4th SADC GROUNDWATER CONFERENCE

10th -12th of November 2021

VIRTUAL CONFERENCE

GROUNDWATER MANAGEMENT INSTITUTE

Using Magnetotelluric technique to investigate a typical bedding plane Karoo fractured-rock aquifer

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IUCN BRIDGE International Association of Hydrogeologists the World-wide Groundwater Organisation IWMI International Water Management Institute GRIPP GROUNDWATER SOLUTIONS INITIATIVE FOR POLICY AND PRACTICE igrac International Groundwater Resources Assessment Centre BGS British Geological Survey IGS INSTITUTE FOR GROUNDWATER STUDIES UNIVERSITY BOTSWANA

Presentation Outline

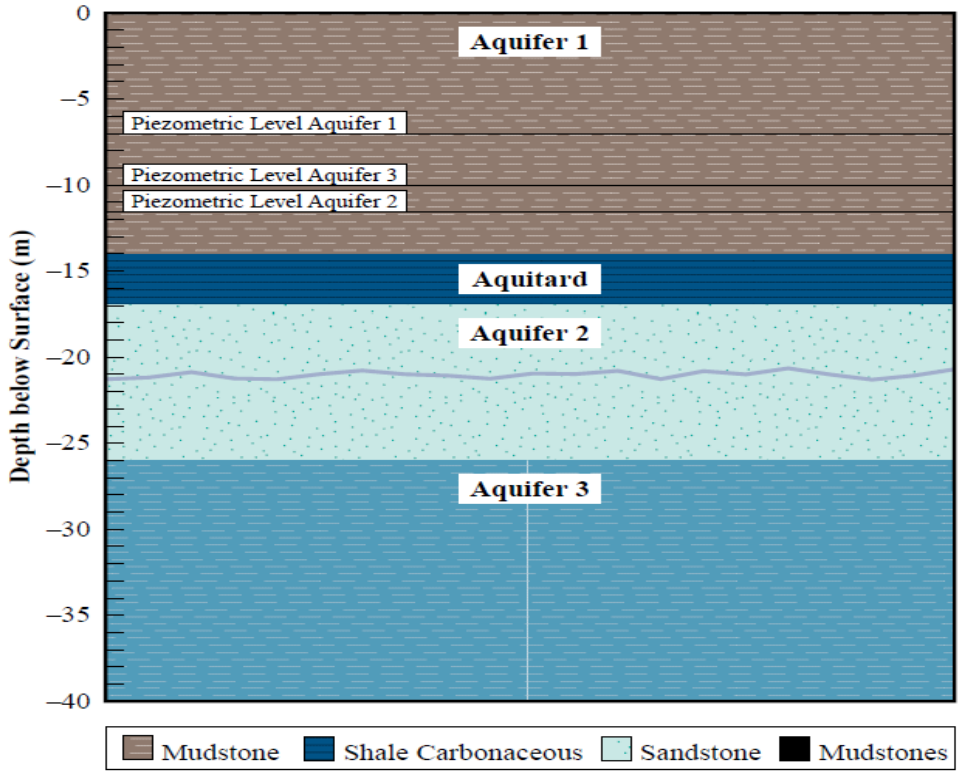
- Introduction
- Methods and material
- Results
- Conclusion

Introduction

- The magnetotelluric (MT) geophysical survey technique uses both electrical and magnetic field principles to investigate hundreds of meters of the subsurface resistivity structures.
- Despite this unique ability to effectively image and outline the vertical variation of the Earth's resistivity structures with depth, the MT method has not been applied to map fractured aquifers.
- In this study, the application of MT geophysical technique to delineate a typical bedding plane Karoo fractured-rock aquifer.
- The bedding plane fracture is located at the University of the Free State in Bloemfontein in South Africa. The site has been extensively used for research purposes by the Institute of Groundwater Studies (IGS) (Van der Voort and Van Tonder (2000); Fourie (2003))and as such as provided detailed information for comparing the MT results.

Introduction

- Previous studies on fractured aquifers in the Karoo revealed that the fractured zones may be formed between two closely-separated bedding-plane (Riemann and Van Tonder, 2001).

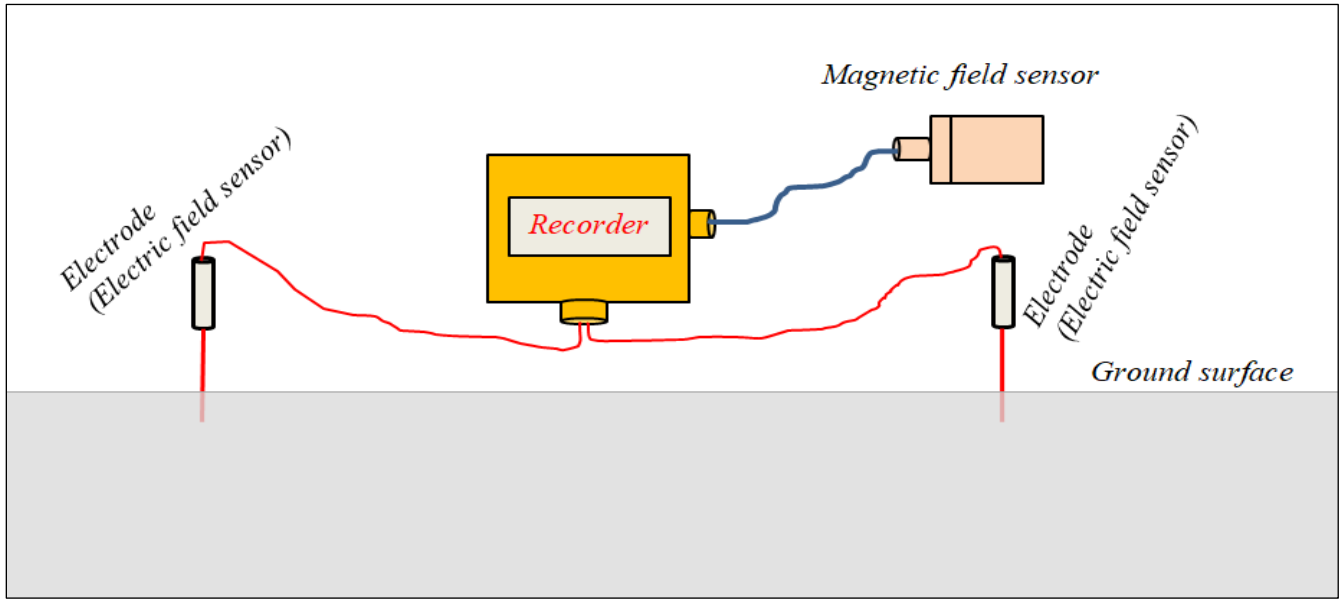


Source: Botha et al 1998

Methods and Materials

Principles of MT operation

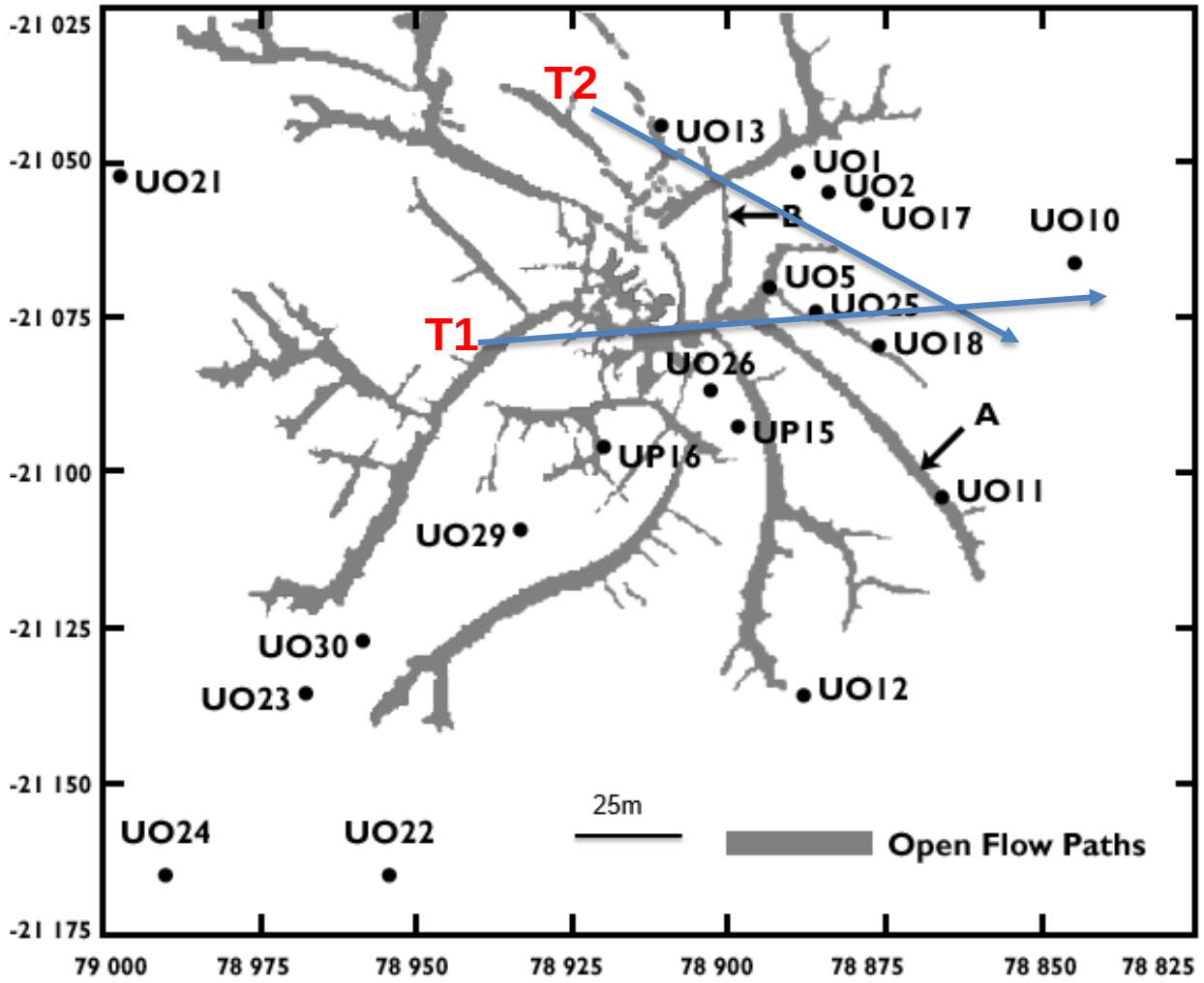
- Is an EM technique for which electric and magnetic fields are measured in orthogonal direction of the Earth surface.
- It utilises the geomagnetic variations as power source (Chave, 2012).
- Measurements are made every 5m depth intervals to create a vertical apparent resistivity profile of up to 150m deep.
- 1m station spacing was used.
- separation spacing between the two electrodes was10m.



Field layout of the MT survey (Gomo,2021)

Methods and materials

Traverse layout

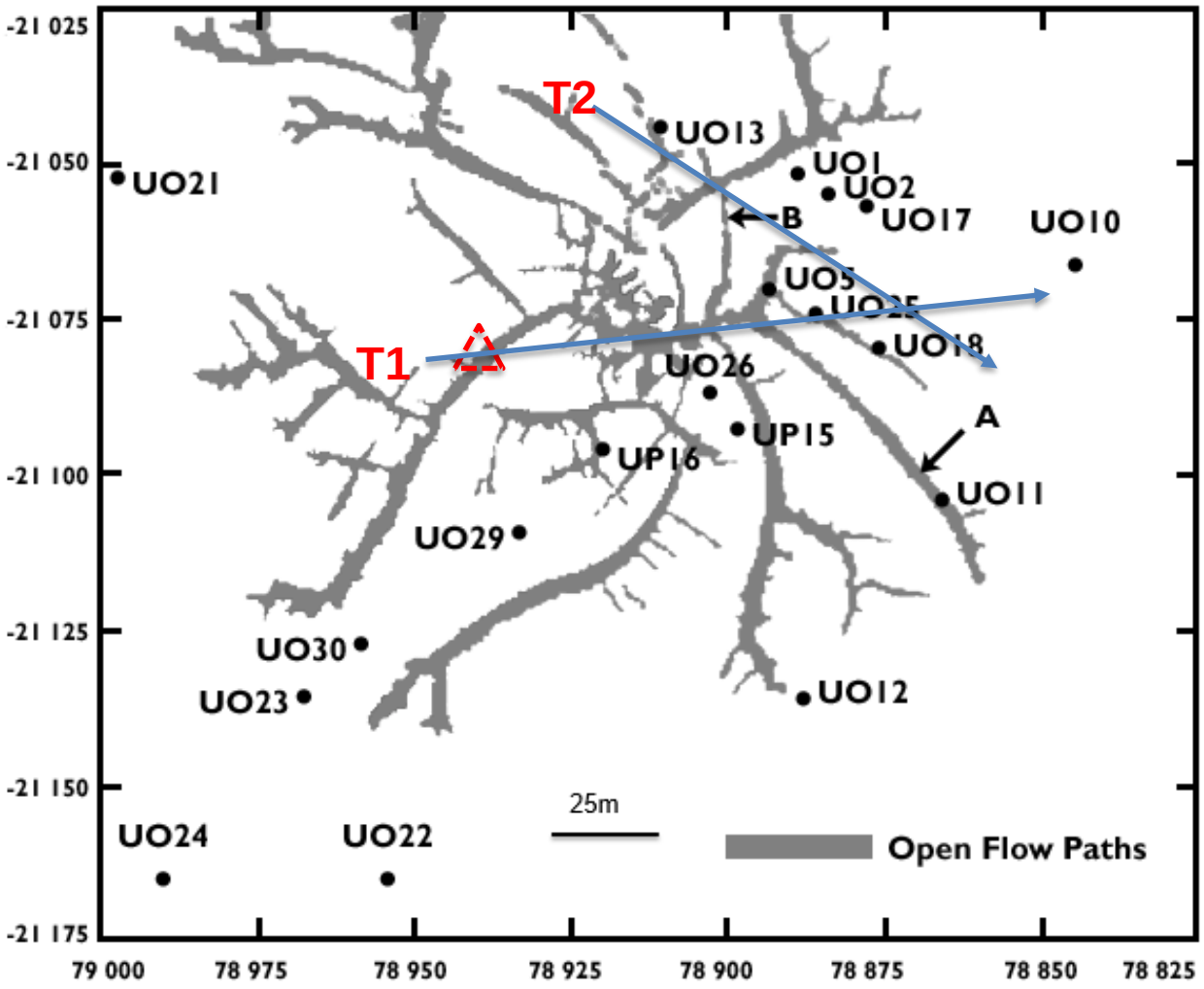


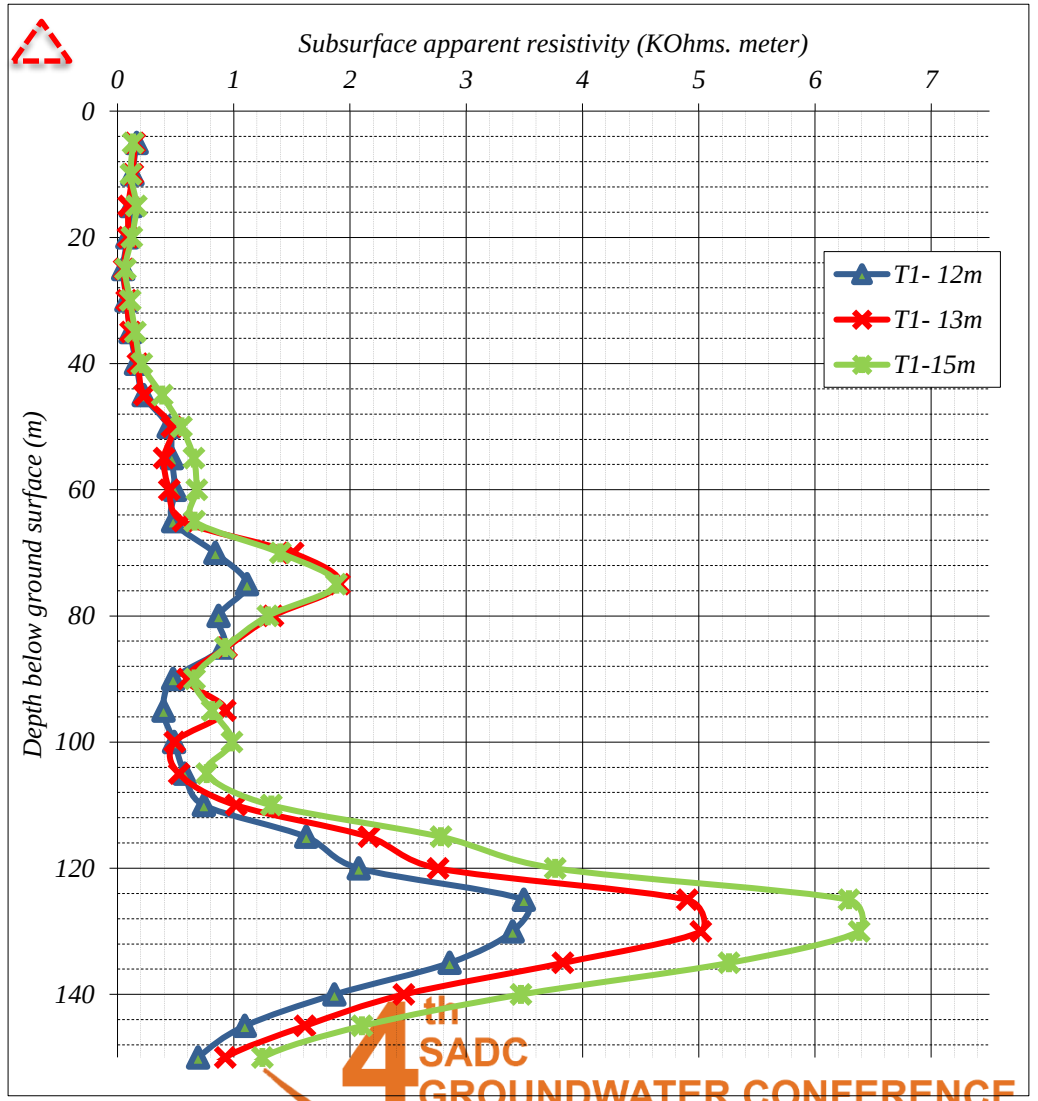
Representation of the geometry of the fracture on Campus Test (Van der Voort and Van Tonder, 2000)

- Two traverse lines (T1 and T2) were identified, targeting mainly to intersect the horizontal fracture network multiple points)
- T1 was 80m and T2 was 70m long.
- The traverses were mainly limited by the presence of local infrastructure (fence and road) closer to the site.

Results

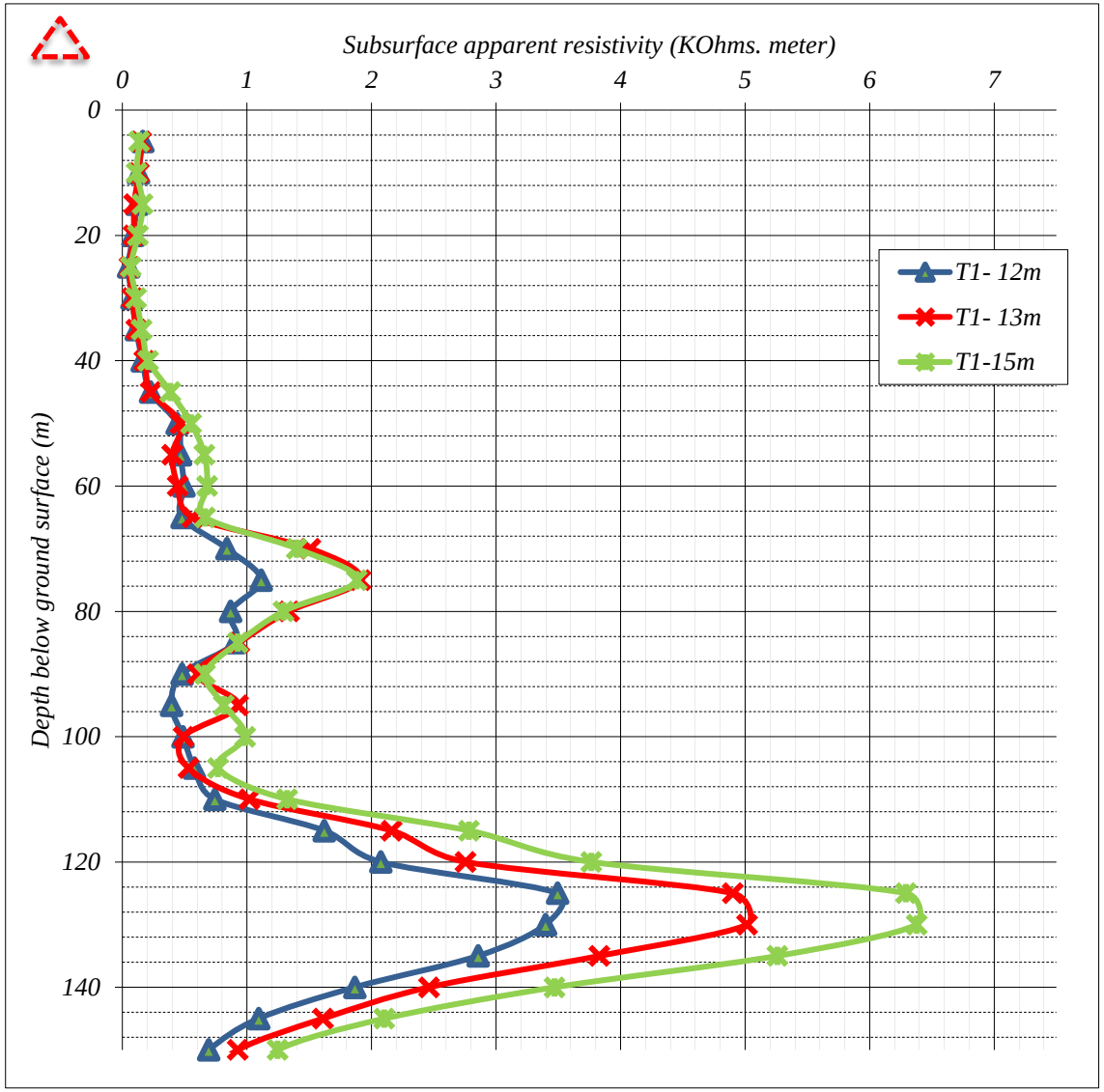
On the fracture





Representation of the geometry of the fracture on Campus Test (Van der Voort and Van Tonder ,2000)

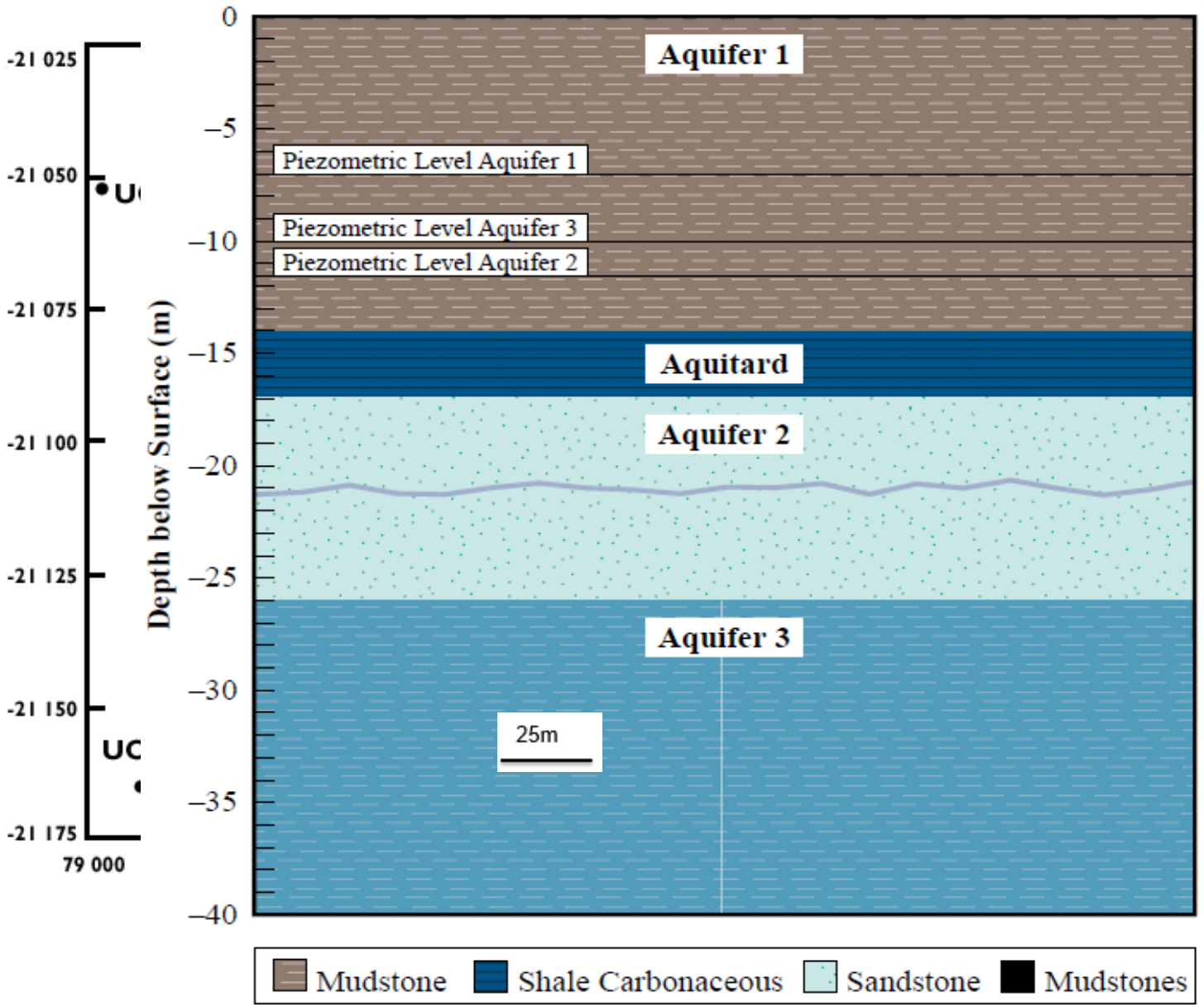
Results

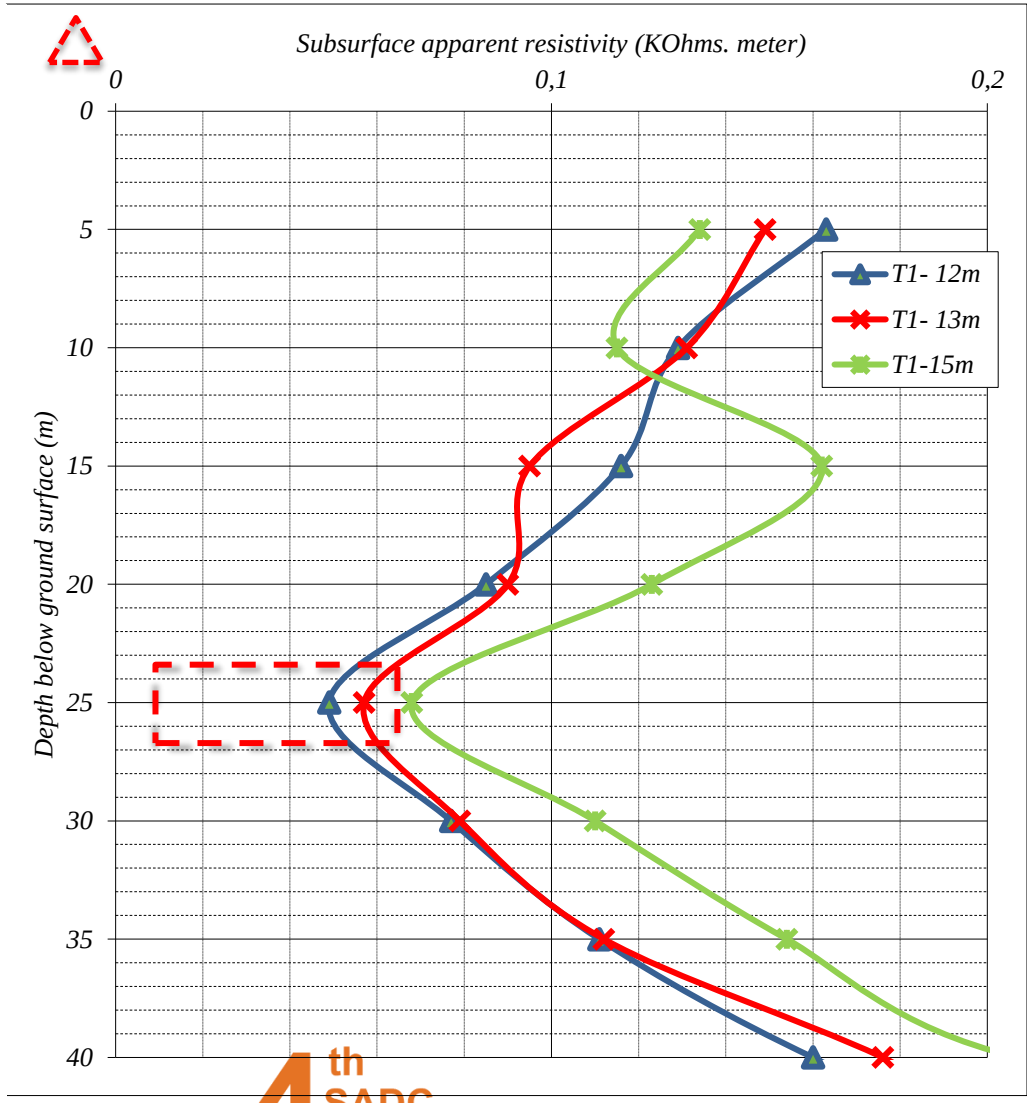


Apparent of resistivity of the subsurface measured along traverse T1

- The apparent resistivity profile shows oscillations with depth which is an indicative of varying geological material with depth.
- Some studies suggest that low apparent resistivity zones (<0,05 KΩm) are a typical indication of saturated groundwater bearing zones (Gomo, 2021).

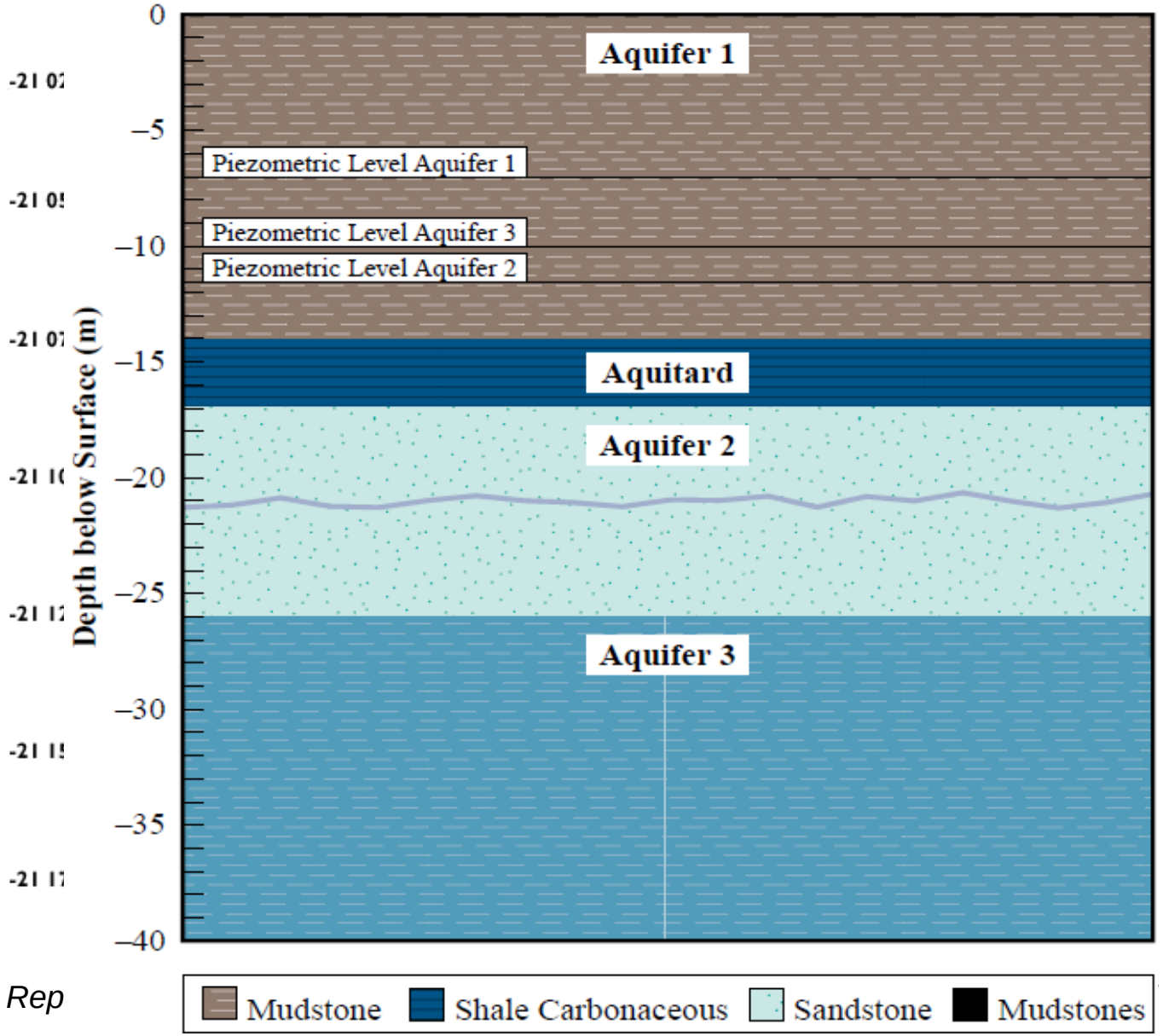
Results





Representation of the geometry of the fracture on Campus Test Van der Voort and Van Tonder (2000)

Results



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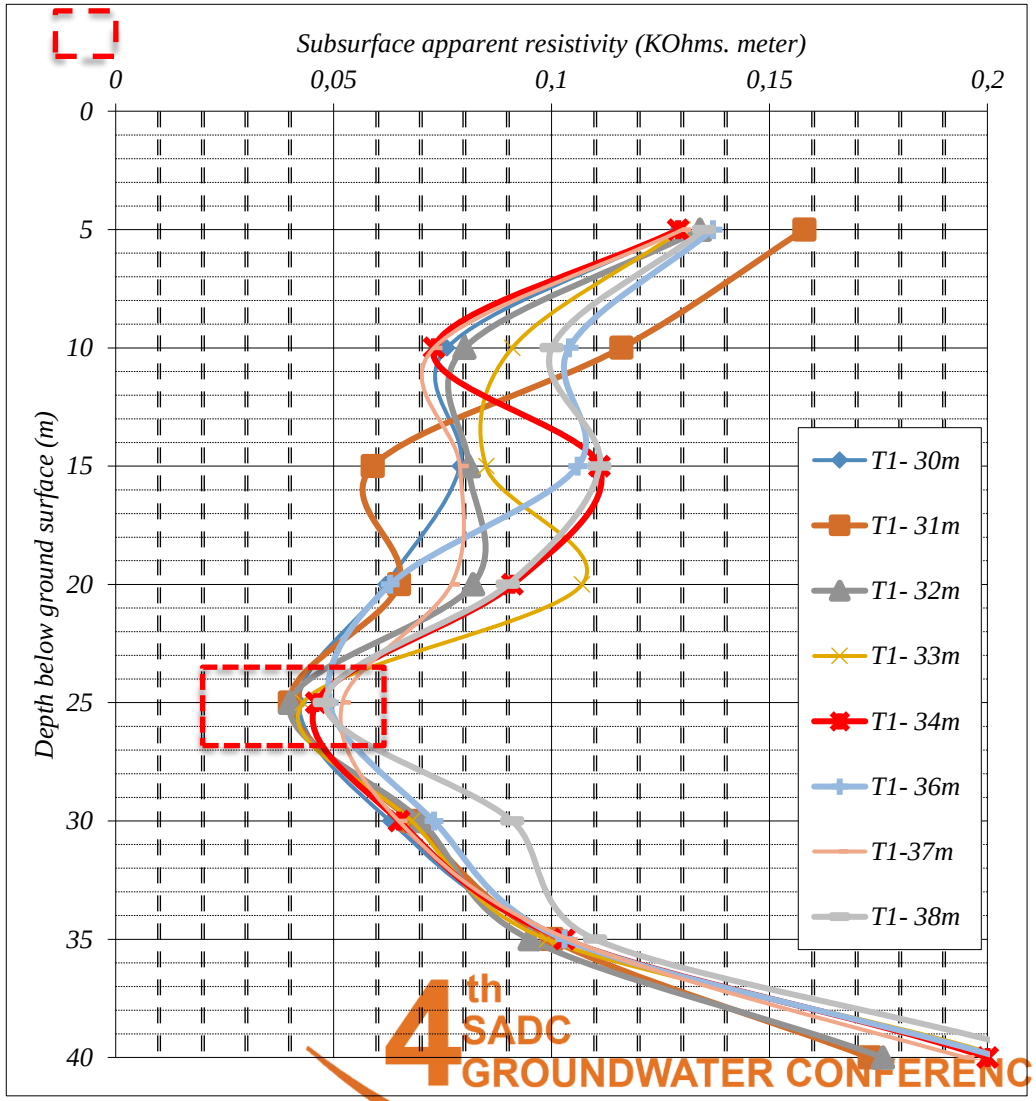
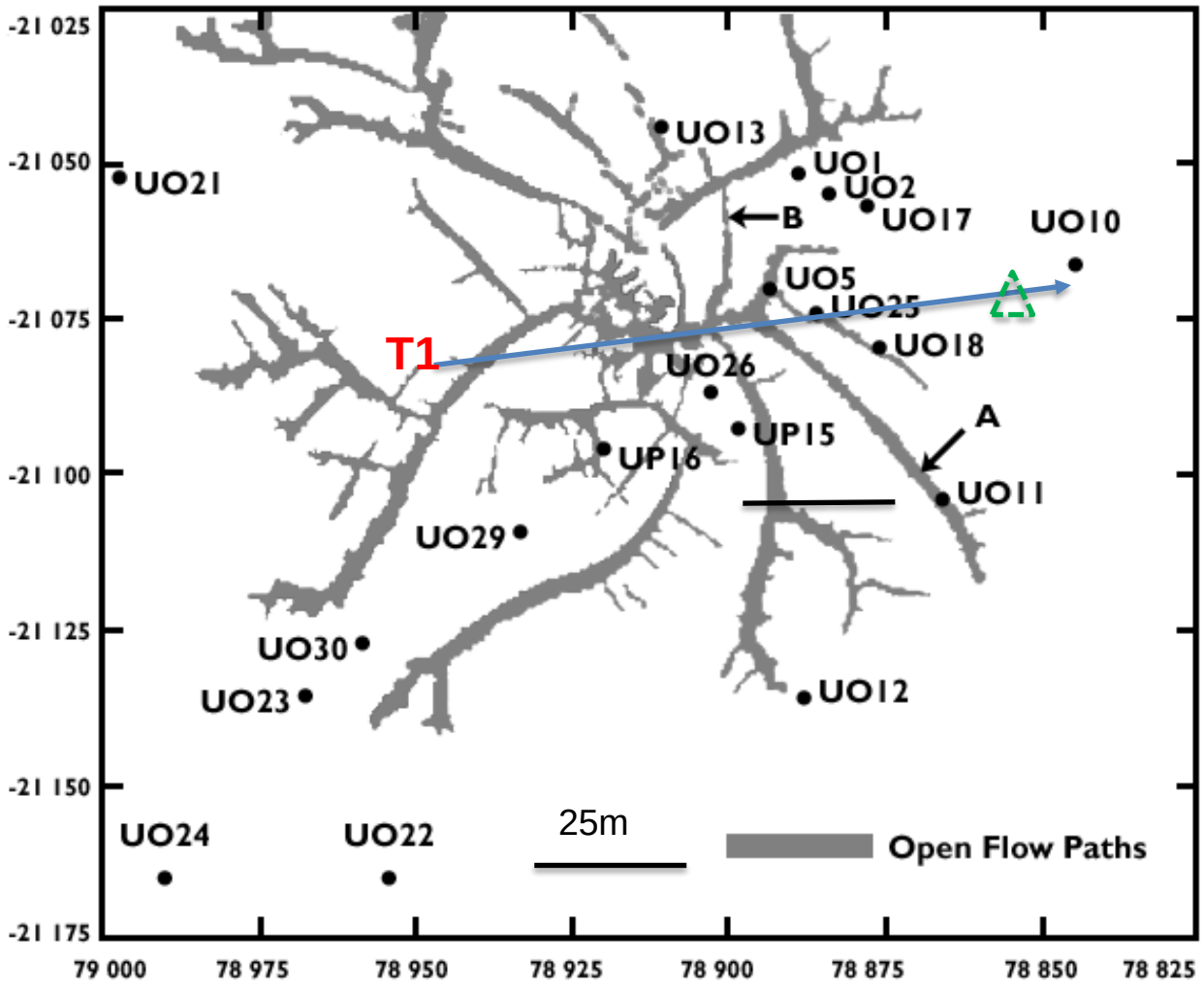
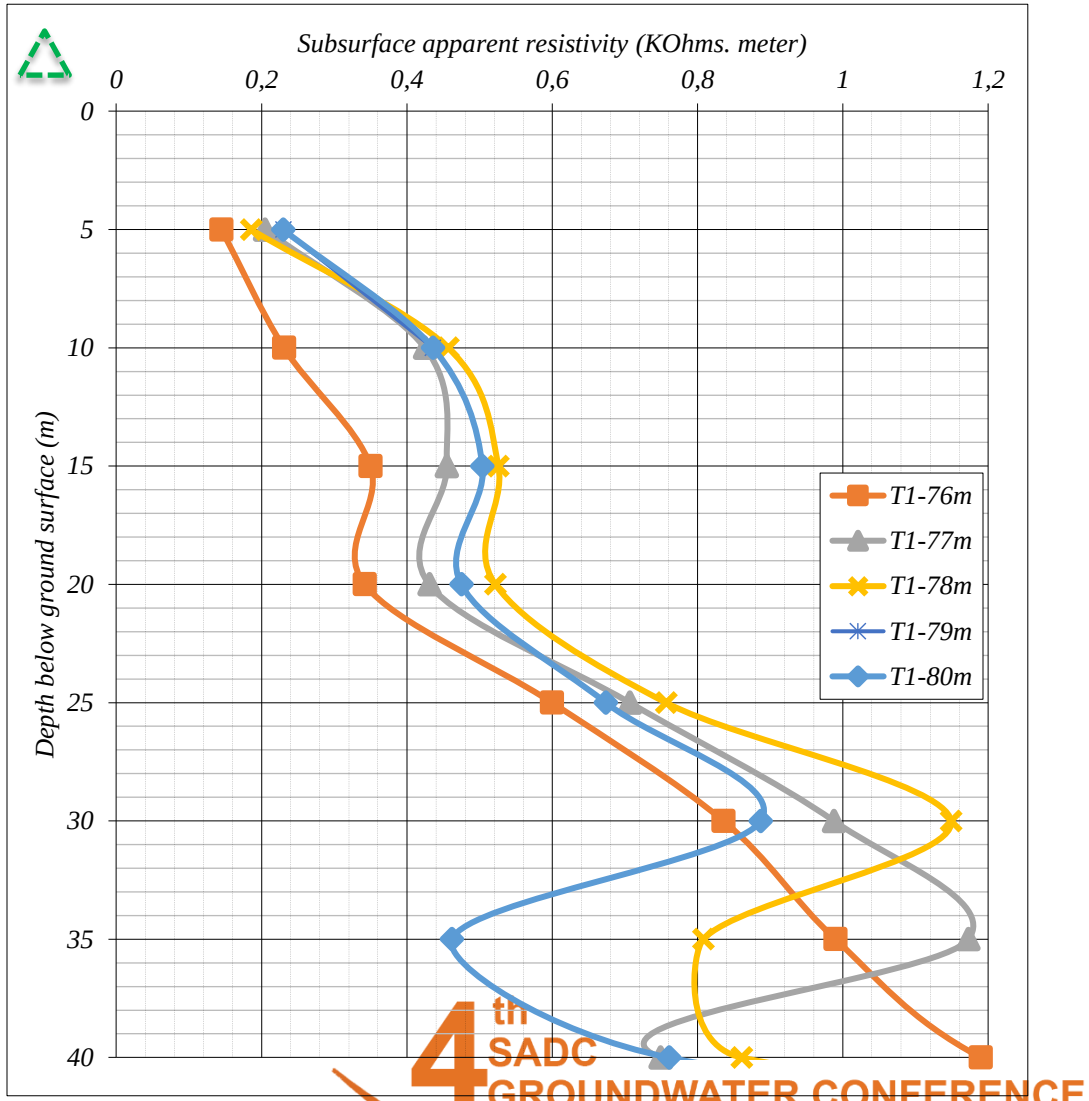


Van Tonder (2000)

Results

Outside the fracture





Representation of the geometry of the fracture on Campus Test (Van der Voort and Van Tonder, 2000)

Conclusion

- The MT results are inline with the results from previous studies that have been conducted on the study site such as the EC profiling, the geology of the area which all shows that the fractured aquifer is located between 17 and 27 meters deep.
- MT geophysical technique is able to vertically delineate the bedding plane fractured-rock aquifer on the basis of resistivity contrast.
- The findings demonstrate the potential of MT in groundwater exploration and further studies can build on this foundation.

Thank You

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