

DEMARCATIION OF SALINE BELT USING COMBINATION OF WENNER AND SCHLUMBERGER METHODS FOR 3-D MODELING

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ABSTRACT

In many areas of the India, ground water is been used as a main source of water and as per Indian rituals it is also considered as fresh and well filtered source of water. The ground water supply is continually depleted. It calls for increasing the awareness for increasing the importance of ground water management and increase the water restoration capacity in the ground. A cost effective solution has been proposed optimize Wenner array and Schlumberger array methods of resistivity measurements. Sample data taken in coastal areas have been analysis for simple 3D modeling.

KEY WORDS: Wenner array, Schlumberger array, Resistivity, Sea water.

I. INTRODUCTION

Most of the populated areas of the world use groundwater as the main source of freshwater .Freshwater is getting continuously depleted as the population is increasing .The importance of groundwater monitoring and management are becoming all the more important . A major concern in a wasted belts in the included flow of saltwater into freshwater aquifer due to mainly pumping .In areas where groundwater is pumped from aquifer connected sea ,induced effect causes a gradient for migration of saltwater. The controlling mechanism rest on the balance between water pumped from aquifer and amount of water buy replenished. Geophysical methods are very useful for coastal areas. A proper matching has to be done between geophysical methods and surveying objects. Extensive surveying has been done by Vacquier and others (1957).

II. RESEARCH METHODOLOGY:

To achieve an objective of the study, Intrusion of seawater implies the movement of seawater into freshwater aquifers due to natural processes human actions. Fresh water is less dense than seawater and so it floats on top of seawater when the unconfined aquifer contacts the sea at the shoreline. Freshwater recharge move down gradient and eventually gets into low lying areas. Migration of seawater into freshwater aquifer is known as seawater intrusion. The interface zone is like a transition zone which depends on

a) Tide, b) Relative density, c) Pumping of wells & d) Rate of recharge and other parameters like hydraulic features of aquifer.

Pumping out of freshwater diminishes the weight of overlying freshwater which can decrease on even reverse the seawater movement. In that case, sea water moves landward into freshwater aquifer. Seawater rises 40m for every 1meter freshwater depression and forms cone of ascension.

III. CONDITIONS OF DEMARCATIION:

Resistivity of fresh ground water varies from 10 to 100ohm m depending on concentration of salts. Alluvium has 10 to 800ohm m. salty sea water has approx 0.2ohm m resistivity.

In marine clay we have to consider hydraulic conductivity

$$K = c(d_{10})^2$$

MN= potential electrodes

AB =outer electrode

AR = apparent resistivity

k= hydraulic conductivity 0.004 to 0.1 cmsec⁻¹

C= constant

C value 40-100 (cmsec⁻¹)

Soil shows moderate permeability (4*10⁻⁵ to 1*10⁻⁴ msec⁻¹)

d10= 0.001 cm (cmsec⁻¹)

Table 1: Representing about Apparent Resistivity values

| Sr. no | AB/2 | MN | AR |
|--------|------|------|----|
| 1 | 1 | 10 | 60 |
| 2 | 10 | 100 | 50 |
| 3 | 20 | 200 | 55 |
| 4 | 50 | 500 | 55 |
| 5 | 100 | 1000 | 65 |
| 6 | 100 | 1000 | 10 |
| 7 | 500 | 5000 | 3 |

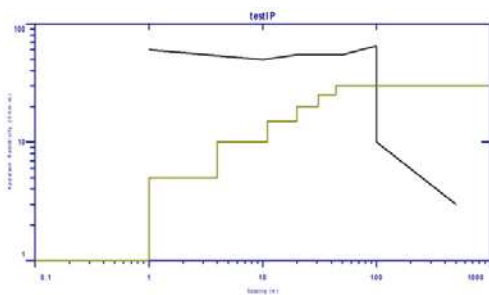


Figure 1:1D Image of site

Array selection:

Wenner array is the obvious choice as the ground transverse given by it provides a dense near surface covers of resistivity data. This also provides a good vertical resolution and provide very clear image of groundwater and sand clay boundaries as horizontal structures.

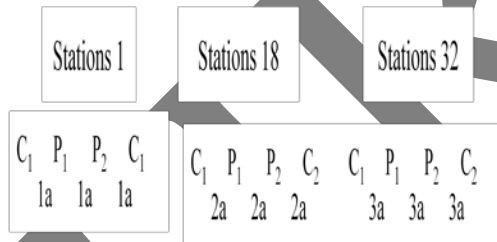


Table 3 Positions of electrodes

| Electrode number | 1 | 2 | 3 | ... | 20 |
|------------------|---|---|----|-----|----|
| n=1 | | 1 | | | |
| n=2 | | | 18 | | |
| n=3 | | | | 32 | |
| n=4 | | | | | 56 |
| n=5 | | | | | |

Table 2: Represents the resistivity model

| ρ_0 | Thickness | Depth | Elevation |
|----------|-----------|-------|-----------|
| 1 | 1.000 | 1 | -1 |
| 5 | 3.000 | 4 | -4 |
| 10 | 7.000 | 11 | -11 |
| 15 | 9.000 | 20 | -20 |
| 20 | 11.00 | 31 | -31 |
| 25 | 13.00 | 44 | -44 |
| 30 | 15.00 | 59 | -59 |

Steps for developing seawater-freshwater infrastructure:

- 1) Estimate transition region of one hundred years 1950
- 2) Estimate transition region of when pumping is done 1960-1990
- 3) Low pumping rates 1990-2015

In ERT it was fixed that up gradient change is 0mg/l where as TDS transparent down gradient is 30mg/l

Choice of configuration:

$$\Delta V = \frac{\rho}{\pi} \left(\frac{1}{r_1} - \frac{1}{r_2} - \frac{1}{r_3} + \frac{1}{r_4} \right)$$

It is in the form that dipole - dipole or pole dipole have more semi huts for 3d freeze.

Inverse method:

Sankarnaryan (1974) discussed these techniques methods for modeling:

- 1) Plotting a/ρ_a against a
- 2) Plotting $1/a$ against of ρ

$$\frac{a}{\rho_a} = \frac{1}{2R} * 3.14$$

For Plotting $1/r$, the results must be multiplied by $2*3.14$ for quality resistivity value as

$$\frac{1}{R} = \frac{a}{\rho_a} * 2 * 3.14$$

ERT studies/3-D modeling

Pole electrode array is used with 2 remote electrodes so that reductions of telluric effects are also taken into consideration.

Inverted resistivity studies give the following results.

| | |
|----------------------|--------------------|
| $h_1 = (0 - 0.65)$ | $\rho_1 = 220$ |
| $h_2 = (0.65 - 1.4)$ | $\rho_2 = 130$ |
| $h_3 = (1.4 - 2.4)$ | $\rho_3 = 50 - 80$ |
| $h_4 = (2.4 - 3.5)$ | $\rho_4 = 20 - 50$ |
| $h_5 = (3.50 - 4.7)$ | $\rho_5 = 7 - 18$ |

For salinity of 1.2ppt, electrical resistivity of aquifer was found to be arrow 1.00ohm. For salinity of 0.5ppt, it was around 2.0ohm.

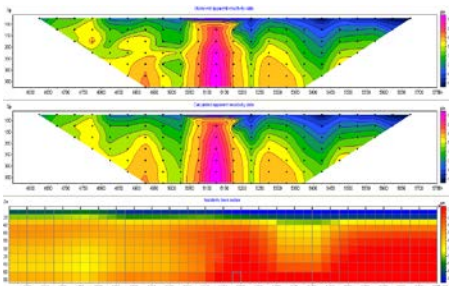


Figure 2: The boundaries layers under focus are marine clay, sand of salt clay

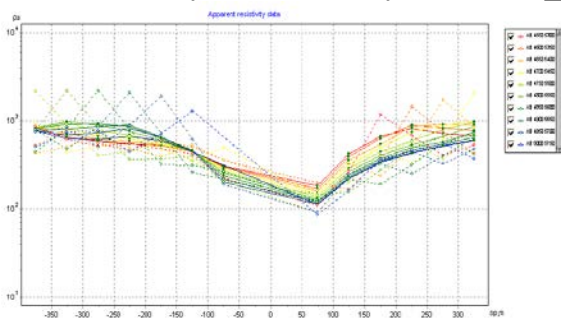


Figure 3: Apparent Resistivity Data

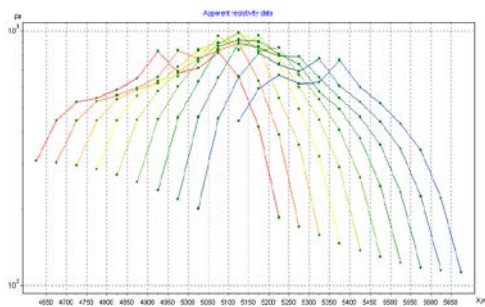


Figure 4: Apparent Resistivity data

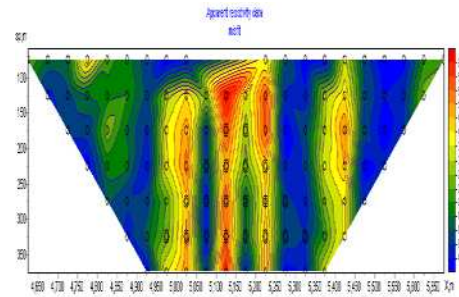


Figure 5: Apparent resistivity data misfit

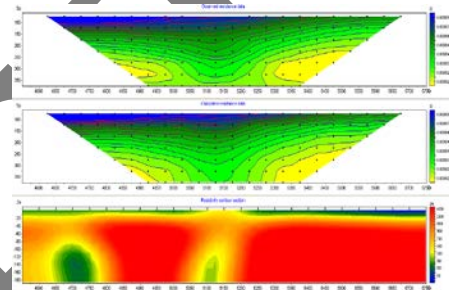


Figure 6: Resistivity in Contour

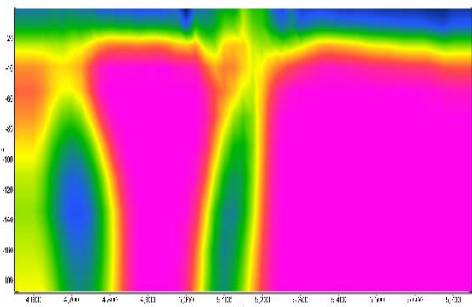


Figure 7: Output in 3D View

CONCLUSION: A detailed electrical resistivity imaging was carried out on the site. While working on this project, BTKS WDDS-2/2B instrument which gives digital reading has been used approximately at every 1.5 mtr to 5 mtr. A method suggested by great scientist wenner has been adopted for carrying out this study and while adopting this method care is taken that profiles must be perpendicular to shore line. The depth of the investigation ranged from 25mtr to 50 mtr. The nice representation of the pseudo section is been drawn by using RES2DINV software. It's been observed that saline water intrusion was approximately at 20 mtr. This is indication of up coning of saline water in the formation of sandstone.

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