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A Hydro-Geophysical Investigation of Groundwater Potential

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Abstract:- The electrical resistivity method is being employed for hydro geophysical investigation of groundwater. Wenner configuration of electrode arrangement with vertical electrical sounding (VES) is mostly practiced. IGIS signal stacking resistivity meter model SSR-MP-ATS was used to obtain the pattern of aquifer distribution in selected laterritic terrain and to delineate possible sites for locating aquifers. The inverse of the resistance measured 1/R was plotted against Wenner electrode separation on a linear graph. Even thin layers at deeper layers could be detected.

Keywords:- Aquifer, Groundwater, Electrical resistivity survey, Wenner electrode configuration, Vertical electrical sounding (VES), Inverse slope curve

I. INTRODUCTION

Groundwater contains various types of dissolved salts in it which are ionically conductive and this enables electric currents to flow into the ground. The presence of water can be identified by measuring the ground resistivity [1], [2]. Surface investigations allow us in deciding the information about type, porosity, water content and the density of subsurface creation. It is usually done with the help of electrical and seismic characteristics of the earth and without any drilling on the ground [5]. Electrical resistivity method is one of the geophysical techniques to investigate the nature of subsurface formations, by studying the variations in the electrical properties of the formations. In this method current is sent into the ground through current electrodes, resulting potential difference between potential electrodes is measured. If the resistivity in the ground is not homogeneous, then the measured resistivity will vary with relative and absolute location of the electrodes. In this case, the measured resistivity is an apparent resistivity (ρa), which depends on the shape and size of anomalous regions, layering and relative values of resistivities in these regions. With this method we can identify the aquifer. The Electrical Resistivity method with vertical electrical sounding has been used for the geophysical investigation of groundwater in a laterritic terrain (10°51'08.27"N, 75°59'08.75"E, elevation 25m). Wenner configuration of electrodes was used and inverse slope method was used to interpret the values.

The present study has been undertaken, keeping in mind the following objectives; to study the procedure for hydro-geophysical investigation of groundwater potential in a laterritic terrain, to obtain aquifer distribution within the study area and to delineate possible sites for locating aquifers for sustainable water supply.

II. MATERIALS AND METHODS

A. Materials

1) Resistivity meter model: SSR-MP-ATS

The Signal Stacking Resistivity Meter Model SSR-MP-ATS is a high quality data acquisition system incorporating several innovative features**.** The special feature in SSR-MP-ATS is that, it can store the data up to 20,000 measurements in its FLASH memory. It has provision to transfer the entire data directly to the computer through USB port for further analysis. The SSR-MP-ATS measures ΔV & current (I). It calculates the Resistance ($R = \Delta V / I$), Apparent resistivity ρ_a and Strip Resistivity ρ_{strip}.

2) Winches

There are four winches. Each winch has a wire winded on it which has a different colour end. The open end of wires has a pin connected to it which in turn is to be attached to the respective probes. The other end of the wires is concluded on the banana socket located at the reverse side of handle of the winch. At this end the corresponding wires from instrument terminals are connected.

3) Probes

There are four stainless steel probes which are of the appropriate sizes and they are supplied along with the instrument. Each probe has a pointed end. This facilitates to hammer the probe in ground. The probes are hammered in the ground in such a way that the firm electrical contact is established. To these electrodes the corresponding wire ends are connected.

4) Battery box

This is a compartment with 2x12 7 AH batteries. This battery supplies charge to the main instrument while taking the measurements.

B. Methods

1) Setting up of instrument

The measurements were taken in a straight line of about 100 meter. At a centre point "O" the device was placed and the points at which the electrodes are to be placed were marked on the basis of electrode spacing which ranges from two meters for the first reading and gradually increased by two meters for further readings. The potential electrode spacing is considered as "AB" and the current electrode spacing is "MN".

2) Measurement of resistivity

The resistivity meter was switched on the details of location was entered. When the resistivity meter asked for AB/2, MN/2, number of stacks for the measurement and confirmation of all the values respective values were entered. After completing all the stacks, instrument finally shows R for resistance, RHOa for resistivity, d for depth of sounding and STRIP for strip resistivity.

3) Interpretation of VES

Interpretation of VES was done with inverse slope software (AT 3.0). The linear plot was prepared between (AB/2) on X-axis and {(AB/2)/ ρa} on Y-axis. The various types of lithologic formations can be identified on the basis of the obtained readings.

4) Water table readings in wells

Water table readings of the open wells in the campus were also noted. The well readings were taken with an objective to correlate the values with the results obtained from the investigation.

III. RESULTS AND DISCUSSIONS

A. Hydro-geophysical investigation of groundwater potential

The geophysical observations were taken from 6 locations spread over the laterritic terrain and so that the chances for the occurrence of a phreatic water surface are minimum. However, certain points may be located where there is a chance for occurrence of ground water and feasibility for digging bore wells. Different types of formations were distinguished from the curve.

The graph representing inverse slope curve are drawn with VES interpretation software for all the locations.

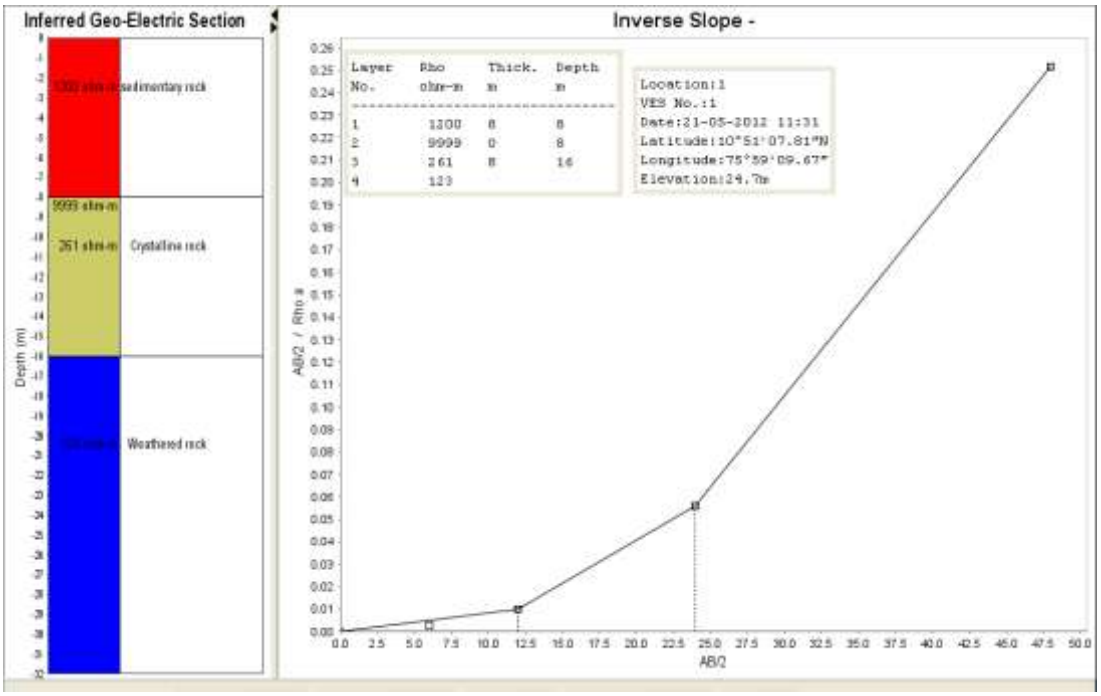

Fig. 1: *Inverse slope curve obtained for location 1*

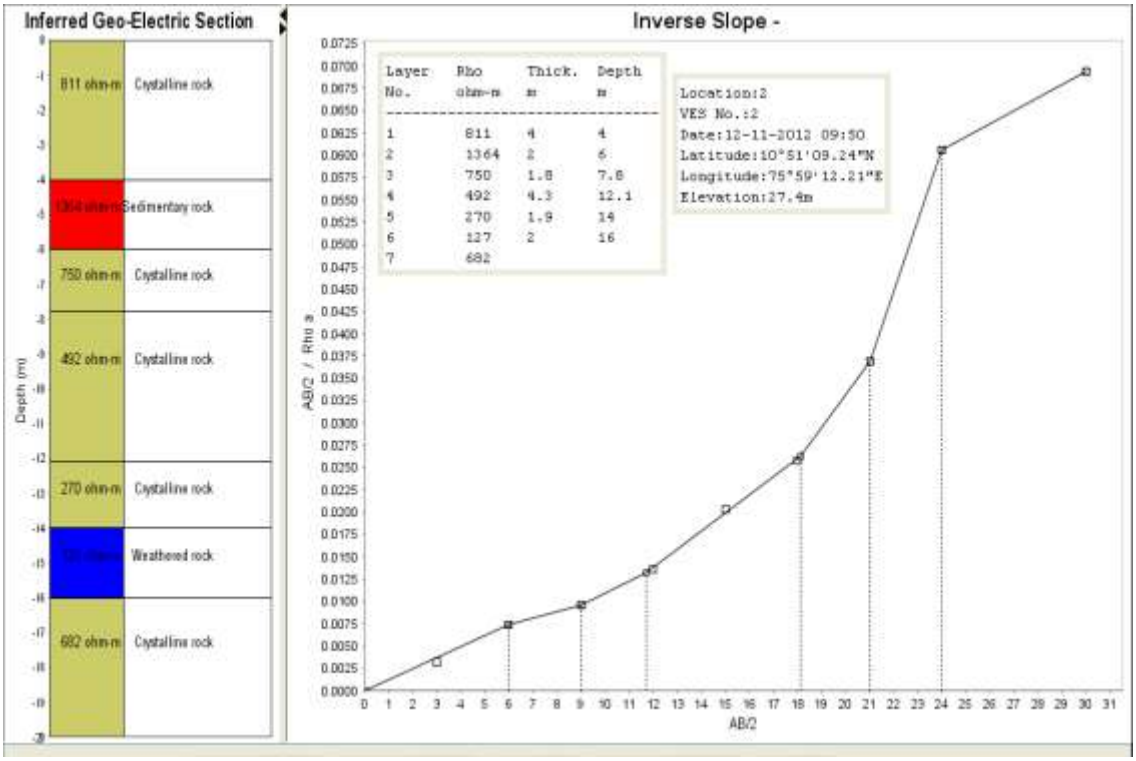

Fig. 2: *Inverse slope curve obtained for location 2*

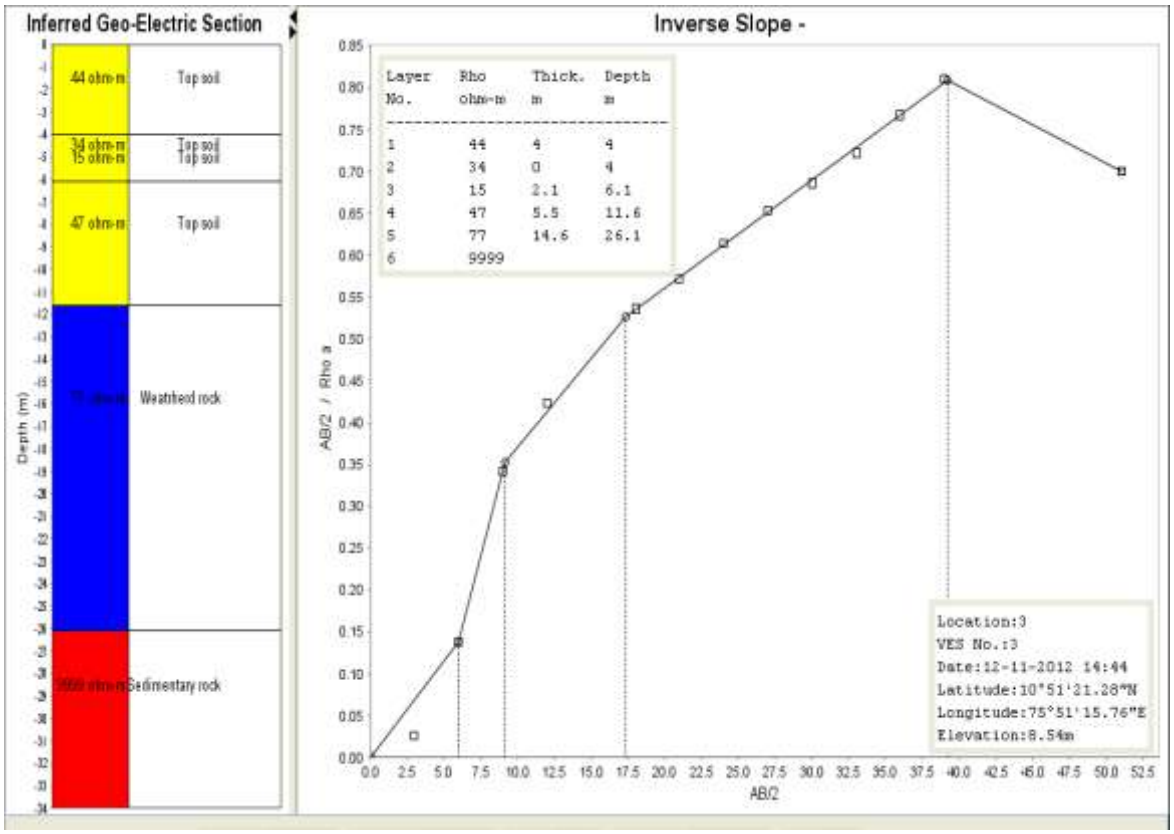

Fig. 3: *Inverse slope curve obtained for location 3*

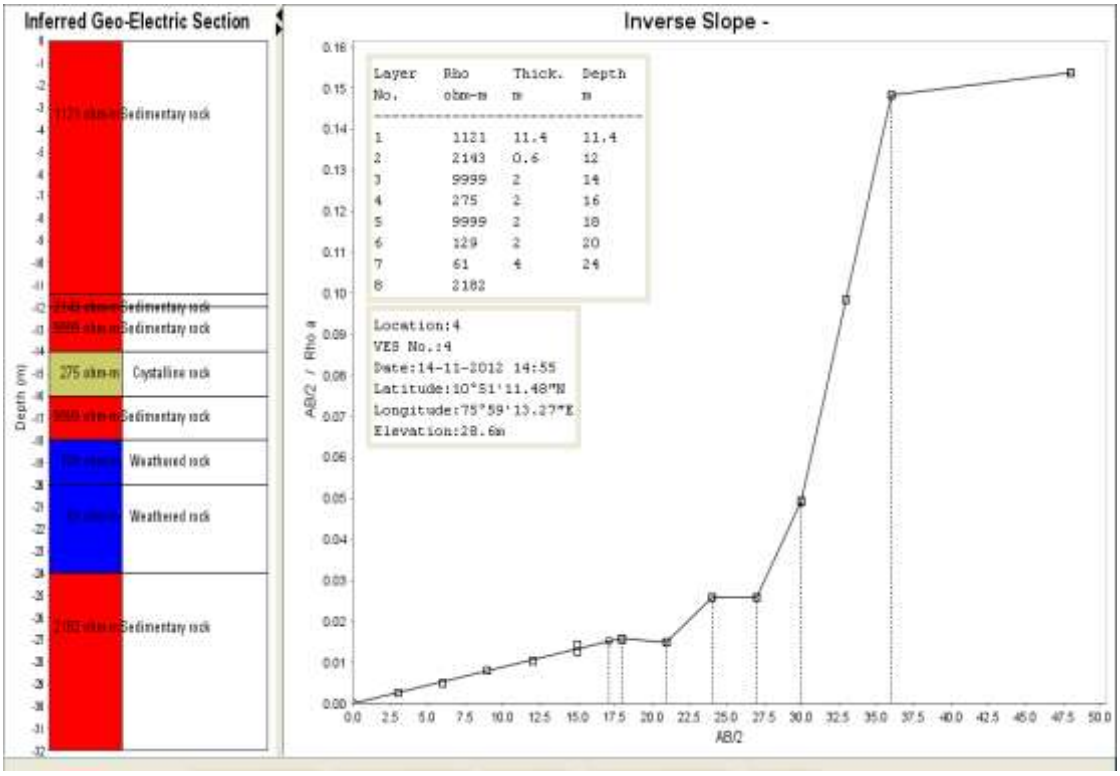

Fig. 4: *Inverse slope curve obtained for location 4*

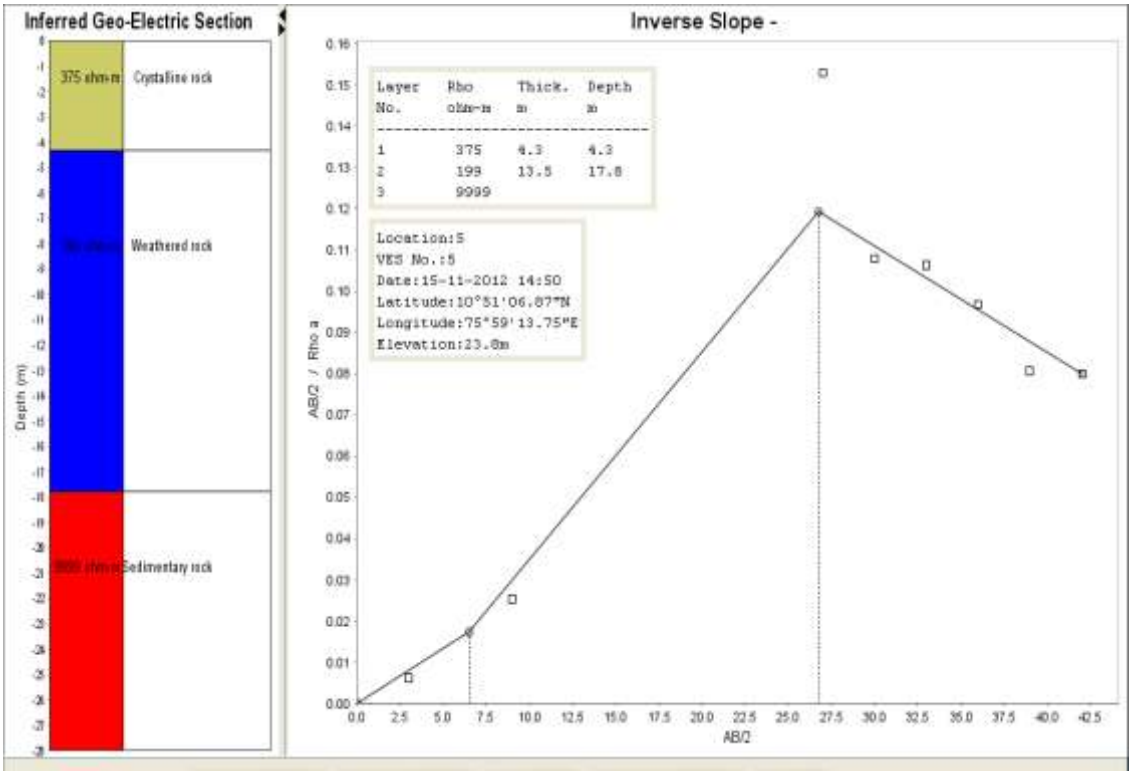

Fig. 5: *Inverse slope curve obtained for location 5*

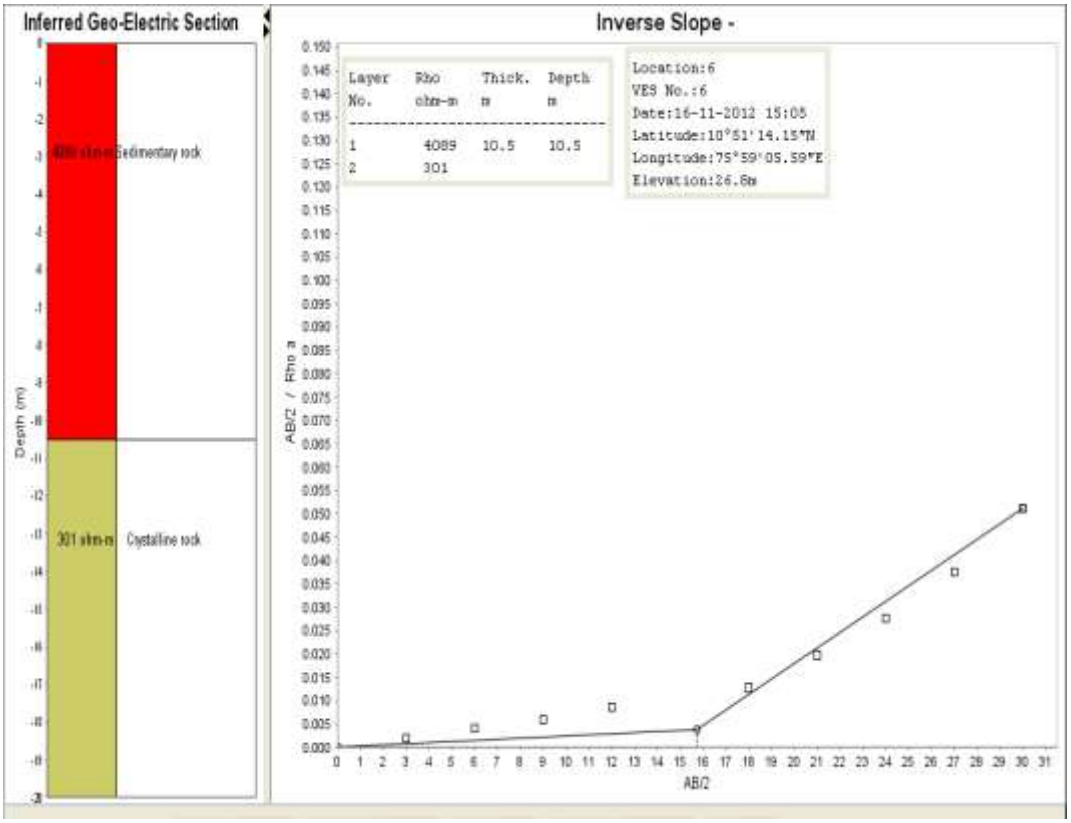

Fig. 6: *Inverse slope curve obtained for location 6*

B. Aquifer Distribution

The hydro-geophysical survey conducted on laterritic terrain revealed that the formations were basically rocky.

Table 1: Geographical locations and elevations of the sites

Location number	Geographical location	Elevation (m)
1	10°51'07.81"N 75°59'09.67"E	24.7
2	10°51'06.87"N 75°59'13.75"E	23.8
3	10°51"09.94"N 75°59'12.21"E	27.4
4	10°51'14.15"N 75°59'05.59"E	26.8
5	10°51'11.48"N 75°59'13.27"E	28.6
6	10°51'21.48"N 75°59'15.76"E	8.54

The soundings were done at location 1 and from the graph a three layered formation is found to have been present. The upper two layers were identified as hard rock formations whereas the bottom layer was identified as weathered form and this may yield satisfactory discharge. The formations at location 2 were found to be basically hard rock. The aquifer thickness being only 2 meters it cannot yield appreciable discharges. From the graph of location 3 it can be said that no significant yield can be expected from the area by drilling tube wells. The potential of constructing filter point wells may be explored in this area.

The inverse slope curve for location 4 showed this may yield sufficient discharge from the weathered formation which was found to be confined. The fractures present may not make the aquifer suitable for ground water extraction. At location 5 weathered formations may serve as a good confined aquifer was identified. Location 6 was identified as high hard rock area and the area may not be suitable for wells.

C. Potential Sites For Drilling Tube Wells

The hydro-geophysical survey conducted on this laterraitic terrain revealed that the formations were basically rocky. Appreciable amount of fracture and weathered formations could be found near to location 1, location 3 and near to location 5. So the study reveals that there are three potential areas for drilling tube wells.

D. Correlation With The Well Reading

The water table of this terrain from the well is found to lie at around a depth of 16 meters below ground surface. The result from the investigation shows that the weathered formation lies between the depths 18-20 meters. So the results can be said to be converging to a common result.

IV. CONCLUSION

By this study, all possible sites in the study area were explored for the presence of ground water. The study could come to a positive conclusion, whereby potential areas for sustainable water supply were delineated. From the six locations under consideration, three of the locations revealed potential groundwater reserves which could be a good source of water to be explored. In one site filter-point wells may be a possibility. So the present project has succeeded in fulfilling its primary objectives. Therefore, drilling of bore wells is suggested in the potential sites located.

The water table readings taken could be successfully correlated with the results of the hydro-geophysical investigation.

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