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APPLICATION OF GEOELECTRIC SOUNDING METHODS TO LOCATE THE CARBONATE PAN IN WESTERN RAJASTHAN

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ABSTRACT

In geoelectrical soundings, resistivity of 80 to 300 ohm metres indicates presence of the dry carbonate (*kankar*) pan whereas 50 to 100 ohm metre resistivity indicates presence of the moist *kankar* pan. Grid pattern survey is one of the possible rapid and indirect methods to work out the depth and thickness of the *kankar* pan.

INTRODUCTION

Presence of various types of pans, i.e. calcrete, silcrete and ferricrete are well known in all arid and semi-arid regions. In western Rajasthan, carbonate pan is known as *rotha, morum, kankar*, etc. The hard pans generally develop due to the precipitation of salts produced as a result of the physico-chemical weathering processes at shallow depth, under low to moderate rainfall conditions (Roy *et al.*, 1969). The depth and thickness of such pans play an important role in deciding the land use, especially for afforestation, silvipastoral practices and to introduce irrigation of crops under arid and semi-arid conditions. The presence of pan at shallow depth restricts the growth and penetration of plant roots and hinders movement of water through the profile resulting in water logging and development of salinity.

Hand augering and pitting methods used to study the presence and thickness of *kankar* pan are time consuming and costly. There are several geographical methods available by which the subsurface conditions could be studied and assessed. Electrical resistivity depth sounding method is relatively less costly, faster and easier to adopt. In this report, results of studies done with this method at the Central Arid Zone Research Institute, Jodhpur are reported.

MATERIAL AND METHODS

Electrical resistivity depth soundings were carried out with the help of low frequency aquameter. The entire area of the research farm of the Central Arid Zone Research Institute, Jodhpur was covered with 43 soundings with an electrode separation of 400m each. Schlumberger configuration was used for vertical electrical depth sounding and the results obtained were analysed to know the true resistivity of various layers, as suggested by Bhattacharya and Patra (1968) with the help of master curves published by the European Association of Exploration Geophysicists.

RESULTS AND DISCUSSION

The lithological logs of the bore holes in the farm area are given in table 1.

Table 1. Thickness (m) of various lithological formations encountered in the tube wells (T_1 to T_5) at the Central Arid Zone Researeh Institute, Jodhpur

Lithology	T_1	T_2	T_3	T_4	T_5
Surface sand	0—7	0—2	—	0—2	0—2
Kankar (*Murad*)	—	2—37	0—3	2—28	—
Gravel + *kankar*	7—37	37—40	—	—	—
Clay with *kankar*	—	40—63	—	28—60	—
Kankar + quartzite + rhyolite	—	—	3—30	—	2—30
Fine gravel	—	—	—	60—77	—
Sandy clay + rhyolite	—	63—88	—	—	30—54
Red silty clay + *kankar*	37—43	—	—	—	—
Red shale	—	88—106	30—40	77—83	54—67.5
Rhyolite + *kankar*	—	—	40—62	—	—
Sandy clay + *kankar*	43—77	—	62—81	—	—
Weathered rhyolite	—	106—117	—	—	—

Based on the resistivity values observed, the entire farm area was divided in to three zones, viz; A, B, and C (Figs. 1 a to 1 d) The inferred resistivity values of various surface formations upto a depth of 10 m are given in Table 2.

Table 2. Inferred resistivity values for the surface formations

Surface and subsurface formations	Resistivity range (ohm metres)
Dry sand (with little silt)	100—200
Wet sand, loamy sand	60—130
Loamy sand with adequate moisture	45—90
Dry *kankar* pan	80—300
Moist *kankar* pan	50—100

The resistivity values upto 2 m below ground level showed a good correlation with the soil characteristics and its moisture contents. Dry *kankar* formation showed high resistivity values ranging from 80200 ohm m. However, when the moisture contents increased, the resistivity ranged between 50-100 ohm m. The dry *kankar* formations were generally compact and hard whereas the moist *kankar* formations were soft. The higher resistivity of dry formation indicated low conductive nature of the formation.

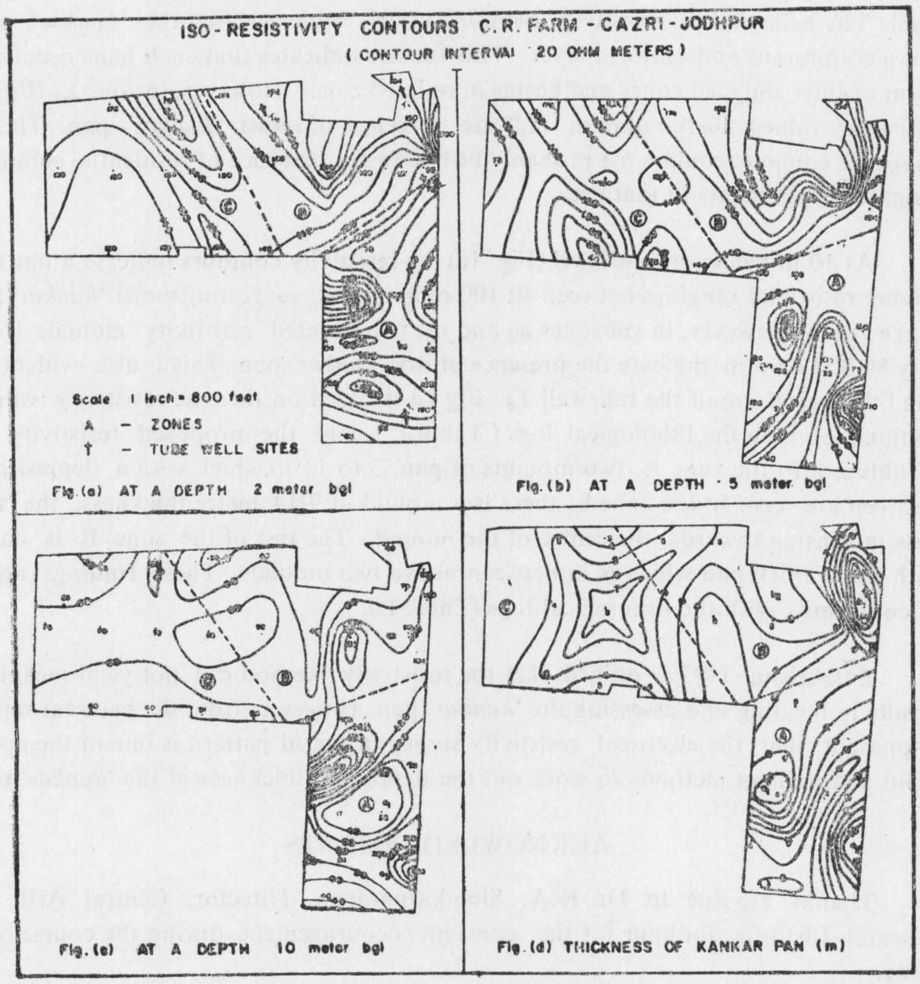

Fig. 1. Iso-resistivity contours in different zones (A,B,C,) at CAZRI Farm, Jodhpur, for (a) 2 m below ground level (b) 5 m bgl (c) 10 m bgl (d) thickness of *kankar* pan (true resistivity values).

Figs. 1a and 1b show the iso-resistivity contours at 2 and 5 m below ground level to be almost identical in nature (resistivity values 80-300 ohm metres). Based on the resistivity contours (Figs. 1 a to 1 c), and the comparison of lithological logs (Table 1), it is apparent that the dry *'kankar'* pan starts from 2 m below ground level. The behaviour of resistivity contours clearly indicates that the *'kankar'* pan is not a continuous and uniform layer. This further indicates that such pans occur in the form of inter-tongued cones and basins in isolated zones. However, in zone a_2 (Fig. 1b), resistivity values 40-100 ohm m indicate presence of moist *'kankar'* pan. The high moisture contents could most probably be due to the presence of residential colony and irrigated experiments in that area.

At 10 m below ground level (Fig. 1c) the resistivity contours indicate a flat trend, having resistivity rangings between 40-100 ohm metres, suggesting moist *'kankar'* in the three zones. However, in subzones a_2 and a_3, two isolated resistivity mounds (resistivity 80-200 ohm m. indicate the presence of dry *'kankar'* pan. This is also evident from the lithological log of the tubewell T_5. Fig 1d is based on the true resistivity values in conjunction with the lithological logs (Table 1) and the proposed resistivity scale (Table 2). In the zone A, two mounds of pan, 3 to 11 m. thick with a depression in between are seen. In the zone b_1 there is a mound of 7-14 metre thickness, the thickness increasing towards the centre of the mound. The rest of the zone B is covered with a less thick pan which is in between above two mounds. These findings are all in conformity with the lithological logs (Table 1.).

Balakrishna (1979) opined that the resistivity method did not yield meaningful results in locating and assessing the *'kankar'* pan. However, from the peresent report it isapparent that the electrical resistivity survey in a grid pattern is one of the possible rapid and indirect methods to work out the depth and thickness of the *'kankar'* pan.

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REFERENCES

Balakrishna, S. 1979. Sponsored Groundwater and bed rock investigations. *GRB BUL.* *17* (4) : 61 73.

Bhattacharya, P. K. and Patra, H.P. 1968. *Direct current Geo-electric Sounding* – Elsevier Publishing Company, New York.

Roy, B.B., Chatterji, P.C and Pandey, S. 1969. Genesis of carbonate pan in arid regions of Rajasthan. *Ann. Arid Zone* 8 (2) : 247–250.