Approach for borehole site investigations

The survey will be carried out using resistivity equipment (ABEM SAS300 / SAS1000). The method is used to find low resistivity zones or conductors that may be caused by water bearing layers or aquifers. Two types of aquifers are targeted:

1) near vertical zones in fractured or faulted rock
2) areas with substantial thickness of the regolith (weathered bedrock)

Resistivity profiles are carried out to identify the lateral variation in resistivity at one target depth (usually target depth is approximately 40-60m). The zones are identified through anomalies on the profiles. The interpretation of the profile is both qualitatively and quantitatively. The shape and the lowest resistivity value of the anomaly are considered. Parallel profiling is mainly carried out in areas where anomalies have been detected that had not been identified during the API. The results of the parallel profiling are used to establish the orientation of the anticipated fractured zone.

A vertical Electrical Sounding is carried out at the anomaly to identify the vertical variation in resistivity at that particular spot[1]. The VES gives resistivity values of the layers down to ½ AB=120 m which corresponds to approximately 75-90 m. When the bedrock is shallow ½ AB values of 83 m suffice and sometimes ½ AB values have to be extended to 160m or 200 m. Preliminary interpretation of resistivity soundings is based on experience. Interpretation of the sounding curve is based on the convolution method of Ghosh (1971) a mathematical curve fitting procedure. Without any additional data for correlation it can easily lead to a fitting solution that does not quite correspond to reality. The layered earth model is actually very much a simplification of the many different layers which may be present. The various equivalent solutions that can be generated by a computer programme should therefore be carefully analysed. In general a single resistivity sounding should never be interpreted in isolation as this leads to a meaningless result. Also the fact that a clay layer (not water producing) has the same resistivity as a water bearing sand layer and the fact that some specific minerals present in the rock may also be highly conductive and show up as an anomaly on the resistivity profile makes the interpretation a delicate activity.

When interpreting the VES with computer software it is important to realize the following two effects:

1) Equivalence: equivalence is the problem of having different interpreted computer models for the same resistivity curve. This is the result of the fact that usually more than one solution is possible e.g. a relatively thin layer with a low resistivity may give the same result as a thick layer with a slightly higher resistivity.

2) Suppression: when the thickness of a layer intercalated within a sedimentary sequence is relatively small it may not be noticed in the resistivity graph and is 'suppressed' and therefore not sensitive to the computer interpretation. Nevertheless, where justified (e.g. when it is known to exist from borehole data) this 'invisible' layer may be introduced in the interpreted model.

In view of the above it is clear that no Consultant can give a 100% guarantee for productive boreholes. It is also impossible to give accurate estimates of borehole yield or water quality based on the geophysical measurements only. The results of an analysis of many rural water supply projects however indicate that the above discussed methodology is likely to increase success rates up to 70 to 100% depending on the hydrogeological conditions of the area**.**

[1] *The VES only gives an indication of the built up at one particular spot as opposed to resistivity profiling that gives an indication at many locations along the profile line. A survey in basement areas where fractures are targeted consisting of VES measurements only is therefore not recommended*.

Field activities

Based on the results of a desk study on geology, hydrogeology and borehole data, and the results of a detailed aerial photograph interpretation focused on lineaments target sites are selected for further geophysical investigations.

- Next to boreholes with known well log data a sounding is carried out to calibrate the interpretation model of soundings carried out for the geophysical survey. If no well log data are available, a sounding is carried out in each area of interest to get an idea about the depth to the fresh bedrock
- The geophysical profiling will be carried out perpendicular to major lineaments marked during the aerial photograph interpretation. The resistivity profiling will be done using a station interval of 10 m.
- In case significant anomalies are recorded sometimes a short (100-200 m) parallel profile at a lateral distance of 20 – 100 m will be carried out to verify the existence and direction of an anomalous zone coinciding with the mapped lineament. (*in this project however we will give preference to run longer profiles instead of parallel profiles to cover a bigger survey area*)
- In the centre of the most significant anomaly that can be related to an anomalous zone a resistivity sounding is carried out. The array of the sounding is extended until sufficient data are available to define the 45 degrees slope indicating fresh (dry) bedrock.
- Finally, an analysis of all soundings carried out on significant anomalies will be carried out to select the sites which are most favourable in terms of groundwater, being a suitable pre-bedrock resistivity and sufficient depth of weathering.

A vertical electrical sounding takes 1 to 2 hours, depending on the AB array separation needed to establish the 45 degrees rise of fresh bedrock, the roughness of the terrain and weather circumstances. In accessible terrain, between 1500 and 2000m of resistivity profiling can be done on one day, depending on station interval, electrode contact resistance and rainfall. Inaccessible terrain circumstances will require preparatory line cutting, which is estimated at 1 hour per 50 m of line cutting. Trees though will be spared.

If you need any more information on borehole siting procedures or the company's experience, please do not hesitate to contact us or visit our website www.we-consult.info.

Kind Regards,

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Director