - Hydrogeological/ geohydrological
  - Soil assessments
  - Wetland delineation



## PROJECTS ON THE TOPIC

- Dippenaar, M. A. (2013). Hydrogeological Heritage Overview: Pretoria's Fountains – Arteries of Life. WRC Report No. SP 44/13. Water Research Commission. Pretoria.
- Dippenaar, M. A. et. Al. (2014). Vadose Zone Assessment Manual. WRC Project K5/2052. Water Research Commission. Pretoria.