Ethiopian Journal of Environmental Studies & Management 15(4): 511 – 531, 2022
ISSN:1998-0507 doi: https://ejesm.org/doi/v15i4.9
Submitted: June 6, 2022 Accepted: August 5, 2022

METALS DISTRIBUTION IN THE WATER BODIES AROUND QUARRY SITES IN OGUN STATE, NIGERIA

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Abstract
Quarrying of rock for construction purposes is a significant industry in Nigeria thus contributing to Gross Domestic Product (GDP). This study examined the heavy and trace metal distribution in the water bodies around quarry sites in Ogun State. Geographic Information System approach was used to map eight selected sites namely Isara, Idode, Iwaye, Ogbere, Ilagbe, Adelokun, Baaki Ake and Igodo. A total of 48 samples from surface and ground water were collected and analysed from the eight selected locations for nickel, iron and cadmium, arsenic, nickel and copper (heavy metal) and potassium, silicon, aluminium, magnesium and zinc (trace metal) using standard methods. Sampling was done in dry and wet seasons between November 2015 and July 2017. Data were subjected to descriptive and inferential statistics using SAS package (9.4 version). Cadmium in surface were higher than WHO limits across all locations in both seasons. Surface water nickel (0.138±0.01 - 0.264±0.01 mg/L) and iron (0.035±0.01 – 0.051±0.01 mg/L) across locations in dry and wet season respectively were higher than their corresponding WHO limits. Ground water (cadmium) were higher than WHO limits across all locations in both seasons. Ground water (iron) across locations (0.030±0.00 – 0.040±0.00 mg/L) in wet season were higher than the WHO limit (0.03 mg/L). None of the trace metal values in surface and ground water across locations surpasses the WHO limit. In conclusion, the water bodies in surrounding localities of quarries were polluted with cadmium, nickel and iron.

Key Words: *Trace, Heavy metal, Distribution, Water, Quarries*

Introduction

A potable water is of basic importance to human physiology and existence, which are not readily available, though the whole world is surrounded by water but because of their purity they are not consumable. Hence, potable water are scarce (ojekunle *et al.,* 2015). The little presents; that are good enough to be taken as drinking and for domestic chore were being polluted by one activity or the others being embarking on by man. However, most of where the quarries are sited are villages, that do not have access to portable water, they solely depend on the well, stream, pond, river etc.

There is an indication that the surroundings of quarries are polluted with heavy metal as a result of mining activities (Ekpo *et al.,* 2013; Fedra *et al*., 2005). According to Khaled (2005), heavy metals enter the aquatic environment through geological weathering and human activities. The concentration of heavy metals in bottom sediment were significantly higher than those recorded in water samples (Ekpo *et al.,* 2013). The high level of these metals in the sediments could be attributed to the waste generated from quarry site (Ekpo *et al.,* 2013). Zuhairi *et al.* (2009) reported in their study that, the concentrations of As, Cu, Fe, Mn, Pb and Zn in surface water, exceeded regulatory limits in both active and abandon quarry/mine sites in Pahang (Malaysia).

Quarries operations affected the environment in many ways, and water pollution is a major concern in such operations. For instance quarry dust can change the chemistry of water resources by dissolving therein. It can also settle in water bodies and cause pollution (Sayara, 2016). Furthermore, these operations disrupt the existing movement of surface water and groundwater; they interrupt natural water recharge and can lead to reduced quantity and quality of drinking water for residents and wildlife near or downstream from a quarry site (Sayara, 2016; Urich, 2002).

In fact, the removal of top soil and surface rock strata can increase the vulnerability of groundwater to contamination (Darwish *et al.,* 2008). Water quality do change because of the karst characteristics of hard limestone and high infiltration rate of disturbed sands (Abu Khalaf, 2010; Urich, 2002; El-Nashar, 2009; Nasserdine *et al.,* 2009). Improper management of the quarry industry wastes is the main reason for the increasing levels of the Total Suspended Solids (TSS) in Hebron groundwater (Sayara, 2016). The industry, unfortunately discharge dust that settles not only on land, plants and trees, but also on surface waters used for drinking and other domestic chores by the community (Osha, 2006).

Furthermore, much work has not been done on the water in relation to the quarry activities in Nigeria. However with increase in agitation by neighbouring villages complaining on the pollution of their water bodies by quarry activities from the quarry sites. Hence, need to carry out meaningful investigation to unravel the true of the matter; thus, the aim of this study; metals distribution in the water bodies around the quarry sites in Ogun State, Nigeria.

Materials and Methods

Study Area

Ogun State is on latitudes 7.9031 and 6.3142°N and longitudes 2.7073 and 4.5750°E. It covers a geographical area of 16,980.55 square kilometres with a population of about 3,751,140 (NPC, 2006). The state is very close to Lagos State (former capital of Nigeria) that surrounded with water bodies includes Atlantic Ocean. However, Ogun State is within the Rain forest zone of Nigeria and enjoys a tropical climate with distinct wet and dry seasons (www.ogun state.gov.ng).

Quarrying is an old industry in Nigeria that was in existence before the advent of colonial master but small and technologically simple until the establishment of the British colonial administration. Quarry (granite) rocks are widespread in Ogun State in Nigeria; that cut across eight local government area within three divisions (Egba, Ijebu and Remo) out of four divisions of ethnic and cultural line in the state. Figure 1 shows the locations of quarry sites in the local government areas of Ogun state.

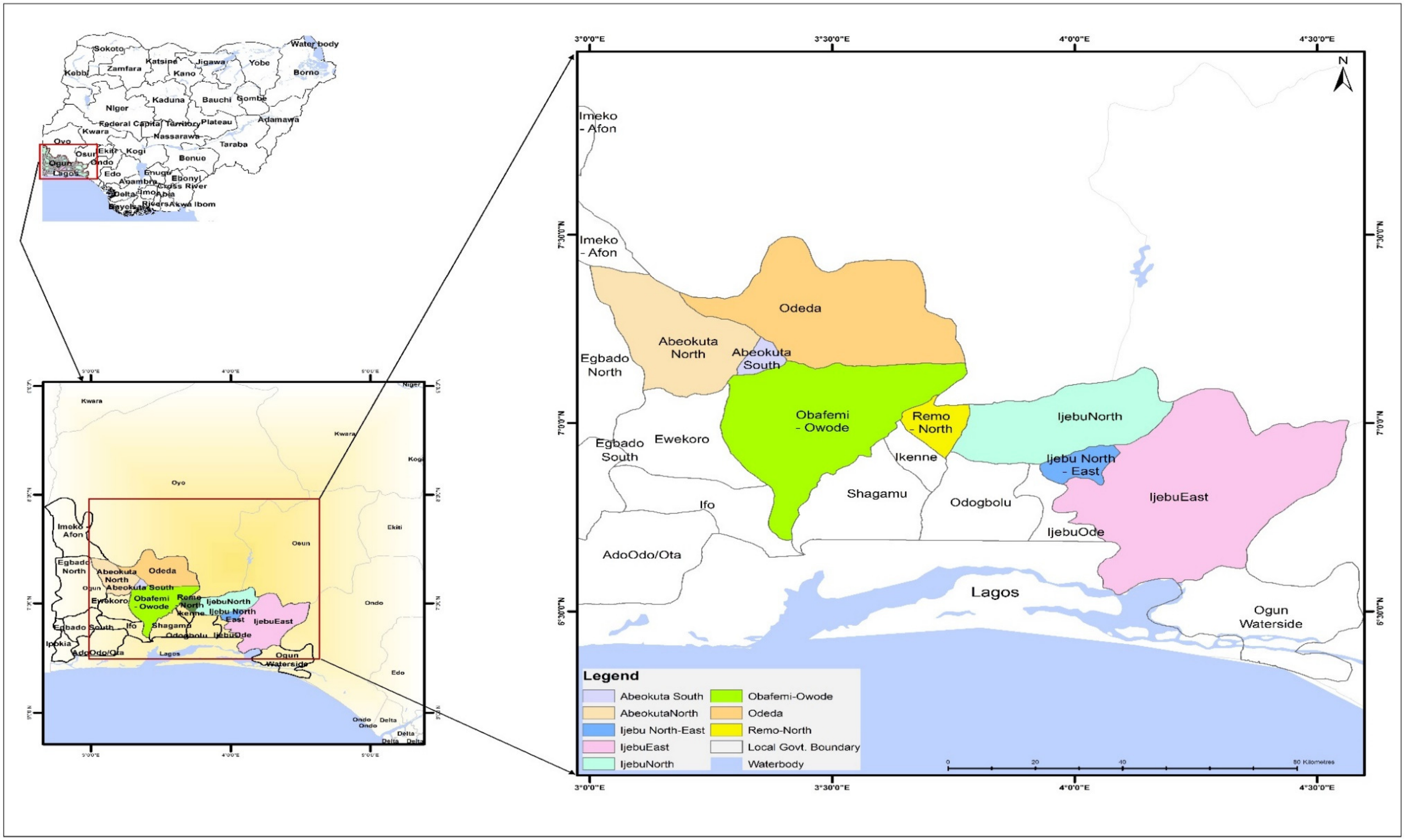

Figure 1: Map of quarry sites Local Government Areas in Ogun State

Sampling Techniques

Purposive sampling method was used to select eight (8) quarry locations in the study area. Sampling was carried out in eight (8) selected locations communities due to their closeness (500 – 1000 m) to the quarry sites in all six local government areas. Two (2) locations were selected from each of Odeda and Obafemi/Owode Local Government Areas due to presence of higher number of quarry sites in them. One location was sampled from each of the remaining four (4) Local Government Areas. Sample locations with their coordinates in each Local Government Area are presented in Table 1.

Table 1: Selected quarry sites in Ogun State

Local government area	Locality or village	Industry	Long(E)°	Lat(N)°
Ijebu East	Ogbere	Julius Berger	3.557	6.889
Ijebu North East	Iwaye	Paras	3.631	7.175
Ijebu North	Idode	CCECC	3.423	7.138
Remo North	Isara	CCECC	3.534	7.155
Odeda L.G	Igodo	F.W.S.AN.H.Concept 2	3.492	6.931
Odeda L.G	Ilagbe	DLK	3.553	6.931
Obafemi/Owode	Baaki ake	Blaco	3.625	7.119
Obafemi/Owode	Adelokun	Zanex	4.070	6.965

Longitude (Long), Latitude (Lat)

Collection of Water Samples

Samples were collected from both surface and ground water (hand dug well); three from each sampling location (quarry sites) in November, 2015 and July, 2017. The water samples were collected twice; covering both dry and wet seasons. At each of the quarry sites, water were sampled and analysed for essential heavy and trace metals. The following chemical parameters were determined on the samples taken

- Trace metals**:** potassium, magnesium, aluminium, silicon and zinc
- Heavy Metals**:** lead, cadmium, nickel, arsenic, iron, copper and selenium.

The means and standard deviation of each three samples per location (trace and heavy metal) were calculated.

Water Analysis

Trace and Heavy Metals

American Public Health Association (APHA, 2008) metal analytical methods were used to determined various heavy and trace metals in surface and ground water samples collected in all locations with the exception of potassium.

Potassium

All the digested samples from AAS were sub-sampled into pre-cleaned borosilicate glass containers for Flame Photometer Spectrophotometry analysis for Potassium. Standards of Potassium of 0.2, 0.4, 0.6, 0.8 and 1.0 mg/l were made from the each of the metal solution of 1000 mg/l stock solutions of the analytes. The set of standards solution and the filtrate of the digested samples were analyzed by Flame Photometer (Jenway PFP 7). The detection limit of the metals in the sample was 0.0001 mg/l.

Data Analysis

Data were analysed using descriptive (mean, standard deviation) and inferential analysis (ANOVA, T-test and Peason correlation) to compare and show variations among the parameter concentrations in the study area. All these were achieved using statistical package (SAS9.4 version). The results were compared with World Health Organisation (WHO) standard (2017).

Result and Discussion

Table 2: Trace metal (mg/L) Contents of Surface Water in Dry Season (N=3)

Location	Zinc	Magnesium	Silicon	Aluminum	Potassium
Ogbere	0.07±2.8	0.62±1.9	0.0006±0.22	0.0018±0.08	0.16±0.45
Iwaye	0.05±0.36	0.48±2.6	0.0005±3.00	0.0021±0.00	0.22±2.05
Idode	0.04±2.4	0.68±0.1	0.0008±0.25	0.0012±0.32	0.18±1.00
Isara	0.05±0.36	0.41±2.8	0.0007±0.05	0.0015±0.03	0.12±0.34
Ilagbe	0.08±1.4	0.38±0.56	0.0011±0.02	0.0014±0.34	0.20±1.89
Adelokun	0.07±2.7	0.04±0.03	0.0014±0.34	0.0018±0.08	0.22±2.90
Baaki Ake	0.06±2.8	0.42±0.2	0.0013±1.02	0.0024±0.06	0.21±1.08
Igodo	0.11±0.01	0.03±0.4	0.0016±0.00	0.0011±0.00	0.15±0.00
Control	0.03±0.00	0.53±0.00	0.0006±0.00	0.0013±0.00	0.19±0.00
WHO (2017)	1.5	150	40	0.2	20
OverallMean±SD	0.04±0.02	0.03±0.02	0.0004±0.00	0.0011±0.00	0.013±0.01
t-statistic	-180.75	-1964.6	-297422	-1367.3	-1734.3
P-value	0.000	0.000	0.000	0.000	0.000

Table 3: Trace metal (mg/L) Contents of Surface Water in Wet Season (N = 3)

Location	Zinc	Magnesium	Silicon	Aluminum	Potassium
Ogbere	0.06±0.01	0.41±0.11	0.0001±0.00	0.0015±0.00	0.00±0.00
Iwaye	0.06±0.01	0.45±0.12	0.0013±0.00	0.0017±0.00	0.19±0.01
Idode	0.07±0.01	0.41±0.11	0.0009±0.00	0.0021±0.00	0.23±0.11
Isara	0.08±0.01	0.38±0.13	0.0009±0.00	0.0016±0.00	0.01±0.00
Ilagbe	0.12±0.01	0.38±0.12	3.4519±0.00	0.0016±0.00	0.18±0.01
Adelokun	0.07±0.01	0.42±0.14	0.0008±0.00	0.0018±0.00	0.22±0.01
Baaki Ake	0.06±0.01	0.40±0.11	0.0010±0.00	0.0021±0.00	0.00±0.00
Igodo	0.11±0.01	0.31±0.12	3.4742±0.00	0.0012±0.00	0.17±0.01
Control	0.02±0.00	0.01±0.01	0.0007±0.00	0.0004±0.00	0.00±0.00
WHO (2017)	1.5	150	40	0.2	20
Overall Mean±SD	0.07±0.03	0.35±0.13	0.7702±1.53	0.0016±0.00	0.11±0.10
t-statistic	-145.3	-3351.4	-77.1	-1150.5	-569.4
P-value	0.000	0.000	0.000	0.000	0.000

Table 4: Trace metal (mg/L) Contents of Ground Water in Dry Season (N =3)

Location	Zinc	Magnesium	Silicon	Aluminum	Potassium
Ogbere	0.02±0.01	0.02±0.01	0.0001±0.00	0.0006±0.00	0.01±0.00
Iwaye	0.02±0.00	0.01±0.01	0.0002±0.00	0.0008±0.00	0.01±0.00
Idode	0.01±0.00	0.18±0.02	0.0003±0.00	0.0008±0.00	0.01±0.00
Isara	0.03±0.00	0.01±0.01	0.0002±0.00	0.0004±0.00	0.01±0.00
Ilagbe	0.06±0.01	0.01±0.01	0.0005±0.00	0.0013±0.00	0.004±0.00
Adelokun	0.06±0.01	0.01±0.01	0.0010±0.00	0.0014±0.00	0.01±0.00
Baaki Ake	0.06±0.01	0.01±0.01	0.0008±0.00	0.0021±0.00	0.01±0.00
Igodo	0.05±0.01	0.01±0.01	0.0008±0.00	0.0016±0.00	0.004±0.00
Control	0.01±0.00	0.01±0.01	0.0001±0.00	0.0013±0.00	0.05±0.01
WHO (2017)	1.5	150	40	0.2	20
Overall Mean±SD	0.04±0.02	0.03±0.02	0.0004±0.00	0.0011±0.00	0.013±0.01
t-statistic	-201.0	-7984.6	-349659	-1107.3	-4260.0
P-value	0.000	0.000	0.000	0.000	0.000

Table 5: Trace metal (mg/L) Contents of Ground Water in Wet Season (N=3)

Location	Zinc	Magnesium	Silicon	Aluminum	Potassium
Ogbere	0.06±0.01	0.014±0.00	0.0005±0.00	0.0012±0.00	0.004±0.00
Iwaye	0.05±0.01	0.013±0.00	0.0005±0.00	0.0014±0.00	0.004±0.00
Idode	0.04±0.00	0.012±0.00	0.0004±0.00	0.0012±0.00	0.004±0.00
Isara	0.05±0.01	0.012±0.00	0.0004±0.00	0.0011±0.00	0.172±0.00
Ilagbe	0.05±0.01	0.011±0.00	3.32±0.91	0.0011±0.00	0.003±0.00
Adelokun	0.06±0.01	0.012±0.00	0.0004±0.00	0.0011±0.00	0.005±0.00
Baaki Ake	0.05±0.01	0.016±0.00	0.0006±0.00	0.0014±0.00	0.21±0.00
Igodo	0.05±0.01	0.022±0.01	3.4±0.67	0.0014±0.00	0.004±0.00
Control	0.01±0.00	0.004±0.00	0.0004±0.00	0.0007±0.00	0.001±0.00
WHO (2017)	1.5	150	40	0.2	20
Overall mean±SD	0.05±0.02	0.013±0.01	0.7464±1.48	0.0012±0.00	0.045±0.08
t-statistic	-290.7	-95154	-79.6	-2682.4	-719.5
P-value	0.000	0.000	0.000	0.000	0.000

Table 7: Heavy Metal (mg/L) Content of Surface Water in Wet Season (N=3)

Location	Lead	Arsenic	Nickel	Selenium	Copper	Iron	Cadmium
Ogbere	0.022±0.01	0.006±0.00	0.224±0.00	0.0005±0.00	0.042±0.01	0.043±0.01	0.016±0.01
Iwaye	0.018±0.01	0.006±0.00	0.001±0.00	0.0005±0.00	0.042±0.01	0.045±0.01	0.013±0.01
Idode	0.014±0.01	0.004±0.00	0.001±0.00	0.0003±0.00	0.031±0.01	0.035±0.01	0.012±0.01
Isara	0.022±0.01	0.006±0.00	0.211±0.00	0.0007±0.00	0.033±0.01	0.042±0.01	0.012±0.01
Ilagbe	0.020±0.01	0.007±0.00	0.219±0.00	0.0009±0.00	0.037±0.01	0.040±0.01	0.013±0.01
Adelokun	0.015±0.01	0.006±0.00	0.001±0.00	0.0004±0.00	0.032±0.01	0.051±0.01	0.013±0.01
Baaki Ake	0.026±0.01	0.007±0.00	0.238±0.00	0.0003±0.00	0.050±0.01	0.041±0.01	0.013±0.01
Igodo	0.015±0.01	0.005±0.00	0.242±0.00	0.0007±0.00	0.032±0.01	0.035±0.01	0.013±0.01
Control	0.010±0.01	0.003±0.00	0.001±0.00	0.0002±0.00	0.014±0.01	0.012±0.00	0.058±0.01
WHO (2017)	0.015	0.015	0.02	0.01	0.5	0.03	0.002
Overall Mean±SD	0.018±0.01	0.006±0.00	0.126±0.12	0.001±0.00	0.035±0.01	0.038±0.01	0.018±0.02
t-statistic	1.809	-21.25	2.675	-124.4	-139.1	2.245	3.221
P-value	0.108	0.000	0.028	0.000	0.000	0.055	0.012

Table 8: Heavy Metal (mg/L) Contents of Ground Water in Dry Season (N=3)

Location	Lead	Arsenic	Nickel	Selenium	Copper	Iron	Cadmium
Ogbere	0.016±0.01	0.003±0.00	0.004±0.00	0.001±0.00	0.003±0.00	0.003±0.00	0.002±0.00
Iwaye	0.009±0.00	0.004±0.00	0.005±0.00	0.001±0.00	0.004±0.00	0.004±0.00	0.002±0.00
Idode	0.007±0.00	0.003±0.00	0.004±0.00	0.001±0.00	0.003±0.00	0.012±0.00	0.004±0.00
Isara	0.008±0.00	0.002±0.00	0.004±0.00	0.001±0.00	0.004±0.00	0.007±0.00	0.002±0.00
Ilagbe	0.015±0.01	0.005±0.00	0.008±0.00	0.001±0.00	0.031±0.01	0.034±0.00	0.010±0.00
Adelokun	0.013±0.01	0.006±0.00	0.012±0.01	0.001±0.00	0.036±0.01	0.034±0.00	0.011±0.00
Baaki Ake	0.021±0.01	0.006±0.00	0.011±0.01	0.001±0.00	0.041±0.01	0.041±0.00	0.012±0.00
Igodo	0.016±0.01	0.001±0.00	0.011±0.01	0.001±0.00	0.034±0.00	0.036±0.00	0.011±0.00
Control	0.004±0.00	0.002±0.00	0.006±0.00	0.001±0.00	0.003±0.00	0.005±0.00	0.001±0.00
WHO (2017)	0.015	0.015	0.02	0.01	0.5	0.03	0.002
Mean difference	0.002	-0.010	0.078	-0.008	-0.444	-0.006	0.006
t-statistic	1.251	-14.366	3.297	-12.948	-17.733	-1.649	6.003
P-value	0.227	0.000	0.004	0.000	0.000	0.116	0.000

Table 9: Heavy Metal (mg/L) Content of Ground Water in Wet Season (N=3)

Location	Lead	Arsenic	Nickel	Selenium	Copper	Iron	Cadmium
Ogbere	0.015±0.01	0.005±0.00	0.009±0.00	0.0007±0.00	0.036±0.00	0.034±0.00	0.010±0.00
Iwaye	0.014±0.00	0.005±0.00	0.001±0.00	0.0007±0.00	0.026±0.00	0.032±0.00	0.009±0.00
Idode	0.010±0.00	0.003±0.00	0.000±0.00	0.0005±0.00	0.010±0.00	0.030±0.00	0.008±0.00
Isara	0.012±0.00	0.004±0.00	0.008±0.00	0.001±0.00	0.029±0.00	0.032±0.00	0.009±0.00
Ilagbe	0.014±0.00	0.004±0.00	0.008±0.00	0.0006±0.00	0.040±0.00	0.032±0.00	0.010±0.00
Adelokun	0.013±0.00	0.004±0.00	0.000±0.00	0.0006±0.00	0.025±0.00	0.031±0.00	0.009±0.00
Baaki Ake	0.019±0.01	0.005±0.00	0.010±0.00	0.0004±0.00	0.029±0.00	0.040±0.00	0.011±0.00
Igodo	0.015±0.01	0.005±0.00	0.010±0.00	0.0005±0.00	0.033±0.00	0.032±0.00	0.011±0.00
Control	0.007±0.00	0.002±0.00	0.000±0.00	0.0004±0.00	0.006±0.00	0.009±0.00	0.003±0.00
WHO (2017)	0.015	0.015	0.02	0.01	0.5	0.03	0.002
Mean difference	0.006	-0.010	0.046	-0.0095	-0.4705	0.0043	0.012
t-statistic	0.519	-30.394	1.888	-191.520	-188.86	1.762	4.255
P-value	0.611	0.000	0.076	0.000	0.000	0.096	0.001

Table 10: T-test for trace and heavy metal (mg/L) of Water in dry and wet Seasons

Metal	Mean values		T – Statistics		
	Dry	Wet	T-Stat.	P-value	Decision
Zinc	0.05	0.06	-1.20	0.24	Not Significant
Aluminum	12.60	0.00	31.82	0.00	Significant
Magnesium	0.21	0.18	0.43	0.67	Not Significant
Potassium	0.09	0.08	0.49	0.63	Not Significant
Silicon	0.00	0.76	-2.20	0.03	Significant
Selenium	0.00	0.00	19.45	0.00	Significant
Copper	0.03	0.03	0.28	0.78	Not Significant
Lead	0.02	0.02	0.81	0.42	Not Significant
Iron	0.02	0.03	-2.34	0.02	Significant
Arsenic	0.00	0.00	-0.51	0.61	Not Significant
Cadmium	0.00	0.01	-1.83	0.08	Not Significant
Nickel	0.10	0.07	1.05	0.30	Not Significant

Table 11: Correlations of Trace metal (mg/L) by Location (N=20)

		Ogbere	Iwaye	Idode	Isara	Ilagbe	Adelokun	Baaki Ake	Igodo	Control
Ogbere	Pearson Correlation	1	.935**	.933**	.936**	-.051	.487*	.911**	-.121	.821**
	Sig. (2-tailed)		.000	.000	.000	.832	.030	.000	.610	.000
	N	20	20	20	20	20	20	20	20	20
Iwaye	Pearson Correlation	.935**	1	.945**	.900**	-.068	.726**	.887**	-.130	.699**
	Sig. (2-tailed)	.000		.000	.000	.775	.000	.000	.584	.001
	N	20	20	20	20	20	20	20	20	20
Idode	Pearson Correlation	.933**	.945**	1	.858**	-.077	.530*	.825**	-.146	.795**
	Sig. (2-tailed)	.000	.000		.000	.748	.016	.000	.540	.000
	N	20	20	20	20	20	20	20	20	20
Isara	Pearson Correlation	.936**	.900**	.858**	1	-.087	.561*	.986**	-.148	.676**
	Sig. (2-tailed)	.000	.000	.000		.716	.010	.000	.533	.001
	N	20	20	20	20	20	20	20	20	20
Ilagbe	Pearson Correlation	-.051	-.068	-.077	-.087	1	-.103	-.098	.997**	-.045
	Sig. (2-tailed)	.832	.775	.748	.716		.666	.681	.000	.852
	N	20	20	20	20	20	20	20	20	20
Adelokun	Pearson Correlation	.487*	.726**	.530*	.561*	-.103	1	.585**	-.117	.080
	Sig. (2-tailed)	.030	.000	.016	.010	.666		.007	.624	.736
	N	20	20	20	20	20	20	20	20	20
Baaki Ake	Pearson Correlation	.911**	.887**	.825**	.986**	-.098	.585**	1	-.157	.679**
	Sig. (2-tailed)	.000	.000	.000	.000	.681	.007		.509	.001
	N	20	20	20	20	20	20	20	20	20
Igodo	Pearson Correlation	-.121	-.130	-.146	-.148	.997**	-.117	-.157	1	-.118
	Sig. (2-tailed)	.610	.584	.540	.533	.000	.624	.509		.620
	N	20	20	20	20	20	20	20	20	20
Control	Pearson Correlation	.821**	.699**	.795**	.676**	-.045	.080	.679**	-.118	1
	Sig. (2-tailed)	.000	.001	.000	.001	.852	.736	.001	.620	
	N	20	20	20	20	20	20	20	20	20

Table 12: Correlations of Heavy metal (mg/L) by Location (N=28)

		Ogbere	Iwaye	Idode	Isara	lagbe	Adelokun	Baaki Ake	Igodo	Control
Ogbere	Pearson Correlation	1	.642**	.642**	.977**	.985**	.631**	.981**	.983**	.589**
	Sig. (2-tailed)		.000	.000	.000	.000	.000	.000	.000	.001
	N	28	28	28	28	28	28	28	28	28
Iwaye	Pearson Correlation	.642**	1	.993**	.499**	.627**	.942**	.650**	.642**	.889**
	Sig. (2-tailed)	.000		.000	.007	.000	.000	.000	.000	.000
	N	28	28	28	28	28	28	28	28	28
Idode	Pearson Correlation	.642**	.993**	1	.498**	.636**	.955**	.660**	.654**	.896**
	Sig. (2-tailed)	.000	.000		.007	.000	.000	.000	.000	.000
	N	28	28	28	28	28	28	28	28	28
Isara	Pearson Correlation	.977**	.499**	.498**	1	.962**	.475*	.957**	.953**	.440*
	Sig. (2-tailed)	.000	.007	.007		.000	.011	.000	.000	.019
	N	28	28	28	28	28	28	28	28	28
Ilagbe	Pearson Correlation	.985**	.627**	.636**	.962**	1	.662**	.995**	.997**	.578**
	Sig. (2-tailed)	.000	.000	.000	.000		.000	.000	.000	.001
	N	28	28	28	28	28	28	28	28	28
Adelokun	Pearson Correlation	.631**	.942**	.955**	.475*	.662**	1	.675**	.680**	.877**
	Sig. (2-tailed)	.000	.000	.000	.011	.000		.000	.000	.000
	N	28	28	28	28	28	28	28	28	28
Baaki Ake	Pearson Correlation	.981**	.650**	.660**	.957**	.995**	.675**	1	.995**	.598**
	Sig. (2-tailed)	.000	.000	.000	.000	.000	.000		.000	.001
	N	28	28	28	28	28	28	28	28	28
Igodo	Pearson Correlation	.983**	.642**	.654**	.953**	.997**	.680**	.995**	1	.600**
	Sig. (2-tailed)	.000	.000	.000	.000	.000	.000	.000		.001
	N	28	28	28	28	28	28	28	28	28
Control	Pearson Correlation	.589**	.889**	.896**	.440*	.578**	.877**	.598**	.600**	1
	Sig. (2-tailed)	.001	.000	.000	.019	.001	.000	.001	.001	
	N	28	28	28	28	28	28	28	28	28

Table 2 presents trace metal content of surface water in dry season; the zinc value ranges from Idode and (0.04±2.4 – 0.11±0.01mg/L) Igodo. All the values of zinc in surface water across locations were higher than the control (0.03±0.00 mg/L); and this signifies that quarry activities had polluted the surface water around the quarries. However, none of these values were higher than the World Health Organization (WHO) standard (1.5mg/L). The concentrations of zinc (1.7mg/L) in the surface water exceeded regulatory limits (1.5mg/L) in quarry sites (Zuhairi *et al.,* 2009). There were significant differences among the values across locations.

For magnesium in surface water, the values vary from 0.03±0.4 – 0.68±0.1mg/L across locations, with the exception of Ogbere (0.62±1.9mg/L) and Idode (0.68±0.1mg/L). Other locations were lower than the control (0.53±0.00 mg/L); and this confirms the fact that quarrying had not increased magnesium level of the surrounding surface water in the quarry sites. All the magnesium values across locations were lower than the WHO standard (150mg/L). Sayara (2016) asserted that quarry dust can change the chemistry of water resources by dissolving in them. It can also settle in water bodies and cause pollution. Furthermore, there were significant differences among values in all the locations.

The values of the silicon (surface water) in all sampled locations vary from 0.0005±3.00 – 0.0016±0.38mg/L. Of all these values; only Iwaye (0.0005±3.00mg/L) was lesser than the control (0.0006±0.00mg/L). This means that quarry activities had increased the silicon content of the surrounding surface water in the quarry sites. The WHO standard of 40mg/L was higher than any of the values of silicon in surface water across locations (Khaled, 2005). Moreover, there were significant differences among the values across the locations.

The values of aluminium across sampled locations vary from 0.0011±0.00 – 0.0024±0.06mg/L; all except Idode (0.0012±0.32mg/L) and Igodo (0.0011±0.00mg/L) were higher than the control (0.0013±0.00mg/L). This signifies that quarry activities had impacted on the aluminium content of the surface water around the quarries (Darwish *et al.,* 2008). However, none of these values in all locations surpass the WHO standard (0.2mg/L). The values across the locations were significantly different from one and another.

In addition, the potassium level in surface water across locations varying from Isara (0.12±0.34 – 0.22±2.90mg/L) Adelokun. Moreover, only Ogbere (0.16±0.45mg/L), Idode (0.18±1.00mg/L), Isara (0.12±0.34mg/L) and Igodo (0.15±0.00mg/L) were lower than the control (0.19±0.00mg/L). The remaining locations were higher. This finding implies that quarrying had impacted the potassium levels of the surface water around quarry sites. The WHO standard (20 mg/L) was higher than any of the potassium values of the surface water in all locations during the dry season (Nasserdine *et al.,* 2009). There were significant differences among the values across locations.

Table 3 shows the trace metal contents of surface water in wet season. However, the zinc content ranges from (Ogbere) 0.06±0.01 – 0.12±0.01mg/L (Ilagbe) and all the values across locations were higher than the control (0.02±0.00mg/L). This implies that quarry activities increased the zinc content of the surface water in the wet season. The WHO standard (1.5mg/L) was higher than any of the values in all sampled locations (Zuhairi *et al.,* 2009). However, the values across the locations were significantly different from one another.

The magnesium content of the surface water during wet season in all locations varies from Igodo (0.31±0.12 – 0.45±0.12mg/L) Iwaye. Of all these values, none was lower than the control (0.01±0.01mg/L). This shows that quarry activities increased the magnesium content of the surface water around quarry sites (Sayara*,* 2016). The magnesium content of surface water in all location were lower than the WHO standard (150mg/L). Furthermore, the values across the locations were significantly different from one another.

The level of silicon for all locations varies from (Ogbere) 0.0001±0.00 – 3.47±0.00mg/L (Igodo) all these values across locations with the exception of Ogbere (0.0001mg/L) were higher than the control (0.0007±0.00mg/L) symbolizes that quarrying had increased the silicon content of the surrounding surface water in the quarry sites (Khaled, 2005). These levels of the silicon across locations were lower than the WHO standard (40µg/L). In addition, there were significant differences among the values across locations.

Aluminium levels range from (Igodo) 0.0012±0.00 – 0.0021±0.00mg/L (Idode/Baaki Ake) and none of these values lower than the control (0.0004±0.00mg/L). This shows that quarry activities had increased the aluminium content of the surrounding surface water in the quarry sites (Nasserdine *et al.,* 2009). The WHO standard of 0.2 mg/L was higher than any of the values of the aluminium in all the locations. There were significant differences among the values across locations as well.

With the potassium values ranging from (Ogbere/ Baaki Ake) 0.00±0.00 – 0.23±0.11mg/L (Idode). However, none of these values were found to be lower than the control (0.00±0.00mg/L). This implies that quarry activities increased the potassium contents of the surface water around the quarry sites (Sayara, 2016). None of the values of potassium in surface water across locations were up to the WHO standard (20mg/L). There were significant differences among the values across locations.

Trace metal contents of groundwater in dry season were shown in Table 4. Moreover, the zinc content of the ground water varies from Idode (0.01±0.00 – 0.06±0.01mg/L) Ilagbe/Adelokun/ Baaki Ake and none of the values across locations were lower than the control (0.01±0.00mg/L); which signifies that quarrying activities increase the zinc content of the ground water around the quarry sites (Zuhairi *et al.,* 2009). The WHO standard of 1.5 mg/L was higher than any of the values of the zinc in ground water across locations and there were significant differences among the values across locations.

The magnesium levels in ground water in all locations range from 0.01±0.01 – 0.18±0.02mg/L. All locations with the exception of Ogbere and Idode. All these values were not lower than the control (0.01±0.01mg/L); which signifies that quarrying had increased the magnesium content of the ground water around quarry sites (Zuhairi *et al.,* 2009). The values of magnesium in the ground water across locations were lower than the WHO standard (150 mg/L). Also, there were significant differences among the values across locations.

Furthermore, silicon levels in ground water vary from 0.0001±0.00 – 0.0010±0.00mg/L and Ogbere and Adelokun respectively. None of these values was lower than the control (0.0001±0.00mg/L); rather they were higher. Hence, quarrying can be said to have increased the silicon content of the ground water around the quarry sites (Khaled, 2005). The WHO standard (40 mg/L) was higher than the silicon values of the ground water in all locations. Also, the values across the locations were significantly different from one another.

Aluminium values of the ground water across locations vary from Isara to (0.0004±0.00 – 0.0021±0.00mg/L) Baaki Ake. In all, only four locations were lower than the control (0.0013±0.00 mg/L); namely, Isara (0.0004±0.00 mg/L), Ogbere (0.0006±0.00 mg/L), Iwaye (0.0008±0.00mg/L) and Idode (0.0008±0.00µg/L). Hence, there were pollutions of aluminium; in the four locations; Ilagbe (0.0013±0.00mg/L), Adelokun (0.0014±0.00mg/L), Baaki Ake (0.0021±0.00mg/L) and Igodo (0.0016±0.00mg/L). When comparing these values with the WHO standard (0.2mg/L), all of them were found to be lower than the WHO limit; and in furtherance of the values across the locations, they were also found to be significantly different from one another.

The potassium contents of ground water in all locations from Ilagbe/ Igodo (0.004±0.00 – 0.01±0.00mg/L) Ogbere/Iwaye/Idode/Isara/Adelokun/Baaki Ake. All the values of ground water in all locations were not up to that of the control

(0.05±0.01mg/L). The foregoings show that quarrying is rather depreciating the value of the potassium content of the surrounding ground water of the quarries (Nasserdine *et al.,* 2009). The WHO Standard (20 mg/L) was greater than any of the potassium values of ground water across the locations and there were significant differences among the values across locations.

Trace metal contents of ground water (GW) in wet season were presented in the Table 5. The zinc level in the GW in the wet season ranges between Idode (0.04±0.00 – 0.06±0.01mg/L) Ogbere/Adelokun. Moreover, none of these values were lower than the control (0.01±0.00mg/L); which implies quarry activities had increased the zinc content of the GW around the quarries (Zuhairi *et al.,* 2009). The WHO limit of 1.5mg/L was higher than any of the values of the zinc in the sampled locations and there were significant differences among the values across locations.

The magnesium levels in the GW varies from 0.011±0.00 – 0.016±0.00mg/L across locations. Also, none was lower than the control (0.004±0.00mg/L); which means that, quarry activities had increased the magnesium level of the surrounding GW across locations (Zuhairi *et al.,* 2009). However, the WHO limit (150mg/L) was higher than any of the values of the magnesium in all locations. Hence, it is still within the WHO limit. Also there were significant differences among the values across locations.

The range of the silicon in the surrounding GW in wet season ranged between 0.0004±0.00 – 3.40±0.67mg/L across locations. Also, none of the values were found to be lower than the control (0.0004±0.00mg/L). This implies that quarrying had increased the silicon content of the GW around the quarries (Nasserdine *et al.,* 2009). The values in all locations were lower than the WHO limit (40mg/L). Also, there were significant differences among the values across locations.

The values of the aluminium across locations ranged from 0.0011±0.00 – 0.0014±0.00mg/L and all values were higher than the control site (0.0007±0.00µg/L). This means that quarry activities had increased the aluminium content of the GW around the quarries in wet season (Darwish *et al.,* 2008). WHO limit (0.2mg/L) was higher than any of the values of the aluminium in all locations. Also, the values across the locations were significantly different from one another.

The potassium levels of the GW across locations in wet season vary from 0.004±0.00 – 0. 21±0.00mg/L and all were higher than the control (0.001±0.00mg/L). This implies that quarrying had positive impact on the potassium content of the GW around the quarries in wet season (Nasserdine *et al.,* 2009). All the values of the potassium in all locations were lower than the WHO limit (20mg/L) and there were significant differences among the values across locations.

Table 6 presents the heavy metal contents of surface water in dry season. Lead level in the surface water ranges between Idode and (0.014±0.00 – 0.032±0.0mg/L) Baaki Ake. Among these, only Ogbere (0.031±0.01mg/L) and Baaki Ake (0.032±0.01mg/L) were higher than the control value (0.029±0.00mg/L). Hence, the surface water around the quarries had not been affected with increase in lead content by the quarry activities. All the lead values across locations with the exception of Idode

(0.014±0.00mg/L) were higher than the WHO limit (0.015mg/L); which portends danger because over consumption of lead could cause neurological disorder. However, there were no significant difference among the values of lead across locations. The concentration of lead (0.18mg/L) in surface water surpassed the regulatory limits (0.015mg/L) in both quarry/mine sites that were investigated (Zuhairi *et al.,* 2009).

The arsenic level ranges between 0.004±0.00 – 0.007±0.00mg/L; with Ogbere and Ilagbe/ Adelokun/ Baaki Ake respectively. Among these, none of the locations was lower than the control (0.003±0.00mg/L). Hence quarrying affects the surface water around the quarries with arsenic. None was higher than the WHO limit of 0.015mg/L and there were significant differences among the values of arsenic deposit across locations. Zuhairi *et al.* (2009) reported that the concentration of arsenic (0.23mg/L) in surface water was higher than the WHO (regulatory) limit (0.015mg/L) in the quarry sites investigated.

The range of values of nickel in all sampled locations ranged from 0.138±0.01 – 0.264±0.01mg/L; with Isara and Adelokun respectively. However, all the values were above that of the control (0.126±0.01mg/L). This implies that quarry activities had impacted the surface water around quarries. More so, the values in all locations were observed to be higher than the WHO limit of 0.020mg/L (Khaled, 2005). There were significant differences among the values of the nickel in all locations.

The selenium ranges between (Baaki Ake) 0.000±0.00 – 0.009±0.00mg/L (Ilagbe); with the exceptions of Ogbere, Adelokun, Igodo (0.001±0.00mg/L), (Baaki Ake) and Idode and Isara (0.002±0.00mg/L). Others were higher than the control (0.002±0.00mg/L). This implies that quarrying had not taken its toll on the surrounding surface water of the quarry sites as regard selenium (Ekpo *et al.,* 2013). However, all of these selenium values across locations were lower than the WHO limit (0.010mg/L) and there were significant differences among the values of the selenium in all locations.

The levels of the copper across locations vary from 0.035±0.01 – 0.061±0.01mg/L with Adelokun and Iwaye respectively. Also, all the values of the copper were higher than the control (0.034±0.00mg/L). Hence, quarrying can be said to have impacted the surface water around quarries with the copper. More so, none of these values of copper in all locations were higher than the WHO limit (0.500mg/L). There were significant differences among the values of the copper across locations. Zuhairi *et al.* (2009) also ascertained that concentrations of copper (0.6mg/L) in surface water exceeded the WHO limits in (0.5mg/L) quarry sites under investigation.

The iron contents of surface water in all locations range from 0.013±0.01 – 0.054±0.01mg/L in Idode and Adelokun respectively. In all, only Ogbere (0.015±0.01mg/L), Idode (0.013±0.01mg/L) and Isara (0.016±0.01mg/L) were lower than the control (0.017±0.01mg/L). This means that quarry activities had increased the iron content of the surrounding surface water of the sampled quarries. However, only four locations; Ilagbe (0.038±0.01mg/L), Adelokun (0.054±0.01 mg/L), Baaki Ake (0.047±0.01 mg/L) and Baaki Ake (0.35±0.01 mg/L) had iron contents of the surface water that were higher than the

WHO limit (0.030µg/L); which poses health risk to human health. There were no significant differences among the values of the iron content in all locations. Zuhairi *et al.* (2009) reported that, the concentration of iron (0.12mg/L) in surface water exceeded the WHO limit (0.03mg/L).

In a nutshell, cadmium levels in the surface water during dry season vary from 0.006±0.00 – 0.014±0.01mg/L in Idode and Adelokun/Igodo respectively. Out of all these locations, only Idode (0.006±0.00mg/L) was lower than the control (0.007±0.00mg/L). This implies that quarry activities had increased the cadmium content of the surrounding surface water of the quarries. However, all these values of cadmium in all locations were higher than the WHO limit (0.002µg/L) (Ekpo *et al.,* 2013). Hence, it is evident that residents' health is at risk if it is consumed. There were significant differences among the values of the cadmium in all locations.

Table 7 demonstrates heavy metal content of surface water in wet season. In lieu of this, lead level of the surface water sampled in all locations ranges between 0.014±0.01 - 0.026±0.01mg/L in Idode and Baaki Ake respectively. All of these values was higher than the control (0.010±0.01mg/L) which means the lead of the surface water around quarries had been increased by the quarrying activities. Also, none of these values was lower than the WHO limit (0.015mg/L) except Idode (0.014±0.01mg/L) (Zuhairi *et al*., 2009). This indicates health risks if consumed. Furthermore, there was no significant differences among the values of lead across locations.

The arsenic contents of the surface water in wet season vary with locations values ranged from 0.004±0.00 – 0.007±0.00mg/L in Idode and Ilagbe/Baaki Ake respectively. Of all these values, none was lower than the control (0.003±0.00mg/L). Hence, the arsenic content of the surface water around the quarries had been increased by the quarrying. The WHO limit (0.015mg/L) was higher than any of the values of the arsenic in all the locations (Zuhairi *et al.,* 2009). Also, there were significant differences among the values of arsenic across locations.

Nickel levels across locations showed that Iwaye, Idode and Adelokun had 0.001±0.00mg/L (lowest); while Igodo had 0.242±0.00mg/L (the highest). Of these values none was lower than the control (0.001±0.00mg/L) which implies that the surrounding surface water had been affected with nickel from the quarry activities (Khaled, 2005). However, five locations among the eight; Ogbere (0.224±0.00mg/L), Isara (0.211±0.00mg/L), Ilagbe (0.219±0.00mg/L), Baaki Ake (0.238±0.00mg/L) and Igodo (0.242±0.00mg/L) were higher than the WHO limit (0.02mg/L) (Ekpo *et al.,* 2013). This portends serious implication on the human health if consumed. In addition, the values of nickel in all sampled locations were significantly different from one another.

Selenium level varies with locations; from 0.0003±0.00 – 0.0009±0.00mg/L; Idode/Baaki Ake and Ilagbe respectively. Of these values, none was lower than the control (0.0002±0.00mg/L); which means that the surrounding surface water of the quarries had been added with selenium by the quarry activities (Urich, 2002). All the values with no exception; were lower than the WHO limit (0.01 mg/L) and the values of selenium in all sampled locations were significantly different from one another. Moreover, the values of the copper in surface water vary with the locations: (0.031±0.01 – 0.050±0.01mg/L); Idode and Baaki Ake respectively. Also, every value of the copper in all locations was higher than the control (0.014±0.01mg/L); which implies that the surface water around the quarries had been added with copper from the quarry activities. The WHO limit (0.5mg/L) was higher than any of the copper values in all locations (Zuhairi *et al.,* 2009) and there were significant differences among the values of copper across locations.

The values of iron in all locations vary from Igodo (0.035±0.01 – 0.051±0.01mg/L) Adelokun and all were higher than the control (0.012±0.00mg/L). This shows that the surface water around quarries had been increased with iron by the activities of the quarry. Every values of iron in all locations were higher than the WHO limit (0.03mg/L) (Zuhairi *et al*., 2009). This also implies that the surface water had been polluted with the iron and it portends health risks. However, there were no significant differences among the values of iron across locations

In conclusion, the cadmium values range between Idode/Isara (0.0012±0.01 – 0.016±0.01mg/L) Ogbere; and these values were lower than the control (0.58±0.01mg/L). This implies that the surface water around the quarries had not been disturbed with the addition of the cadmium from the quarry sites; but all these values of cadmium in all locations were higher than the WHO limit (0.002mg/L). Hence, it portends health risks as well. Naturally, the cadmium level of the surface water around every location and control were high; because of natural process rather than the quarries. Ekpo *et al.* (2013) also reported that the values of heavy metals recorded in the water sample were significantly higher than the World Health Organization (WHO) limits; a clear indication that the environment may be polluted with regard to the quarrying activities and geological weathering of rocks by natural processes. There were significant differences among the values cadmium across locations.

Table 8 shows the heavy metal contents of ground water in the dry season. Firstly, lead was sampled across the locations and it was found to range from Idode (0.007±0.00 – 0.021±0.01mg/L) Baaki Ake. Of all these values of lead in ground water during dry season; none was lower than the control (0.004±0.00mg/L). This implies that the activities of the quarry had affected the lead content of the ground water around the quarry sites and four out of sampled locations; Ogbere (0.0016±0.01mg/L), Ilagbe (0.015±0.01mg/L), Baaki Ake (0.021±0.01mg/L) and Igodo (0.016±0.01mg/L) were higher than the WHO limit (0.015mg/L) (Zuhairi *et al.,* 2009). This means other locations will soon be affected and if not checked, it portends serious health risks for residents around the quarries. There were no significant differences among the values of lead in ground water across locations.

The arsenic level sampled in all locations gave the following range; 0.001±0.00 – 0.006±0.00mg/L with Igodo and Adelokun as their locations respectively. However, with the exception of Igodo (0.001±0.00mg/L), none of these values across locations was lower than the control (0.002±0.00mg/L). This means that the groundwater around the quarry site had been affected with increase in arsenic content by the quarry activities. According to El-Nashar (2009), water quality can change because of the karst characteristics of hard limestone and high infiltration rate of disturbed sands. The arsenic contents of the ground water in all locations were lower than the WHO limit (0.015mg/L) and there were significant differences among the values of the groundwater across locations.

Furthermore, the levels of nickel in groundwater vary from 0.004±0.00 – 0.012±0.01mg/L with Ogbere/Idode/Isara and Adelokun as their respective locations. However, four locations; Ilagbe (0.008±0.00mg/L), Adelokun (0.012±0.01mg/L), Baaki Ake (0.011±0.01mg/L) and Igodo (0.011±0.01mg/L) were higher than the control (0.006±0.00mg/L) and the rest locations, Ogbere, Idode, Isara (0.004±0.00mg/L) and Iwaye (0.005±0.00mg/L) were very close to the control. This means that there is a tendency for the values to surpass that of the control. This also implies that the quarrying had infiltrated into groundwater around the quarries by increasing the nickel level (Urich, 2002).However, none of these levels of nickel across locations was higher than the WHO limit (0.02mg/L) and there were significant differences among the levels of nickel across locations.

Selenium values in groundwater during dry season were 0.001±0.00mg/L in all locations. The control was no different and the likehood here is that; with time those location selenium levels will increase by quarry activities. In fact, the removal of top soil and surface rock strata can increase the vulnerability of groundwater to contamination (Darwish *et al.*, 2008). However, all values of selenium were lower than the WHO limit of 0.01mg/L. There were significant differences among the selenium values across locations.

The range of the copper level across locations was 0.003±0.00 – 0.041±0.01mg/L with Ogbere/Idode/ and Baaki Ake respectively. In addition, none of these values were found to be lower than the control (0.003±0.00mg/L). This shows that quarrying had increased the copper content of the ground water around the quarry sites (Darwish *et al.*, 2008). The WHO limit of 0.5mg/L was higher than the entire values of copper in all locations. More so, there were significant differences in the values of the copper across locations. Moreover, the iron content in all locations vary from (Ogbere) 0.003±0.00 – 0.041±0.00mg/L (Baaki Ake). Of all these values, only Ogbere and Iwaye were lower than the control (0.005±0.00mg/L). The remaining six locations were higher. This shows that quarry activities had increased the iron contents of the ground water around quarries. Among the eight locations, four locations namely; Ilagbe (0.031±0.00mg/L), Adelokun (0.036±0.00mg/L), Baaki Ake (0.041±0.00mg/L) and Igodo (0.034±0.00mg/L) were higher than the WHO limit (0.03mg/L) which implies that the ground water of these four locations were polluted; (Darwish *et al.*, 2008; Zuhairi *et al.*, 2009 and Ekpo *et al.,* 2013). Hence, it should be checked. There were no significant differences in the values of iron in all locations.

Finally, cadmium levels across locations showed that Ogbere, Iwaye and Isara had 0.002±0.00mg/L (lowest); while Baaki Ake had 0.012±0.00mg/L (highest). Also, all the values in all locations were higher than the control (0.001±0.00mg/L); which means that the cadmium levels of the surrounding ground water in the quarry sites were increased by the quarry activities. However, none of these values was lower than the WHO limit (0.002mg/L) (Zuhairi *et al.,* 2009). Hence, the ground water can be said to be polluted and needs to be checked. There were significant differences in the values of cadmium in all locations.

Heavy metal contents of ground water in wet season were demonstrated in the Table 9. The lead content varies from Idode (0.010±0.00 – 0.019±0.01mg/L) Baaki Ake and all these values were higher than the control (0.007±0.00mg/L). This implies that the lead content of the ground water around quarries had been increased by quarry activities (Zuhairi *et al.,* 2009). Three out of eight locations; Ogbere (0.015±0.01mg/L), Baaki Ake (0.019±0.01mg/L) and Igodo (0.015±0.01mg/L) were higher than the WHO limit (0.015mg/L). Thus, they are polluted and there were no significant differences among the contents of the lead in all locations.

The levels of the arsenic across locations range from 0.003±0.00 – 0.005±0.00mg/L with the corresponding locations; Idode and Ogbere/Iwaye/Baaki Ake/ Igodo. More so, and all these locations were higher than the control (0.002±0.00mg/L) which means that arsenic levels of the groundwater around had been increased by quarry activities (Abu Khalaf, 2010). The WHO limit (0.015mg/L) was higher than any of the values of the arsenic in all locations and there were significant differences in the values of the arsenic deposit in all locations.

However, the level of the nickel in ground water during wet season varies from 0.000±0.00 – 0.010±0.00mg/L with their corresponding locations; Idode/Adelokun and Baaki Ake/Igodo and none of these values across locations were lower than the control (0.000±0.00mg/L). This means that the increment was as a result of quarry activities in those locations (Urich, 2002). None of these values of nickel was higher than the WHO limit (0.02mg/L) and there were no significant differences among the values of nickel in all locations.

Selenium values in all locations were 0.0004±0.00 – 0.001±0.00mg/L with Baaki Ake and Isara as locations respectively. Of all these values, none was lower than the control (0.0004±0.00mg/L). This implies that the increment was as a result of the quarrying in all locations (Urich, 2002). The WHO limit (0.01mg/L) was higher than all the values of the selenium in all locations and there were significant difference among the values of the selenium across locations.

The copper levels were (0.010±0.00 – 0.040±0.00mg/L) Idode and Ilagbe respectively and all the values across locations were higher than the control (0.006±0.00mg/L). This implies that the copper contents of the surrounding ground water were increased by the quarry activities in all locations (Abu Khalaf, 2010). More so, the WHO limit (0.5mg/L) was higher than all values of copper in all locations and there were significant differences among the values of copper in all locations.

Furthermore, the iron contents of the ground water in the wet season across location vary from Idode (0.030±0.00 – 0.040±0.00mg/L) Baaki Ake and all these values were higher than the control (0.009±0.00mg/L). However, this implies that iron contents of the ground water around quarries were increased by the quarry activities. The WHO limit

(0.03mg/L) was lower than all the values of iron across the locations (Darwish *et al*., 2008; Zuhairi *et al*., 2009 and Ekpo *et al.,* 2013). Hence, the ground water around the quarries in wet season were polluted and needs to be checked. In addition, there were no significant differences among the values of iron in all locations.

In conclusion, cadmium values of ground water in wet season range between Idode (0.008±0.00 – 0.011±0.00mg/L) Baaki Ake/Igodo and all were higher than the control (0.003±0.00mg/L). These values imply that the higher cadmium contents in surrounding ground water were due to quarrying activities in all locations. All the values of cadmium in all locations were higher than WHO limit of 0.002mg/L (Zuhairi *et al.,* 2009). This indicates that all locations were polluted with cadmium in wet season and there were significant differences among the values of cadmium across locations.

The t- test among trace and heavy metals concentrations of water in dry and wet season across locations were presented in Table 10. The result of the analysis of the trace metals was considered first. Also, zinc in all locations during both dry and wet season were compared and found not to be significantly different from each other. Aluminium in all locations during the dry season was compared with that of the wet season and was found to be significantly different from each other. In furtherance to the trace metal, magnesium in all locations during dry season was compared with that of the wet season and found not to be significantly different with each other. There was no significant difference between all potassium values in all locations during both dry season and season. The total silicon values across the locations during dry season was compared with that of the wet season, and it was found to be significantly different from each other.

Moreover, the heavy metal; selenium values put together across the locations in the dry season was compared with that of the wet season, and found to be significantly different from each other. Copper in all locations in dry season was t –tested with that of the wet season in all locations. The finding revealed that, they were not significantly different from each other. Lead across locations in the dry season was also t-tested with the wet season counterpart and it was found not to be significantly different from each other. Iron across locations in the dry season was significantly different from that of the wet season. Furthermore, arsenic level was not significantly different in dry season from that of the wet season when t-tested together with their total values put together across locations. Cadmium was another heavy metal t- tested in dry season with that of the wet season; thereby having all their respective values add together across locations and was not found to be significantly different from each other. Lastly, all nickel values added up across locations in dry season was significantly different from that of the wet season.

Table 11 shows that all the locations have significant high positive correlation among themselves at 5% level of significant ($p < 0.05$), except for Ilagbe and Igodo, which have insignificant negative correlation with other locations but positive correlation with each other. This implies that the abundance of trace metals in these two locations are the same but different from other locations. The two locations (Ilagbe and Igodo) were among the quarry industries that protested the royalty proposed by Ogun State

Government, thus resulted into the stoppage of quarry activities for sometimes that lasted for several months.

Table 12 shows that all the locations have significant high positive correlation among themselves at 5% level of significant ($p < 0.05$). This implies that the abundance of heavy metals in all the locations have similar distribution.

Conclusion

All heavy metal of surface and ground water were not affected with the exception Cadmium in surface and ground water were higher than WHO limit across locations in both seasons. Surface water nickel and iron in dry and wet season respectively across locations were higher than their corresponding WHO limits. Ground water (iron) in wet season across locations were higher than the WHO limit. Although some other locations be it in surface and ground water might above the control site but not yet higher than WHO permissible limit. However, among the trace metals analysed; none was higher than WHO, though, there were traces or evidence that some of the trace metals polluted the water in some locations but still within the control limits of WHO. Hence, proactive action ought to be taken by the concerned agents of the government to regulate the activities of the quarries so as not to go beyond present values so as to stop any menace that might likely result from the outrageous values of these metals

References

Abu Khalaf, M. (2010). Environmental impacts assessment and horizons of rehabilitation of abandoned limestone quarries: A case study from the Southern part of the West Bank. Unpublished Ph.D Thesis. Faculty of Engineering, Universita Degli Studi Di Roma Tor Vergata. http://dspace.uniroma2.it/dspace/handle/2108/1256 (06 February 2011).

American Public Health Association (APHA), (2008). “Standard methods of examination of water and waste water, 20th Edition. Washington DC, USA.

Darwish, T.M., Stehouwer, R. Miller, D. Sloan, J. Jomma, I. and Shaban, A. (2008). Assessment of abandoned quarries for revegetation and water harvesting in Lebanon, East Mediterranean. Presented at 2008 National Meeting of the American Society of Mining and Reclamation. Richmond VA, New Opportunities to Apply Our Science. 22.

Ekpo, F.E., Agu, U. and Udoakpan, U.I. (2013). Influence of heavy metal concentration in three common fish, Sediment and water collected within quarry environment Akampa L.G. area, Cross River, Nigeria. *European Journal of Toxicology and Science,* 5(3): 34 – 38.

El-Nashar, A.M. (2009). Seasonal effect of dust deposition on a field of evacuated tube collectors on the performance of a solar desalination plant. pp 66 - 81.

Fedra, K., Winkelbauer, L. and Pantulu, V.R. (2005). Systems for Environmental Screening. An Application in the Lower Mekong Basin. International Institute for Applied Systems Analysis. A-236l Laxenburg, Austria. 169p.

Khaled, M. M. (2005). Impact assessment of heavy metals in aquatic environment. National Institute of Oceanography and Fishery, Alexandria. pp 204 - 292

Nasserdine, K., Mimi, Z., Bevan, B. and Elian, B. (2009). Environmental management of the stone cutting industry. *Journal of Environmental Management.* 90: 466 - 470.

National Population Commission (NPC). (2006). Federal Republic of Nigeria, Legal notice on publication of 2006 census final results. http//www.npc.ng.org. (6 Apr.2014)

Ogun state fact sheet. https://www.ogun state gov.ng. (3 Feb. 2015)

Ojekunle, Z.O., Ojekunle, V.O., Eruola, A.O., Oyebanji, F.F., Olatunde, K.A., Amujo, B.T., Sangowusi, O.R, Adekitan, A.A. and Taiwo, A.G (2015). The Effects of Storage on Sachet Water Quality in Ogun State, Nigeria. *Journal of Applied Science and Environmental Management,* 19(2): 183 – 189. Full-text Available Online at www.ajol.info and www.bioline.org.br/ja

Osha, O.L. (2006). Occupational safety and health Administration. Information Booklet on Industrial Hygiene. (Revised ed.); U.S. Department of Labour OSHA/OICA Publications, Washington; USA. 23 - 35.

Sayara, T. (2016). Environmental impact assessment of quarries and stone cutting industries in Palestine: Case Study of Jammain. *Journal of Environmental Protection and Sustainable Development,* 2(4): 32-38. ISSN: 2381-7739 (Print); ISSN: 2381-7747 (Online).

Urich, P.B. (2002). Land use in karst terrain: Review of impacts of primary activities on temperate karst ecosystems science for conservation. Department of Conservation. Wellington, New Zealand. 198pp.

World Health Organisation. (2017). Guidelines for drinking-water quality, fourth Edition. Incorporating the Third Addendum Volume 2; Recommendations. 225 – 1235. http//www.who.drinking - water guideline.org. (23 Feb. 2021).

Zuhairi, W., Yaacob, W., Syuhadah, N., Pauzi, M. and Mutalib, H. A. (2009). Acid mine rainyage and heavy metals contamination at abandoned and active mine sites in Pahang. *Geological Society Malaysia Bulletin*, 55: 15 - 20.