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A COMPARATIVE STUDY OF SOIL ELECTRICAL CONDUCTIVITY AND SALINITY IN PREDOMINANT AND NON-PREDOMINANT CRUDE OIL AREAS OF AKWA IBOM STATE OF NIGERIA

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ABSTRACT

The electrical conductivity and salinity of some soil samples in Ibeno Local Government Area (crude oil rich area) and Etinan Local Government Area (non-crude oil rich area) have been measured. The results show a nigh positive correlation coefficients of r_B = 0.685 and r_T = 0.769 between soil electrical conductivity and salinity in both Ibeno and Etinan respectively. (r_B for Ibeno and r_T for Etinan). The electrical conductivity measured falls within the range of $0.613 \leq E_C \leq 0.813\ \Omega^{-1}cm^{-1}$ for Etinan. While the measured salinity falls within the range of $0.023 \leq E_C \leq 0.634$ and $0.220 \leq S \leq 0.710$ ds cm^{-1} for Ibeno and Etinan respectively. The t-test analysis reveals that there are no significant differences between the mean values of electrical conductivity and salinity in both Ibeno and Etinan Local Government Areas.

KEY WORDS: Soil Electrical conductivity, Salinity, Crude Oil Area.

INTRODUCTION

Akwa Ibom State of Nigeria located in the southern part of the country is considered to be rich with crude oil mineral. As good as this claim is, it is obvious that oil wells are not located in all parts of the state. Comparative analysis is therefore necessary for the impact assessment of oil exploration in the crude oil rich area and non-crude oil rich area of the state. Soil electrical conductivity and salinity are the two parameters used for the purpose of this study.

The knowledge of the properties of soil enhances soil utilization for various purposes. Prominent among which include agriculture, road and building constructions, and waste management. The measurement of soil electrical conductivity and salinity in this study therefore becomes very significance.

Recent investigations on the properties of soil in the state include the thermal properties of soil samples (Ekpe and Akpabio, 1994; Ekpe, etal, 1996) and measurement of salinity and electrical conductivity in Uruan Local Government Area of the State (Akpan, etal, 2002). These studies were all aimed at maximum utilization of soil in the state for either agricultural purposes or other developmental projects. The aim of this study therefore is to highlight the comparative effect between electrical conductivity and salinity in crude oil mineral rich area and non-crude oil mineral rich area of the state.

Soil Electrical Conductivity and Salinity

Soil electrical conductivity is a property of soil, which is determined by standardized measures of soil conductance by distance and cross sectional area through which current flows. The electrical conductivity of soil has been found to show a high correlation with the total salt concentration (Rhoades etal, 1989, Hartsock etal, 2000 and Akpan etal, 2002). Soil salinity is the amount of salt content present in a given quantity of soil sample. It is observed to be contributed mainly by the present of SO_4.Cl, KCO_3 and NO_3 ions. Various ions do exist but in very small quantities (Russel, 1961). Rhoades et al (1982) classified soil salinity as low, medium and excessive. He observed that low salinity with relative level $S \leq 0.2$ ds/cm is not injurious to plant; medium salinity with relative level of $0.2 \leq S \leq 0.3$ ds/cm is well fertilized soil, and excessive salinity with level $0.8 \leq S \leq 1.5$ ds/cm is mostly injurious to plant.

Sample Collection and Preparation

Soil samples were collected from two identified Local Government Areas of the state. The Local Government Areas were selected based on the availability and non-availability of oil wells in the area. Based on this criterion, Ibeno and Etinan Local Government Areas were used for the work. Ibeno has a large collection of oil wells while Etinan has none. To ensure uniformity of data, ten villages were randomly selected from each of the two local government areas, and soil samples were collected at the depth of 10cm from each of the twenty villages selected. Each of the samples was heated to dryness to remove water molecules. The heating was done in a way that percentage water content in each sample was negligible. This was to ensure uniformity in the result obtained from each of the measurements. Wet soil will normally constitute the problem of redistribution of water under the influence of temperature gradient.

Measurement of Electrical Conductivity

Soil water mixture at a ratio of 1: 2 was formed for each of the soil samples using distilled water. The mixtures were introduced in turn to the shaking cup and agitated on mechanical shaker for 15 minutes and allowed to settle for 1 hour. The electrical conductivity of each sample was measured using conductometer in which the relation $1/\rho = L/RA = \sigma$ was employed where ρ and σ are the resistivity and conductivity respectively; R is the resistance measured in ohms with ohmmeter, L and A are the length and cross sectional area measured in metres and metres squared respectively with metre rule. This method of estimating soil electrical conductivity has been used by Rhoades (1989) and Akpan etal (2002). The method has been found to be reliable since it eliminates errors associated with human imperfection in titration method. The conductivity of the samples were measured at a temperature $20^{\circ}C \leq T \leq 30^{\circ}C$.

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Measurement of Salinity

5.0g of soil sample was measured into the shaking cup and 50.0ml of distilled water added to it. The cup was shaken for 30 minutes using mechanical shaker. Using Whatman's filter paper, the extract of the mixture was obtained. 30.0ml of the extract was pipetted into a conical flask and 1.0ml of potassium chromate indicator was added. This was then titrated with silver nitrate solution until an end point of red brown colour was obtained. This was repeated for all the soil samples.

RESULTS PRESENTATION

Table 1 shows the detail of discrete measurements of soil electrical conductivity and salinity in Ibeno and Etinan Local Government Areas. It also gives the computational details of the correlation coefficient of the parameters. Figures 1 and 2 show bar representation of the electrical conductivity and salinity in the two local government areas.

Table 1: Showing Correlation Coefficient Computation Data

Village	IBENO L. G. A.					ETINAN L. G. A.				
	EC (mho/cm)	S (ds)	ECR	SR	$(ECR - SR)^2$	EC (mho/cm)	S (ds)	ECR	SR	$(ECR - SR)^2$
V1	0.835	0.634	10	10	0	0.324	0.052	3	3	0
V2	0.723	0.234	3	3	0	0.539	0.070	5	4	1
V3	0.813	0.623	9	9	0	0.450	0.153	7	7	0
V4	0.634	0.434	2	6	16	0.210	0.220	1	1	0
V5	0.720	0.534	4	7	9	0.703	0.343	10	10	0
V6	0.810	0.331	8	5	9	0.404	0.094	6	5	1
V7	0.721	0.240	4	4	0	0.334	0.045	4	2	2
V8	0.613	0.233	1	2	1	0.524	0.233	8	8	0
V9	0.801	0.554	7	8	1	0.359	0.340	5	9	16
V10	0.732	0.023	5	1	16	0.234	0.102	2	6	16

Correlation coefficient r is given by Spiegel (1972) as

$$r = 1 - \frac{6\sum(EC_R - SR)^2}{N(N^2 - 1)} \quad \text{......... (eqn. 1)}$$

where N is number of samples; ECR and SR are the electrical conductivity and salinity ranks of the samples.
Hence $r_B = 0.685$ and $r_T = 0.769$.
Where r_B and r_T are the correlation coefficients of Ibeno Local Government Area and Etinan Local Government Area respectively between soil electrical conductivity and salinity. The values of r_B and r_T both indicate that there is a high positive correlation between soil electrical conductivity and salinity in both Local Government Areas.

Table 2 shows the t-test computation data comparing the mean values of soil electrical conductivities between Ibeno and Etinan Local Government Areas; and the mean values of soil salinity in the two areas also.

Table 2: Showing t-test Computation Data from Table 1

	Electrical Conductivity				Salinity			
Location	N	x	$\sum x^2$	σ	N	x	$\sum x^2$	σ
Ibeno	10	0.740	5.53	0.744	10	0.384	2.080	0.456
Etinan	10	0.408	1.869	0.432	10	0.145	0.340	0.184

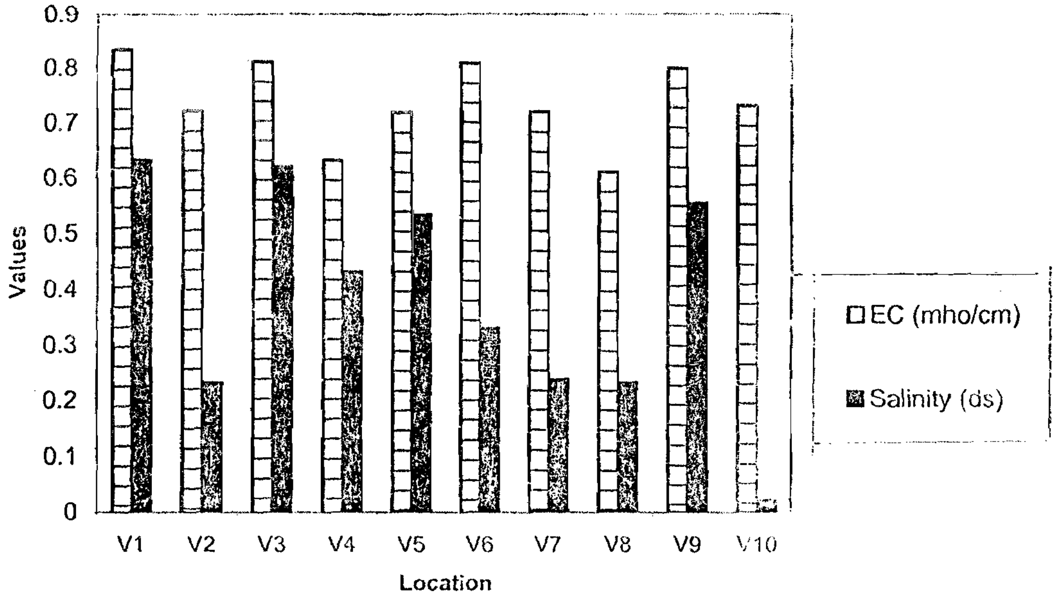

Fig. 1: A bar representation of soil electrical conductivity and salinity in Ibeno Local Government Area.

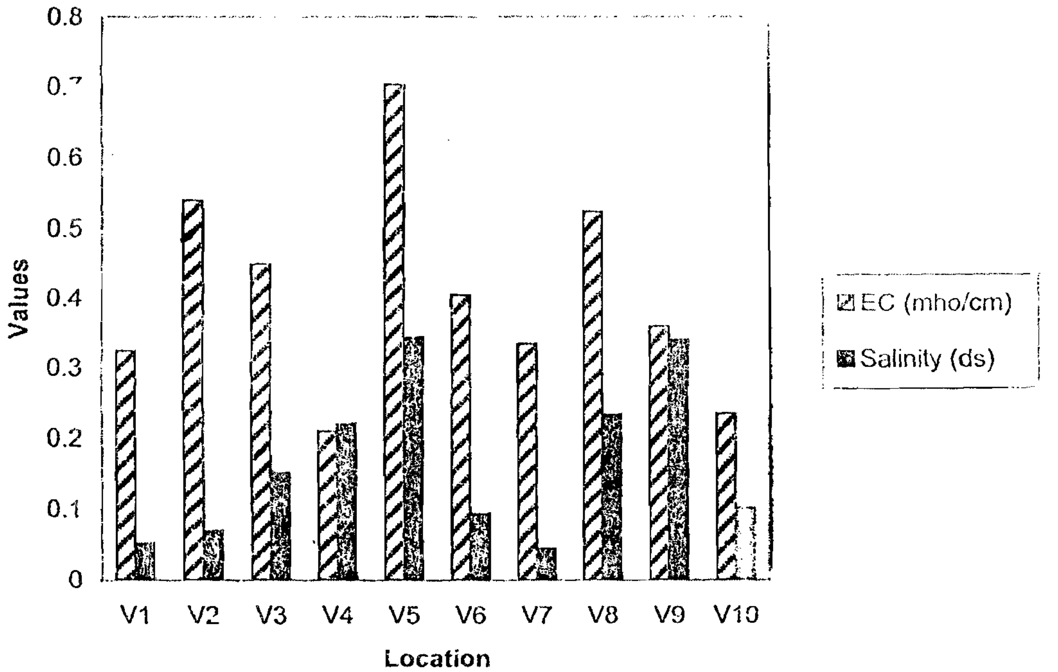

Fig. 2: A bar representation of soil electrical conductivity and salinity in Etinan Local Government Area.

Generally, from Spiegel (1972),

$$t = \frac{\overline{X}_1 - \overline{X}_2}{\sqrt{\dfrac{(N_1\delta_1^2 + N_2\delta_2^2)(N_1 + N_2)}{(N_1 - N_2 - 2)(N_1N_2)}}} \quad \text{......... (eqn. 2)}$$

and the **standard deviation between means** σ is given by

$$\sigma = \sqrt{\frac{\sum x^2}{N}} \qquad \text{......... (eqn. 3)}$$

From table 2, it is seen that for soil electrical conductivity in Ibeno and Etinan Local Government Areas, $t_{cal} = 1.161 < t_{table} = 2.101$ at 18 degree of freedom (df) and 0.05 level of significance (LS). This shows that the mean values of soil electrical conductivities in both Local Government Areas are not significantly different from each other. Similarly, from the table it is also reveals that for soil salinity in the two areas $t_{cal} = 1.457 < t_{table} = 2.101$, and that of Etinan, $t_{cal} = 1.675 < t_{table} = 2.101$ at df = 18, LS = 0.05. This implies that again there are no significant differences between the means of soil electrical conductivity and salinity in either Ibeno or Etinan Local Government Areas.

DISCUSSION

The high positive correlation coefficients of $r_B = 0.685$ and $r_T = 0.769$ between soil electrical conductivity and salinity in both Ibeno and Etinan Local Government Areas respectively were obtained as expected. Soil electrical conductivity and salinity have been found to correlate highly positively from recent works (Rhoades etal, 1989; Harksock et al, 2000; and Akpan, etal, 2002).

The t-test analysis reveals that for Ibeno and Etinan Local Government Areas, there are no appreciable differences in the means of soil electrical conductivity. A similar result is also obtained for soil salinity.

Salinity of the soil is the term used to characterize the accumulated soluble salts in the soil. Salts occur naturally in many bedrock deposits. The ground water flowing through these deposits dissolves and transports the salts. Under capillarity and other physical processes the ground water rises to the surface where the water evaporates, leaving the salts behind. Salts are also carried in land from the ocean by winds and deposits during rainfall. Other possible sources of soil salinity are ancient drainage basins that evaporated during arid periods leaving behind salts deposit.

The prevailing conditions for soil salinity in both areas might have been the same. This could possibly be justified by the result of this work, though there is high concentration of oil wells in Ibeno and none is found in Etinan.

CONCLUSION

This study shows that the oil exploration venture in Akwa Ibom State does not affect the correlation trend between soil electrical conductivity and salinity. It is also concluded that the mean values of soil electrical conductivity and salinity in mineral crude oil rich area do not differ significantly from those obtained from non crude oil rich area of the state.

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