

Impact of Marble Mining on Selected Soil Properties in Igbedi, Oke-Ogun Area of Oyo State, Nigeria.

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ABSTRACT

Marble is one of the solid minerals metamorphosed from limestone and its relevance cannot be underscored in the building and construction sector of the nation. However, global population growth and urbanization have increased pressure on its utilization more than ever. This study examines the impact of marble mining on soil properties in Igbedi community of Olorunsogo Local Government Area of Oyo State. Soil samples were randomly collected from five mining sites at 0-15cm and 15-30cm depths considered as topsoil and subsoil. The samples were analyzed for key physic-chemical properties. Descriptive statistics were used to summarize the results. Results revealed deterioration of soil quality around the mining sites due to particulate deposit, SOM and SOC were slightly reduced in distance from the mining sites and average value of cations were all less than 1 cmol/kg. Similarly, the results also indicate soils are generally alkaline with pH values between 7.9 - 10.6. The study recommends the use of sustainable mining methods, proper monitoring and auditing of mining activities through strict adherence to Nigeria's EIA and EIS standard in the mining sector and soil fertility management for crop production purpose.

Keywords: Environment, mining, physicochemical, soil, value

1. INTRODUCTION

Marble mining is one of the major industries flourishing throughout the world (Rushabh *et al.*, 2008). Mining activity is a necessity that provides much of the materials used for construction, interior and exterior decoration such as granite, marble, limestone, sandstone and clay for ceramic tiles. It has been commonly used in sculpturing of statues and construction of building and monuments since ancient times (Rushabh *et al.*, 2008). Some are used directly while some still need to be subjected to further processing (Rushabh *et al.*, 2008). However, rapid population growth, urbanization, science and technology globally have brought out the crucial usefulness of marble into lime-light. Similarly, the quest for economic growth and development globally has attracted human

population to areas with naturally occurring and valuable mineral resource deposits.

The scale of mineral exploration and exploitation affect the environments where such minerals are found. Like many other man-made activities, quarrying activities have significant impacts on the environment (Nwafor, 2006). In particular, it is often necessary to blast with explosives in order to extract materials for processing but this method of extraction gives rise to noise, air pollution and damage to biodiversity and natural habitats (Lameed and Ayodele, 2010). In marble production process, about 25% of the original marble mass is lost as dust into the atmosphere (Lameed and Ayodele, 2010). An attempt to explore and exploit them has been the source of

environmental degradation and development of ecological problems such as air, land, and noise and water pollution within and beyond the immediate environment. The industrial disposal of the marble powder material, consisting of very fine powder constitutes one of the environmental problems around the world (Nwafor, 2006; Lameed and Ayodele, 2010) leading to biodiversity loss, pollution, health challenges, crop failure, reproductive issues, soil contamination and others.

Mineral exploration directly or indirectly affects both living and non-livings things through the physical and chemical modification of the soil environment (Ratcliffe, 1974). Mining also results in vegetation clearance, loss of essential nutrients and organic matter of the soil and decreased productivity of soils (Pandey and Kumar, 1996). Deposit of marble and other solid minerals dust on vegetation have adverse effect on yield (Pandey and Kumar, 1996; Lqbal and Shafiq, 2001; Tahseen *et al.*, 2016). Its deposit in plant bud automatically neutralized the ability to produce fruit (Pandey and Kumar, 1996; Lqbal and Shafiq, 2001; Tahseen *et al.*, 2016). Soil with large deposit of marble and calcium carbonate cannot support the growth of thick vegetation and surface water retention. For example, Tahseen *et al.*, (2016) observed that the particulate matter (dust) produced as a result of the different activities associated with quarries and stone cutting industries causes several problems to the environment and people living in the area. Dust from mining sites are known to be responsible for vegetation injury and crop yield loss and thus become a threat to the survival of plants in industrial areas (Lqbal and Shafiq, 2001). Dust from solid minerals mining sites generally reduce crop yield rate especially during the fruiting period of the year (Lqbal and Shafiq, 2001). All these, therefore may cause low productivity of crops in the areas

affected by marble particulates (Pandey and Kumar, 1996; Lqbal and Shafiq, 2001; Tahseen *et al.*, 2016). Soil is the bedrock of agricultural production and farming is a major economic activity in Igbedi and the surrounding villages. However, the in the study area soils have been inadvertently altered as a result of mining activities (Rahji, 2005). It is on this basis that the study investigates the impact of marble mining on soil properties in Igbedi community. Specifically, the objectives of the study include examining the responses of soil physic-chemical properties to marble mining activities in the study area, with the view of establishing changes in the soil quality.

2. MATERIALS AND METHODS

2.1 Study Area

Igbedi town is located within the Guinea Savannah between the latitude $8^{\circ} 44'N$ and $8^{\circ} 46'N$ and longitude $4.5^{\circ}E$ and $4^{\circ}15'E$ (see Figure 1). Igbedi is the administrative headquarters of Olorunsogo Local Government Area of Oyo State. Igbedi covers an estimated $1,069\text{km}^2$ with an average population of 81, 751 persons (National Population Commission, 2006). The study area is characterized by tropical climate with alternate wet and dry seasons. It has an average rainfall of 800-1500 mm and an average temperature of 24°C . Geologically, the study area belongs to the Basement complex rocks. Igbedi lies mostly on highlands which are surrounded by series of hills. It is punctuated by rocky granitic outcrops. Hills, plains and river valleys dominate the landscape of the Igbedi region. Associated with these hills are numerous tourist attractions such as Iyamopo hill, which is regarded as Mother of rocks, Odo-orogun (rival wells) on Iyamopo hills, Ile

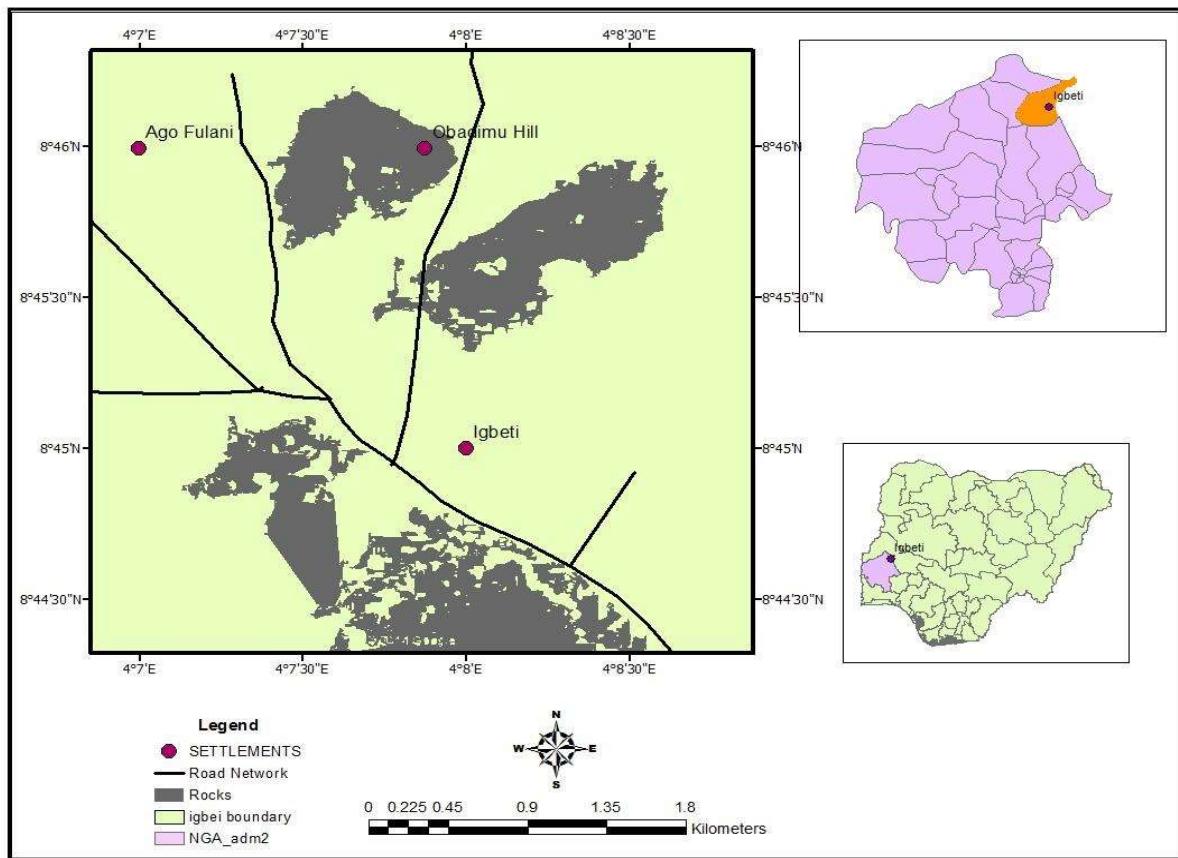


Figure 1: Geographical Location of the Study Area.

Source: Author Fieldwork (2020)

Sango, Bata Erugba and others. The region is well drained by some rivers with several tributaries.

The soils of the study area belong to the ferruginous tropical soil type. Pure white marble and gray white marble are the two types associated with Igbeti geological bedrock and they are of very high quality with about 98% purity. The predominant economic activities are farming, trading, artisanry and mining. Apart from Yoruba, the indigenous people, several ethnic groups such as the Nupe and Hausa are found in Igbeti town.

2.2 Sampling Techniques

A total five (5) out of the nine (9) operational mining sites in Igbeti were purposively selected for the study. Composite soil

samples were collected from five (5) selected points with the aid of soil auger at 0-15 cm and 15-30 cm considered as top and sub-soil in the study area with the buffer zone of 150 meters, 300 meters, 450 meters, 600 meters and 1000 meters away from the mining site. Samples were stored in polythene bags before laboratory analysis. Collected soil samples were analyzed at the Department of Agronomy Laboratory, Faculty of Agriculture, University of Ilorin.

Soil samples were air-dried, thoroughly mixed-up together, sieved with 2.0 mm sieve and analyzed for key physicochemical parameters, using standard laboratory techniques. Total porosity was determined by using method outlined by Odu (1956). Soil pH was determined potentiometrically in

0.01M calcium chloride solution ratio of 1:2 according to Peech (1965). Organic carbon was determined using the Walkley - Black digestion method. After ash and digestion of soil sample with 5ml of nitric acid (HNO_3), exchangeable cations (Ca^{2+} , K^+ , Mg^{2+} and Na^+) were determined using the Atomic Absorption Spectrophotometer. The exchangeable acidity (H^+) in the soil was extracted with 1M KCl (Thomas, 1982). Total nitrogen (N) was extracted with Bray-P solution in line with Kjedahl Method (Bremmer and Malvancy, 1982). The results were summarized using descriptive statistics.

3. RESULTS AND DISCUSSION

The results presented in Table 1 and Table 2 summarize the mean values, standard deviation and coefficient of variation for physical and chemical properties of soils

variation in soil layers; top soil and subsoil. Topsoil of sampling point 1, subsoil of sampling point 2 as well as both the top and the subsoil of sampling points 4 and 5 clearly suggest sandy loamy conditions. Meanwhile, topsoil of sampling points 2 and 3 as well as subsoil of sampling point 1 indicate sandy/clay/loam soils.

Generally, coefficient of variation of silt, clay and sand are 30.22%, 10.96% and 5.90%, respectively. Soil porosity values show loose soils except for sampling points 1 and 5 with 19.31% and 28.9% respectively. For the control points, the topsoil has a porosity value of 17.8% and subsoil porosity value of 32.1%. Decrease in porosity at the top soil may be attributed to soil compaction due to presence of dense crystallized rock (Adewole and Adesina, 2011). Overall, the soil porosity

Table 1: Results of Soil Physical Analysis

Distance from Mining Site (CP)	Sample Points	Porosity (%)	Silt (%)	Clay (%)	Sand (%)	Textural Class
150 Meters	Point 1 TS	19.31	23.00	5.04	71.96	Sand/loam
	Point 1 SS	14.49	22.00	5.04	72.96	Sand/clay/loam
300 metres	Point 2 TS	26.77	16.00	7.04	77.96	Sand/clay/loam
	Point 2 SS	36.85	12.00	5.04	82.96	Sand/loam
450 metres	Point 3 TS	21.15	22.00	5.04	72.96	Sand/clay/loam
	Point 3 SS	25.23	16.00	5.04	79.96	Loam/sand
600 Metres	Point 4 TS	24.17	14.00	5.04	80.96	Sand/loam
	Point 4 SS	29.19	12.00	5.04	82.96	Sand/loam
1000 Metres	Point 5 TS	28.19	12.00	5.04	83.96	Sand/loam
	Point 5 SS	17.89	10.00	5.04	84.96	Sand/loam
0 Metres	CP TS	17.81	12.00	5.04	82.96	Loam/sand
0 Metres	CP SS	32.07	12.00	5.04	82.96	Loam/sand
		Mean	24.42	15.25	5.20	79.79
		Std. D.	6.59	4.61	0.57	4.71
		Co-Var.	26.98	30.22	10.96	5.90

TS = Topsoil; SS = Subsoil; CP = Control Point

Source: Author Fieldwork (2020)

respectively. For the particle size distribution, the results show 82.96% sand, 5.04% clay, and 12% silt; an indication of sandy-loamy properties. The result exhibits

values range from 14.49 - 36.85% with a mean value of 24.42% and standard deviation of 6.59%.

Table 2: Results of Soil Chemical Analysis

Distance	Points	pH	H ⁺	Ca ²⁺	OC	OM	Mg ²⁺	Na ⁺	K ⁺	P (ppm)	N(%)	
0 Metres	CP TS	7.9	0.38	0.05	1.20	2.28	1.28	0.17	0.09	0.0221	0.05	
0 Metres	CP SS	9.4	0.86	0.03	0.60	1.04	0.03	0.99	0.06	0.0260	0.04	
150 Metres	1 TS	8.6	0.62	0.03	1.56	2.70	0.82	0.14	0.04	0.0218	0.03	
300 Metres	1 SS	8.4	1.34	0.02	2.67	4.62	0.95	0.16	0.04	0.0205	0.05	
450 Metres	2 TS	9.0	0.34	0.03	2.39	4.13	1.14	0.15	0.17	0.0312	0.20	
600 Metres	2 SS	8.8	0.62	0.02	2.75	4.76	0.85	0.16	0.19	0.0314	0.03	
450 Metres	3 TS	9.7	0.38	0.03	3.19	5.52	0.86	0.17	0.14	0.0380	0.14	
600 Metres	3 SS	10.6	0.38	0.05	2.87	4.96	1.33	0.15	0.05	0.0227	0.10	
1000 Metres	4 TS	10.1	0.34	0.04	3.35	5.79	1.38	0.16	0.05	0.0222	0.07	
1000 Metres	4 SS	9.6	0.36	0.04	2.55	4.41	1.46	0.16	0.05	0.0219	0.09	
		5 TS	8.9	0.38	0.05	1.96	3.39	0.81	0.17	0.06	0.0228	0.03
		5 SS	8.3	0.34	0.05	2.91	5.03	0.84	0.15	0.06	0.0337	0.08
		Mean	9.10	0.52	0.04	2.33	4.05	0.98	0.22	0.08	0.026	0.07
		SD	0.79	0.30	0.01	0.84	1.43	0.385	0.24	0.052	0.005	0.05
		CV	8.70	58.07	27.5	36.00	35.20	39.28	110	65	19.23	72.85

Note: TS = Topsoil, SS = Subsoil, CP = Control Point.

Source: Author Fieldwork (2020).

Soil pH values ranges between 7.9 - 10.6 and a coefficient of variation of 8.70%. The slightly alkaline soil condition may be attributed to the concentration of hydrogen ions and calcium carbonate in the soil. Also, the average values of cations (Ca²⁺, Mg²⁺, Na⁺, K⁺) were less than 1 cm0/kg. Studies found Igbeti marble quality composition to be 44.26–67.26 % (CaCO₃) and 37.80–45.60 % (MgCO₃) while soil pH changed greatly from 5.90 in control site to 8.20 in highly polluted soils (Emefurieta and Ekuajemi, 1995).

Soil organic matter and carbon slightly reduced from the mining sites especially when topsoil is considered. The finding is supported by Adewole and Adesina (2011) who found that soil organic matter, total nitrogen and available phosphorus decreased with increased dust particulate from mining sites. Reduced organism activities in mining environments have also been found to result to a decline in soil organic matter (SOM) and soil organic carbon (SOC) respectively (Emefurieta and Ekuajemi, 1995; Celik, 1996). Around 40% of marble waste is generated worldwide during quarrying operations in the form of rock fragments and

being dumped either in nearby empty pits, roads, riverbeds, pasturelands, agricultural fields or landfills (Celik, 1996). At the end, the impacts of marble mining directly influence the soil physicochemical properties as well as vegetation within the neighboring sites through losses in vegetation cover, essential nutrients and organic matter (Pandey and Kumar, 1996).

4. CONCLUSION AND RECOMMENDATIONS

The study examined the impact of marble mining on selected soil properties in Igbeti, Oke-Ogun Area of Oyo. The results indicate that soils in the study area are sandy loam, with decreased porosity values at the topsoil and soil pH values between 7.9 - 10.6. The slightly alkaline soil condition may be attributed to the concentration of hydrogen ions and calcium carbonate in the soil. Also, the average values of cations (Ca²⁺, Mg²⁺, Na⁺, K⁺) were less than 1 cm0/kg. It is concluded that existing deterioration in soil quality in areas around mining sites in Igbeti may be due to generated particulate deposits. Therefore, there is the need for the implementation of sustainable mining methods, proper monitoring and auditing of

mining activities through strict adherence to the Nigeria's EIA and EIS standard in the mining sector and soil fertility management for crop production purposes.

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