3D Earth Exploration

Tsholotsho Water Survey using Controlled Source Audiofrequency Magnetotelluric (CSAMT) Unit

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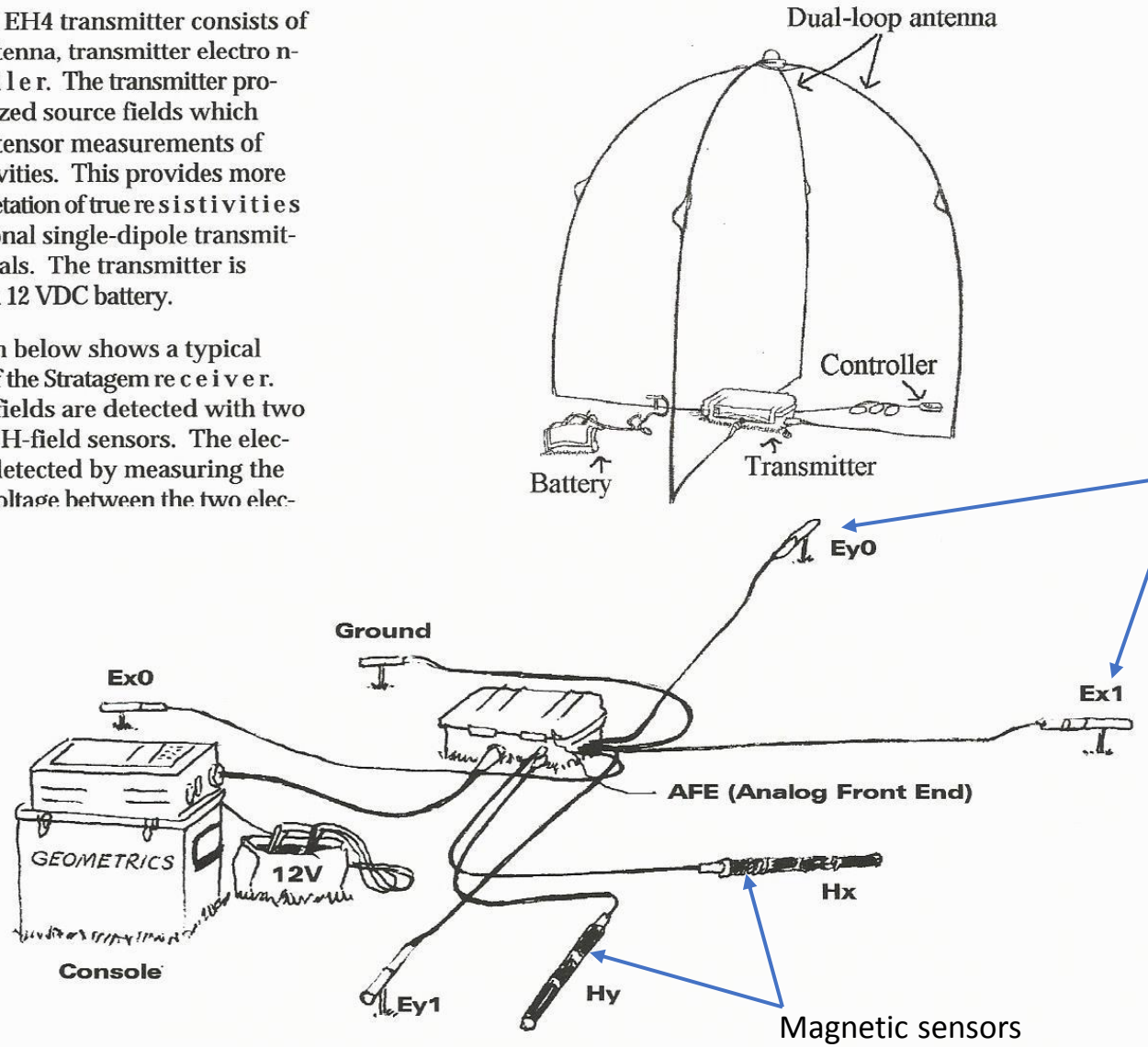
Introduction

- The Stratagem is a CSAMT unit manufactured by Geometrics, USA
- Measures natural and transmitted electromagnetic (EM) signals of the earth
- The frequency (skin-depth effect) of the EM signal determines the depth of measurement
- The ratio of Electrical and Magnetic components of EM determine the resistivity value
- The survey for water was carried out by 3D Earth Exploration in 2021 in Tsholotsho area, west of Bulawayo
- A team of two geophysicists and 4 assistants carried out the survey
- A 25m dipole array was used for the survey at 25m station intervals
- On average 20 soundings were completed daily
- Test survey was done at the Epping Forest Farm in Nyamandlovu where there is a known aquifer
- A number of holes have since been drilled to test the geology for water

The Stratagem

The Stratagem EH4 transmitter consists of a dual-loop antenna, transmitter electro n- ics, and contro l l e r. The transmitter pro- vides unpolarized source fields which allow for true tensor measurements of g round resistivities. This provides more accurate interpretation of true re s i s t i v i t i e s than conventional single-dipole transmit- ter source signals. The transmitter is p o w e red by a 12 VDC battery.

The illustration below shows a typical configuration of the Stratagem re c e i v e r. The magnetic fields are detected with two perpendicular H-field sensors. The elec- tric fields are detected by measuring the d i ff e rential voltage between the two elec- t rodes of the Ex0 and Ex1 for example. sensors is an Analog Fron transmitted t the console for analog-to digital conve sion and digital signal p rocessing.



The transmitter is set 200m off the survey line

Electric dipoles

The receiver set up moves along the survey line with one dipole along the line and the other perpendicular and so are the magnetic sensors

Magnetic sensors

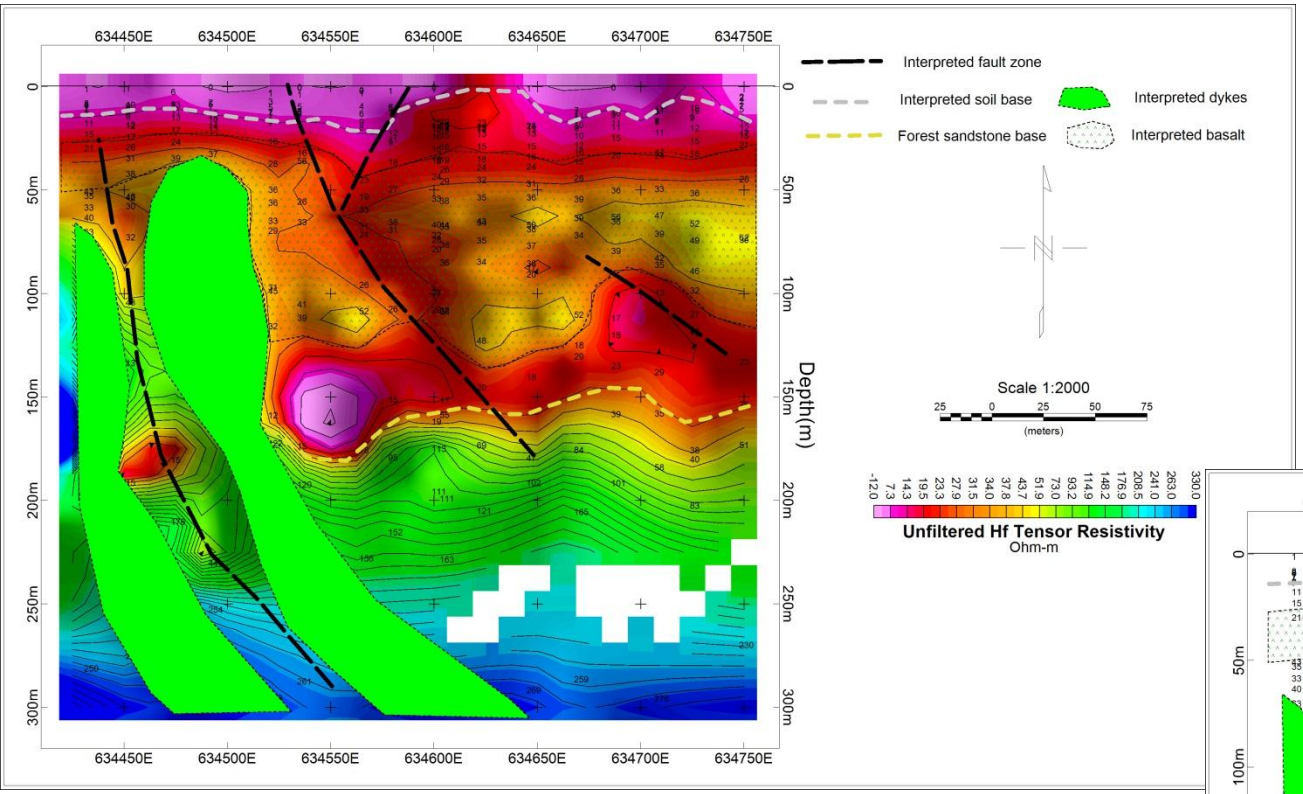
Field Work

More action

Taking readings at the receiver

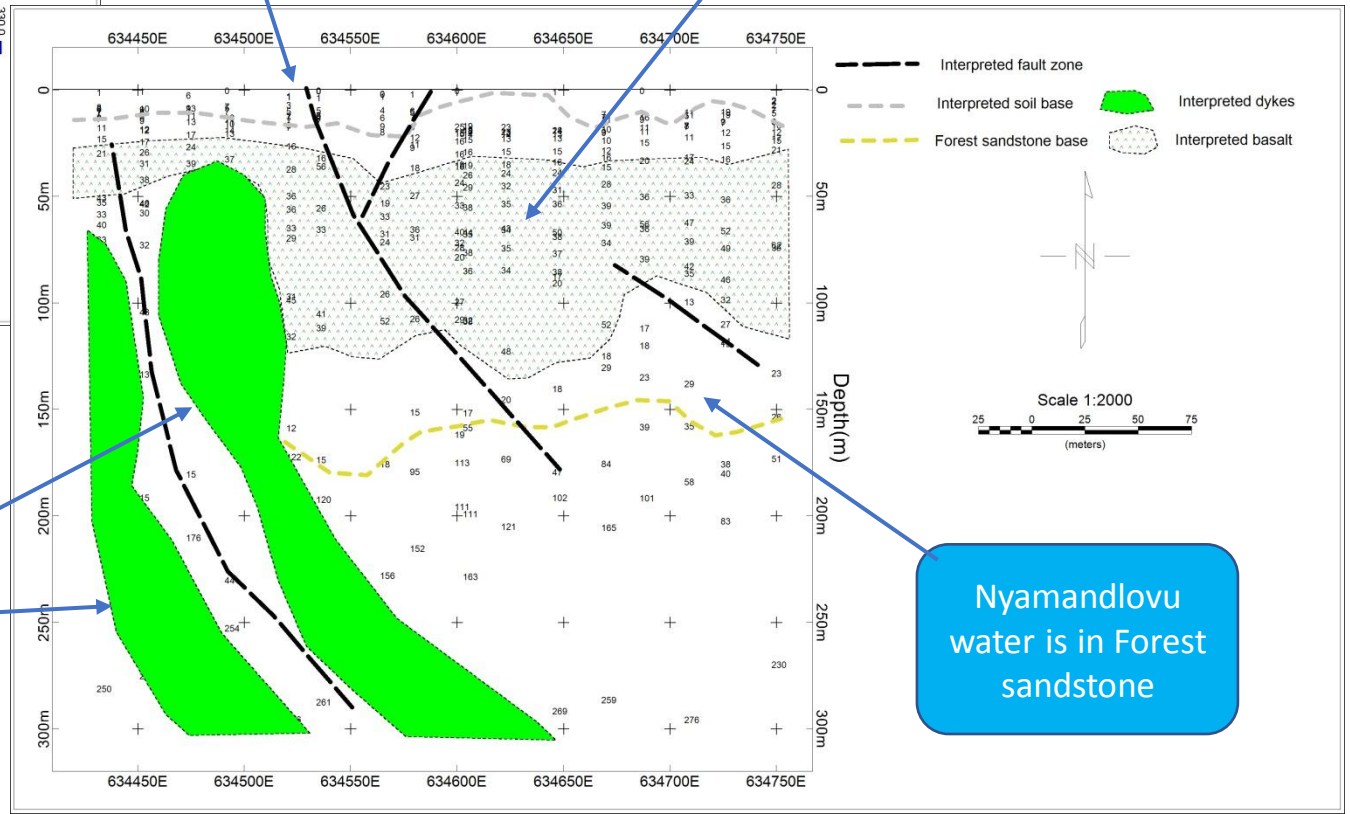
Receiver setup in transit

Epping Forest Orientation Line



Faults can also be a good source of water

Basalt layer caps the aquifer in Forest sandstone

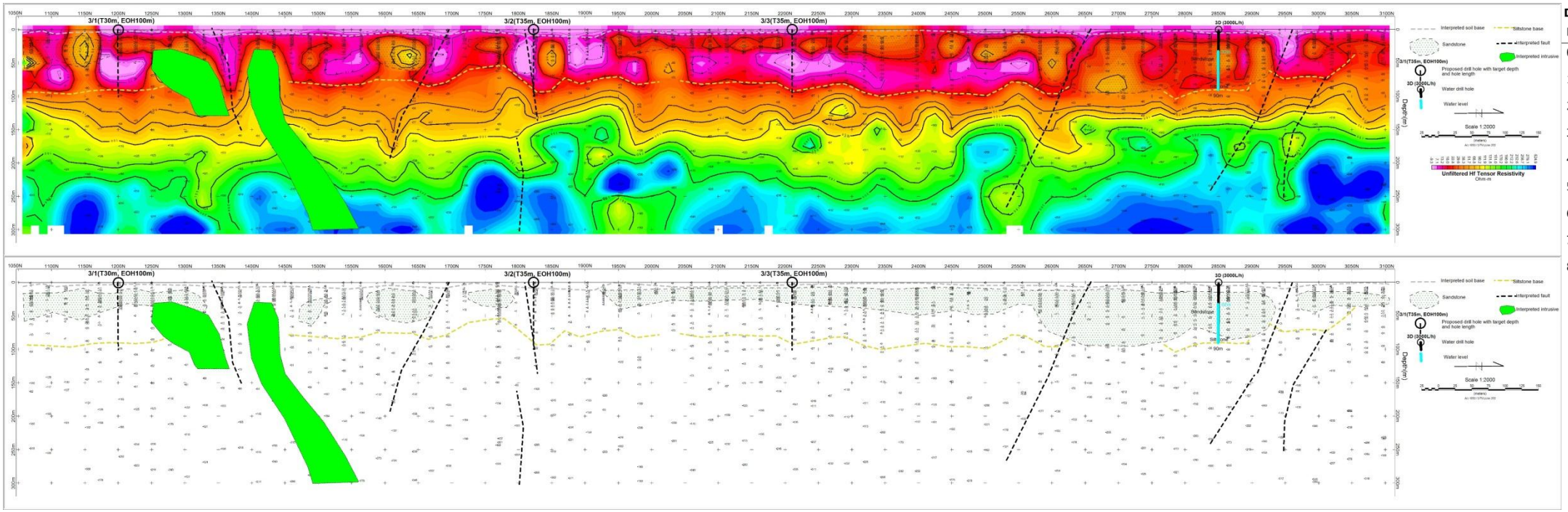


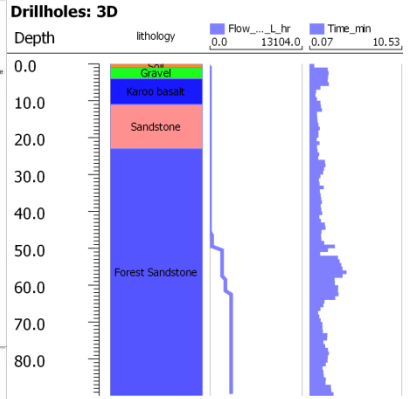
Mafic dykes form barriers that dam underground water to enhance aquifer yield

Nyamandlovu water is in Forest sandstone

Survey Line 3E Clipped to 300m Depth

Water borehole



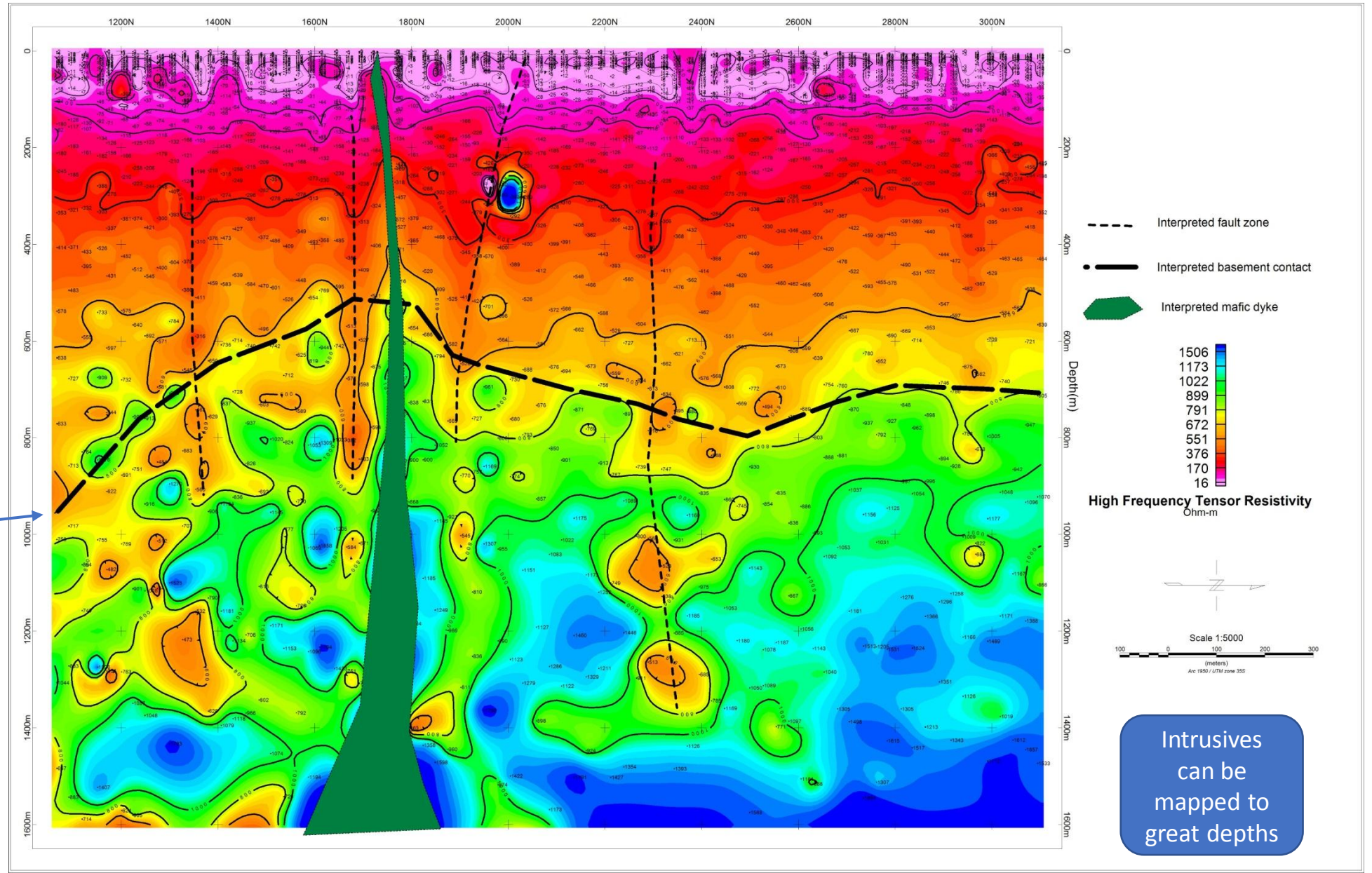


- Borehole 3D has yield of **3000 litres/hr** from 32m depth
- Aquifer in Forest sandstone capped by resistive sandstone
- Forest sandstone extends over large area
- Vertical mafic dykes could act as dam

In the survey area the resistive layer capping the aquifer is sandstone instead of basalt

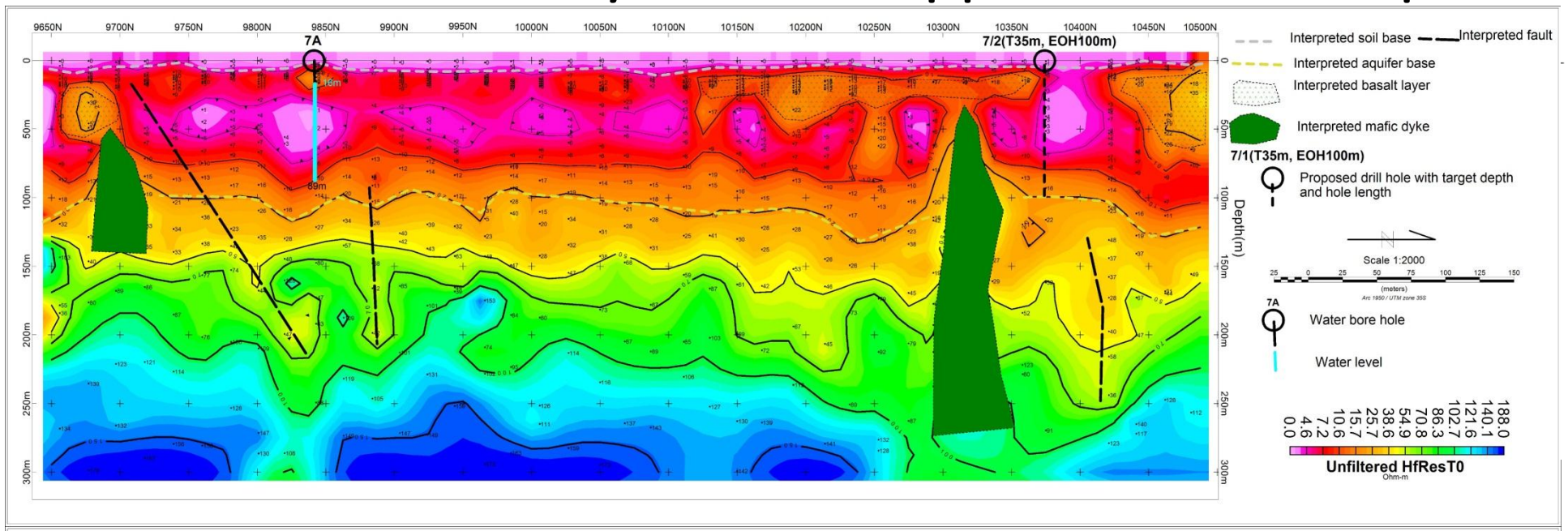
Survey Line 3E Clipped to 1600m Depth

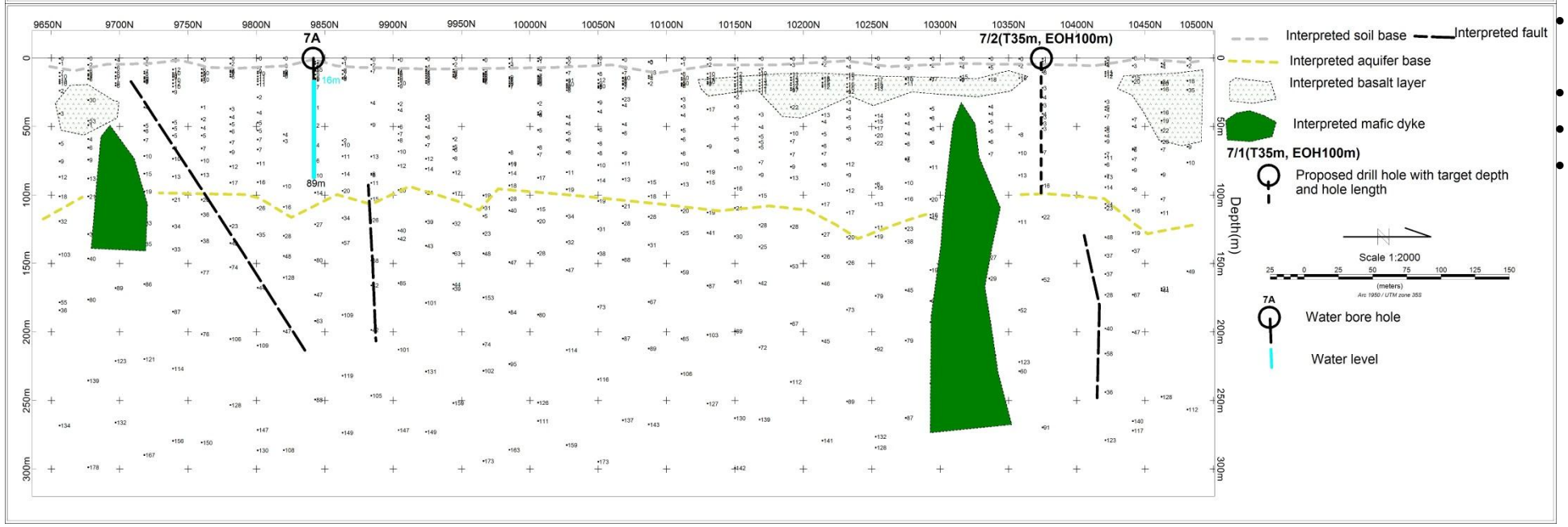
The deep section shows marked increase in resistivity around 700m depth. This is likely to be basement contact

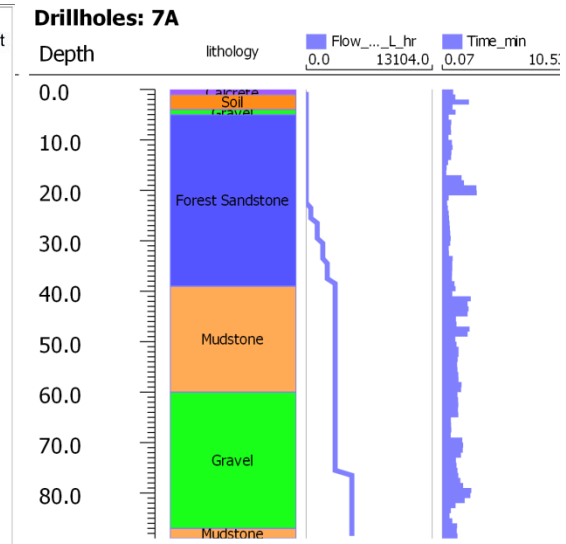


Intrusives can be mapped to great depths

Survey Line 7E Clipped to 300m Depth

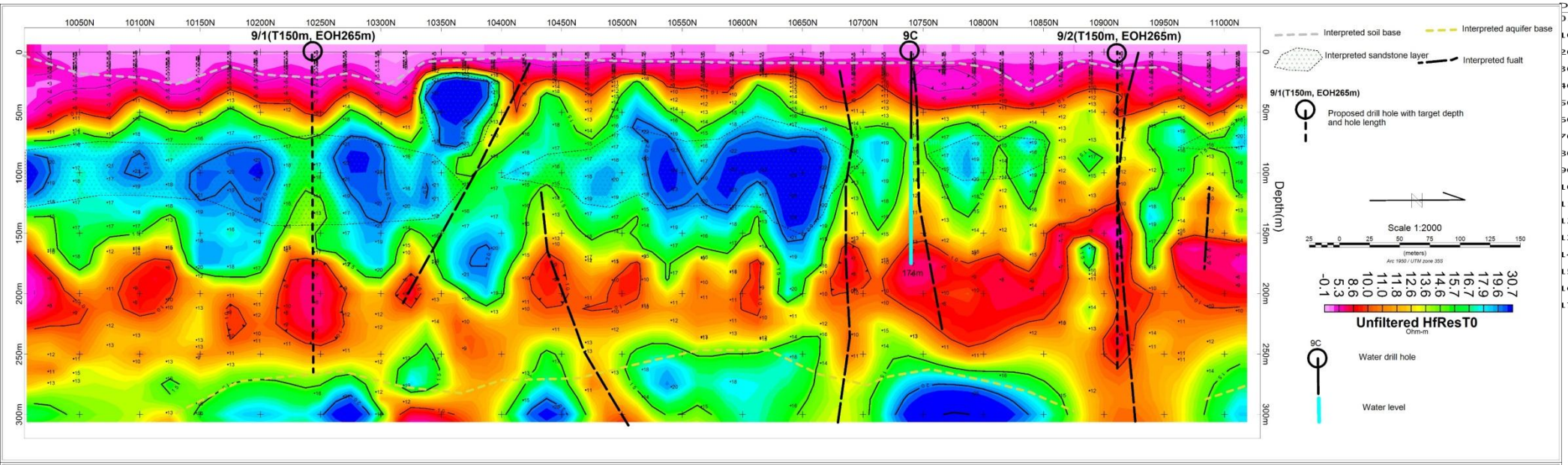


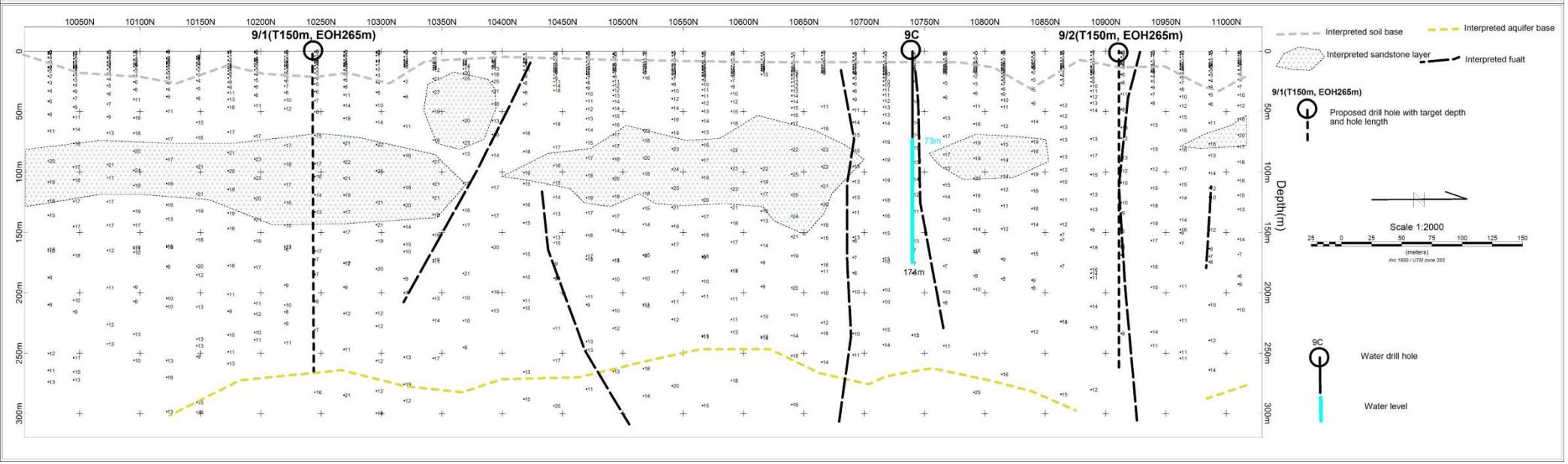


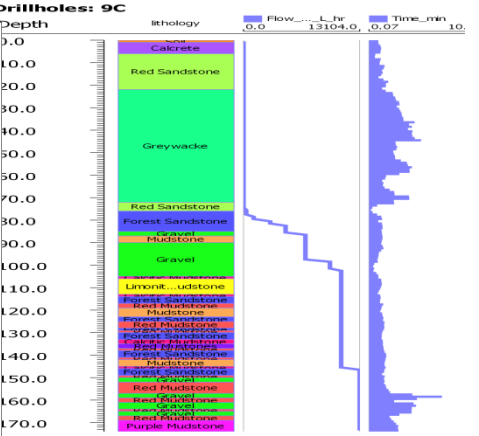


- Hole 7A has **4748 litres/hr** from 16m depth
- Aquifer mainly in gravels
- Vertical dykes and faults mapped
- No capping

Survey Line 9E Clipped to 300m Depth

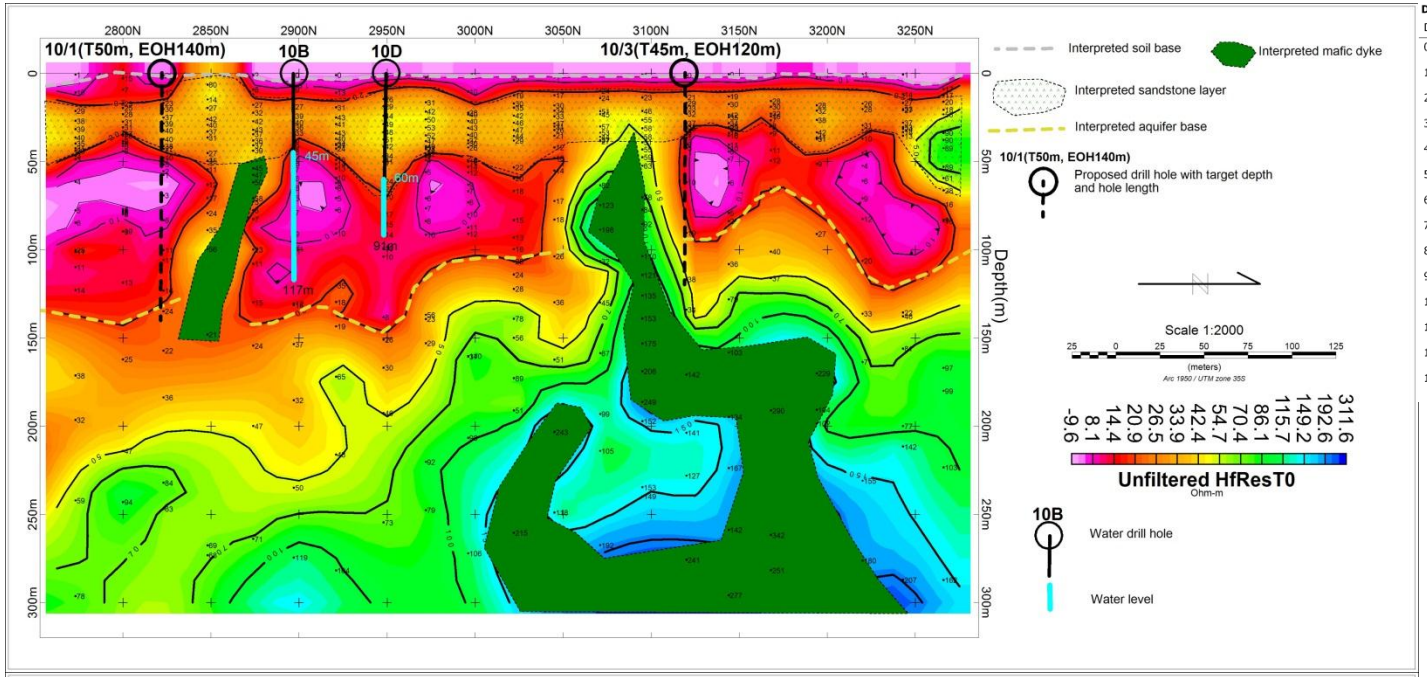


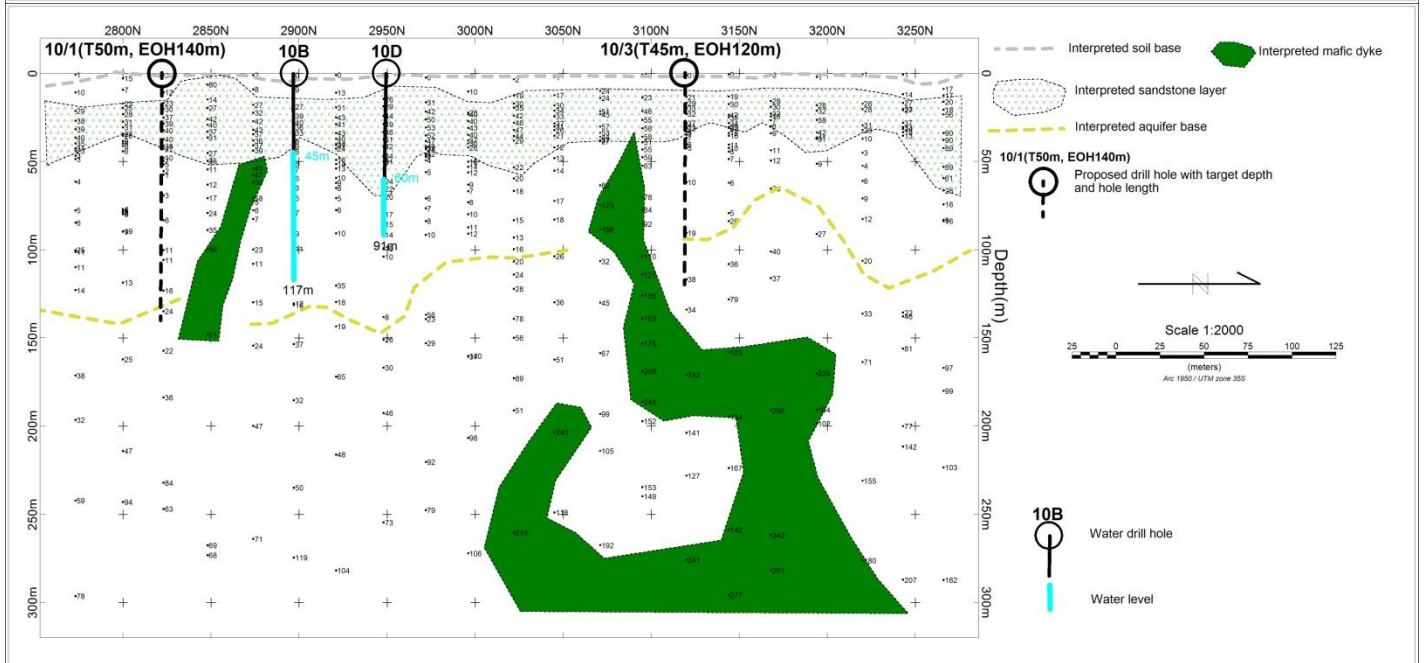


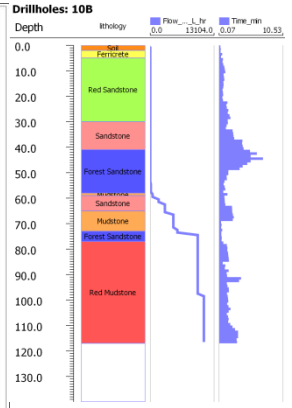


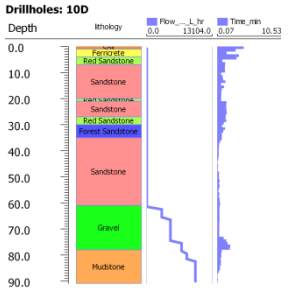
- Aquifer here in Forest sandstone and gravels capped by greywacke
- **Fault** may be the reason for very good yield of **13104 litres/hr** from 73m

Survey Line 10E Clipped to 300m Depth



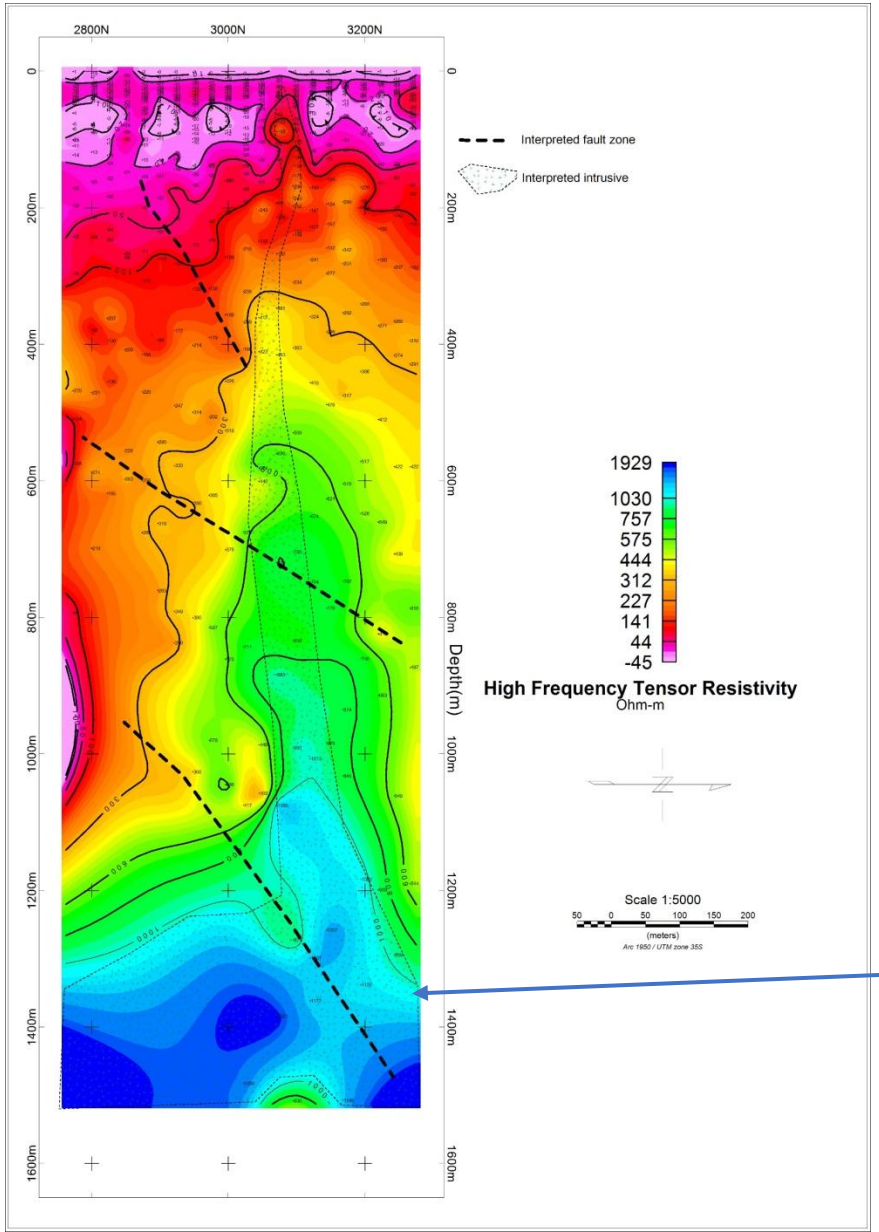






- Hole 10B yield is **11012 litres/h and 10D is 9748 litres/hr**
- Aquifer in gravels and Forest sandstone capped by sandstone
- Vertical dykes could be damming the water increasing yield

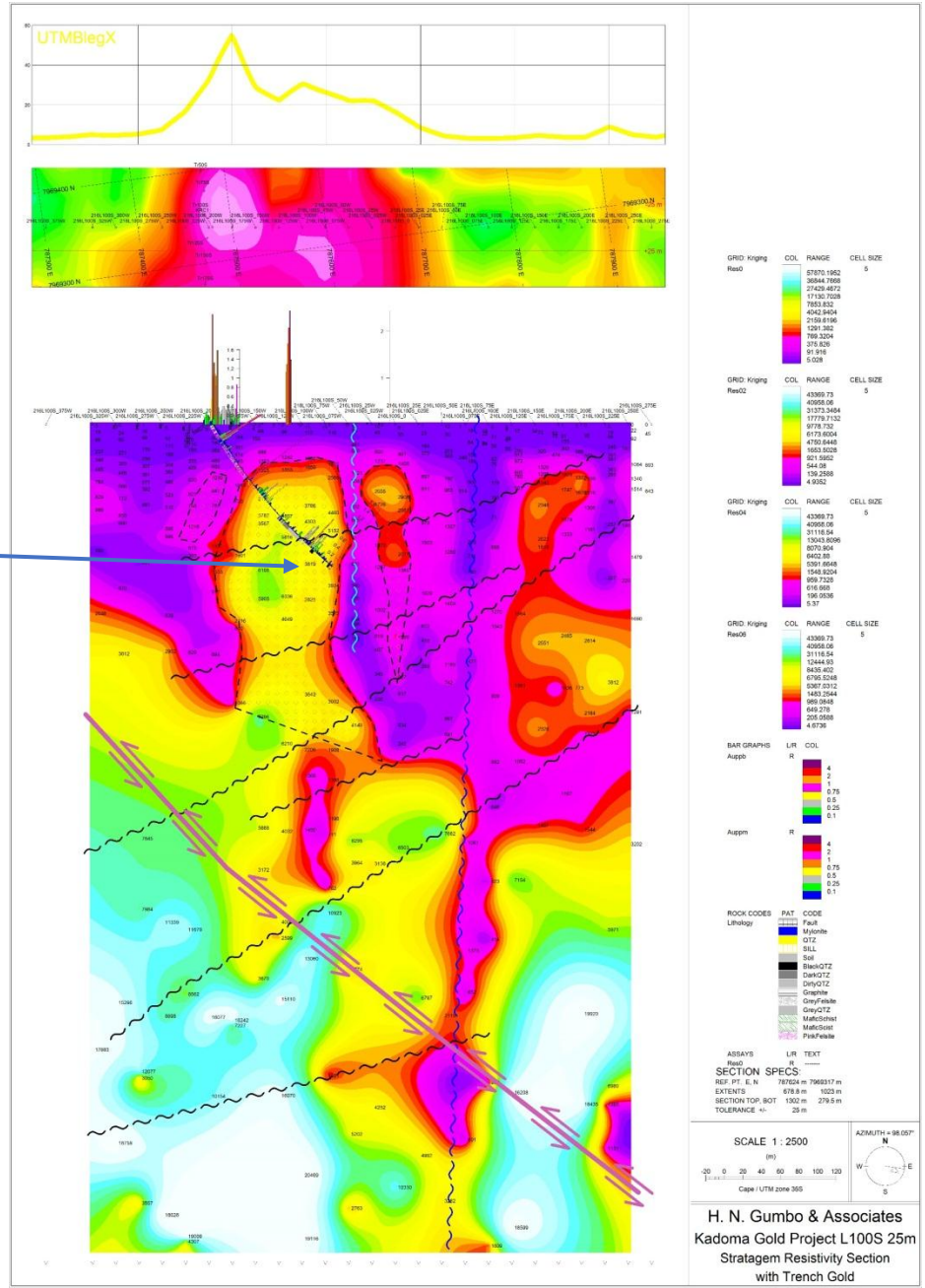
Survey Line 10 Clipped to 1600m Depth



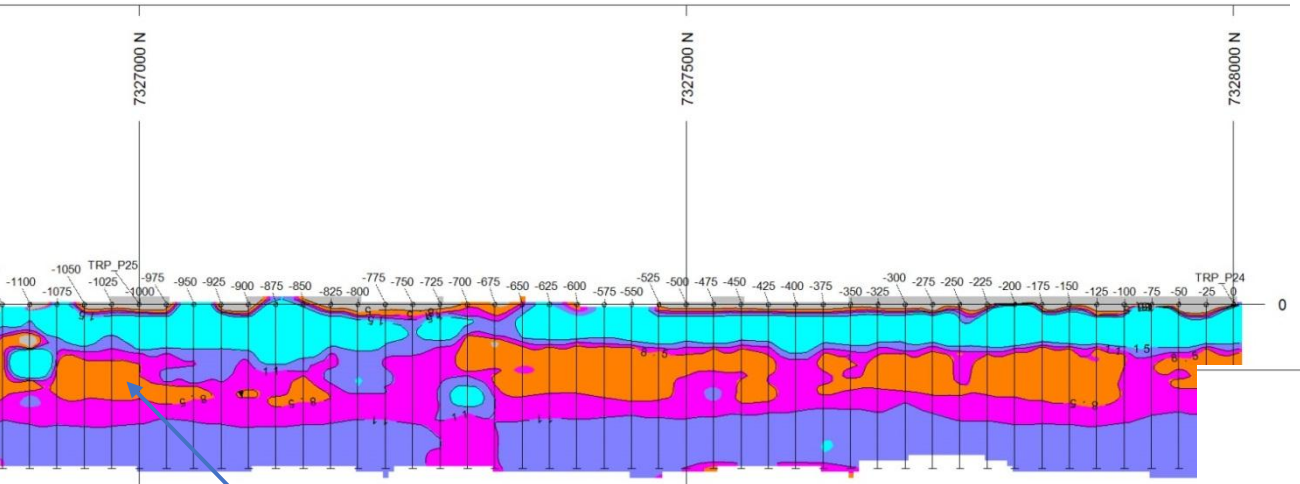
Mafic dykes in the area clearly deep-seated

Other Applications: Gold Project in Kadoma

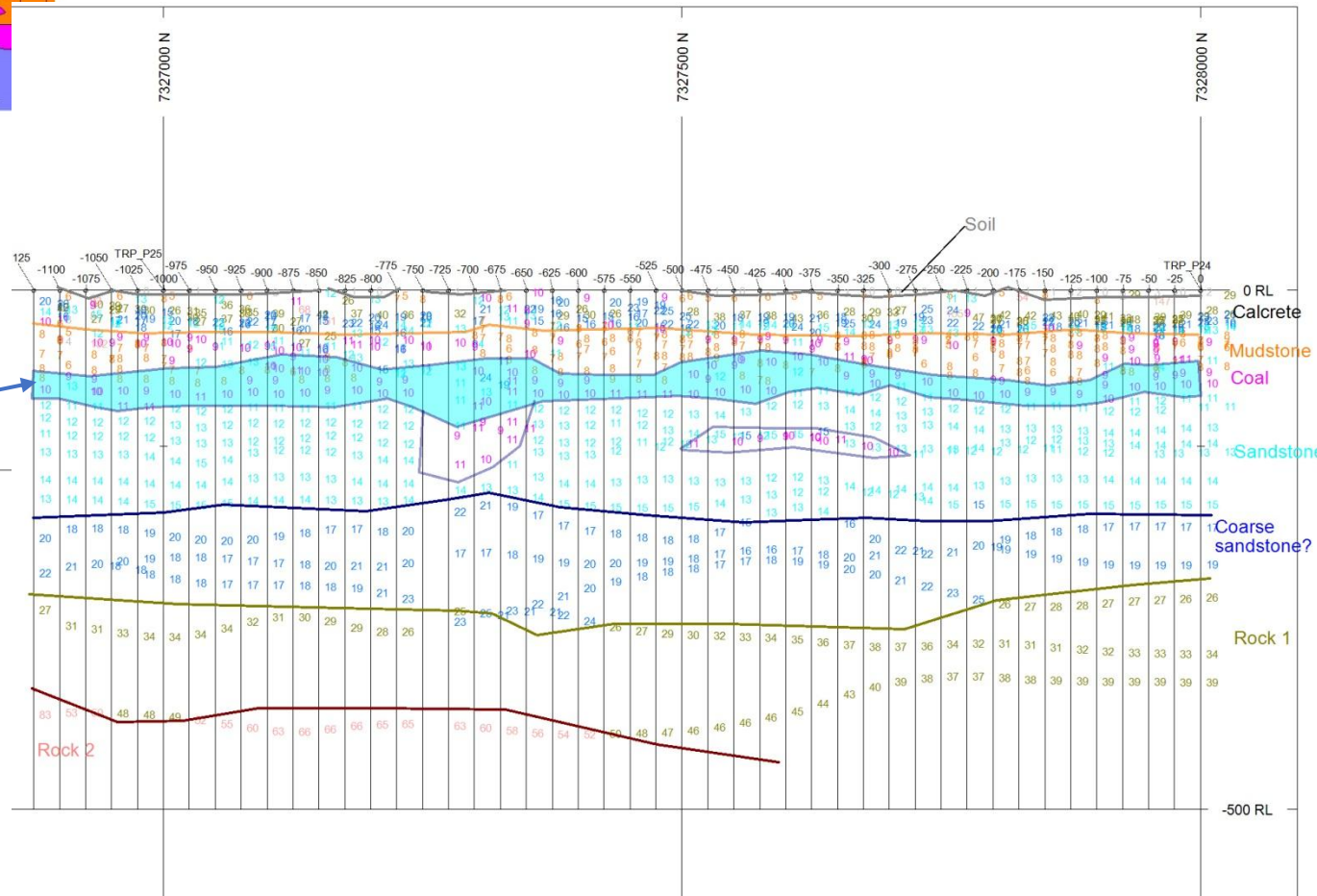
Sub-cropping over 100m wide silicified zone with gold



Coal Survey in Botswana



Coal and mudstone mapped very well



Conclusion

- The CSAMT survey was able to map stratigraphy (resistivity layering) very well enabling siting of some fairly productive boreholes
- Other surveys such as ground magnetics can be useful in enhancing interpretation
- The CSAMT method can also be used for a variety of other geological application especially to aid siting of exploration drill holes

The End