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Investigation of Aquifer by Electrical Resistivity Method

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Abstract: ***Water present below the Earth surface is called as ground water, which has rainfall as its main source. Ground water that accumulates between rock layers is termed as aquifer. Depth of aquifer can be found by using various geophysical methods. Electrical resistivity method is prominently used for finding out depth of aquifer of which Schlumberger Electrical Resistivity was used in Naigaon village of Tal-Purndhar in Pune district. In this paper the author has presented and interpreted ground water condition, depth of aquifer in summer season, subsurface geology. Field survey was carried out to study different rock forms in vicinity and collected information related to lithology. After the thorough investigation by ERM confined aquifer was found to be present at depth of 45m to 75m.***

Keywords: Aquifer, Schlumberger Electrical Resistivity, geomorphology, Basalt

1. Introduction

The investigation for depth of aquifer was carried out at Naigaon village located in purndhar taluka of pune district, Maharashtra, India was drought prone area in 1974. Rainfall of this area is 300 to 450mm [7] Rainfall increases from east to west; east portion was dry compare to west portion of India. Temperature varies from 9.6°c to39.8°c. Pani panchayat activity was carried out in naigaon village. The Pani Panchayat is a voluntary activity of a group of farmers engaged in the collective management (harvesting and equitable distribution) of surface water and groundwater (wells and percolation tanks). Pani Panchayat is the name first given to a movement by Mr. Vilasrao Salunke for motivating farmers of Naigaon village of the drought-prone Purandhar taluka of Maharashtra. [6]

Resistivity survey is also known as the electrical or electromagnetic method of survey. Widely used electrical resistivity method for investigation of ground water and also used for mineral exploration and determine resistance of rock .it's based on principle of any change in specific resistance bring about a change in current Flow through the media and consequent change in electrical potentials. This process is easy and handles all instruments. If calculated resistivity of homogeneous or isotropic surface then it is true resistivity, if sub surface is not homogeneous then it will be apparent resistivity. In resistivity two arrays are used shclumberger and wenner . In wenner arrays potential and current electrode placed in straight line at equal distance. But in shlumberegr arrays potential and current electrode placed in straight line but in an unequal distance.

2. Geology and Geomorphology of the Area

Naigaon is located in Purndhar taluka of Pune district. The entire Pune district is covered by the Deccan trap lava flows of Eocene to upper cretaceous. The Deccan trap is overlain by alluvium along the major rivers flowing through the district.

Formation	*Lithology*	*Age*
Alluvium	Sandy and clayee alluvium	Recent
Deccan Traps	Amygdular vesicular zeolitic basalt and massive basalt, of then reported by Red bole	Eocene to upper cretaceous

Table 1: The Stratigraphical Sequence of the Various

The following image shows geographical map;

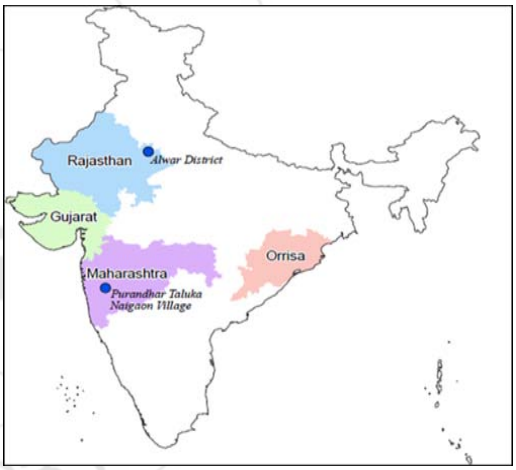


Image 1: Geographical map of India

Field traverse had been taken from the ridge through the valley to the check dam. Along the traverse we observed the various lithology and also studied their characteristics.

Compact Basalt I
Latitude -N 18° 21'22.7"
Longitude-E 74°13'31.2"
Compact Basal is fine grained, thick and extensive flow. Jointing pattern absent. The rock is weathered, so less chance of percolation of water and surface run-off will be high.

Image 2: compact basalt

Amygdaloidal Basalt
Lattitude-18°21'25.3"
Longitude-74°13'41.9"
Generally amygdaloidal basalt is not permeable when fresh, but it becomes permeable due to development of sheet jointing which is an intermediate stage of jointing. Amygdaloidal basalt shows much variation in field and is characterized by much smaller size and irregular forms. In case amygdaloidal basalt, vesicles filled by secondary minerals like zeolites, silica, green earth and calcite. Rock also shows pipe amygdaloidal structure at many places. The rock is highly jointed so lot of chances for the percolation of water through the joints. Tight joints due to vein fillings are developed in rock masses due to stresses built up in rock mass. These plane of weakness tight due to filling up of ascending mineralizing solutions –white in colour, siliceous / zeolitic or green in colour, chlorophaeitic.

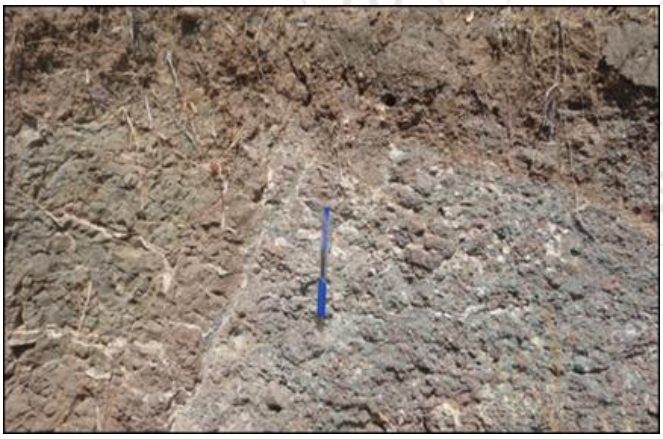


Image 3: Amygdaloidal Basalt

Compact Basalt -II
Lattitude-18°21'25.7"
Longitude-74°13'45.6"
Compact Basalt which is highly jointed. The joint is vertically oriented. Jointing pattern play an important role in the percolation of water. So percolation of the water will be in vertical direction. But jointing pattern shows variation even within short distances. Joint may be inconsistent broadly spaced or closely spaced. Basalt colour is light due to chemical weathering. Radiating joint pattern is also common. The following image shows compact basalt;

Image 4.1: Compact Basalt

Image 4.2: Compact Basalt

Compact Basalt-III
The rock showed sheet joints and horizontal joints. Due to this the percolated water will flows horizontally.

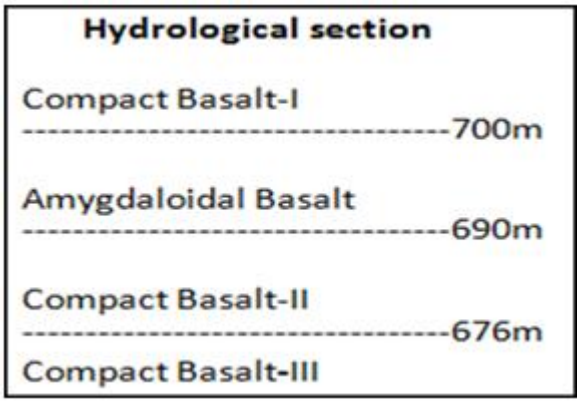


Figure 1: Lithostratigraphy

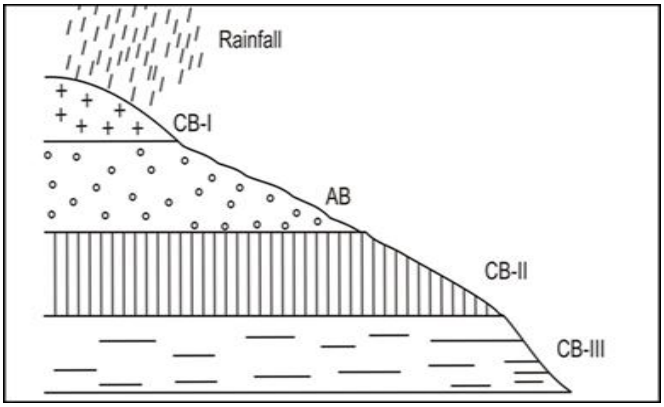


Figure 2: Lithostratigraphy

3. Vegetation

Indian soils are very poor in organic matter, especially in drought-prone areas. This can be improved by leaving the crop residue in situ (on the fields). Vegetation is crucial in preserving productive soil and conserving rain water for sustaining life. Soil and water need to be preserved for crop production (both annual and plantation crops). Minor vegetation such as creepers, shrubs, various kind of like Agave, which yield fiber have an important role when grown in gullies of various kinds and also on upstream and downstream sides of mechanical structures such as gully checks, water harvesting structures, etc. These provide reinforcement and extend the life span of the structures by binding the soil through the network of their root systems. These plants also provide fodder to animals in the area. Medium to small agaves work well in containers or combined with groundcovers and wildflowers for colorful landscape combinations. They are best suited for fall and late winter planting. Irrigation should be deep and infrequent for best plant health.

4. Methodology

4.1 Resistivity Surveys

Image 5.1: Photo showing connection for resistivity method

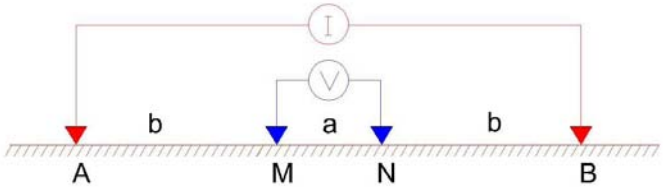
To proceed resistivity survey in the field, used potentiometer and ammeter, resistance and pair of electrode, two pair of electrode are set on the ground in a line, the distance from one electrode to other is not same for schlumbereger arrays. The distance from one electrode to other is being same for wenner arrays. Current is passed in to ground through the two end of electrode and reduction in voltage is measured through the central pair of electrodes and resistivity calculated.

Resistivity (ρ) = R. × A/L
Where, R= resistance
A=area of cross section
L=length of the rod

5. Field Procedure

We used slumberger array for this survey, in slumbereger array four electrode arranged in straight line ,in which outer two electrodes are current (A and B)and inner two electrodes are potential electrode(M and N) . Potential electrode is receiver and current electrode is source. Potential electrode placed at center of this array .distance between potential and current electrode are not same , The current electrodes are increased to a greater separation during the survey while the potential electrodes remain in the same position until the observed voltage becomes too small to measure

Figure



Formula

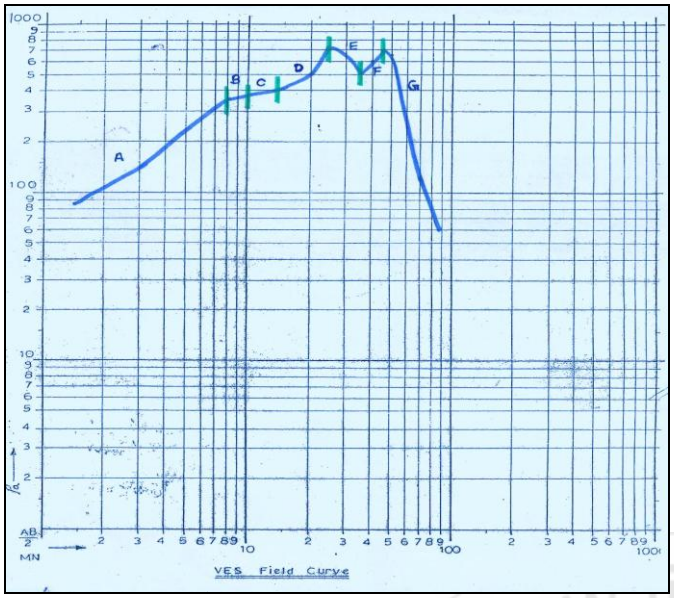
$$\rho_a = \frac{(\frac{AB}{2})^2 - (\frac{MN}{2})^2}{MN}\ \pi(\frac{V}{I})$$

Schlumberger Electrical Sounding Data

Owner: Pani panchayat Survey no: 1 Acreage: 5 Village: Naigaon Long: N18^{0}20'22.4" Lat: 18^{0}21'22.6"
Elevation: 680 m Depth of water table: 12 m

AB/2 (in meters)	MN/2 (in meters)	K (Constant)	R (Resistance)	pa (Resistivity R*K)
1.5	0.5	7.0	12.5	87.5
3	0.5	28.2	5	141
5	0.5	78.5	2.9	227.65
8	0.5	201	1.8	361.8
10	0.5	314	1.5	471
10	1.5	104.7	2.9	303.63
15	1.5	235.6	1.7	400.52
20	1.5	418.8	1.2	502.56
25	1.5	654.5	1.0	654.5
30	1.5	942.4	1.0	942.4
30	5	282.7	1.5	424.05
35	5	384.8	1.3	500.24
40	5	502.6	1.2	603.12
45	5	636.2	1.1	699.82
50	5	785.4	1.0	785.4
50	10	392.7	1.5	589.05
55	10	475.2	-	-
60	10	565.5	-	-
65	10	663.7	-	-
70	10	767.7	0.16	122.83

Resistivity Graph



Where,
Zone A: Dry, Highly Jointed Columnar Basalt.
Zone B and C: Vesicular Basalt (With Or Without Water).
Zone D: Hard , Compact Basalt.
Zone E: Vesicular Basalt.
Zone F: Compact Basalt
Zone G: Water Bearing Horizon

6. Conclusion

From graphical representation, initially the resistivity values increases from 1.5 meters to 8 meters which indicates presence of harder rock which might be dry, highly jointed columnar basalt. From 8 meters to 15 meters curve shows a flat trend which indicates a softer rock, which can be interpreted as water is still present in the rock formation. Curve shows a steep increase from 15 meters to 25 meters due to presence of hard, compact basalt. Followed by sudden decrease in resistivity from 25 meters to 35 meters, it indicates vesicular basalt with or without water. From 35 meters to 45 meters, curve represents a steep increment may be due to contact between vesicular and compact basalt. Then resistivity curve suddenly decreases from 45 meters to 75 meters which can be interpreted as presence of water bearing horizon. On the basis of above observations it can be concluded that a presence of confined aquifer at the depth of 45 meters to 75 meters.

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