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Geology

GEOPHYSICAL INVESTIGATION IN THE BHULESHWARI RIVER BASIN, AMRAVATI DISTRICT, MAHARASHTRA.

Dr. Sumit D Ingle Assistant Professor in Geology, G. S. Tompe Arts, Commerce and Science College, Chandur Bazar Dist Amravati

ABSTRACT Detailed geophysical investigations were carried to characterize the subsurface geological structure for the alluvial aquifer in the Bhuleshwari river basin, Amravati District, Maharashtra. The Bhuleshwari river basin covers an area about 380 Sq. Km. from Bhatkuli and Achalpur Taluka, Amravati district, Maharashtra. It flows over varied geological formation from Deccan trap to Alluvium with groundwater quality varying from fresh water to saline water. Twenty VES's were recorded with the Schlumberger electrode configuration in the study area for evaluation. The maximum current electrode spacing was 120m. The data obtained were interpreted by computer iterative modeling with curve matching for calibration purposes.

Three layer, four layer and five layer geoelectrical earth models are obtained with the help of IPI2 WIN for every sounding, which represents K-type, KH type, AA type, KQ type, HK-type, HA-type, HKH-type curves. These curves are used to find out favorable locations of occurrence of ground water.

In order to ascertain the subsurface geological framework, the general distribution of resistivity responses of the geological formations was obtained and geoelectrical sections along four different directions were prepared and interpreted for subsurface structure and groundwater occurrences. Geoelectrical sounding provides an inexpensive technique for calculating the hydraulic parameters and characterizing the aquifer system of the basin. Probable aquifer horizons from these sections were identified.

KEYWORDS : Groundwater exploration, Resistivity sounding, Alluvial aquifer, Bhuleshwari river basin, Amravati district.

Introduction

Hydro-geophysics has attracted much attention during the last two decades for detecting subsurface features of earth models. Here, geophysical data inverted to geophysical models and interpreted in terms of the hydrogeology. The geoelectrical method is an effective tool for ascertaining the subsurface geologic framework of an area (Keller and Frischknecht 1966; Zohdy et al., 1974; Zohdy, 1989, Khadse and Ingle, 2011). Groundwater potential of any region can be revealed through geological, hydro geological and geophysical investigations. Different geological formations have different hydrogeological conditions from groundwater occurrences, development and potential point of view, therefore, the present investigation have been undertaken to apply an integrated approach using geological, geophysical properties were studied in the basin.

Detailed geological, geophysical, and hydrogeological investigations were carried out for the alluvial aquifer in the Bhuleshwari river basin, Amravati District, Maharashtra, to delineate the architecture of different subsurface geological horizons using lithologs and generated vertical electrical sounding (VES) data.

Study area

Bhuleshwari basin covering an area of 380 km^2 from Bhatkuli Taluka and Achalpur Taluka of Amravati District, Maharashtra is bounded by longitude 78^{0}17'E to 78^{0}28'E and latitudes 20^{0}55'N to 21^{0}20' N falling in the Survey of India toposheets No. 55 H/5, 55 G/7 and 55 G/8 (Fig.1).

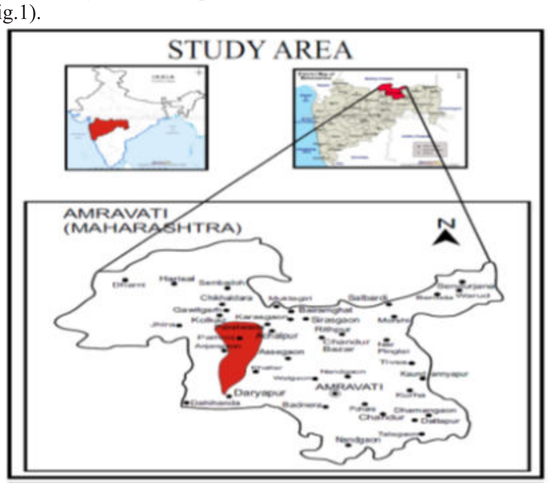


Fig.1.
Location of the Bhuleshwari river basin, Amravati district, Maharashtra.

Average annual rainfall in this region is about 780 mm. The average yearly minimum temperature is 9.2°C and maximum temperature is 46.4°C and July is the hottest month. The entire catchment is under the influence of the monsoon front, and the major part of the precipitation is received between July and October.

Geological and hydrogeological setting

Geologically the study area consists of 420 m thick Alluvium. Only the top 40m is accessible for direct observation in the bank sections of the river and dug wells. The upper cover of the alluvial deposit comprises three lithostratigraphic formations (i) Virul formation (ii) The Kural Formation (iii) The Purna Formation (Tiwari and Mukhopadhyay, 1989; Tiwari, 1990). The Virual Formation and the Kural Formation form morphostratigraphic units referable to the older and younger flood plains of the Purna respectively, while the Purna formation is observed only in the bank sections. All these formations comprise boulders, pebbles, and gravels, coarse to fine sand, silt and clay in various proportions (Fig.2).

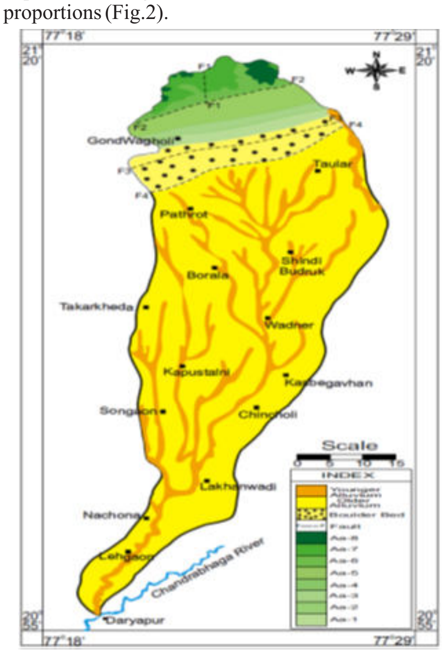


Fig.2.
Geological Map of the Bhuleshwari basin, Amravati District, Maharashtra.

Hydrogeologically, unconsolidated alluvial deposits, characterize the basin. The alluvial deposits are composed of flood plain alluvium consisting of poorly graded to well graded sands and gravels interbedded with clay lenses. Lithological data from tube wells shows that the thickness of the aquifer increases in the central part of the basin and reaches up to 110 m, whereas it ranges from 5 to 10 m in the periphery.

The occurrence of groundwater in the area is controlled by diverse geological factors such as structure, geological sequences, and stratigraphical disturbances of hydrogeological units (Jaipurkar, 2010). Groundwater recharge in the aquifer occurs via direct infiltration of rainfall, infiltration through river beds, and lateral subsurface inflows. Existence of deeper layers can be furnished through the aid of geoelectrical data only. The movement of groundwater is from the recharge area of the upper hills towards the central part of the basin and ultimately the discharge is towards the river chandrabhaga in the south. Depth to the water table is highly variable, being shallow in the eastern part and as deep as 30 m or more below ground level (b.g.l.) in the central part of the basin. The increase in groundwater abstraction combined with prolonged dry periods has been accompanied by a decline in the water table. In the Bhuleshwari river basin average yearly decline is estimated to be 2.5 m.

Salinity of the Purna river has been studied first by Roy (1956) and latter by Adyalkar (1975) and Muthuraman et.al, (1992). Adyalkar and Muthuraman described the genesis of salinity in groundwater for shallow aquifer as diagentically altered meteoric water having a long residence time.

Geoelectrical measurements and interpretation

Twenty vertical electrical soundings (VESs) were conducted with Schlumberger configuration, with AB/2=120 m at Bhuleshwari basin between March and April 2011, in the vicinity of existing wells. ANVIC-CRM 500 was used to in the field survey. The locations of the geoelectrical sections with sounding positions are shown in Fig. 3.

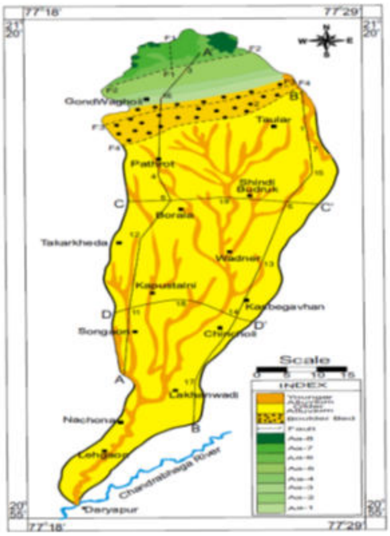


Fig.3.
Geological map of the Bhuleshwari basin with VES locations.

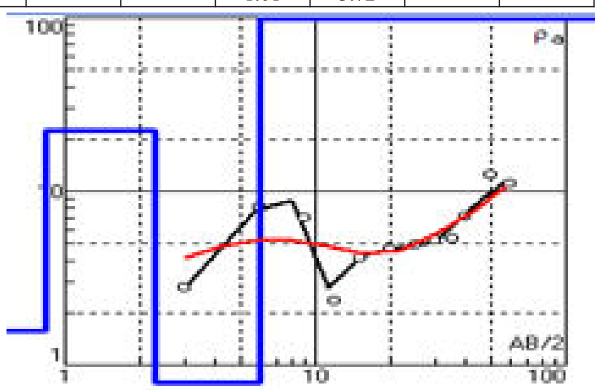
True resistivity and the thickness of different layers were interpreted from resistivity data and presented in table No. 1. These results were used to obtain a realistic picture of the geological framework by quantitative interpretation (Zohdy 1974, Zohdy, 1989). The fast interactive method for automatic interpretation of sounding data by IPI2-Win software (Bobachev 2003) has been used to determine depths and resistivities without any initial guess of the number of layers and their thicknesses. The resistivity data have been carefully compared with the litho-logs of boreholes located in the vicinity of the corresponding sounding.

Table No. 1
Interpreted Vertical Electrical sounding data in terms of Resistivity Models.

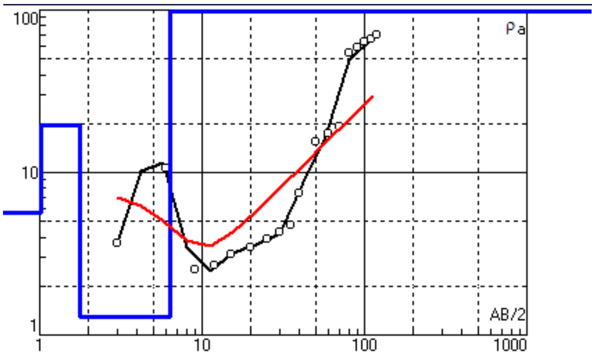
Sr. No.	VES No.	Curve type	Resistivity in Ohm.m					Thickness in m.			
			ρ_1	ρ_2	ρ_3	ρ_4	ρ_5	h_1	h_2	h_3	h_4
1	VES-1	KH-Type	1.56	22.6	0.784	1113		0.834	1.43	3.77	
2	VES-2	KH-Type	0.0502	0.36	0.0621	46.4		0.88	1.65	5.21	
3	VES-3	KH-Type	5.66	19.7	1.3	1477		1.01	0.773	4.55	
4	VES-4	KH-Type	0.183	4.7	0.526	766		0.0607	2.1	4.62	
5	VES-5	KH-Type	0.437	212	0.941	139		0.837	0.986	8.7	
6	VES-6	KH-Type	0.275	1.18	0.239	206		0.942	1.93	3.88	
7	VES-7	HK-Type	12791	4.58	461	0.319		0.442	1.21	4.81	
8	VES-8	KH-Type	2.15	3.56	0.794	1154		0.641	2.36	4.08	
9	VES-9	KH-Type	1.97	23	0.507	1666		0.863	2.15	5.61	
10	VES-10	HKH-Type	3.5	1.23	9.34	0.538	279	2.58	1.84	4.66	10.5
11	VES-11	HK-Type	157	0.131	668	0.949		1.79	2.71	13.4	
12	VES-12	HA-Type	1.07	0.294	1.12	1521		1.61	0.976	14.9	
13	VES-13	HK-Type	9.78	5.08	70.1	0.122		2.32	2.08	4.87	12.3
14	VES-14	HKH-Type	3.07	0.824	19.2	0.778	807	1.33	1.83	3.7	9.01
15	VES-15	KQ-Type	56.1	1187	522	0.395		1.49	6.51	1.54	
16	VES-16	AA-Type	2.79	5.29	17.4	7612		0.764	5.25	6.47	
17	VES-17	KH-Type	2.93	69.6	3.13	2529		0.976	1.13	5.94	
18	VES-18	HKH-Type	6.13	2.33	25.5	8.31	8787	2.05	2.73	4.23	9.61
19	VES-19	K-Type	1.66	2896	4.37			1.01	3.72		

The typical representatives curves are represented in figure No.4.Typically seven type models were obtained, nine KH type, three HK type, three HKH type and one each of K, KQ, HA, and AA type were observed. The sounding points with HA-type, HK-type are good for shallow occurrences of groundwater and can be exploited by dug-wells. Similarly, KH type, are suitable for dug well or dug com tube well while in HKH type deep tube wells can be made. AA type locations are not favourable groundwater sitting. Thus based on type of earth structure, sites and type of structure can be selected for identifying groundwater potential.

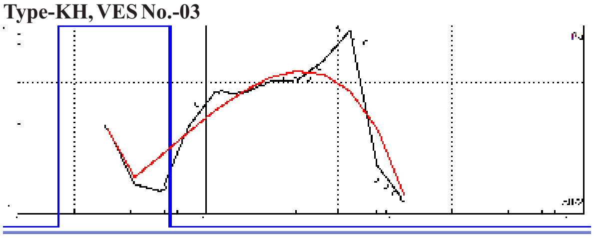
Geoelectrical pseudo resistivity sections were constructed from the interpreted VES data, along selected directions in the basin. Typical four sections along A-A', B-B', C-C' and D-D' are represented in the figure No. 5 These geoelectrical sections can be used to study variations in lithology, and to demarcate the nature of subsurface formations present therein. In the following paragraphs, a brief description of these geoelectrical sections is given.



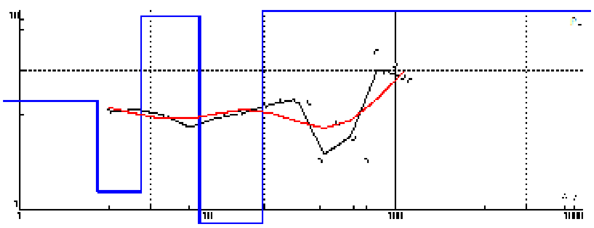
Type- KH, VES No.-01



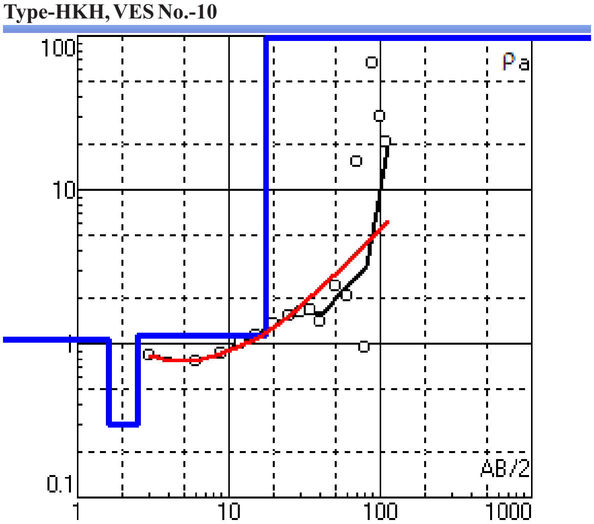
Type-KH, VES No.-03



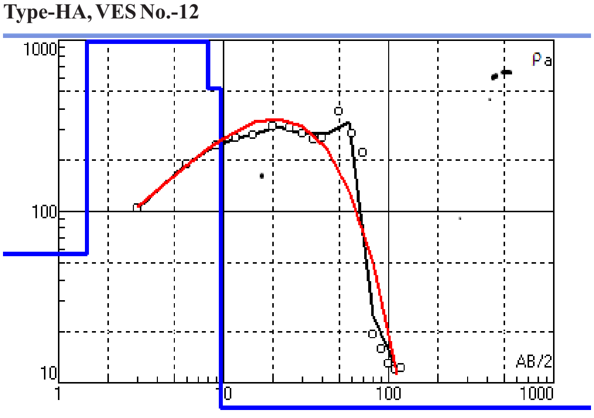
Type-HK,VESNo.-07



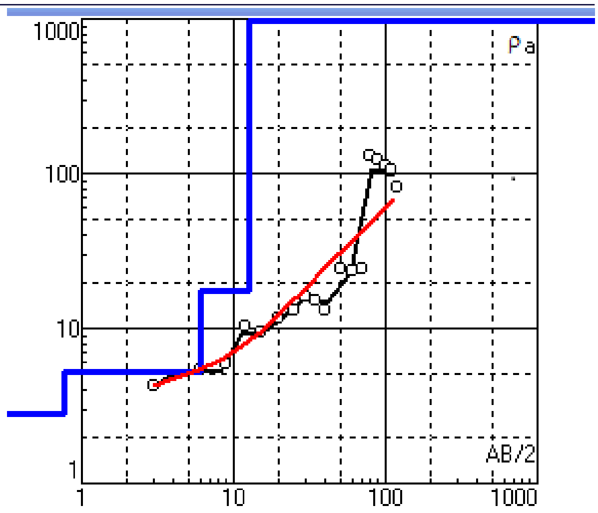
Type-HKH, VES No.-10



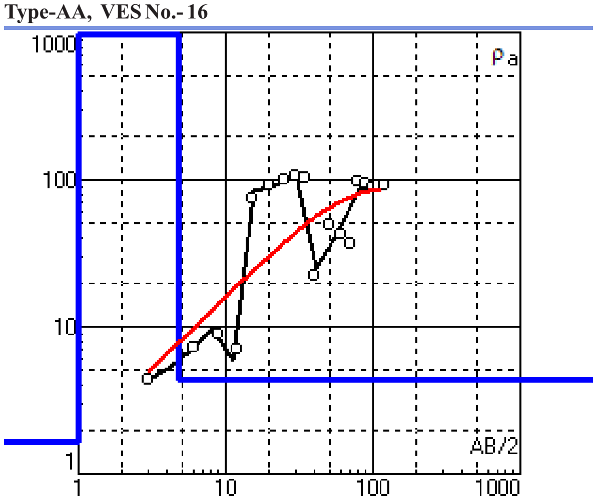
Type-HA, VES No.-12



Type-KQ, VES No.- 15



Type-AA, VES No.- 16



Type-K, VES No.-19

Figure No.4. Typical resistivity model curves observed in the Study area.

Geoelectric Pseudo Resistivity A-A' Section

Section AA' is from western side of basin running from south to north. It has six VES on it. As observed in this figure, low resistivity is observed in section A-A' for VES 12 and VES 5 near the ground surface. While for VES 11 it is found that low resistivity ranges from 15 to 30 m depth. High resistivity observed for VES 16 and VES 3 at 85 to 100m depth.

Geoelectric Pseudo Resistivity B-B' Section

Section BB' is from eastern side of basin running from south to north. It has seven VES on it. In Section B-B' low resistivity is found near the ground surface upto 30m depth for VES 6, While high resistivity is observed near the ground surface upto 70 m depths for VES 15.

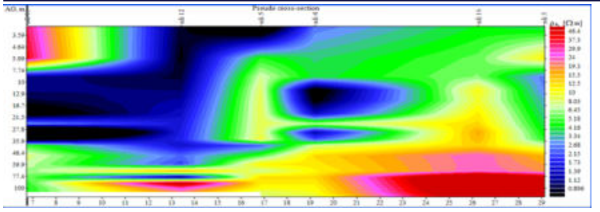
Geoelectric Pseudo Resistivity C-C' Section

Section C-C' is from west to east on northern side of basin. It has three VES on it. In section C-C', low resistivity observed near the surface upto 30 m depth for VES 6. High resistivity is found at depth ranges from 15 to 100 m for VES 19.

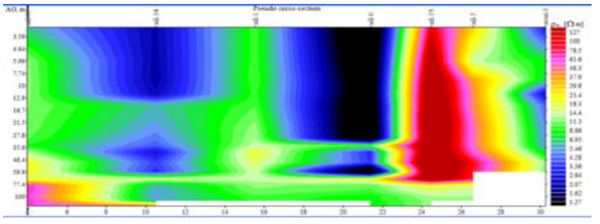
Geoelectric Pseudo Resistivity D-D' Section

Section D-D' is from west to east on southern side of basin. It has three VES on it. In case of section D-D', low resistivity is found near the ground surface upto 30m depth for VES 11. While high resistivity observed near the ground surface upto 10 m depth for VES 11 and for VES 18 it ranges from 80 to 100 depths.

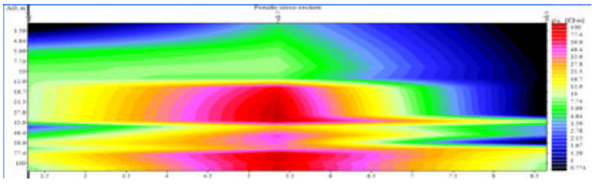
Low resistivity is indicative of good conductance; hence represents the probable locations of good groundwater potentials. High resistivity is indicative of poor conductance are the locations of poor groundwater occurrences.



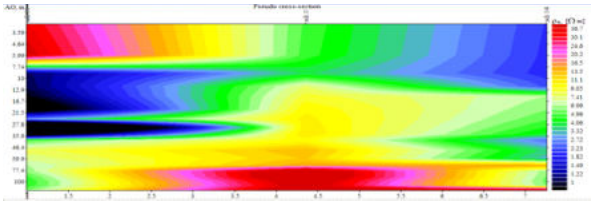
A. Pseudo Resistivity Section along A-A'



B. Pseudo Resistivity Section along B-B'



C. Pseudo Resistivity Section along C-C'



D. Pseudo Resistivity Section along D-D'
Figure No. 5. IPI 2 WIN Resistivity section along four directions.

Conclusions

- Bhuleshwari river basin is located in the western part of Amravati district, Maharashtra and is characterized by semi-arid climatic conditions. The main aquifer system is developed within the unconsolidated alluvial deposits of the basin.
- Twenty vertical electrical soundings (VES) in the vicinity of existing wells were carried out in order to estimate the resistivity using the Schlumberger configuration with a maximum current electrode spacing (AB) ranging from 120 m.
- The use of VES provides an inexpensive technique for characterizing the geological setting, as well the hydrogeological conditions of the basin.
- The geoelectrical sections along a number of lines have been prepared. Geoelectrical sounding provides an inexpensive technique for calculating the hydraulic parameters and characterizing the aquifer system of the basin.
- Typically seven model structures have been identified. Nine KH type, three HK type, three HKH type and one each of K, KQ, HA, and AA type were observed.
- The sounding points with HA-type, HK-type are good for shallow occurrences of groundwater and can be exploited by dug-wells.
- The sounding points with KH type are suitable for dug well or dug com tube well while in HKH type deep tube wells can be made. AA type locations are not favourable groundwater sitting.
- Low resistivity is indicative of good conductance; hence represents the probable locations of good groundwater potentials. High resistivity is indicative of poor conductance are the locations of poor groundwater occurrences.

REFERENCES

1. Adyalkar, P.G. (1975) Pale geographical frame work of sedimentation and groundwater potentiality of the upland alluvial valleys of India. Published by Director, Govt. Printing and stationary, Maharashtra State, Bombay-4.
2. Bobachev, A. (2003) Resistivity Sounding Interpretation IPI2 WIN: Version 3.0.1 a 7.01.03. Moscow State University.
3. Jaipurkar R.S (2010) Geoenvironmental and geotechnical investigations in Amravati taluka and district Amravati, Maharashtra, Unpub. P.hD thesis, S.G.b Amravati Univ. Amravati., pp.275.
4. Khadse S P and Ingle S D (2011) Hydrogeological framework and estimation of aquifer hydraulic parameters using geoelectrical data in the Bhuleshwari river basin, Amravati District, Maharashtra. Paper presented at National Conference on Geology and Mineral Resources of India, Aurangabad, 11-12 Feb. 2011.
5. Keller GV, Frischknecht FC (1966) Electrical method in geophysical prospecting. Pergamon, Oxford, 517 pp.
6. Muthuraman, K., Tiwari, M.P. and Mukhopadhyay, P.K. (1992) Salinity in groundwater of Purna basin- its genesis Jour. Geol. Soc. India. Vol.39. Jan. 92. pp. 50-60.
7. Tiwari, M.P. and Mukhopadhyay, P.K. (1989) Geology of parts of Akola and Amravati districts of Maharashtra. Unpub. Geol. Surv. India Prog. Report (F.S. 1988-89).
8. Tiwari, M.P. (1990) Geology of parts of Amravati districts of Maharashtra. Unpub. Geol. Surv. India Prog. Report (F.S. 1988-89).
9. Zohdy AAR, Eaton GP, Mabey DR (1974) Application of surface geophysics to groundwater investigations. US Geol Surv Tech Water Resour Invest, book 2, chapter D1, 116 pp.
10. Zohdy AAR (1989) A new method for automatic interpretation of Schlumberger and Wenner sounding curves. Geophysics 42:245–253.