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EXPERIMENTAL INVESTIGATION OF LEACHATE CONTAMINATION ON GROUNDWATER EXPLORATION IN BASEMENT COMPLEX AREA

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ABSTRACT

A total of ten groundwater samples were collected from wells around the site of Orita Aperin refuse dump, Ibadan, Southwest, Nigeria, to determine the extent of groundwater contamination. The results of the hydro-chemical analysis show that groundwater samples collected from wells away from the leachate revealed comparable W.H.O. standard values for groundwater consumption. Most obvious parameters are: increase in total hardness (between 184.8 and 239.6mg/l for samples near the leachate; 74 and 102mg/l for samples far from the leachate), low calcium (ranged from 46.2 to 78.7mg/l for samples near the leachate; 3.7 to 32.8mg/l for samples far from the leachate), magnesium (ranged from 5.1 to 30.3mg/l for samples near the leachate; 3.4 to 21.5mg/l for samples far from the leachate), chloride (between 20 and 224mg/l for samples near the leachate, 32 and 174mg/l), and sulphate content (ranged from 9 to 76mg/l for samples near the leachate; 25 to 38mg/l for samples far from the leachate); while high values of TDS (in samples A and C and I), nitrate (in samples A and C) and chloride (in samples A and I) which were due to the effect of leachate on the water quality resulting to contamination of these wells. Thus, adequate treatment should be carried out on wells located close to the leachate before consumption.

Key words: Groundwater, Contamination, Leachate, Percolation and Chemical analysis.

INTRODUCTION

Ibadan, southwest Nigeria is known to be a densely populated city for which pipe-borne water has not been adequate and regular. This has now made most people to result to groundwater exploration, but for the inhabitants around the area of refuse dump, groundwater from such wells is always contaminated due to leaching and percolation; and is not suitable for human consumption (Zanoni, 1973; Salvato *et al.,* 1971). Some of the wells within this area are seasonal and are noted for low quality, below the W.H.O. recommended standard value for consumption, as they contain a sizeable portion of metal (Osibanjo and Ajayi, 1980; Sangodoyin and Adelakun, 1987).

The type of rock in any area is an important factor for the nature of the groundwater. Groundwater in the basement area is often tapped by hand-dug wells for domestic, agricultural and industrial purposes. Ejizu (1984) showed that the depths of borehole and deep wells varies from 42 to 90m, an indication that most wells explore the aquifer

within the solid basement rocks since weathering depth rarely exceeds 40m in southwest Nigeria. It also showed that static water level varies from 0 to 35m. For this study area, the leachate has a direct contact with both ground and surface water, thus there is a likelihood of groundwater pollution on the basis on the basis of high intensity of rainfall coupled with shallow water table and lack of impermeable weathered material such as clay; which serves as a barrier for the leachate infiltration (Robert and William, 1980; Amusa, 1993). The possible occurrence of these contaminants above W.H.O. recommended values calls for immediate chemical analysis before consumption.

Leachate contains both chemical and biological constituents (Schneider, 1970), which is the local source of groundwater pollution. The more rainfall, the deeper a solute can be expected to penetrate a given soil. The contamination from leachate always begins precipitation by carrying the leachate into the land surface and groundwater system, the rainwater penetrating the refuse will partly percolate downward to the soil zone and eventually to the water table. While percolating vertically, water leaches both organic and inorganic constituents thereby becoming part of the groundwater flow system. The character and strength of the leachate are dependent upon the length of time that infiltrated water is in contact with the leachate (Van Fleet *et al.,* 1974).

MATERIALS AND METHODS

A short-term field survey of stream and hand dug wells around the vicinity of Orita-Aperin refuse dump, Ibadan, Southwest, Nigeria was carried out. It involved measurement of the total depth of well (depth to water level using a graduating tape) and collection of 10 water samples (A, B, C, D, E, F, G, H, I, and J) in plastic bottles. Measurements of sensitive quality, geophysical and chemical parameters were carried out on all water samples. Samples A, B, C, and I are at a distance of 50m close to the leachate while samples D, E, F G, H and J are at a distance of minimum 500m away from the leachate (see the details in Table 1).

Parameters such as temperature, total dissolved solid (TDS), pH, and conductivity were taken on the field using a portable HachDR-EL/4 laboratory kit (Bedient *et al.,* 1984). While the hydro-chemical analysis were carried out in the laboratory of Oyo State Water and Sanitation Project (WATSAN), Ibadan, Nigeria, Chloride was measured using a chemetrics Kit (Model K2020) by mercuric nitrate method (Robert and Philip, 1987). A total of 14 parameters (both physical and chemical) were analysed in all.

RESULTS AND DISCUSSION

The geophysical and chemical analyses of water samples analyzed are shown in Table 1. The results show that there is a great impact of leachate on the quality of water samples close to the leachate. Most obvious impact is high average value of TDS, nitrate and chloride in samples A, B, C and I when compared with average values in samples D, E, F, G, and J; an obvious confirmation of contamination of these wells. The pH values for samples close to the leachate range from between 7.10 and 8.10 while for those samples far away from the leachate is between 5.70 and 7.10. The high value of pH in those samples close to the leachate may be due to the release of carbon dioxide, ammonia and methane during decomposition of leachate and subsequent percolation through the ground to the groundwater. The origin

of the major cations in the leachate remains debatable with the possible source being inorganic compound in the leachate and alteration of silicate minerals. Pavoni et al. (1973) reported that clay minerals such as Kaolinite with Ilite and some Vermiculate and Montmorillonite, if used for landfill cover would absorb cations and exchange with ammonium generated in the leachate. Hence, clay material used to cover landfill is the main source of Na, K, Ca and Mg. It is observed that samples A, B, C and I (samples close to the leachate) are attributed to higher value of total hardness far above the accepted drinking water standard (WHO, 1984); thus making these wells unsuitable for domestic use. Wells B, C and I which are close to the leachate, have depths far below the recommended depths for wells, even in an unpolluted basement area.

CONCLUSION

On the basis of the geophysical and hydrochemical analysis carried out, the values of most parameters obtained in the water samples collected at locations close to the leachate have been confirmed to be higher than those collected at locations away from the leachate. Hence, the groundwater near the leachate is confirmed contaminated. The source of this contamination is traced to the leachate, which resulted from biological reactions, percolation and dissolution of inorganic constituent, leaching of sediments, movement of dissolved material, ions exchange, generation and diffusion of gases. Water form wells located close to the leachate should be subjected to adequate treatment before its use. Thus hydrochemical analysis is a useful technique for monitoring groundwater contamination due to leachate at the refuse disposal sites.

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Table 1: Physical and chemical parameters from locations close to the leachate compared with locations away from the leachate and W.H.O standard for consumption.

Parameters	Samples near the leachate				Samples away from the leachate						W.H.O Standards	
	A	B	C	I	D	E	F	G	H	J	Acceptable Level	Maximum Permissible Level
Depth of well (m)	-	15.6	30.3	29.7	10.2	93.6	29.4	33.3	99.3	40.2	-	-
Temperature (^oC)	28.6	34.2	29.0	28.6	28.7	28.8	28.3	30.1	28.8	29.8	-	-
pH	8.1	7.5	7.1	7.1	7.1	5.7	6.3	6.2	6.6	6.7	6.5	8.5
Conductivity (Ns/cm)	1308.0	1349.0	1075.0	1128.0	432.	840.0	482.0	604.0	464.0	756.0	-	-
TDS	850.2	876.9	698.8	733.2	280.8	546.0	313.3	392.6	501.6	491.4	500.0	1000.0
Total hardness (mg/1)	239.6	184.8	217.6	188.8	74.0	100.0	97.6	94.4	100.0	102.0	1000.0	500.0
Na+ + K+ (mg/1)	145.8	95.8	103.6	110.7	24.4	91.5	24.8	79.0	9.8	74.7	-	200.0
Ca+ (mg/1)	46.2	48.0	78.7	49.7	24.0	4.8	3.7	22.1	17.6	32.8	75.0	200.0
Mg^{2+} (mg/1)	30.3	15.8	5.1	15.7	3.4	21.5	21.5	9.6	13.7	4.9	50.0	150.0
Fe^{2+} (mg/1)	0.38	0.73	0.20	0.20	0.40	0.10	1.00	0.03	1.04	0.70	0.30	1.00
Cu^{2+} (mg/1)	0.10	0.03	0.03	0.10	0.10	0.10	1.30	0.10	0.40	0.10	-	-
HCO_3^- (mg/1)	100.0	404	240.0	80.0	24	16	28	28	34	42.0	-	-
$C1^-$ (mg/1)	224.0	20	50.0	186.0	44	174	54	146	32	128.0	200.0	250.0
SO_4^{2-} (mg/1)	76.0	9	76.0	66.0	28	38	35	32	25	38.0	200.0	400.0
NO_3^- (mg/1)	100.0	32.0	120.0	40.4	20.2	1.6	22.0	5.3	30.07	14.1	50.0	100.0
PO_4^{3-} (mg/1)	1.18	0.6	2.30	0.80	0.50	0.10	0.20	0.01	0.30	0.04	-	-

*Sample A is a stream (surface water)
Source: W.H.O. (1984).

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