International Journal of Scientific Research and Engineering Development-– Volume 3 Issue 4, July –Aug 2020

Available at www.ijsred.com

RESEARCH ARTICLE OPEN ACCESS

Physicochemical Assessment of Stream Sediments Within Tewure Iju And Elesun Aiyetoro, Northwestern Part of Ogbomoso

by

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Abstract

Assessment of physicochemical properties of stream sediments of River Ayimoro within the quadrant $08^0$19`24``N, $08^0$21`06``N to 004 02`40``E $004^0$04`46``E, Northwest of Ogbomoso was carried out to provide baseline information for mineral exploration purpose. Composited sediment samples were collected for each location and analyzed for physicochemical parameters (i.e. pH, Organic Carbon (OC) and Organic Matter (OM); Electrical Conductivity (EC) and Particle Size Distribution (PSD) in EMS laboratory using standard methods and also for elemental composition at the Activation laboratory using the method of Inductive Couple Plasma-Mass Spectrometry (ICP-MS).The results obtained indicated a pH of 9.4 and 8.8 for sediments of the two locations(Tewure Iju and Elesun Aiyetoro respectively) thereby indicating that the sediments of these areas are basic. The sediments of Tewure Iju and Elesun Aiyetoro have an EC of 180us/cm and 240us/cm. The low EC indicates that the sediments are also found within the geological materials. The OC and OM of the study areas are also low indicating that the geologic materials have low tendency of capturing carbon which foster the formation of organic matter. The particle size distribution of sediments of the study areas showed that the areas is not well drained. High percentage of sand (92.8% and 60.40% for both Tewure Iju and Elesun Aiyetoro respectively) indicates that sand is the main geological material found in the setting.Manganese (Mg) and Barium (Ba) are the most concentrated metals present in the sediments of both location. The high composition of Mn and Ba indicates that they tend to settle within shorter period of deposition. Using the standard deviation (SD) and the highest mean values, Mn is the most distributed metal across the study area while Mo is the least distributed. Other elements (Pb, Co, Cu, Fe, Cr, Al, and Mo) analyzed for are found to have low concentration in the sediments of the study areas using their corresponding calculated background values. Trace elements like Li, Be, Sc, V, Sr, Y, Zr, Tl, and U were also analyzed for with Vanadium (V) having the highest composition both in the soils and sediment of the study areas. Using the SD also, V is the most distributed metal while Tl is the least distributed in the study areas. These presence of these heavy metals have made the streams inconsumable and has also affected the livelihood of these habitants.

Keywords: Heavy metals, Physicochemical Properties, Trace metals, Composited

INTRODUCTION

Geochemical sampling is taking a small portion of Earth's material for finding its mineralogy, composition and grade such that it represent the whole area. Geochemical sampling is the basic technique used for the exploration of minerals and their ores. So for this exploration multiple sampling techniques can be used to determine the place of ores. There are several methods of sampling, these include stream sampling, vegetation sampling, hydrogeochemistry, soil sampling, gas sampling and rock sampling (Qasim 2020).

Stream sampling is the samples taken from stream running through area and providing water and sediments from catchment area. These water when flow in stream it provides picture of the area from where water flows out. The stream source of sediments are by erosion of soil and rocks. It also gets water from inflow ground water which gives the subsurface mineralogy.Mineralized bedrock, if present, will be revealed by the presence of elevated metal and/or indicator mineral contents in sediment. Ideally, the metal content of sediment collected at intervals along a stream channel will display both a peak value close to the entry point of the metal into the drainage basin and a downstream asymptotic decay curve that reflects dilution of mineralized material (Fletcher, 1997). This dilution is caused by barren bedrock, surficial material or fluvial material. At some point along the dilution curve the anomalous geochemical signal of the mineralization will merge with the geochemical background. While this simple model describes element dispersion in the sediment weathered from a small catchment basin, it is less reliable for predicting dispersion from a larger catchment basin where the stream becomes decoupled from the surrounding valley slopes and the sediment is less representative of bedrock geochemistry (Fletcher, 1997).Metals Vanadium (V), Nickel (N), Cobalt (Co), Cadmium (Cd), Lead (Pb), Zinc (Zn), Magnesium (Mn) and Titanium (Ti), and are capable of causing mortality to abnormal reproductive and behavioral adaptations in marine organisms (Simon, 2003). On getting to the water these pollutants eventually settle at the sediment which serves as a sink of all contaminants in the aquatic ecosystem (Mucha*et al*., 2003).

Heavy metal pollution of aquatic ecosystems isbecoming a potential global problem. Third worldcountries such as Uganda, lack for mechanisms andsensitive tools to detect and monitor water quality andare therefore exposed to heavy metal poisoning (Ochienget al., 2008). Trace amounts of heavy metals are alwayspresent in fresh waters from terrigenous sources suchas weathering of rocks resulting into geo-chemicalrecycling of heavy metal elements in these ecosystems(Muwanga, 1997; Zvinowanda et al., 2009).Heavy metals may enter into aquatic ecosystems fromanthropogenic sources, such as industrial wastewaterdischarges, sewage wastewater, fossil fuel combustionand atmospheric deposition (Linnik and Zubenko, 2000). Trace elemental concentrationsin stream sediment compartments can be used to revealthe history and intensity of local and regional pollution(Nyangababo et al., 2005).

The cost of the environmental degradation due to water pollution is relatively high with serious health and quality of life consequences; as well as increasing the severity of water scarcity problems (Zyadah, 1996). Hence, increasing water pollution causes not only the deterioration of water quality but also threatens human health and the balance of aquatic ecosystems, economic development and social prosperity.

Taking samples from the stream requires choosing area which provides picture of whole stream, sediments should be 80 mesh size acquired by sieving. Gold, magnetite concentrates in the stream sediments will settle down on the sieves as they are heavy minerals and finer sediments will be sieved. (Qasim 2020). For base metals and geochemical mapping 0.5 kg sample should be taken but for Gold 10 kg sample should be analysed. For an active stream sampling should be at interval of 20-30 meters or 50-100 meters. Sampling should be from a depth of 10-15 centimetres to avoid excessive Iron and Manganese oxides.

The geochemical distribution of metals in the sediment samples of the area will be useful in both mineral exploration and environmental analyses. The knowledge of metal concentration in this area will be helpful in the understanding of the health status of the habitats in this area because the major source of water in the areas are the streams and rivers.

METHODOLOGY

The two sampling sites (Tewure Iju with coordinates 08^{0}21` 06`` N and 004 04` 46`` E and Elesun Ayetoro with coordinates 08^{0} 17` 38`` N and 004 02` 44`` E) were selected from the geological map of Ogbomoso Northwest.The purpose for this method of sampling was to evaluate the variation among the sampling location within a particular site both vertically and horizontally. The areas has flat to gentle topography with stream depth of about 30cm and a dendritic drainage pattern. The drainage is moderately sorted because of this soil are fertile and are good for farming. When the tributaries of the drainage join a valley, they forms insequent streams which flow from North to South (fig 1).

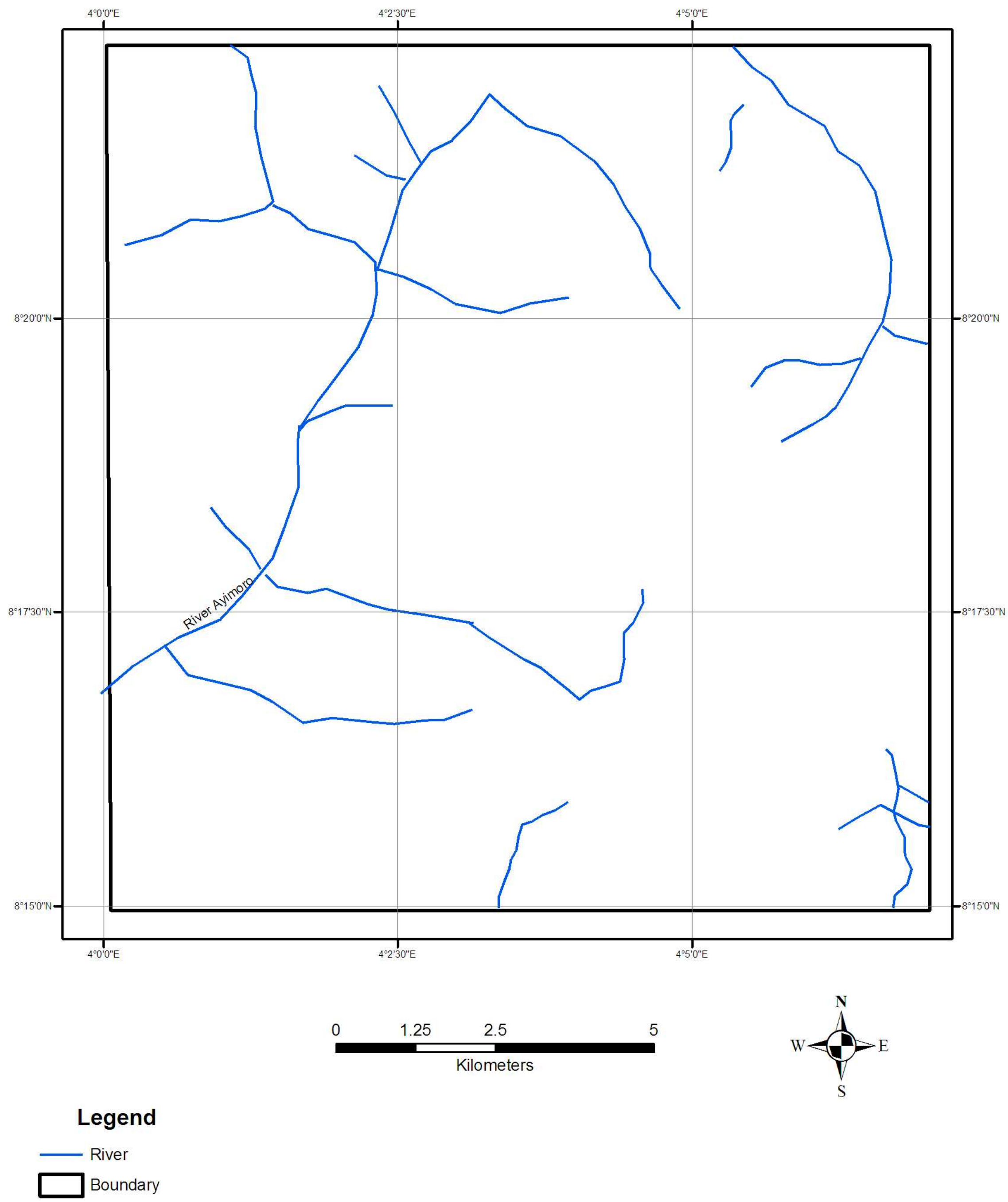

Fig. 1 Drainage Pattern of the Study Area

The annual area ranges from 1755-1905mm and a dual maximal limit in July and September. The mean annual temperature is 29^{o}C and relative humidity of 60% (Ogunbode and Ifabiyi 2019). The vegetation zone of the areas where the field work was carried out cover about 66% of the land surface. The areas were visited April which is a rainy season period, consequently most of the vegetation wears a green look.

Materials used for the work are polyethylene bottles,disposable gloves, disposable filters, clinometers,permanent drawing ink marker, maps (topographical maps, preferred scale 1:50000), heavy duty rubber gloves, metal free polyethylene funnel, sieve sets, plastic bucket shovel and hand trowel, nylon mats, tapes. Collectionof the stream sediment samples was achieved by scooping and it was ensured that all hand jewelleries were removed and that the tools and containers were free from contaminants. The stream sediments were collected from the small drainage basin at the two areas visited. Sites where the stream sediment collected were located at least 100m upstream of roads and settlements.

Stream sediment sampling started from the water sampling point and no composite sample was made from samples taken from the stream beds. Before the stream samples were collected the sample bags were labelled using the permanent ink marker in other to identify the correct samples when carrying out sieving.

Pre Laboratory Sample Preparation

The samples were later air dried in an enclosed environment for two weeks before being sieved. After the samples have been seived they are packed into nylon envelope weighing 1g, 3g, 5g, and 50g. The 1g, 3g, 50g were sent to the laboratory here in Nigeria for analysis of some physicochemical parameters while the 5g was sent to Activation Laboratory in Canada for analysis of metals using Industrial Couple Plasma-Mass Spectrometry (ICP-MS) method

DISCUSSION OF RESULT

Physicochemical Analysis of Stream Sediments

Table 1: Physicochemical Properties of Sediment in the Study Areas

LOCATION	COORDINATE	pH	EC us/cm	O.C %	O.M %	Particle size (%)		
						Sand	Silt	Clay
Tewure Iju	08^{0}21'06"N 004^{0}04' 46"E	9.4	180	3.86	6.72	92.80	3.60	3.60
Elesun Aiyetoro	08^{o}17'38"N, 004^{0}02'44"E	8.8	240	4.48	7.80	60.40	25.20	14.40

The results of the analyzed sediments samples are shown in the table 1 above. From the table, it can be seen that the pH of sediments of the two locations i.e. Tewure Iju and Elesun Aiyetoro are alkaline or basic. It can also be observed that the electrical conductivity (EC) of the sediments at Elesun Aiyetoro (240us/cm) is more than sediments at Tewure Iju (180us/cm). Generally the electrical conductivity of the sediments are low. This indicates that the sediment samples are found within the geologic material. The percentage of Organic Carbon of sediments in Tewure Iju is 3.86% while that of Elesun Aiyetoro is 4.48%. This is lower when compared with the sediments of Bratsk Reservoir (17.70%) in Russia (Rzetala*et al.*, 2019). This low percentage indicates that the sediments samples of the study areas are not rich in organic carbon. The percentage of Organic Matter of sediments in Tewure Iju is 6.72% while that of sediments in Elesun Aiyetoro is 7.80%. This low percentages in organic matter indicates also that the study areas are not rich in organic matter but are higher when compared with the right and left bank of Alzette river of France and Luxembourg which are 5.3±1.0% and 4.8±0.4% respectively (Blandine*et al.,* 2019). These low percentages of OC and OM indicate that the geological materials have low tendency of capturing carbon which foster the formation of organic matter.

The particle size is not well distributed because sand is well above other particles (clay and silt) in percentage. This shows that area is well drained and so do not provide sediment with necessary H^+ ions needed for the formation of acid which is why the sediment samples are alkaline in nature. The high percentage of sand also shows that sand is the main geologic material found in this setting while clay and silt are less.

Elemental Composition of Sediments

Table 2: Elemental Composition of Sediment at Tewure Iju and Elesun Aiyetoro

Sample no	Pb ppm	Ba ppm	Co ppm	Cu ppm	Fe %	Mn ppm	Cr ppm	Al %	Mo ppm
EU_2	5.07	29.40	3.10	1.50	0.62	165.00	12.20	0.35	0.19
EU_3	16.70	131.00	5.60	8.62	2.39	237.00	35.00	2.59	0.75
Calculated Background Value (CBV)	4.50	44.30	2.47	2.75	0.45	181.75	5.70	0.51	0.98

The elemental composition of sediments in the study area tends to vary because of the quantities of soil particle trapped in the sediments and also due to the variation of time of deposition of the elements in the sediment. Here the concentration ofPb, Ba, Co, Cu, Fe, Mn, Cr, Al, and Mo were also analyzed for and it was observed that Mn has the highest concentration. The manganese concentration of the sediment in Elesun Aiyetoro (237.00ppm) tends to be higher than that of Tewure Iju (165.00ppm) and also higher than the CBV (181.75ppm) but lower when compared with the Mn concentration of Nakivubo channelized stream (480ppm) in Kenya (Sekabira*et al*., 2010). Also the Barium concentration of Elesun Aiyetoro (131.00ppm) tends to be higher than that of Tewure Iju (29.40ppm) and the CBV (44.30ppm) but also lower when compared with the stream sediment of River Oyan in Abuja with Ba concentration of 679.10ppm (Oyebamiji*et al*., 2017). Also Mo has the lowest concentration in the elemental composition of sediments of both study area.

Table 3: Trace Element Composition of Sediment at Tewure Iju and Elesun Aiyetoro

Sample no	Li ppm	Be ppm	Sc ppm	V Ppm	Sr ppm	Y ppm	Zr ppm	Tl ppm	U ppm
EU_2	2.20	0.30	0.80	19.00	2.70	4.00	0.80	0.05	0.80
EU_3	8.80	1.00	4.00	51.00	16.40	12.00	3.10	0.22	2.20
Calculated Background Value (CBV)	2.25	0.18	0.87	10.10	9.00	3.16	0.28	0.41	0.50

The trace element concentration was also analyzed for using the ICP-MS method. Considering the trace elements studied i.e. Li, Be, Sc, V, Sr, Y, Zr, Tl, and U, it was observed that Vanadium has the highest concentration. The sediment in Elesun Aiyetoro tends to be richer in V (51.00ppm) than those of Tewure Iju (19.00ppm) and also higher than the CBV (10.10ppm) but these are however lower when compared with the V concentration of River Oyan in Abuja with 148.60ppm (Oyebamiji*et al.,* 2017). Also Tl has the lowest concentration of the trace elements in the study area.

Table 5: Statistical Analysis of Elemental Composition of Sediment of Tewure Iju and Elesun Aiyetoro

Elements	Minimum	Maximum	Mean	Std. Deviation
Pb	5.07	16.70	10.88	8.22
Ba	29.40	131.00	80.20	71.84
Cu	1.50	8.62	5.06	5.03
Co	3.10	5.60	4.35	1.77
Fe	0.62	2.39	1.51	1.25
Mn	165.00	237.00	201.00	50.91
Cr	12.20	35.00	23.60	16.12
Al	0.35	2.59	1.47	1.58
Mo	0.19	0.75	0.47	0.40

The statistical analysis of the heavy metals concentration shows that Mn has the highest mean concentration (201.00) while Mo has the lowest mean concentration (0.47) of the study areas. The standard deviations also showed that Ba is the most widely distributed metal (71.84) while Mo is the least distributed metal (0.40) of the study areas.

Table 6: Statistical Analysis of Trace Element Composition of Sediment of Tewure Iju and Elesun Aiyetoro

Elements	Minimum	Maximum	Mean	Std. Deviation
Li	2.20	8.80	5.50	4.67
Be	0.30	1.00	0.65	0.49
Sc	0.80	4.00	2.40	2.26
V	19.00	51.00	35.00	22.63
Sr	2.70	16.40	9.55	9.69
Y	4.00	12.00	8.00	5.66
Zr	0.80	3.10	1.95	1.63
Tl	0.05	0.22	0.13	0.12
U	0.80	2.20	1.50	1.00

The statistical analysis of the trace elements composition of the sediments showed that V had the highest mean concentration (35.00) while Tl had the lowest mean concentration (0.14) of the study area. Vanadium is also the most widely distributed among the trace elements (22.63) while Tl is also the least distributed trace element (0.12) using the standard deviations.

Conclusion

Heavy metal and trace elements assessment was carried out using baseline analytical tools and this has shown various levels of elements concentration using the stream sediments collected from Tewure Iju and Elesun Aiyetoro area of Ogbomoso Northwest. The physicochemical analysis results shows that the stream sediments are alkaline with low electrical conductivity. The sediments are also found not to be rich in organic carbon and organic matter indicating that they have low tendency of capturing organic matter which foster the formation of organic carbon. The particle size are also not well distributed because of the high percentage of sand compare to silt and clay making it not suitable for plant cultivation.Elemental composition analysisshowed that Manganese (Mn) has the highest concentration which is also higher than the CBV indicating a contaminationwhile molybdenum has the lowest concentration of all the elements considered (not considering the trace elements). Because of the high concentration of some of these heavy metals and trace elements when compared with their individual CBVs and their adverse effect in the body system and the environment, it will be recommended that the habitants of these study areas find other means of water supply both for consumption and for their plants or the water can be treated before consumption.

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