PHYSICO-CHEMICAL CHARACTERISTICS AND MICROBIAL FLORA OF SEDIMENTS IN ITAGUNMODI GOLD MINING COMMUNITY IN ATAKUMOSA WEST LOCAL GOVERNMENT AREA OF OSUN STATE, SOUTHWESTERN, NIGERIA.

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CERTIFICATION

This is to certify that this research work was carried out by **ONIFADE Abiola Theophilus** as part of the requirements for the award of Master of Science (M.Sc.) degree in Environmental Control and Management of the Obafemi Awolowo University, Ile-Ife.

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DEDICATION

This research work is dedicated to Almighty God.

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LIST OF ABBREVIATIONS AND ACRONYMS USED

ANOVA	Analysis of Variance
APHA	American Public Health Association
Ca^{2+}	Calcium ion
CEC	Cation Exchange Capacity
Cl^-	Chloride ion
Cm	centimeter
Cu^{2+}	Copper ion
EDTA	Ethylene diamine-tetra-acetic Acid
EC	Electrical Conductivity
Exc. H^+	Exchangeable Hydrogen ion
Exc. Al^{3+}	Exchangeable Aluminium ion
et al	et alli (and others)
etc	et cetera (and the rest, and all other)
Fe^{2+}	Iron ion
Fig.	Figure
GPS	Geographic Positioning System

g	gram
IITA	International Institute of Tropical Agriculture
K^+	Potassium ion
Km	Kilometer
M	meter
Mamsl	meter above mean sea level
Max	maximum value
Mg^{2+}	magnesium ion
Min	minimum
Mn^{2+}	Manganese ion
N	number of cases
Na^+	Sodium ion
NO_3^-	Nitrate ion
OC	Organic carbon
OM	Organic matter
Op cit	Opere citato
P	Probability

p	page
PAST	Paleotological Statistics
p. m.	Post meridian
PCA	Principal component analysis
pH	Potential of Hydrogen
PO_4^{3-}	Phosphate ion
pp	pages
QA	Quality Assurance
QA/QC	Quality Assurance/ Quality Control
QC	Quality Control
R	Correlation Coefficient
S	Siemens
Sd	Standard Deviation
Sem	Standard error of mean
SO_4^{2-}	Sulphate ion
USEPA	United States Environmental Protection Agency
WHO	World Health Organization
Zn^{2+}	Zinc ion

ABSTRACT

In this study, the physical and chemical characteristics including the microbial flora of sediments in the waterbodies (rivers and reservoir) in Itagunmodi gold mining community of Atakumosa West Local Government Area of Osun State were investigated from June, 2014 to March, 2015. The aim of the study was to provide baseline information on aspects of the benthos limnology and assessing the impact of gold mining activities on the ecosystem functioning of the waterbodies.

Three river stations and four reservoir stations were selected for investigation. Sediment samples were collected from these waterbodies for physical and chemical analysis and microbial analysis. Ambient air, water and sediment temperatures and location grid coordinates of the sampling stations were determined *in situ*. Particle size distribution of the sediment samples was measured using hydrometer method while exchangeable cations (Ca^{2+}, Mg^{2+}, Na^{+}, K^{+}) were determined using flame emission spectrophotometer (for Na^{+} and K^{+}) and atomic absorption spectrophotometer (for Ca^{2+} and Mg^{2+}). The sulphate, pH, electrolytic conductivity, nitrate, chloride and organic carbon content of the sediments were also determined. Microbial analysis was carried out using pour plate technique followed by microscopic examination and determination of morphological characteristics of the colonies (using Bergey's Manual of Determinative Bacteriology). The data obtained were subjected to descriptive statistics and analysis of variance (ANOVA) using paleontological statistics software.

The sediments were classified as acidic to alkaline over a pH range of 5.6 to 8.3 and generally sandy clay in texture. Mean values of calcium, ammonium, chloride, sulphate,

phosphorus, organic carbon, manganese, iron, zinc and copper were significantly higher at the river stations than at the reservoir stations. The percentage base saturation was significantly higher ($p<0.01$) in dry season than in the rainy season. On the other hand, the mean values of organic carbon and calcium were significantly higher during the dry season than rainy season. A total of nine bacterial species and thirteen fungal species were recorded. The microbial flora were classified into taxonomic categories, abundance, distribution were evaluated with respect to river and reservoir stationsl species. Bacterial species were more abundant than the fungal species Seasonal variation in the benthic microbial flora showed more species collected in rainy season than in dry season. Some of the identified species of microbial flora (*Corynebacterium, Micrococcus, Pseudomonas and Staphylococcus*) are known to be pathogenic and capable of causing different types of diseases. However, most of the parameters fell within WHO guideline level.

The study concluded that the residual effect of manual mining activities on sediments of waterbodies in Itagunmodi community of Atakumosa West Local Government Area of Osun State was insignificant.

CHAPTER ONE

INTRODUCTION

1.1 Background Information and Motivation for the Study

Water plays a number of fundamental roles in our daily life. It is required for drinking, bathing, cooking, washing, farming, garden irrigation, transportation, industrial raw materials, recreation and sport, production of hydro-electric power, building construction, agriculture and wildlife survival (Igbozurike, 1998; Simons, 1999; Ajibade, 2004). There are significant pressures on freshwater ecosystems caused by human activities. Water availability and quality are deteriorating due to climate change and land use activities (mining, logging, industrial and sewage discharges) (Jahning, 2010).

Activities such as gold mining usually have effect on the physico-chemical properties of water and sediment. Gold (a chemical element with the symbol Au and atomic number 79) occurs as a small round piece of valuable metal or grains in rocks and in alluvial deposits. It is one of the metals used as money. It is a dense ($19.3 g/cm^3$), soft, shiny and the most malleable and ductile substance known. Pure gold has a bright yellow colour traditionally considered attractive. It is ubiquitous in the environment and has been mined commercially at numerous locations throughout the world for thousands of years. At present, the leading commercial producers of gold in the world is the Republic of South Africa, secondary producers include the United States, the former Soviet Union (Union of Soviet Socialist Republic), Canada, Australia, the People's Republic of China, Brazil, the Philippines, the Dominican Republic, Papua New Guinea, Ghana, Tanzania (Elevatorski, 1981; Greer, 1983; Kirkemo *et al*., 2001), although accurate data on production is difficult to obtain.

Sediment is the loose sand, clay, silt and other soil particles that settle at the bottom of a body of water (USEPA, 2002). It can come from soil erosion or/and from the decomposition of plants and animals. Sediments comprise an important component of aquatic ecosystems, providing habitat for a wide range of benthic and epi-benthic organisms. Exposure to certain substances in sediments represents a potentially significant hazard to the health of these organisms. Effective assessment of this hazard requires an understanding of the relationships between concentrations of sediment associated chemicals since it serves as a reservoir of contaminants. The community of organisms that live on, or in, the bottom of a water body is known as "benthos". The benthic community is complex. It includes a wide range of organisms from bacteria to plants (phytobenthos) and animals (zoobenthos) and from the different levels of the food web. Benthic animals are generally classified according to size: microbenthos < 0.063 mm (microscopes are essential to discern members), meiobenthos 0.063 –1.0 (or 0.5) mm, macrobenthos >1.0 (or 0.5) mm (those readily visible without the aid of microscope) and, sometimes megabenthos > 10.0 mm.

Microorganisms like other life forms are an integral and important component of the ecosystem (Prescott *et al*; 2008). There is a wide variety of microorganisms in nature and they are versatile in the use of diverse nutrients in the environment. The specificity for nutrient or succession of certain organisms in an environment may serve as bioindicators of the presence of pollutants in such an environment (Baker, 1976). The occurrence of such organisms are potential threat to the ecological area, thus possible health remedy can be made from the study for sustainable economic development (Ajayi and Akonai, 2005) and recent research suggests that microbes can sometimes play an important role in forming gold deposits, transporting and precipitating gold to form grains and nuggets that collect in alluvial deposits (Singh, 1999).

Mining is viewed as one of the important economic activities which have the potential of contributing to the development of economies. At the same time, the environmental effects of mining on surrounding communities have been a major concern to governments, public and stakeholder organizations and individuals. While contributions of mining activities to economic development of the country are well acknowledged, others contend that the gains from the mining sector to the economy are achieved at significant environmental and social costs of the country (Awudi, 2002).

Mining activities have lots of environmental and social impacts. These have emanated from the methods of operation by the mining companies. The effects on the natural environment as well as the people in the surrounding communities. "the environmental cost of mining operations sometimes outweighs the benefits gained". In view of this, Awudi (2002) has maintained that, "despite these positive indicators, the role of the mining industry in the economic development of any country is a suspect. The gains from the sector in the form of increased investment are being achieved at great environmental, health and social costs to the people, recording series of public outcry against the mining companies operating in any country who themselves are yet to explicitly concede that their investments are inherently a major pollutant and a source of environmental conflicts around (Awudi, 2002).

Mining is the removal of materials from the earth's crust in the service of man (Down and Stick, 1977 cited by Acheampong, 2004). The Encarta Encyclopedia also defines mining as the selective recovery of minerals and materials, other than recently formed organic materials from the crust of the earth (Encarta, 2005). Mining has also been defined as the extraction of valuable minerals or other geological materials from the earth, usually (but not always) from ore body, vein, or (coal) seam. Materials recovered from mining include gold, bauxite, coal,