GROUNDWATER MANAGEMENT INSTITUTE

5TH SADC GROUNDWATER CONFERENCE
16 – 18 NOVEMBER 2022, WINDHOEK, NAMIBIA
GROUNDWATER: Making the invisible visible for socio-economic development

UNAM
UNIVERSITY OF NAMIBIA

Role of Hydrogeophysical methods in enhancing groundwater potential assessment in crystalline basement aquifers with some case studies from in Southern Africa.

***Innocent Muchingami*[1]*, *Thokozani Kanyerere*[2] *and Dumisani J. Hlatywayo*[3]**

[1] Department of Geosciences, University of Namibia, Namibia

[2]Department of Earth Sciences , University of the Western Cape, South Africa

[3]Geophysics Research Group, Department of Applied Physics, National University of Science and Technology, Zimbabwe

**imuchingami@unam.na*

Outline

- Background
- Main geophysical tools for groundwater investigations
- Case studies
- Conclusion

Background

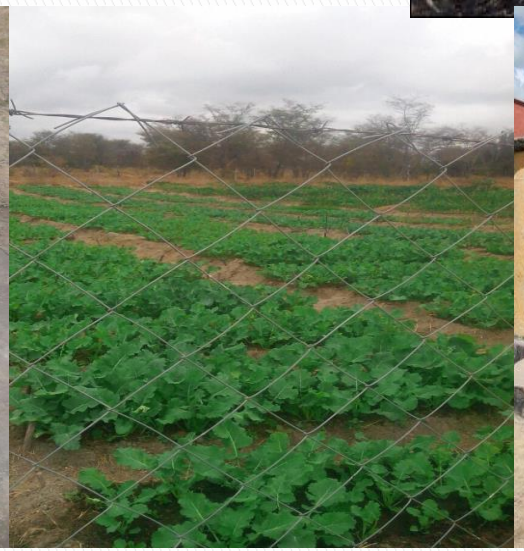
- Increase in water demand for various activities has intensified groundwater exploitation (Joshi *et al*, 2018).
- Most countries in Southern Africa have crystalline basement aquifers being of utmost importance as sources of water supply.
- As there are few alternate sources of year-round water supply, such aquifers are the more often the main source of potable water supply to many rural communities.
- A significant population in Southern Africa is dependent on crystalline basement aquifers for accessing safe drinking water and irrigation

Groundwater utilisation:

- Main source of drinking and domestic water
- small scale garden irrigation.
- Livestock drinking

Farms: commercial

Recent water cuts in urban areas has seen an increased groundwater demand in urban areas

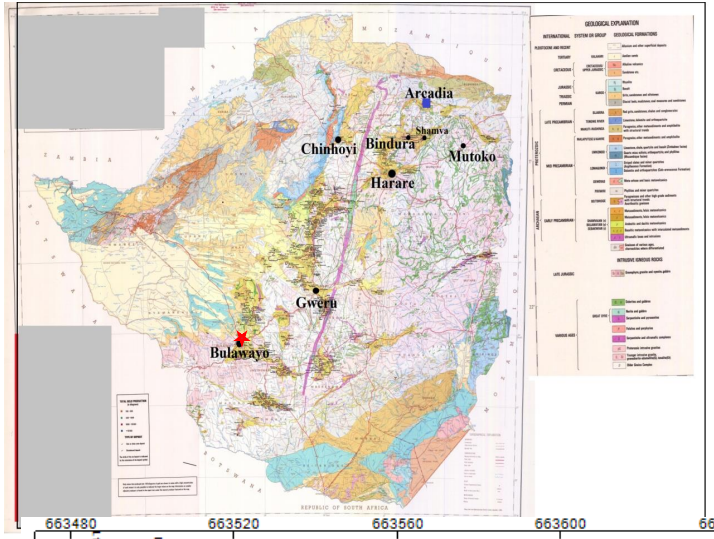


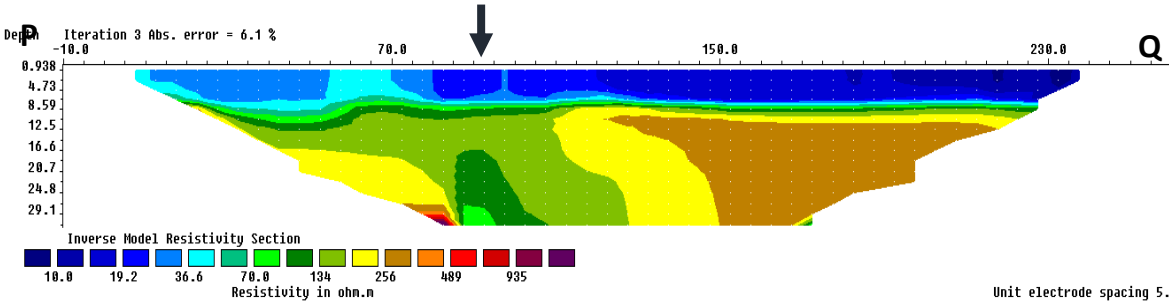
- Groundwater occurrence in such aquifers, is dependent upon the interaction of geology with present and weathering processes controlling recharge to the unconfined aquifers in accordance with theoretical framework in Chilton and Foster (1955).
- Such aquifers typically have a fractured-weathered layer that has a fracture density that decreases with depth
- Aquifer properties controlled by fracture network
- The high number of cases of dry holes and seasonal wells have created a need for comprehensive assessment of groundwater resource potential in crystalline basement aquifers.
- In most crystalline basement aquifers uncertainty is highest and hence a need to reduce risk of dry holes

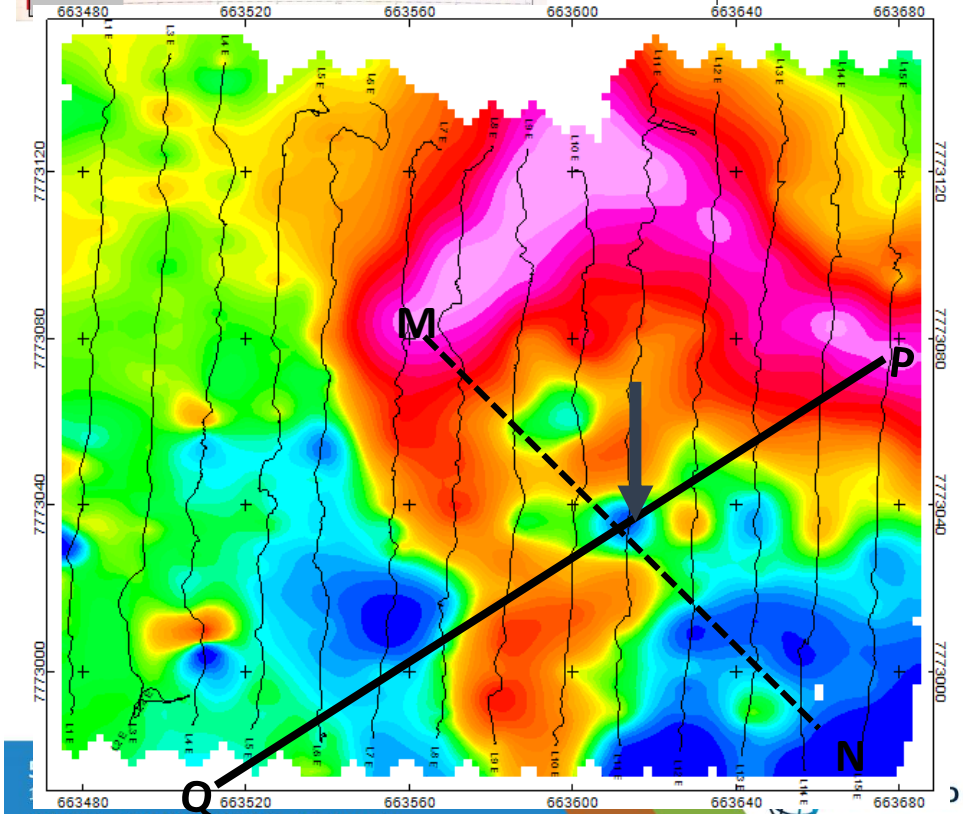
- FINANCIAL and SOCIAL IMPLICATIONS !!!

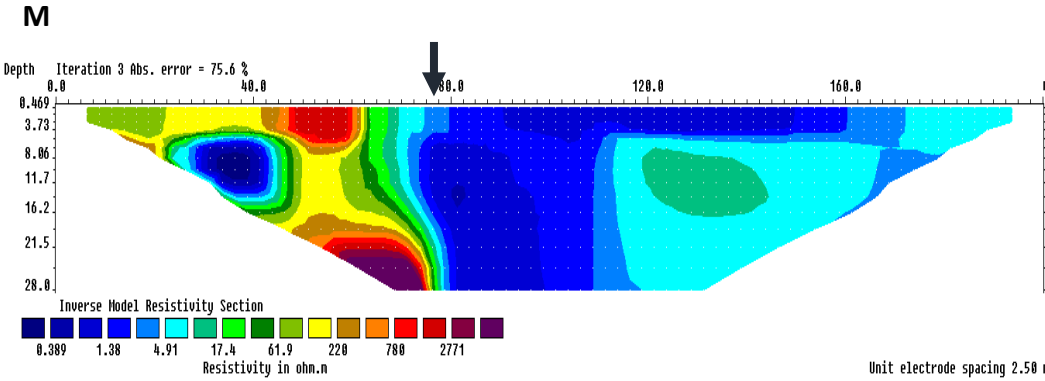
- This study explores the role of Hydrogeophysics in groundwater resources exploration in crystalline basement aquifers

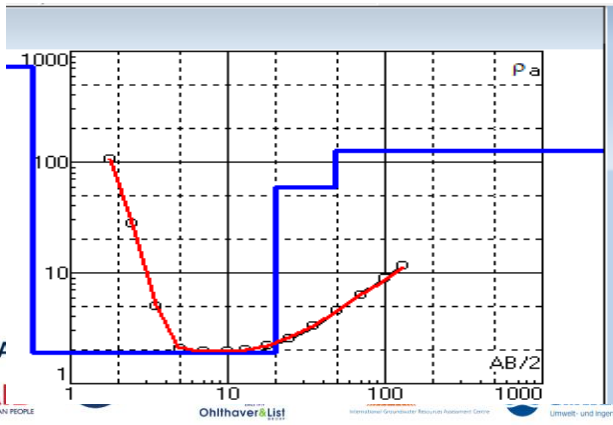
Hydrogeophysical Characterisation: Granitic formation – Bulawayo, Zimbabwe

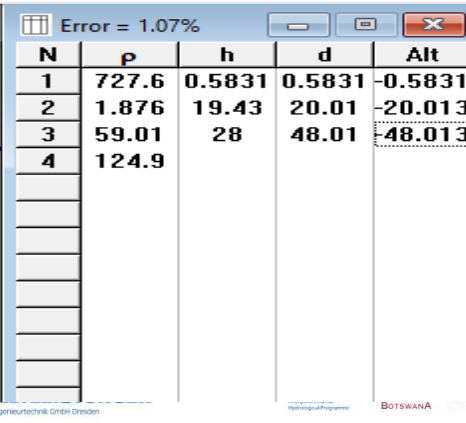










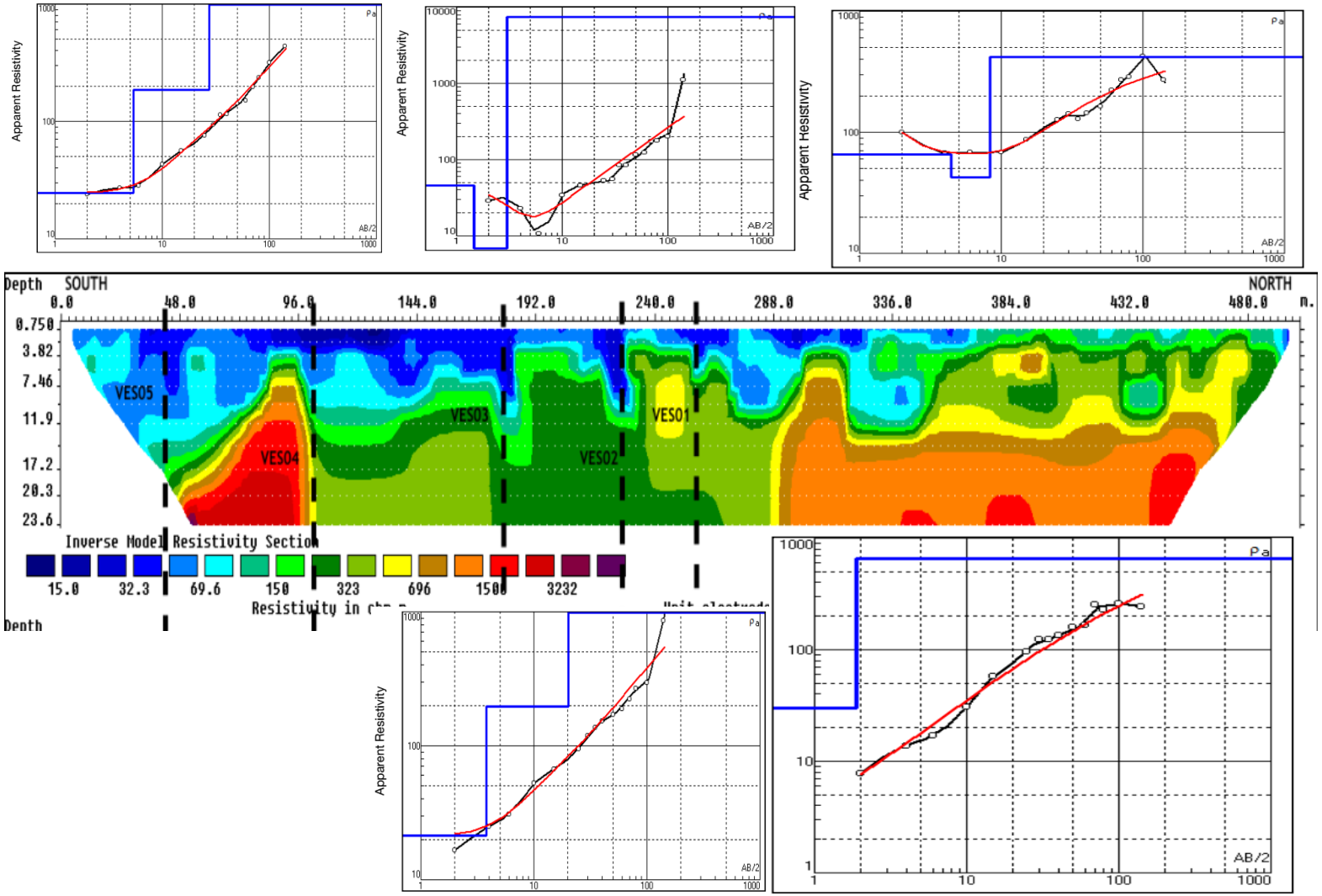


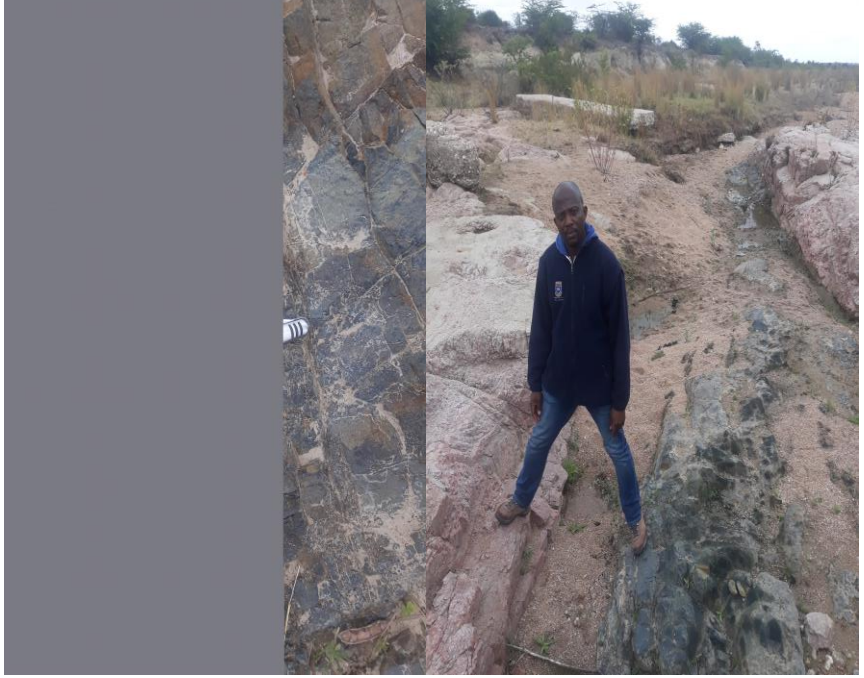
THEME - GROUNDWATER: Making the invisible visible for socio-economic development

USAID FROM THE AMERICAN PEOPLE

BOTSWANA

Geophysical Characterisation: Basaltic Greenstone , Bulawayo, Zimbabwe



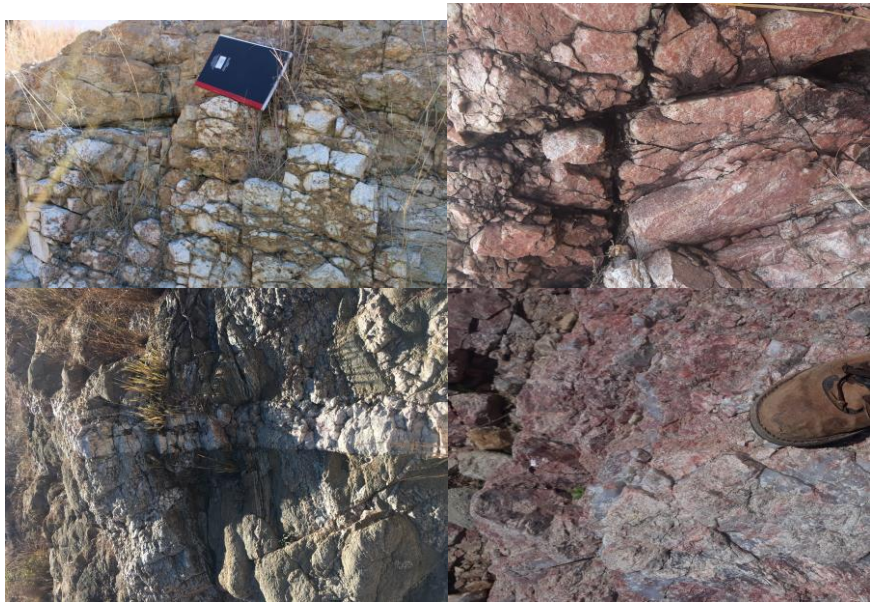


1

2

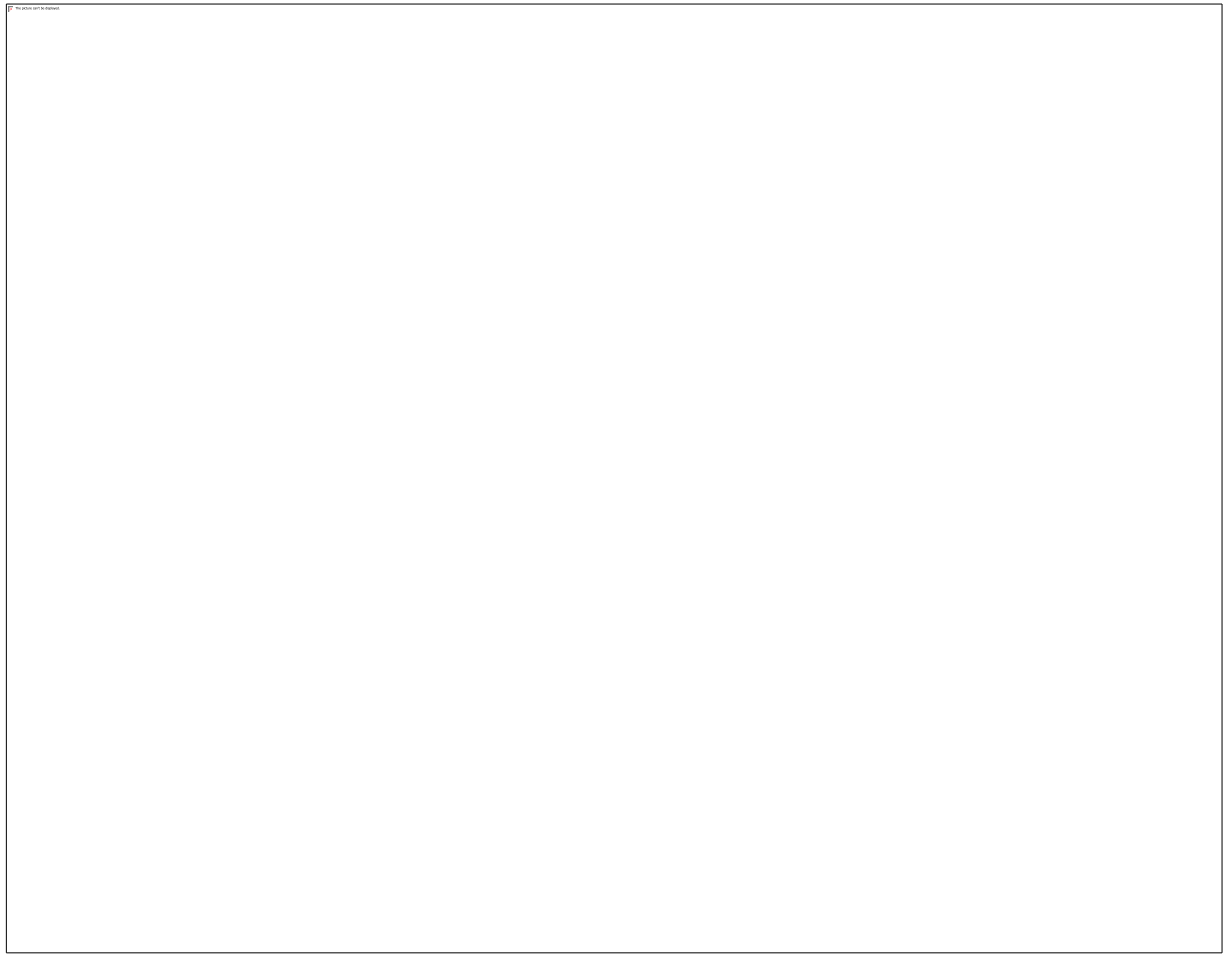
3

4



FIELD INVESTIGATIONS AND DEVELOPMENT

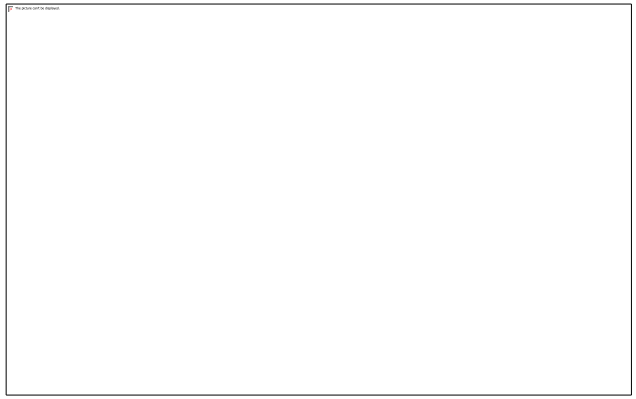
- Geophysical tools for groundwater potentiality and structural elements that control groundwater occurrence and dynamics in crystalline basement aquifers

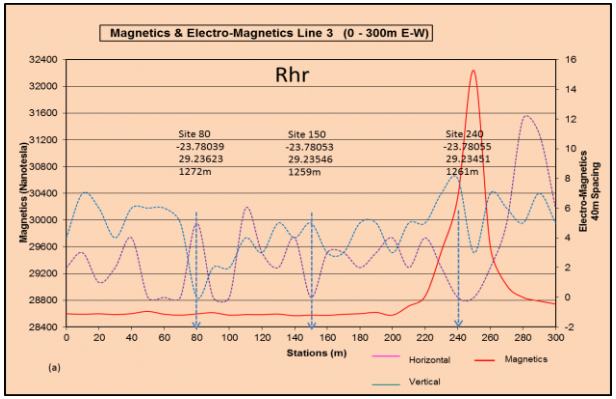


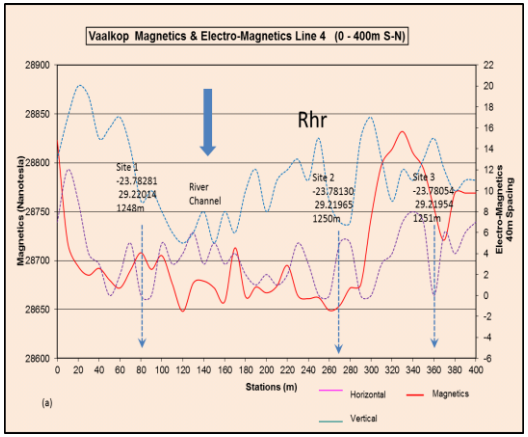
To infer some of the parameters:

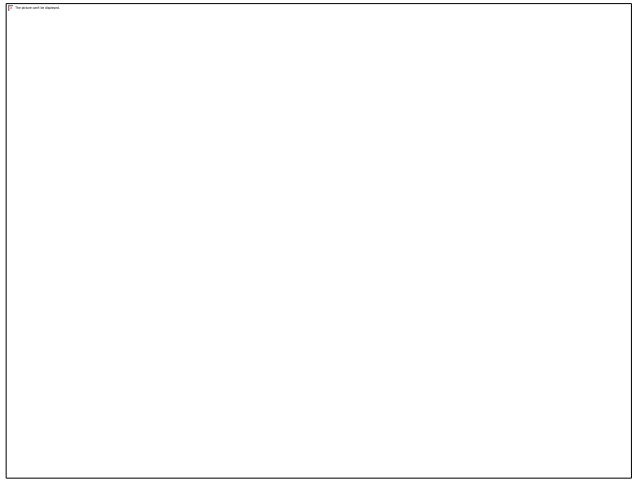
- approximate depth to groundwater table
- thickness of the overlying weathered regolith
- extend and number of fractured zones

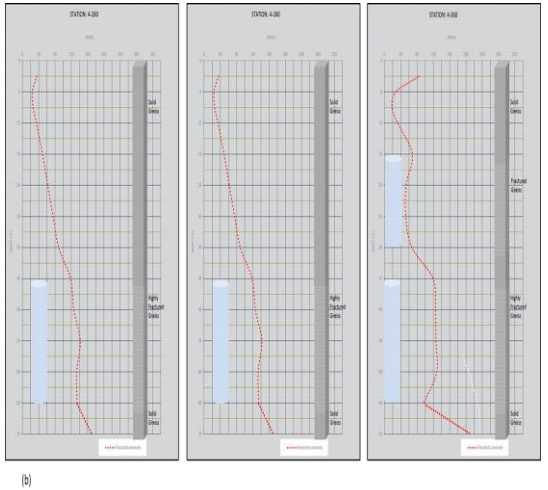
SAMPLE GEOPHYSICAL RESULTS; (magnetics and EM profiles on top , corresponding resistivity section below)



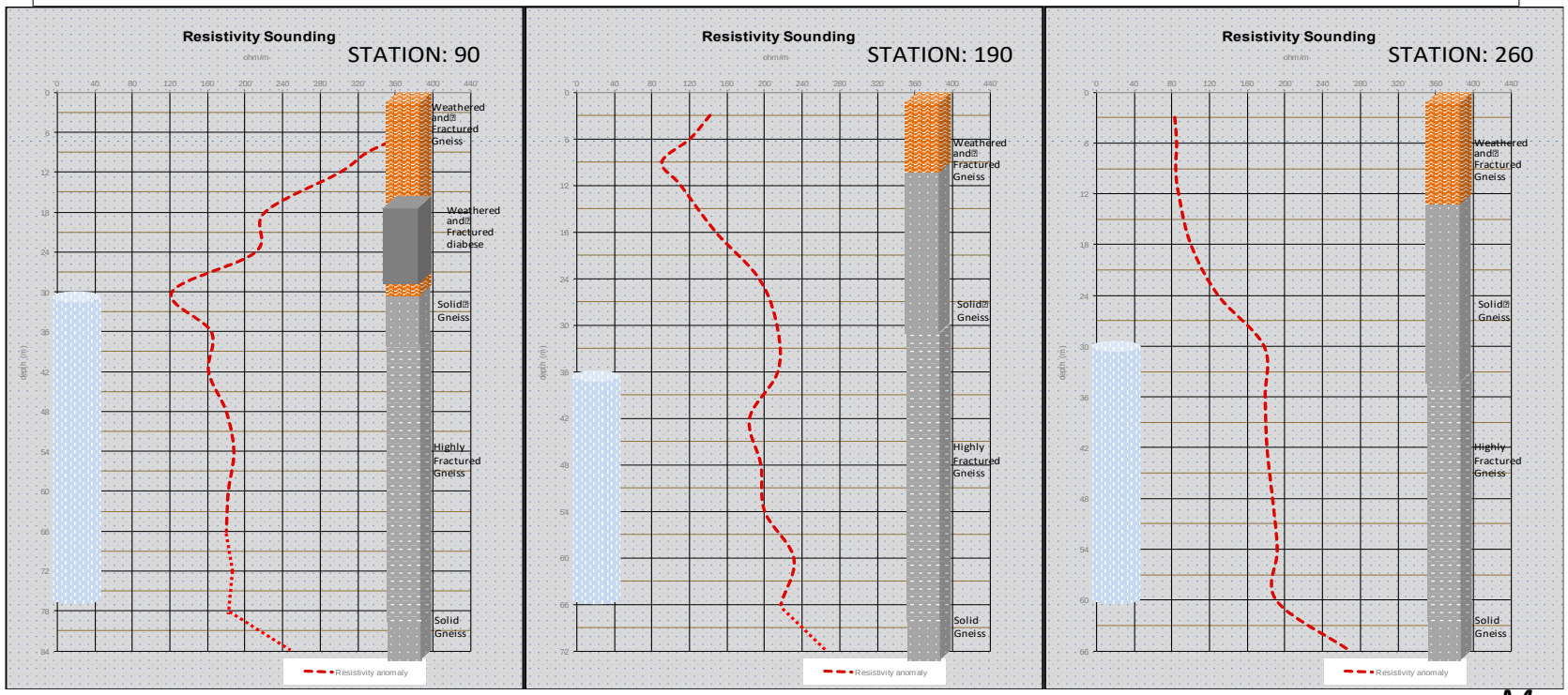








Muchingami et al., 2021



Muchingami et al., 2021

Borehole drilling and geological characterization

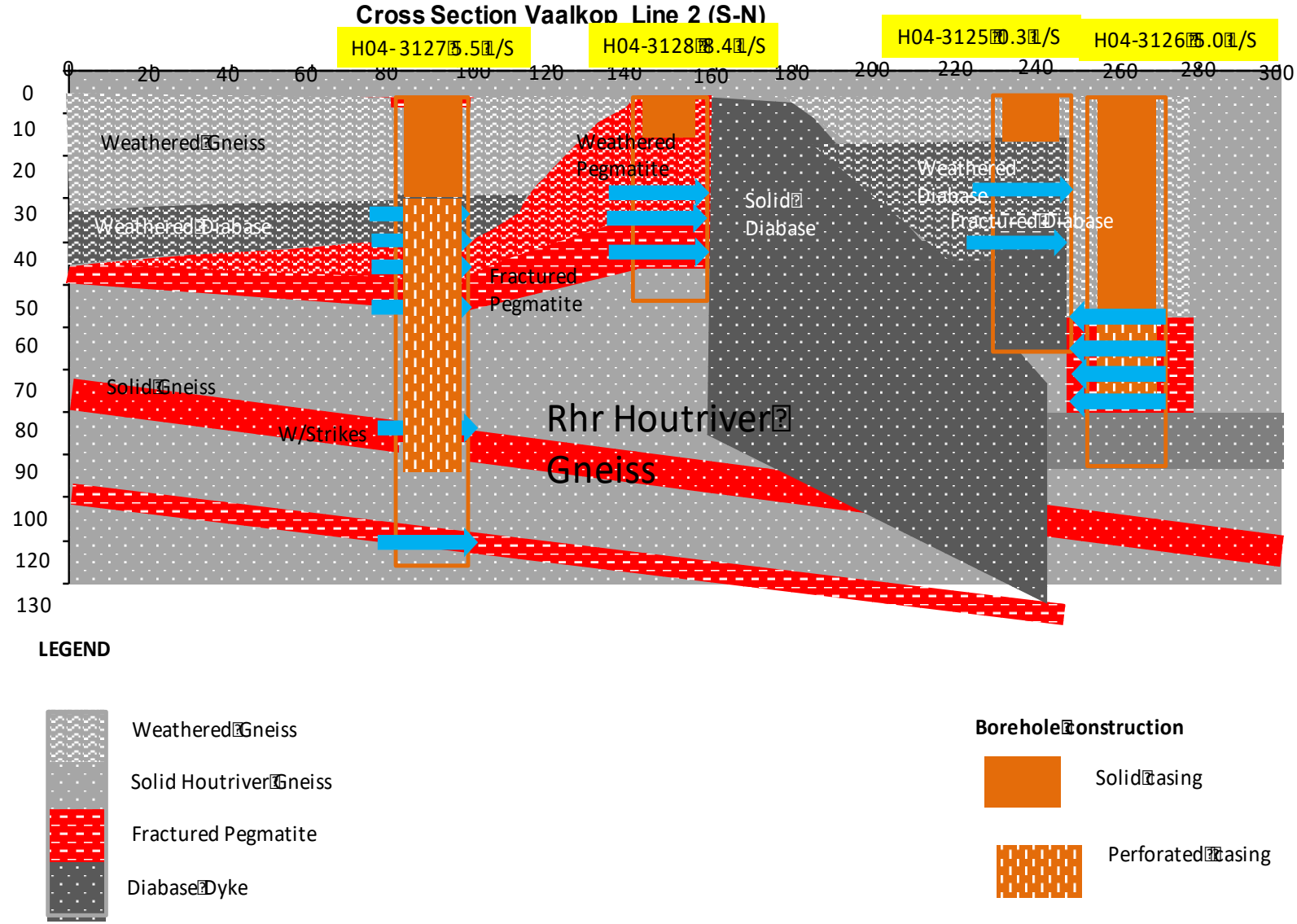
HO4 3127 Depth (m)	Lithology type
0-3	Fractured pegmatite
3-11	Weathered pegmatite
11-24	Weathered diabase dyke
24-32	Fractured diabase dyke
32-41	Fractured gneiss
41-46	Highly fractured pegmatite
46-56	Solid gneiss
56-60	Solid pegmatite
60-68	Solid mica rich gneiss
68-83	Solid pegmatite
83-120	Solid quartz gneiss

Muchingami et al., 2021

HO4B3125 Depth (m)	Lithology type
0-1	Solid gneiss
1-6	Fractured gneiss
6-9	Solid gneiss
9-10	Mica rich gneiss
10-16	Solid gneiss
16-24	Highly weathered gneiss
24-27	Fractured gneiss
27-44	Solid diabase
44-45	Fractured gneiss
45-60	Solid diabase

HO4B3126 Depth (m)	Lithology type
0-2	Fractured gneiss
2-16	Highly weathered gneiss
16-27	Fractured gneiss
27-48	Weathered gneiss
48-72	Highly fractured gneiss
72-84	Solid gneiss

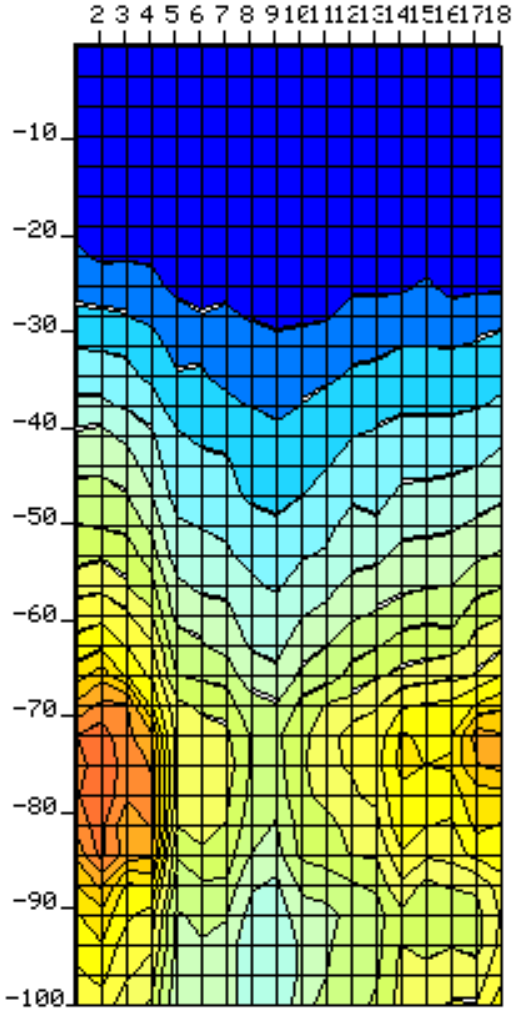
GROUNDWATER POTENTIAL MODEL

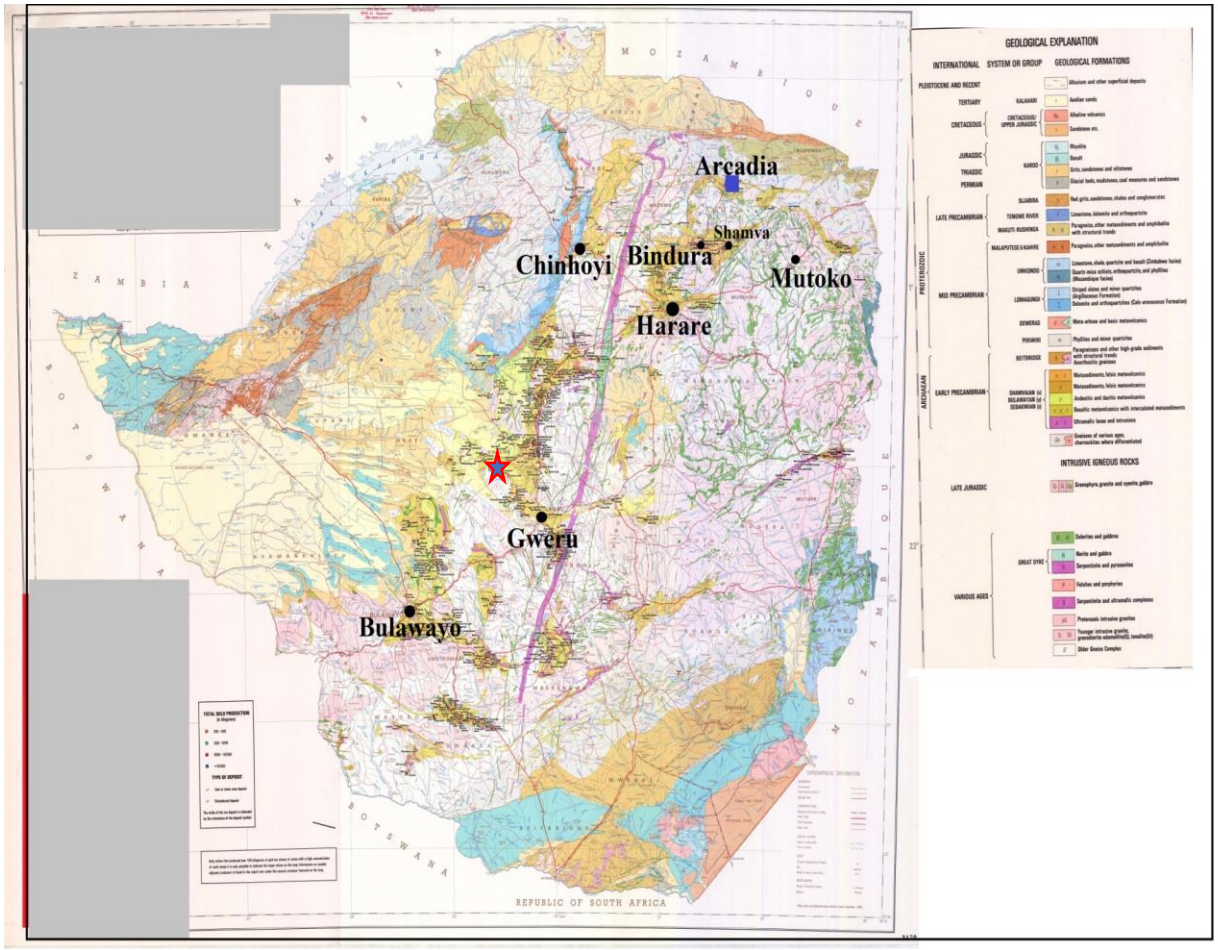


Muchingami et al., 2021

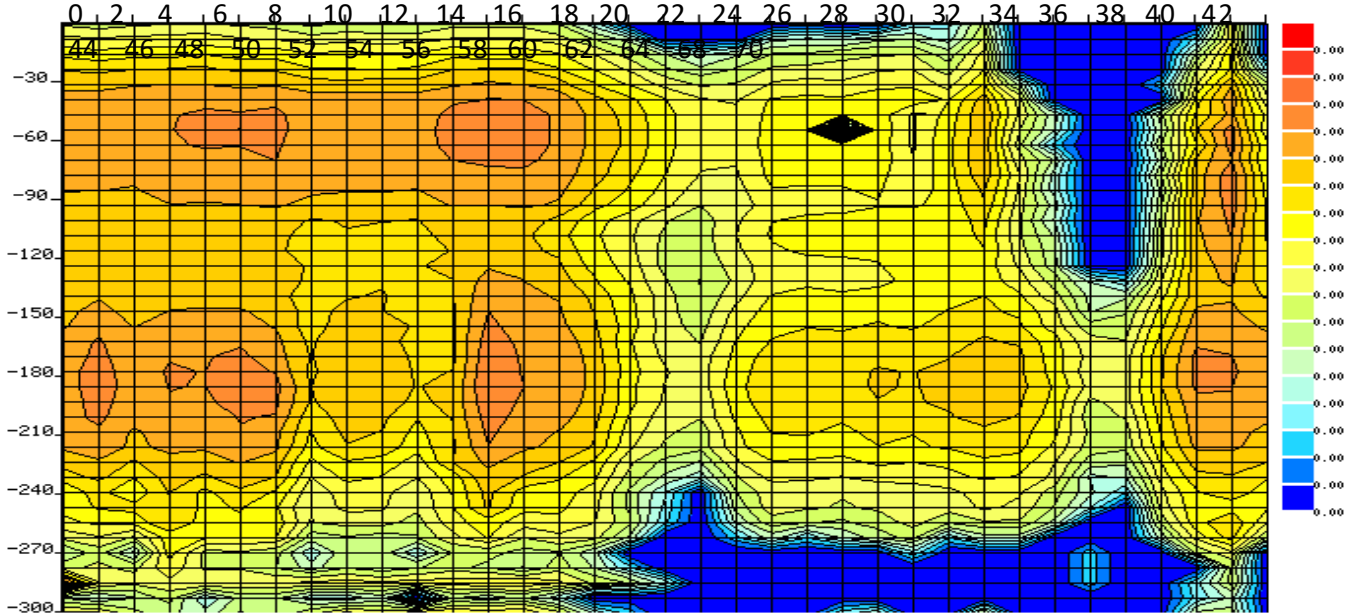
Passive Methods: Natural Magnetotelluric methods in Groundwater Exploration

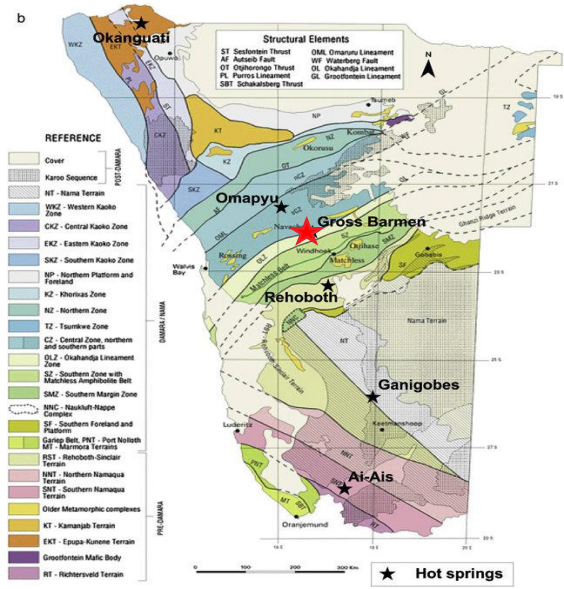
Kwekwe , Central Zimbabwe

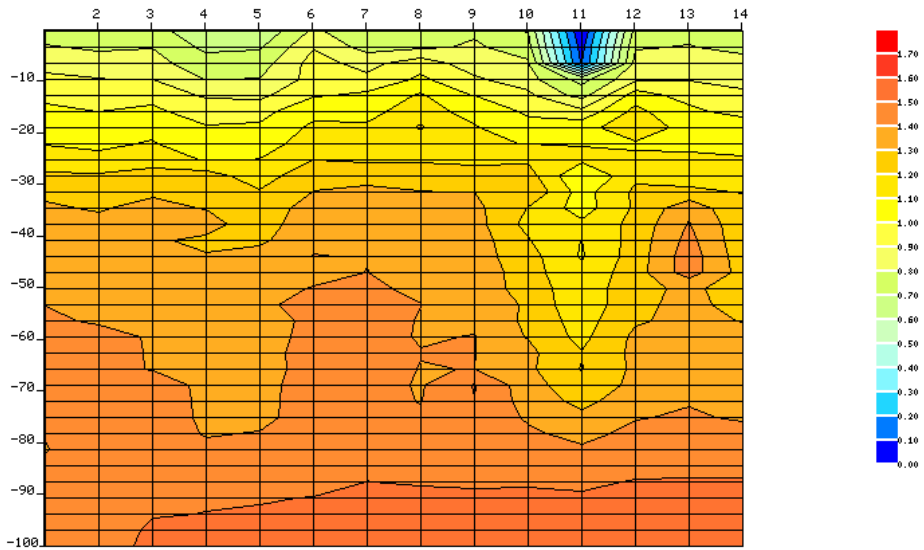




Okahandja Central Namibia







Groundwater controlled by deep seated fractures created by contact between Swakop river pegmatites and amphibolite schists characterizing the study area

Conclusions and recommendations

- Geophysical surveys can be one way to improve confidence in borehole drilling.

- There is need for close collaboration between hydrogeology and geophysics in ensuring sustainable groundwater provision in different aquifer systems in evaluating groundwater potential for complex basement.

- A comprehensive study on calibrating the geophysical models and drill logs and groundwater occurrence needs to be done for different aquifer systems within region in order to improve the accuracy of the geophysical results in groundwater potential assessment

THANK YOU