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THE ENVIRONMENTAL DEPOSITION OF SOME ELEMENTS ENRICHMENT USING DITCH CUTTINGS SAMPLES FROM X – WELL IN OLIOGO, ONSHORE NIGER DELTA

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ABSTRACT

Ditch cuttings were collected at various intervals from X well in onshore Niger Delta. The study area which is Oliogo community Delta State Nigeria is located in North – North East (NNE) of Umutu. The purpose of the study is to evaluate the elemental concentration and determine the environment as well as the prevailing conditions under which the elements were deposited. The elemental concentration was determined with Atomic Absorption Spectrometer (AAS) model 969 unicam series. From the lithos tratigraphic study of the selected interval, two lithologic types were determined which are sandy shale and shale. Studies on the geochemical concentration of some elements and their variations with depth show various levels of elemental enrichment in the following order of relative abundance>Na>Ca>Fe>Mg>Mn> Ni>Co>Pb. The degrees of enrichment suggest a significant difference in depositional environment during accumulation. Further studies on the paleo redox proxies of the samples suggest a high oxygen (oxic) environment.

Keywords*: lithologic, elemental, enrichment, depositional environment, and ditch cuttings.*

1. INTRODUCTION

Elements occur naturally in soils; some at a high concentration while others at low concentration. The sources of these elements may depend not only on anthropogenic and lithogenic input but also upon the textural characteristics, organic matter contents, mineralogical composition and depositional environment of sediments [1]. The occurrence of these elements in sediment is closely tied to several factors such as the organic matter content and depositional environment of the sediments (since measurable quantities of these elements do not automatically infer anthropogenic enrichment).

The magnitude of these elements enrichment in sediments varies. According to [2], the approximate order of enrichment relativities to an average shale is Mo>Pb>Zn>V>Ni>Cu>Cr>Co. However, the degree of enrichment may suggest differences in depositional environment during accumulation. The aforementioned elements can be of considerable help in elucidating probable physicochemical conditions prevailing in a given environment. Other influence and controls of these elements enrichment in sediments include, temperature, salinity, pH, Eh, ionic potential etc. Thus inasmuch as these same factors control to a large extent the physicochemical conditions prevailing in the environment, and indirectly then the availability of both the different elements that are essential to life processes of organism in that environment and the means of incorporating these same elements into the sediments, we ought to expect that when certain elements or groups of elements are identified they will be reflective of specific environment characteristics [3-6].

Various studies have utilized either Al-normalized elemental ratios such as *Mo/Al* [7&8] or some element ratios such as *Ni/Co, V/Cr* and *V/(V+Ni)* [9 &10], to evaluate Paleo-redox conditions. Ni and V occur in tetrapyrrole structures that are preserved preferentially under anoxic conditions [11]. [12] Proposed that the ratio of vanadium to nickel and crude oils which is unaltered by diagenesis, indicates environmental conditions at the time of deposition. They demonstrated that V/(V+Ni) ratio for organics formed under euxinic conditions are greater than 0.5. In a comparison of several geochemical redox

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indicators including the degree of pyritization. According to [10], they suggested that V/(V+Ni) ratios greater than 0.84 for euxinic, 0.54 -0.82 for anoxic, and 0.46 -0.60 for dysoxic conditions. However, the use of other element ratios has led to different interpretations. V/Cr and Ni/Co were used previously to evaluate for redox condition in different sediment studies [9]. Vanadium (V) initially incorporated into tetrapy role structures under anoxic conditions, also may be absorbed unto clay minerals but most likely this occur following burial [13]. Also, Cr is believed to be associated only with the detrital faction and is not influenced by redox conditions [14]. High V/Cr values (>4.25) are thought to indicate anoxic conditions [9]. Both Niand Co occur in pyrite but high' Ni/Co ratio are thought to be associated with anoxic conditions. Similarly [9] suggested that Ni/Co ratio <5 inferred oxic conditions, 5-7 dysoxic conditions and >7 suboxic to anoxic conditions.
Others include works of [6, 15 & 17 - 33].

2. STUDY AREA

The study area is located in Oliogo town at the south western part of Delta State of Nigeria. It lies within latitude 5°06' -5⁰50'N and longitude 6°10' -6°17'E (Fig. 1). The study area is accessible through major roads that run from Umutu to Umuaja (The source of River Ethiope) and environ. Beside the Agbor-Warri Road, other road networks include link roads to oil well heads, minor roads and footpaths connecting neigbouring villages.
The study area is sparsely populated. The topography of the area is quite flat and low lying with no major outcrops. On the average, the low lying area does not exceed an elevation of 30 -37m above sea level. The area falls within the broad Niger Delta described by many workers which include [34-40].

3. MATERIALS AND METHODS

Ditch cuttings were collected at depth intervals from X well in Oliogo and subjected to both granulometric and geochemical analysis. 100g of the dried sample were obtained from the prepared samples; 50g was used for megascopic studies while the other 50g was subjected to geochemical analysis in order to determine the element concentration of the selected elements.
Two grams (2g) of the sample were also weighed in a 250ml conical flask. 50ml of 0.05N Hcl and 50ml 0.1 N H_2S0_4wassubjected to heart for about an hour after which the sample was allowed to cool and then 10 percent dilute Hcl added. Samples were filtered into a 120ml rubber bottle and made up to the mark with distilled water. Metal concentrations were then determined with the aid of the atomic absorption spectrophotometer (AAS) unicam serie medel 969 series, [41].

4. RESULTS AND DISCUSSION

A lithostratigraphic section of the studied well was established based on megascopic description of the ditch cuttings.(Table 1) and (Fig. 2).
The results of geochemical analysis of selected elements (Table 2) indicate significant environmental factors. The varying degrees of enrichment suggest differences in the depositional environment during accumulation. The degree of this enrichment is influenced and controlled by factors such as temperature, salinity, pH, Eh, ionic potential etc. The Eh represents

Table 1. Megascopic Description of X-Well Section.

Well depth (ft)	Lithology	Lithology Description	% Shale
9850	Sandy-shale	Dark brown sandy shale	88
9880	Sandy-shale	Light grey shady shale	70
9910	Sandy-shale	Light grey sandy shale	75
9940	Sandy-shale	Grey sandy shale	82
9970	Sandy shale	Light brown sandy shale	80
10000	Sandy-shale	Light – dark grey sandy shale	75
10030	Sandy-shale	Dark brown sandy shale	60
10060	Sandy-shale	Dark grey sandy shale	68
10090	Sandy-shale	Dark grey sandy shale	85
10120	Sandy-shale	Dark grey – dark brown sandy shale	75
10130	Sandy-shale	Grey – dark brown sandy shale	80
10210	Sandy-shale	Light grey sandy shale	85
10240	Sandy-shale	Light grey sandy shale	88
10300	Sandy-shale	Grey fairly cemented with organic material sandy shale	75
10330	Shale	Light grey shale	100
10360	Shale	Light grey shale	100
10460	Shale	Brown grey shale parthy laminated	100
10510	Shale	Light grey shale	100
10610	Shale	Medium grey shale	100
10640	Shale	Dark grey shale with termination	100
10680	Shale	Dark grey shale with lamination	98

Well depth (ft)	Lithology	Lithology Description	% Shale
10710	Shale	Dark grey shale with lamination	99
10740	Shale	Dark grey shale with lamination	100
10770	Shale	Dark grey laminated shale	100
10800	Shale	Dark grey laminated shale	100
10850	Sandy shale	Dark grey sandy shale	70
10910	Sandy shale	Dark grey sandy shale	65
10940	Sandy shale	Dark grey sandy shale	63
11010	Sandy shale	Dark grey sandy shale	78
11070	Shale	Brown – grey shale	97
11130	Shale	Dark grey laminated shale	100
11160	Shale	Dark grey laminated shale	100
11190	Shale	Dark brown laminated shale	98
11220	Shale	Grey laminated shale	100
11250	Shale	Dark brown laminated shale	100
11370	Shale	Light grey laminated shale	100
11460	Shale	Light browns hale	97
11490	Shale	Light brown poorly cemented shale	90
11550	Shale	Dark grey laminated shale	100
11580	Shale	Dark grey laminated shale	100
11670	Shale	Dark grey laminated shale	100
11730	Shale	Dark grey laminated shale	100

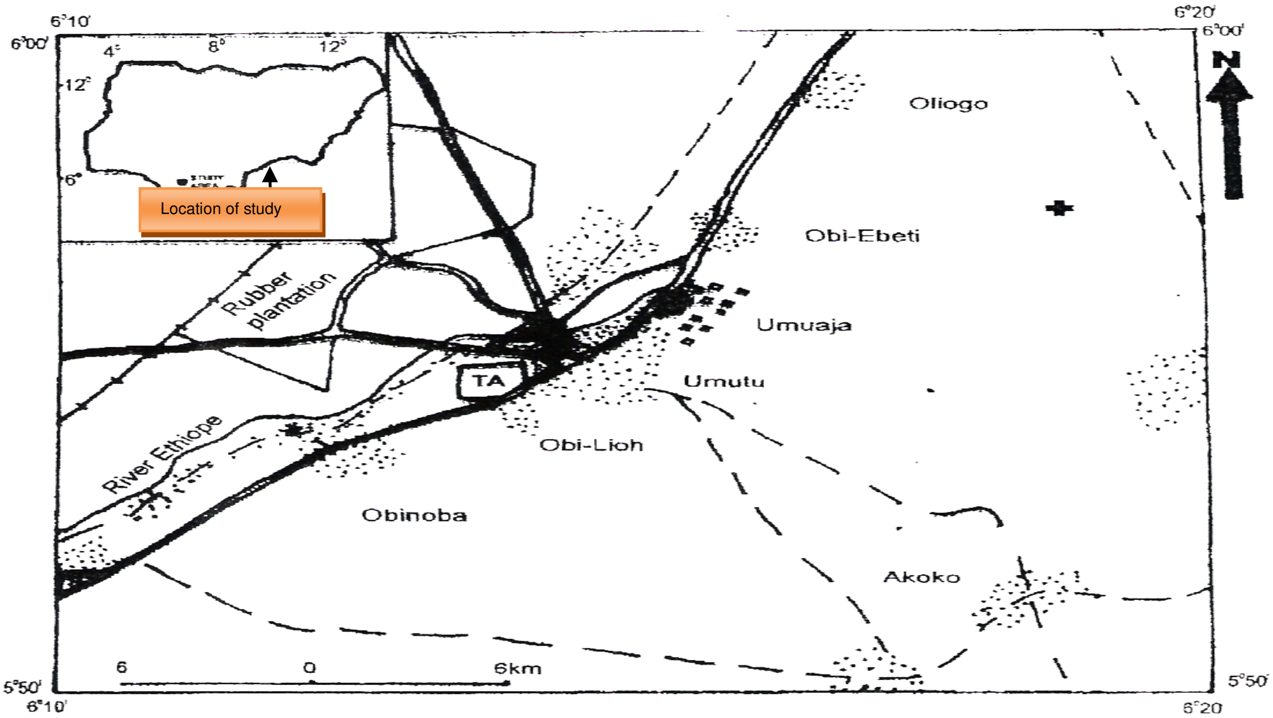


FIG. 1 : MAP OF OLIOGO AND ENVIRONS

Table 2 Concentration of Trace Element In Mg/kg

Depth of X-well Parameter	Ca	Mg	K	Na	Ni	Pb	Mn	Fe	Cr	Co
X-well – 9970	6138.00	4191.60	11160.80	5573.00	7.92	0.62	42.83	4393.50	0.31	5.58
10090	5940.00	4590.80	12157.30	5174.00	8.91	0.62	49.30	2727.00	0.62	4.96
10300	2524.50	3792.40	12954.50	6766.00	11.88	0.62	104.58	4646.00	0.92	5.58
10360	2920.50	4391.20	13751.70	4975.00	6.93	0.62	74.70	4797.50	1.23	8.06
10610	4504.50	3293.40	10762.20	3283.50	7.92	3.08	164.43	1010.00	0.62	3.10
11160	9702.00	5988.40	18734.20	6766.00	15.84	4.31	253.98	2474.50	1.54	8.06
11280	3712.50	2794.40	26148.20	6169.00	9.41	12.92	263.92	8888.00	0.92	11.16

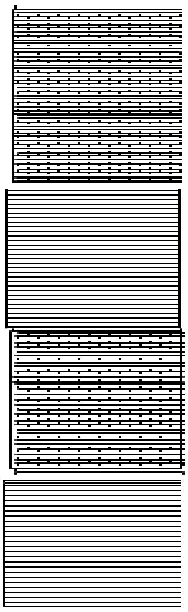
Dept in ft	Litbology	Litbology	Energy/deposition at environment
9800		Dark brown grey to light grey sandy shale fine to medium gram size, subrounded to rounded, and moderately sorted.	Low to medium energy of deposition. Shallow marine environment.
10300		Light to grey to dark shale with lamination. Very fine grain size, rounded and very well sorted.	Low energy of deposition. Mostly marine environment
0900 1010		Dark grey sandy shale. Medium gain size subrounded and moderately sorted.	Low to medium energy of deposition. Estuarine to marine environment.
1730		Dark grey to light brown shale with lamination. Very fine grain size, rounded, rounded and very well sorted.	Low energy of deposition. Marine environment suggested.

Fig. 2 Lithostratigraphy Section of the Well

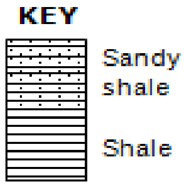


Table 3: Paleo Redox Indicators

Depth of Borehole in ft	Ni	Co	Ni / Co
X_{-well} – 9970	7.92	5.58	1.42
10090	8.91	4.96	1.80
10300	11.88	5.58	2.12
10360	6.93	8.06	0.86
10610	7.92	3.10	2.55
11160	15.84	8.06	1.97
11280	9.41	11.16	0.84

The concentrations of some elements within the X well section were observed to vary in the sample analyzed with depth. Concentration values were in the increasing order of Cr<Pb<Co<Ni<Mn<Mg<Fe<Ca<Na<K (Fig. 2). The values of K indicate a very high enrichment because its lowest and highest limits of concentration were far greater than those of other elements investigated.

Absolute abundance of Potasium (K) is primarily controlled by increase in the amount of dominant clay mineral (illite). It is notable that the highest concentration of Mn, K and Fe occur at the same positions. The Mn content of the shale may be ascribed to concentration of the element by secondary oxidation and would indicate that oxygen was present in the environment during their deposition.

The ratio of K/Na shows a fluctuating scenario for the well studied which is between 1.91 and 4.24. These differences obviously reflect in part the different compositions of the source rocks. Cross plots of concentration of these elements against depth of well (Fig. 3 & 4), show that there is great stratigraphic variability in elements concentration.

From results, the threshold value of the Ni/Co ratios from well section indicates oxic condition during accumulation of sediments (Table 3 and Fig 4).

Ni/Co as an indicator of oxygen level shows that the ditch cuttings have high oxygen values thus suggesting an oxic environment as its paleo -redox proxies.

Table 4: Trace Element Paleo-Redox Proxies indicator for Ni/Co After [9 &10])

Elemental Ratio	V/(V+Ni)	V/Cr	Ni/Co
Euximic	>0.84		
Suboxic/anoxic	0.54 – 0.82	>4.25	>7
Dysoxic	0.46 – 0.60	2 – 4.5	5 – 7
Oxic		<2	<5

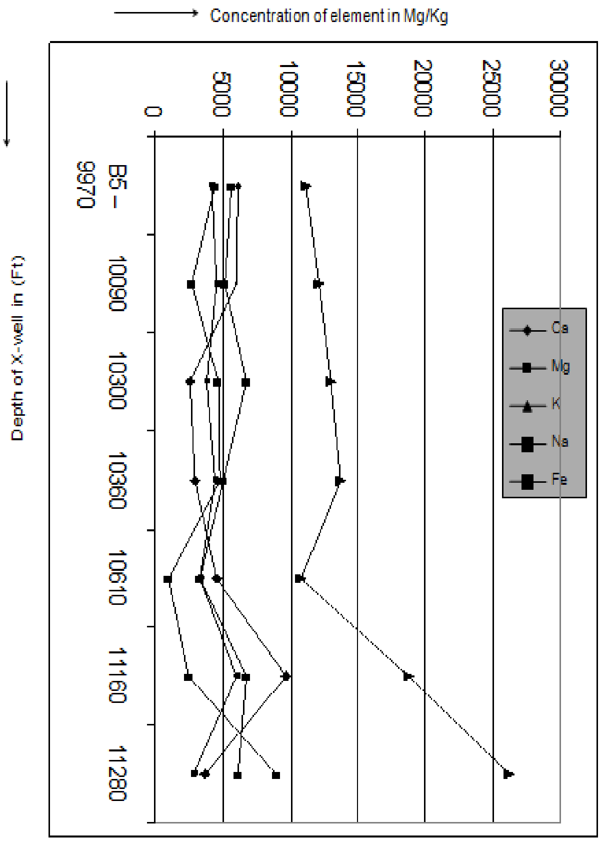


Fig. 3: Cross plot of Conc. Ca, Mg, K, Ni and Fe against Depth

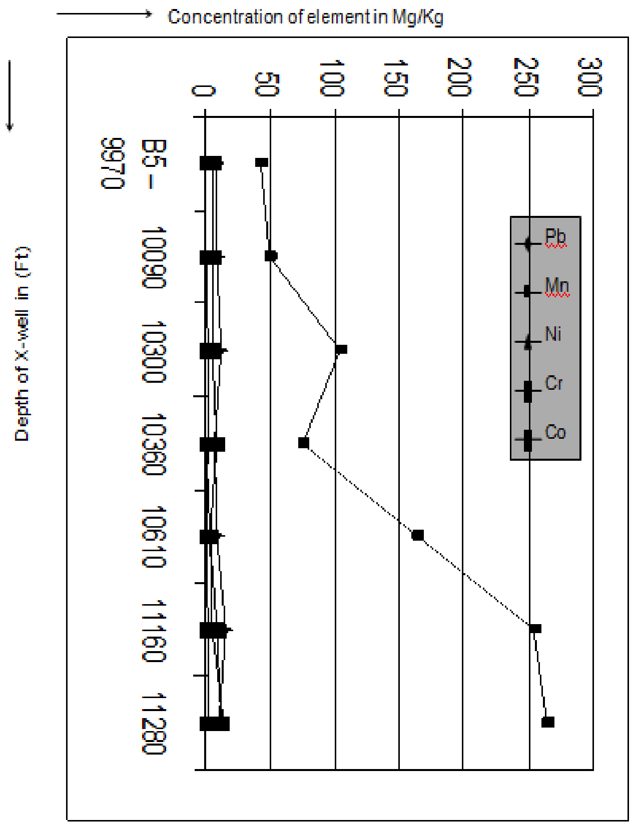


Fig. 4: Cross plot of Conc Pb, Mn, Ni, Cr and Co against Depth

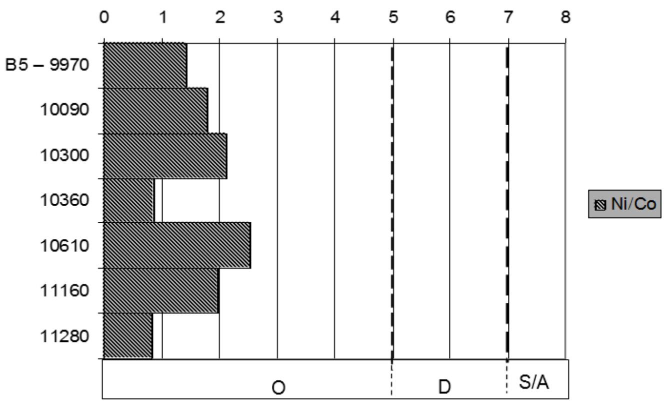


Fig. 5: Trace Element Paleo-redox proxies for Ni/Co, O is the Oxic, D is the Dysoxic and S/A is the Suboxic/ Anoxic.

5. CONCLUSION

The analyses of element concentration within the X-well section vary greatly with depth interval in relation to the different geochemical analysis result of the element. The scattered nature of these elements all over the well section is as a result of differences in depositional environment during accumulation, the physicochemical condition of that environment, synergetic mineralization, and relative mobility of element. All of these distinctive features of the elements are influenced and controlled by different factors such as temperature, salinity, pH, Eh, ionic potential which also help in assessing an environment to be reducing or oxidizing from paleo redox indices of some trace element ratios. Some element redox indices especially *Ni/Co* used here suggest a high oxygen environment for the samples. However, there is no complete agreement between different redox trace-element ratios. Therefore, it is suggested that absolute thresholds established in other studies should be applied carefully, but that ratios may provide information on relative differences in redox conditions. Relationships of some element ratios such as Ni/Co may also provide clues as to whether redox conditions were the primary control on organic matter accumulation. Given the variation in the-element concentration values within the X-well section, it is recommended that investigation to determine these element concentrations in ditch cuttings should be based on the average value obtained from different wells where such previous works have successfully been carried out. This will yield more accurate results in comparison with such standard average value from previous work.

For further investigation to determine the clastic influx which control the organic carbon concentration in such sample through dilution, by influencing burial rate, or by providing site for organic matter absorption in and on aluminosilicates of such a sample. It is recommended that elements such as Ti and aluminium in such samples should also be determined since the ratio of Ti/Al has been used as all indicator of siliclastic grain size. Hence sedimentation rate and this ratio also give an indication of the paleo-wind strength. K/AI ratio gives an idea of uniform detrital clay influx and increase in K/AI could also suggest a more micaceous clay input or possibly an increase in fine -grained K - feldspar.

All these information when tied together will give a detail understanding of these elemental enrichment in ditch cuttings and the degree of variability within the stratigraphic framework and to help decipher the paleo-redox proxies of these elements precisely and accurately in that environment with conditions that had prevailed.

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