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Electrical Resistivity Distribution Studies for artificial recharge of groundwater in the Dhubdhubi Basin, Solapur District, Maharashtra, India

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ABSTRACT
Electrical resistivity distribution at different depth horizons for the Dhubdhubi Basin in Solapur District, Maharashtra has been delineated and represented by contour maps at different electrode spacing. These are correlated with local Geology for a semi quantitative interpretation to detect the potential zones of groundwater. The selection of sites and depth at which the artificial recharge is possible and the structures required are also suggested.

INTRODUCTION

Electrical resistivity distribution at different depth horizons have been demarcated for the Dhubdhubi basin, a sub basin of Bhima river, which covers part of South Solapur and Akkalkot Talukas of Solapur District Maharashtra, located on survey of India Toposheet no.47 0/14, 47 0/15, 56 C/2 and 56 C/3 on the scale of 1:50000, lies between latitude 17^0 21' to 17^0 41'N and longitude 76^0 00' to 76^0 11'E as shown in the fig.1 covering an area of 450 sq.km.

The Dhubdhubi basin consists of unclassified basaltic lava flows (GSI 2001) representing Indrayani stratigraphic unit of Sahyadri group of Deccan trap formation of Upper Cretaceous to lower Eocene age. Stratigraphic succession as observed in the Dhubdhubi basin is shown in the table 1 (Sabale 2008).

Weathered zeolitic/fragmentary lithounit is exposed in the southern portion of the basin, at Kudal and Devkavate villages and is overlained by redbole of 1m thickness, around Andhewadi and near Kalhippargi, representing oldest flow (I^{st} flow) in the basin. The thickness of this flow is 21m. Flow II^{nd}, also of 21m thickness, consisting of lower 8m thick weathered basal clinker, starts at an altitude of 431m between Shaval and Kalhippargi. This is overlained, by fractured/ massive basalt of 12m thickness, around Kalhippargi, Handral, Karajgi, Shirval and Kadabgaon villages. One meter thick redbole graded into zeolitic/vesicular basalt is exposed NE of Handral, Jeur, Ingalgi, Achegaon, Tillyal, Hipale, extending beyond Ratnapur (Borul). It is the marker bed between II^{nd} and III^{rd} flow. This is overlained by 4m thick unit of Basal Clinker around Hanjagi, South of Karjal and north of Hipale. Above these rocks, massive basalts of 19m thickness are resting and are outcropped around Akkalkot station, Dodyal, Konhalli, Karjal, Shingadgaon, Hanamgaon and Rampur. 22m thick vesicular zeolitic basalt unit is overlaying this around Bagehalli, NE Konhali, North of Dahitanewadi, Walsang, Gurdehalli and Kardehalli. This vesicular zeolitic lithounit is graded into 1m thick red bole and basal clinker of the younger flow, exposed near Wadgaon. The total thickness of the III^{rd} flow is 46m. This is overlained by fractured / massive basalts of the younger flow (IV^{th} flow) in the basin around the villages Halhalli, Dindur, West of Thirth, North of Wadgaon, Dhotri and North of Shirpanhalli. The basin boundary in the North and NE shows exposures of zeolitic basalt.

The massive portion of I^{st}, the oldest flow in Dhubdhubi basin is not represented. The general gradient of lava flows in the basin is around 1:550 to 1:800 towards SE. The geological map of the basin is shown in the fig. 2.

However, Exposures of alluvium, having a thickness range of four to seven meters are the quaternary formations exposed in the basin around Andhewadi (K) and near Handral along the stream.

ELECTRICAL RESISTIVITY STUDIES

Extensive use of electrical resistivity method for groundwater exploration is extensively used because of direct relation between electrical conductivity and groundwater, simple field operations and improved interpretation techniques. Depth of the occurrence of groundwater and location of well sites can be determined more precisely by electrical resistivity

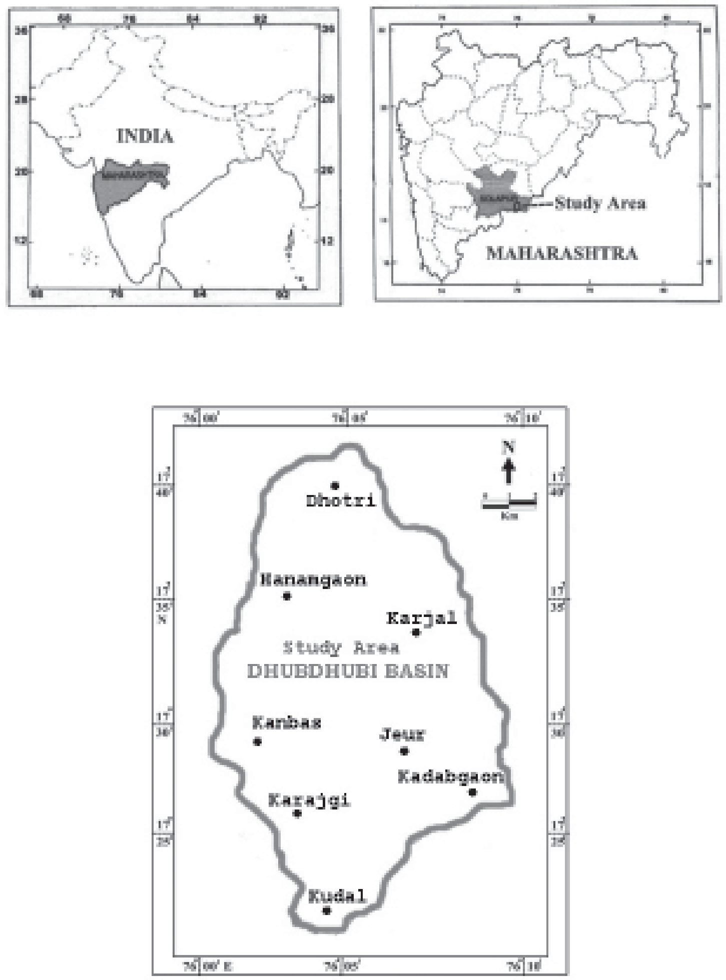

Figure 1. Location map of Dhubdhubi Basin, Solarpur District,Maharashtra.

Table 1. Stratigaphic successions of the deccan basalts from the Dhubdhubi Basin

Age	Super group	Group	Stratigraphic Unit/ Formation	Litho unit	Thickness in meters	Flow number in the Basin
QUATERNARY			ALLUVIUM	Poorly sorted sediments	4-7	
UPPER CRETACEOUS TO LOWER EOCENE	DECCANTRAP	SAHYADRI	INDRAYANI	Massive Basalt Fractured/ Jointed Basalt Basal Clinker (weathered)	5 9 8	IV
				Red bole Zeolitic Massive/Fractured Basalt Basal Clinker	1 22 19 4	III
				Red bole/ Zeolitic Massive Basalt Basal Clinker (weathered)	1 12 8	II
				Red bole Zeolitic (weathered)	1 20	I

method. However, these studies besides mapping and delineation of potential areas on small and regional scales, help geologists for the determination of hydraulic characteristics of aquifers (Senthil Kumar, Gnanasundar & Elango 2001), characterization of lineaments to locate groundwater potential zones, (Subhas Chandra et. al. (2006) flow pattern of groundwater (Narayanpethkar, Vasanthi & Mallick 2006) and estimation of natural recharge (Chand et.al. 2004). Electrical resistivity studies have also been used to study groundwater pollution (Natkar et.al.2008) and to carry out groundwater modeling and to estimate groundwater recharge (Narayanpethkar, Gurunadha Rao & Mallick 1993, 1994).

RESISTIVITY CONTOUR MAP

The resistivity distribution over the entire area would qualitatively correspond to variations of the resistivity at different depths. This is achieved by increasing electrode spacing. More the electrode spacing, deeper is the current penetration. This could be used to establish lithological correlation. Keeping this view in mind, resistivity contouring has been carried out with Wenner configuration for different electrode spacing, a = 10, 25, 50, 75 and 100m. This provides the variation of resistivity at five different horizons carried out at 40 locations.

Fig.3 shows resistivity variations at shallow depths by apparent resistivity contours for a = 10m. There are six high resistivity contour closers, having highest value over 240 ohm-m in NE portion of the basin, SE of Tirth denoted by (H1) in the figure. Resistivity is close to 100 ohm m around Kardehalli (H2), west of Dindur. North of the Basin east of Kanbas and near Ingalgi there is a resistivity high (H3). The resistivity ranges close to 70 ohm m around Hanamgaon (h4) in the NW. Kadabgaon (H5) near the South central margin and (h6) SE of Walsang and East of Konhali. Exposures of hard basalts are found in these regions. Low resistivity contours showing less than 30 ohm m are distributed around Kudal, Kalhippargi and Jeur denoted by (L1) in the area, occupying southern zone of the basin. Kanbas and Auj (L2) in the western part and Achegaon in the west central portion of the basin, also show low resistivity (L2). The elongated contour

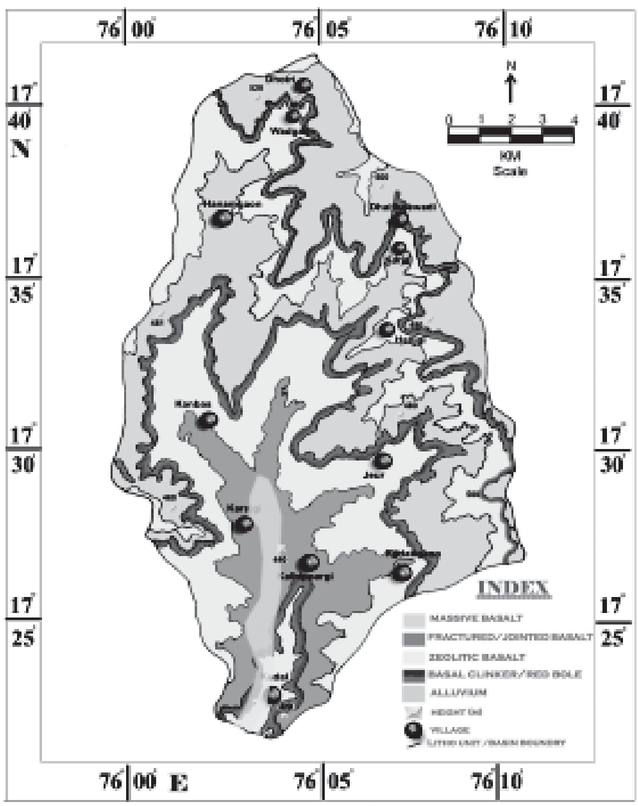

Figure 2. Geological map of Dhubdhubi basin, Solapur District, Maharashtra.

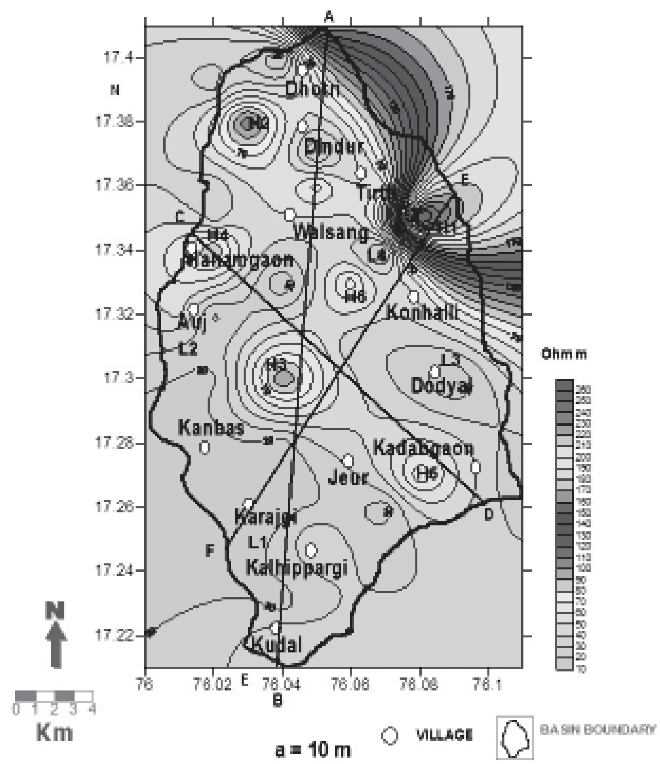

Figure 3. Apparent resistivity contour map in Dhubdhubi Basin, Solapur Dist, Maharashtra Contour Interval: 10 m. a = 10 m.

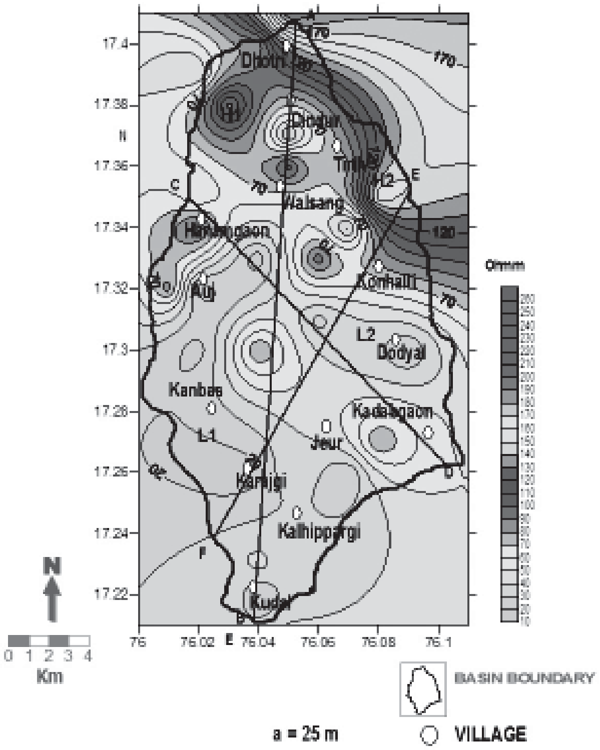

Figure 4. Apparent resistivity contour map in Dhubdhubi Basin, Solapur Dist, Maharashtra Contour Interval: 10 m. a = 25 m.

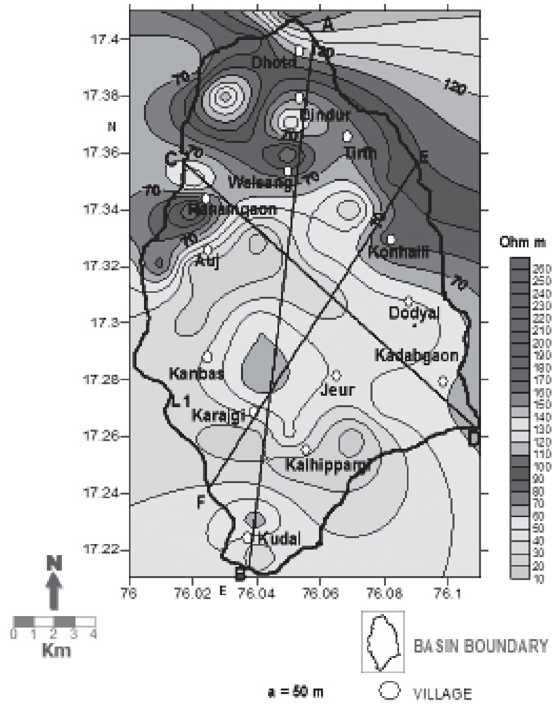

Figure 5. Apparent resistivity contour map in Dhubdhubi Basin, Solapur Dist, Maharashtra Contour Interval: 10 m. a = 50 m.

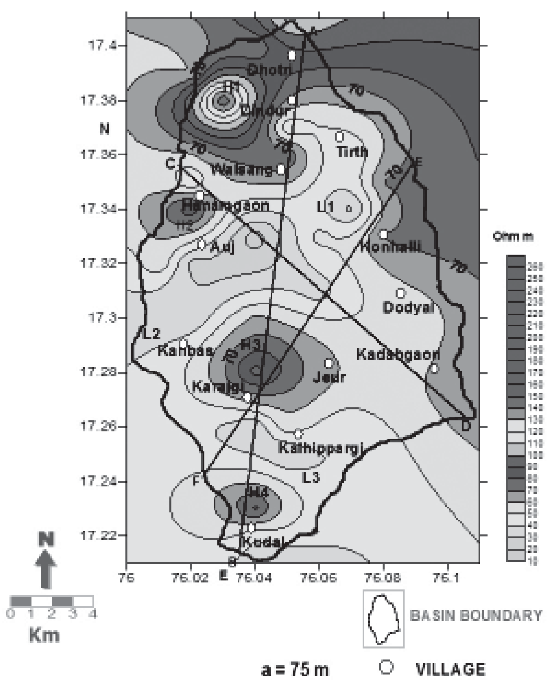

Figure 6. Apparent resistivity contour map in Dhubdhubi Basin, Solapur Dist, Maharashtra Contour Interval: 10 m. a = 75 m.

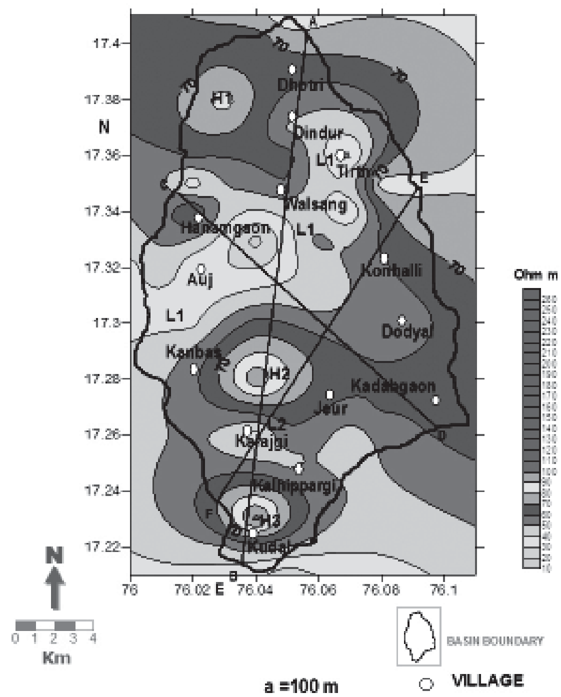

Figure 7. Apparent resistivity contour map in Dhubdhubi Basin, Solapur Dist, Maharashtra Contour Interval: 10 m. a = 100 m.

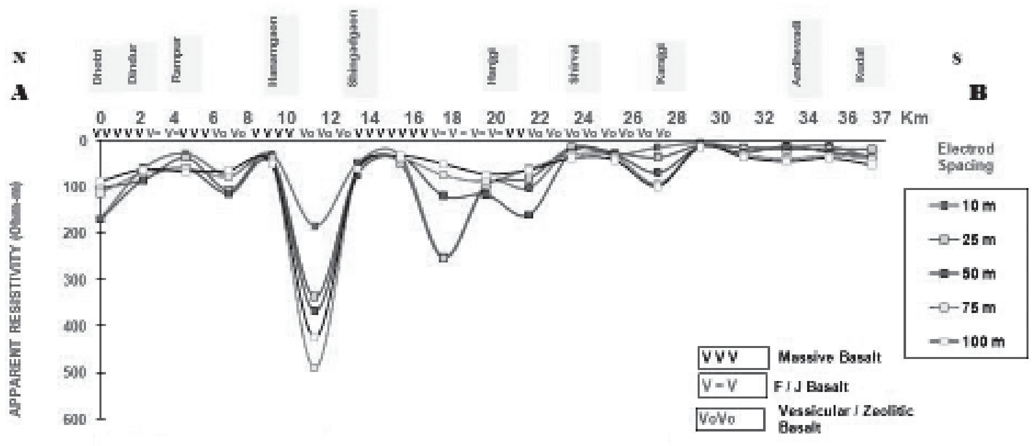

Figure 8. Resistivity Profile along AB.

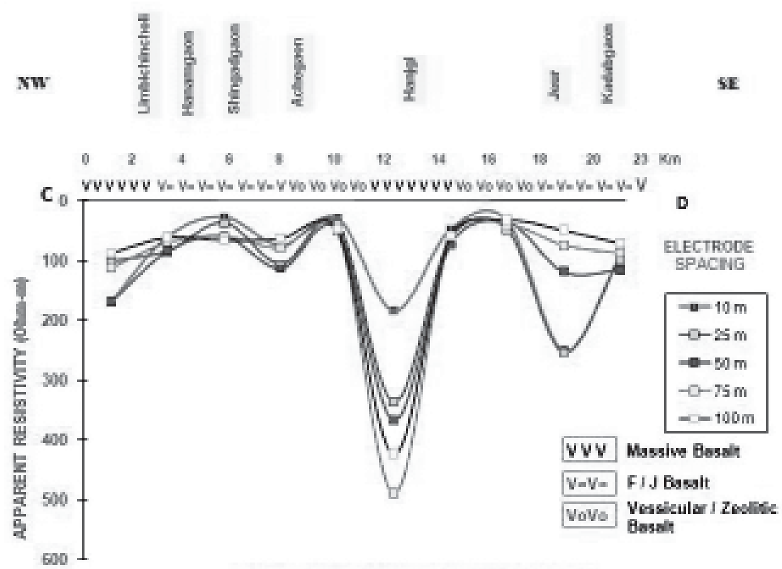

Figure 9. Resistivity Profile along CD.

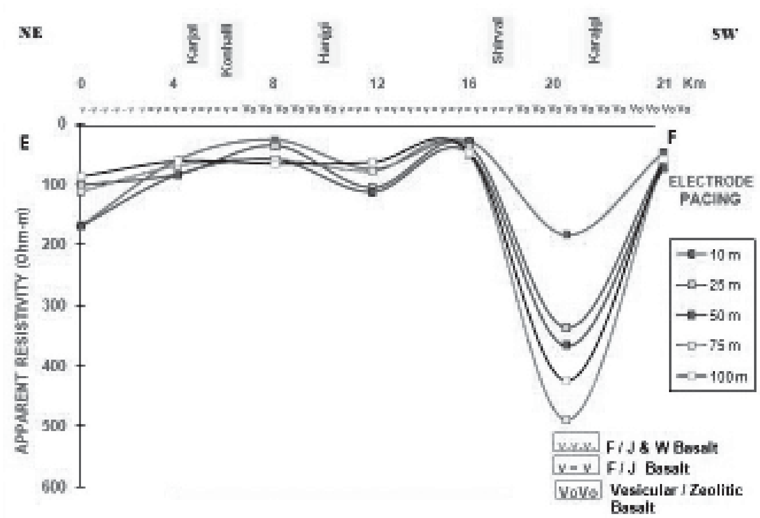

Figure 10. Resistivity Profile along EF.

closer may be because of the presence of a curved lineament. Low resistivity is also observed at Dodyal (L3) in the east central zone, South of Dindur and West of Dhotri in the north. In all these locations the top layers is weathered or vesicular/zeolitic and in the south most of the portions are occupied by alluvium.

The apparent resistivity contours for a = 25m in the Basin are shown in fig. 4. Low resistivity (L1) over an extensive area in the south, covering Kudal, Kalhippargi, Karajgi, Jeur shows NE – SW trend originating from Achegaon and extending in the SW direction moving through Auj, Kanbas and forming a crescent shape, getting enlarged towards SE portion, east of Kalhippargi. An extended low resistivity contour trending almost EW is also observed bordering Dodyal (L2). However, elongated high resistivity contours are seen capping the basin in the north and moving towards Kardehalli (H1) and Dahitanewadi (H2) in the NW and NE zones.

The low resistivity trends observed at a= 25m resistivity distribution continue for a= 50m. Along Achegaon, Kanbas and towards Kalhippargi, the contours more or less get flattened except in some parts in the north and north-west as shown in the fig. 5. However, the resistivity still shows same distribution pattern as was observed as low and high resistivities for a = 25m.

A peak of high resistivity is seen for a = 75m in the NW portion of the basin at Kardehalli (H1) and Hanamgaon (H2). An extended closer of resistivity contours enclosing Karajgi, Jeur (H3) and Kudal (H4) in the south. Highly elongated NE-SW trending low resistivity contour, extending NE of Tirth (L1) and spreading in the SW direction enclosing Auj and Kanbas (L2) is observed in the fig.6. At Kalhippargi, low resistivity contour extends narrowly, trending in the EW direction.

Fig.7 shows the horizon correspondence resistivity distribution at a = 100m. The NE-SW trending low resistivity trend still exists around Dindur, Tirth, Walsang, Achegaon and Auj (L1). This low is flanked in the north by moderately high resistivity (H1) and two prominent peaks are observed in the central and southern portion of basin, south east of Kanbas (H2) and Kudal (H3) respectively. Karajgi (L2) shows an extended, moderately low resistivity of the order of 30 ohm m to 40 ohm m.

RESISTIVITY PROFILES

Resistivity profiles are shown along the sections A-B, C-D and E-F for different electrode spacing, the quantitatively reflect the geologic setting along the respective profiles.

The profile along AB, in fig. 8 runs for 37km and bisects the basin in the NS direction. Resistivities for all electrode spacing show low values around Dindur, Rampur, Hanamgaon, Shingadgaon, Hanjgi, Shirval, Karajgi, Andhewadi and Kudal. The lowest resistivity is seen in the south. However the portion between Hanamgaon and Shingadgaon shows very high resistivity peak. This may be due to the presence of compact basalts.

NW-SE running C-D profile in Fig. 9 represents the low resistivity values between Hanamgaon, Shingadgaon and Achegaon. At Jeur moderately high value of resistivity are seen. The portion below Hanjagi show high values.

Fig.10 shows resistivity distribution along EF section running in NE–SW direction. This shows high values of resistivity at Karjal for all electrode spacing's and moderately low between Konhalli, Hanjgi, SE of Karajgi. However, along Shirval for a = 10m and 25m it shows low to moderately low resistivities respectively. For a = 50, 75 and 100m the resistivities progressively increase with the increasing freshness of the rocks.

DISCUSSION AND CONCLUSIONS

Based on the resistivity variations both depth wise and laterally, it is possible to estimate the depth and the lateral distribution of groundwater. The low resistivity values less than 40 ohm-m are distributed around Karajgi, Kalhippargi, Kanbas, Auj, for a= 10 and 25m, indicate the presence of weathered zones (first aquifer) which are favorable for groundwater accumulation. This is unconfined aquifer and sites are also suitable for surface artificial recharge structures. Borehole structures up to the depth of 50m are useful to recharge the second aquifer, at Achegaon and Kanbas. The third aquifer can be recharged at Tirth and Dindur by placing bore well recharge structures, 75 to 100m deep

Thus it is concluded that processing and interpretation of electrical resistivity data yield apparent resistivities for different electrode separations which, in turn, correspond to lateral resistivity distribution at different depths. This data represented low and high resistivity zones. These are also correlated with local geological setting for a semi quantitative interpretation of potential groundwater zones. However this is also useful for suggesting sites and depths for artificial recharge.

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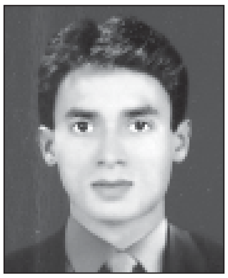

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