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## **Forestalling the Continued Depletion of Nigeria's Mineral Resources through Proper Conservation**

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### **Abstract:**

*Nigeria has witnessed an increase in mining of mineral resources in the last sixty years or so. Through critical review of related works the paper has discovered the reasons for the alarming increase in mining these non-renewable natural resources. It has been stressed in the paper that though, extracting the mineral stimulates growth and development in different spheres through foreign exchange earnings, transportation network, development of cities, improving people's standard of living, provision of social amenities, education of the people and boosting the nation's social, economic and political ego among comity of nations, the activity is gradually leading to their depletion which could affect the incoming generations negatively. Hence the position of this paper is that there is urgent need for proper conservation of these non-renewable resources in order to cater for the present and incoming generations. The paper concluded by suggesting as solutions: the reuse and recycling of metals, reducing unnecessary waste of these non-renewable resources, replacement of mineral raw materials with cheaper substitutes, manufacturing durable products to last longer, protection of existing mineral deposits, search for new deposit and adopting the economic and comprehensive methods of mining as it is being practised in some developed countries of the world.*

### **1. Introduction**

The physical environment of the Federal Republic of Nigeria is 923,768km<sup>2</sup> in extent and lies between latitudes 4<sup>0</sup> and 14<sup>0</sup> North of the Equator, and longitudes 3<sup>0</sup> and 15<sup>0</sup> East of Greenwich (Omodanisi and salami, 2011:668). Thus ranking it among the largest states on the African continent and bigger than any country in Western Europe (Floyd and Ekpoh 2003:1) Apart from the Atlantic Ocean found in the south, the country is surrounded by French-speaking countries; the Republics of Niger, Cameroun and Benin to the north, east and west respectively (Ologe, 2002:58).

The country has a kaleidoscopic pattern of landforms and landscape; soils vegetation and climatic types that extent from the mangrove swamps and rainforest of the Guinea coastal lowlands to the Savanna woodlands of the High Plains of Hausaland and to the semi-arid Sahelian lands in the far north east (Floyd & Ekpoh 2003:1). There are generally two marked seasons: the rainy season which covers April to October and dry season which is usually experienced from November through March.

According to FMIC (2008:14), Nigeria lies within the mobile belt affected by Pan- African Orogeny; sandwiched between the geologically more stable and older West African craton and Congo craton. The basement complex range in age from the Pan-Africa 500 – 650 million years to Archaeon, 1.5–2.5 billion years which underlay several parts of the country. This Basement Complex includes migmatite–gneiss with marble and banded iron formation found around Kaduna; the schist belt composed of meta sediments and metavolcanics with rare mafic-ultramafic rocks in ironstone, gold, manganese and marble; the older granites which consists of granitic, dioritic, rare syenitic, grabbroic, charnockitic rocks and pegmatittes containing gemstones, colobite- tantalite and cassiterite.

On the other hand, about 50% of the remaining surface area of Nigeria is said to be underlain by sedimentary rock series which form depressions, basins and troughs that characterized the country. According to FMIC (2008:14), the mineral resources associated with Basement Complex rocks include ores of lead, zinc, tin, niobium, tantalum, copper, uranium, thorium and gemstones while those found in sedimentary rocks are oil, natural gas, coal, lignite, barites, gypsum, limestone, clays, diatomite, dilute brine, bitumen, ironstone, kaolinite and glass sand.

Ikporkpo (2002:103) reported that the country's oil reserves amount is 25 billion barrels while gas reserves are reported to be about 256 trillion cubic feet. Similarly, the National Bureau for Statistic report states that 44 solid minerals are found in commercial quantity and are spread across the 36 states of the country and the Federal Capital Territory, FCT Abuja (The Economic 2016:46)

Nigeria also has one of the fastest growing populations in the world where the population census results of 1991 and 2006 were 88,514,501 and 140,003,542 respectively (FMIC, 2008:37). The sex structure of 1991 stood at 44,544,531 (50.32%) males and 68,293,683 (48.78%) females. With her current growth rate of 3.3% per annum, there is high population pressure on the existing non-renewable resources which unless proper care is taken the continued flaring of gas and over-exploitation of these minerals will sooner or later get depleted; thus throwing the present and incoming generations into state of lack misery and poverty. It is high time the relevant authorities took action or suffer the consequences of this misuse and abuse of the country's wealth that account for over 90% GDP.

The purpose of the paper therefore is to critically examine from related works the mineral endowment of the country, reasons for the continued exploitation, the historical and economic perspective of mining these resources, ways in which natural gas and other minerals are being abused—all with the intention of suggesting some principal ways of conserving these valuable resources.

To achieve the purpose of the paper, discussion is made under seven sub-headings namely: introduction, methodology of the study and clarification of some concepts, theoretical framework, depletion of associated gas resources through flaring and the environmental impact, the historical, economic and trends in mining of minerals in Nigeria and recommended ways of conservation of mineral resources in Nigeria in that order.

## 2. Methodology of the Study and Clarification of Some Concepts

The data for this article were obtained mainly from secondary source; although personal observation on the activities of some mining firms and individuals over the years gave some insight into the problem being discussed in this paper. Many books and articles published in reputable academic journals were read by the authors while preparing this paper. As a result, a lot of ideas and information derived from the secondary data were taken note of and later expanded to meet the need of this paper. The authors are indeed grateful to all the sources of information obtained in the course of preparing this article.

Some words frequently used in this paper requiring some clarification are conservation, depletion, forestalling, mineral, resources and non-renewable resources.

➤ Conservation: This refers to the planned, controlled, judicious exploitation and usage of natural resources to ensure their continued availability. In other words, conservation is the preservation of natural resources from loss, waste or exploitation through rational use so as to ensure continued availability and preserve their physical and intrinsic qualities for the present and future use.

➤ Depletion: This refers to the complete physical loss of valuable resources as a result of over-exploitation and misuse which is detrimental to the present generation and those yet to be born.

➤ Forestalling: This refers to deliberate safety action taken to avoid and prevent depletion of a given valuable resource so that the present and future generations should not suffer lack, misery and poverty.

➤ Mineral: This refers to naturally occurring constituent of rocks found within the earth crust which can be mined and processed into a variety of products to meet the needs of human beings both directly and indirectly. It includes metallic minerals like copper, iron, aluminum, gold, silver, tin, columbite as well as non-metallic minerals like quartz, marble, limestone, coal, natural gas and crude oil.

➤ Resources: Resources simply means the riches of the earth that provide treasure chest of materials that improve people's lives. They are inheritance that we use and leave to our children and grandchildren.

➤ Non-renewable Resources: This term refers to naturally occurring substances of the earth which when exhausted they cannot be replaced within short, historic time. Fossil fuels like coal, natural gas and crude oil as well as metallic minerals like tin, columbite, iron ore, limestone and marble are good examples of non-renewable resources.

## 3. Theoretical Framework

Understanding why Nigerian government continues to encourage mining of the nation's minerals in recent times can be enhanced with the aid of **Maslow's Hierarchy Needs Theory**. The theory is concerned with identification of factors and processes to which attention is paid in order to develop in people the willingness and the interest required before one can do anything at all (NTI, 1990: 105). The first part of the theory hinges on the premises that:

- Man has more than one motive at any given time; these needs are arranged in hierarchy in which there are lower and higher level of needs; the lower needs have to be satisfied first before the higher level needs can be satisfied; once a need is satisfied, other needs automatically emerge to replace the satisfied needs; and the lower needs can be satisfied much more readily than the higher needs which are more difficult to fulfill (NTI, 1990:105).

The second part of the theory deals with the hierarchy of human motives. It is represented schematically in a triangular form (fig. 1) where every person and nation struggle hard to reach the peak known as self-actualization or self-realization.

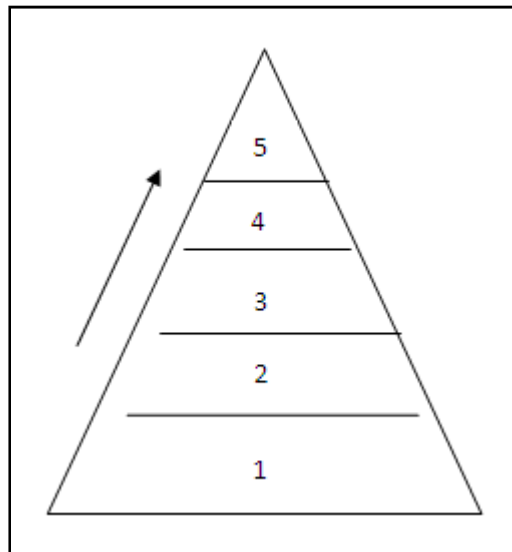


Figure 1: Maslow's Hierarchy of Needs Model

1. Physiological needs: e.g. need for food, clothing, shelter, rest.
2. Safety needs: e.g. desire for security, protection & freedom from dangers.
3. Self-esteem needs: e.g. desire for respect, confidence, admiration.
4. Love and belonging needs: e.g. motives for friendship & companionship.
5. Self-actualization or self-realization needs: e.g. autonomy, independence originality, creativity, self-fulfillment.

What is glaring in Maslow's Model is that in the life of a person or nation, the basic, physiological needs are first met before the secondary needs- comprising safety, security, belonging, self-esteem, intellectual achievement, aesthetic, autonomy and independence. As no nation would want to remain at the cradle stage, thus, in the last fifty years, the country has experienced increased activities in areas of exploration, exploitation, refining and products marketing operations to diversify the economy (Nwankwo & Ifeadi, 1988:208).

The power and wealth of the advanced countries of the world are based on industrialization and it is the aim of Nigerian government to also establish industries for self-actualization and self-realization. Being a responsible country in Africa continent, Nigeria is aspiring to attain the highest possible level of development through increased mining activities in order to uplift the well-being of its people as is the case in highly developed nations of the world like USA, UK, Japan, to mention but a few. Hence, of recent government has established Ministry of Petroleum, Ministry of Solid Mineral Resources, Ministry of Mines and Power, Department of Nigeria National Petroleum Corporation which issue mining license to both national and international companies, believed to be the panacea to the existing problems of socio-economic development.

In line with **Maslow's Hierarchy Needs Theory**, Nigerian government's policies on increased mining activities is for self-actualization: hence has to showcase her creativity, originality, autonomy and independence technology wise in order to emulate the more, technological and economically advanced nations of the world. Virtually every product we use, ranging from household products like building and roofing materials, cooking utensils, electronic gadgets: to national such as automobiles, farm machinery, telecommunications and weapons for the defense of the nation are all mineral products that prompt the Nigerian government to give support to continued mining of mineral resources which unfortunately, is a threat to these non-renewable resources.

Nigerian government is therefore working assiduously hard through good mining policies in order to reach the peak of Maslow's Model for self-actualization: given the fact that mining industry is the backbone of national development. The sector contributes to the country's GNP in a number of ways; creates job opportunities; boost international trade and improves trade balance; stimulates other sectors of the economy; leads to development of transport network and towns; provision of social amenities, education of the people as well as help to diversify the economy to boosts the nation's social, economic and political ego among comity of nations.

#### 4. Historical, Economic and Trends in Mineral Exploitation in Nigeria

Exploitation of natural resources has been an ongoing activity for so long that historians mark major periods of human history by reference to mineral materials such as Stone Age, Bronze Age and Iron Age, among others (Asthana and Asthana, 2006:109). Searching for rock materials began with flints which were usually fashioned into tools and weapons during Stone Age. As human beings learnt the science and art of smelting metals, bronze and iron, the resources become very useful for making tools. In essence, our present civilization has no doubt, been ignited to a large extent, by the knowledge and application of minerals which provide the basis of machinery that modern manufacturing industry depends.

Back home in Nigeria, the history of mining dates back tens of decades before the advent of the Arabs and European colonialists. Exploitation of minerals, which was locally carried out using locally-made tools was not a threat to the environment nor fear of depletion of reserves. However, the last century actually witnessed a great expansion and intensification which have been attributed to the arrival of the colonialists with their advanced, sophisticated mining equipment and recent government interest in the exploitation

of solid minerals in the country through the creation various mineral-based Ministries that encourage and give mining permits to prospective miners (Lamai and Kola, 1999:90).

It could be argued too, that the availability of 44 different kinds of minerals in the country being attested to by the Nigerian Extractive Industries and Transparency Initiative, NEITI; and the current slump in the oil price with its attendant declining revenue that continues to impact negatively on the Nigerian economy are certainly additional reasons for government's nod on expanded exploitation of solid mineral resources in Nigeria (The Economy, 2016:46).

Nigeria's mineral resources have been classified broadly into: mineral fuels, metallic and industrial minerals by many scholars including Lamai and Kola (1999), NTI (2000), Iloeje (2004) and Emielu (2014). The mineral types, location, scale of exploitation and mining intensity are presented in table 1 that follows.

Major group	Mineral	Location	Scale of mining	Intensity
Mineral fuels	Coal	Enugu, Ezimo, Orukpa, Okaba, Ogboyago & Oti	Commercial	Intensive
	Lignite	Onitsha & Asaba	Small Scale	Less intensive
	Petroleum	Niger Delta and Offshore areas: Delta, Edo, Bayel-sa, Ondo & Rivers States	Commercial	Intensive
Metallic minerals	Tin & Columbite	Rayfield, Bukuru, Ropp (Plateau State).	Commercial	Intensive
	Gold & Silver	Ilesha (Oyo State), Zamfara, River Valley & Niger State.	Small Scale	Less intensive
	Iron ore	Agbaja Plateau, North of Lokoja, Nsude (Enugu State), Itakpe near Ajaokuta (Kogi State).	Commercial	Intensive
	Barites	Nasarawa & Benue States	Commercial	Intensive
Industrial Minerals	Limestone	Nkalagu, Shagamu-Ewekoro axis, Sokoto, Ukpilla (Edo State), Gombe, Yandev (Benue State)	Commercial	Intensive
	Marble	Jakura, Ukpilla, Igarrá & Auchi, Igbeti (Oyo State).	Commercial	Intensive
	Gypsum & Uranium	Dukku (Gombe State), Sokoto & Zamfara States	Commercial	Intensive
	Aquamarine	Bauchi and Kaduna States	Commercial	Intensive
	Kaolin	Ropp (Plateau State), Osiele near Abeokuta, Usu near Umuahia, Nasarawa & Benue States	INA	INA
	Phosphates	Abeokuta & Sokoto States	Commercial	Intensive
	Potash	Borno State	Small Scale	Less Intensive
	Salt	Benue valley, Uburu near Afikpo	INA	INA

Table 1: Nigeria's mineral types, location, scale of mining and intensity

INA: Information Not Available

Sources: Computed from variety of sources: (a) Lamai and Kola (in *Osuntokun* pp. 93); (b) NTI (pp.123), (c) Iloeje (pp. 99), and (d) Emielu (pp. 194).

The intensive and extensive exploitation of mineral resources being witnessed in recent years is not only affecting the landscape, quality of air and water, human beings, their economic activities, animals and useful plants, negatively but they are being depleted.

Long before the 1880s, British traders along the Benue River had discovered at Ibi that bundles of **tin metal** were being sold locally and were traced to the local smelters at the present Jos area. Tin ore, which occurs as gravel deposits along ancient river valleys on the Jos Plateau was initially exploited by local people before the advent of British colonialists into the country without causing any significant damage to the landscape but with the coming of Europeans, commercial tin mining was intensified by the British owned Royal Niger Company in 1905 (Ihemegbulem and Nyong, 2002:143). Production increased from about 1,000 long tons in 1909 to its 1943 peak of about 17,463 long tons, and has been steadily declining since then. Currently, production is said to be less than 1,000 long tons annually, largely done through local informal miners due to depletion and closure of mining companies.

The exploitation of **iron ore** in Kogi State which started with the discovery of large deposits at Itakpe in the late 1970s and early 1980s has also increased significantly in recent time. Iron ore, which was locally mined and processed in primitive furnaces for making weapons and agricultural implements has today become the basic raw material for the iron and steel factory at Ajaokuta. An estimated 2 billion metric tons of high grade iron ore capable of feeding the Ajaokuta iron and steel company has been discovered in different parts of Nigeria (Emielu, 2014:194). However, production has not only slowed down but has virtually stopped (Iloeje, 2004:102). This may not be unconnected with the depletion of the resource.

**Limestone** is a sedimentary rock mineral found in large quantities in different parts of the country. With yearly increase in Nigerian population and the desire to build decent dwelling units, exploitation of limestone and marble is on the increase in an effort to meet up with the demand hence, Nigerian landscape, air and water courses are being despoiled to the detriment of human health and their economic activities.

Available record computed by Iloeje (2004:100) from Federal Ministry of Mines, Power and Steel; and from the Department of Petroleum Resources indicates that production of limestone has been steadily declining where in 1995 it was 3,656.6 million metric tons but dropped to 2,095.2 million metric tons and 1,920.0 million metric tons in 1996 and 1998 respectively. The reason for the decline production is not far-fetched-depletion of the mineral resource.

Exploitation of **barite and kaolin** in Nasarawa State are reported to have increased recently on a commercial scale where vast expanse of land has been affected (Lamai and Kola 1999:91). It should be noted that unless proper care is taken, the nation will soon run out of barite because of its limited quantity.

The scene is not different in the case of **gypsum**. Exploitation of the mineral resource has increased in parts of Nigeria with the discovery of gypsum in states like Gombe and Zamfara. In Gombe, it is being mined at Dukku and even though the mineral is used for making cement, fertilizers and plaster of Paris, (NTI, 2000:125), over-exploitation has left behind large burrow pits and reduced vegetation cover and threatens continued use of the land for food production, apart from the threat of depletion.

**Coal** is made up mainly of the decayed remains of the giant ferns and trees which covered parts of the South eastern Nigeria hundreds of millions of years ago. Nigeria's coal deposit is about 400 million metric tons (BBC News 2016 April, 11). The main deposits of coal are around Enugu, Nasarawa and Benue States (see table 1). According to Iloeje (2004:109), the Enugu coal was discovered in 1909, mining began in 1915 and the mining industry boomed for nearly 50 years as its peak production year was in 1959 when it recorded 914,000 metric tons. The use of diesel by the railway which formerly used coal and the 1967- 1970 civil war precipitated a steep decrease in production from 914,000 metric tons in 1959 to 577,000 metric tons in 1953 and almost nil in 1968. Although production rose temporarily to 34,000 metric tons in 1972, nonetheless it fell to just 18,470 metric tons in 1998 (ibid). It should be noted that the continued decline in coal production cannot be attributed to the civil war and discovery of alternative fuel alone but the fast reduction of the reserves. The Nigerian Coal Corporation and its skeletal office staff are now busy managing just the remnants of the Corporation's assets and calculating the pension of its erstwhile staff (Iloeje, 2004:110).

The trend in Nigeria's oil production is characterized by occasional rise and decline. Production started in 1958 when it was discovered at Oloibiri near Port Harcourt in 1956. Production rose from 26 million barrels in 1958 to 208 million barrels in 1966. Production declined steeply to just 48 million barrels in 1968 but has been rising to the extent that daily production as at 2002 was over 2 million barrels (Ikporukpo, 2002:103).

Although, there is no serious threat of oil depletion now but conservative estimates show that it can last for just 34 years beginning from 2002 because daily production is said to be about 2 million barrels and Nigeria had a reserve of about 25 billion barrels. There is urgent need for the relevant authorities to take necessary measures to conserve this black gold for sustainable development.

##### **5. Depletion of Associated Gas Resources through Flaring and the Environmental Impacts**

Natural gas is a mixture of hydrocarbons in gaseous form found in pockets beneath the earth, usually in association with liquid petroleum products which consists largely of 85% methane, ethane and propane, formed as a result of the anaerobic decay of organic matter (Kemp 1998:257). As high energy clean burning product, it is much in demand as fuel and is used as feedstock in the chemical industry. Every year when crude oil is brought to the surface, most oil producing countries flare and vent large volumes of gas which is equivalent to the consumption of Central and South America or Germany of France (Dada 2009:24). The world Bank (cited in Dada 2009:24) estimates that globally over 150 billion cubic metres (5.3 trillion cubic feet) of natural gas are being flared and vented annually and the flared gas is said to be equal to 25% of the United State's gas consumption, 30% of the European Union gas consumption or 75% of Russia's gas exports.

World Bank Maintained that the annual 40 billion cubic metres (1.4 trillion cubic feet), of gas flared in Africa alone is equivalent to half of the continent's power consumption. According to the World Bank report for the year 2004, four countries: Iran, Iraq, Russia and Nigeria together flared 60 billion cubic metres of associated gas.

Despite its rank as Africa's economic powerhouse, Nigeria's electricity capacity stands at about 3000 megawatts and the lack of electricity has undermined the domestic economy, forcing local business to resort to costly diesel generators and poor masses to candle light and kerosene lamps and cooking with firewood or charcoal which are all producers of greenhouse gas (Dada 2009:25). Paradoxically, the country continues to flare between 40% and 75% of associated gas amounting to over 23 billion cubic metres each year, economically valued at USD 1.4 billion per annum which ought to have been wisely harnessed to power the ailing and lame energy sector.

Nigeria's oil is the source of 80% of Federal Government's budget and 95% of export earnings where in 2008, it ranked the world's eighth largest oil exporter, produced an average of 2.1 million barrels of oil per day, apart from its status as the world's seventh largest reserves of natural gas, possessing over 256 trillion cubic feet of gas associated with crude oil.

The production of petroleum has generally been increasing where crude oil rose from 760. 117 million barrels in 1980 to 797.88 million barrels in 2000 while the production of gas was 24,551.0 million cubic metres in 1980, rose to 28,163.0 million cubic metres in 1990 and further to 47,537.5 million cubic metres in 2000; however only about a quarter of the gas is utilized as the rest is flared (Onwuka, 2005:77).

The basic challenge of natural gas exploitation is that of the problem of its ineffective use where it flares more of its gas than any other country in the world (Ikporukpo, 2002:104). Only a relatively small proportion of the natural gas produced is utilized as the rest is flared. Table 2 indicates the proportion of the gas flared from 1996- 2000 where though the percentage is decreasing progressively due to government policy but it has been more than 70% in most of the years.

Year	% flared	% Utilized
1966	92.6	7.4
1968	89.7	10.3
1970	98.6	1.4
1972	98.4	1.6
1976	97.0	3.0
1978	95.0	5.0
1980	90.5	9.5
1982	77.6	22.4
1984	78.8	21.2
1986	74.3	25.7
1988	72.0	28.0
1990	88.3	11.7
1992	78.3	21.7
1994	80.0	20.0
1996	72.5	27.5
1998	69.7	30.3
2000	53.8	46.2

Table 2: Pattern of Gas Utilization in Nigeria for 17 years (1966- 2000)  
Source: Atlas of Nigeria 2002: Page 104.

It is widely recognized that flaring and venting of gas and by-product of petroleum lead to the pollution of environment by contributing to greenhouse effect. However, this product that was historically disposed of and wasted could potentially bring economic benefits to the country. If wisely used it could be the solution to different problems Nigeria is facing. It reduces the greenhouse emissions and simultaneously improves the nation's economic condition.

There is widespread complaint in the Niger Delta region that gas flaring has resulted in acid rains. The residents in the oil-producing areas have long complained about how their corrugated roofs have been corroded by the composition of the rain that fails as a result of flaring. The primary causes of acid rain are emissions of sulphuric dioxide and nitrogen oxides which combine with atmosphere moisture to form sulphuric acid and nitric acid respectively. In Niger Delta, it is very easy to see an oily hue on collected rain water (Dada 2009:26). These reactions are responsible for the accelerated rusting of roofing materials in oil-producing communities of southern Nigeria. Wasting of roofing materials like the corrugated iron sheets implies that there would be high demand for metallic minerals to manufacture them hence can lead to increased mineral depletion. There is need to protect these metallic products from corrosion in order to conserve the nation's mineral resources from depletion.

At the international level there is an on-going important debate on global warming and climate change mitigation and adaptation, however, flaring of gas is exacerbating the problem through emissions of carbon dioxide, sulphur dioxide, methane gas among others. This has serious implications for both Nigeria and the rest of the world. The impact of global warming is comparable to 'weapon of mass destruction' (Dada, 2009:26). The burning of gas by flaring leads to emission of carbon dioxide, the main greenhouse gas and methane gas, which together crudely make up about 80% global warming to date (ibid).

Gas flaring creates toxic airborne pollutants, many very dangerous toxic and detrimental petroleum compounds can be absorbed by plants and quickly enter into their food chain. Dangerous metals can cause cancer, birth defects and blood disorder with damaging effect on the central nervous system; resulting in premature deaths and increased cases of leukemia.

In spite of threat of depletion and the environmental consequences of flaring associated gas resources, many mining companies have not cut down this obnoxious activity. NNPC (cited in Eboh 2014:24) stated that Nigeria lost USD 198.775 million (N31.8 billion) just in the month of February 2014 alone due to gas flaring by mining companies. The report released clearly shows the abuse and misuse of the associated gas resources which can be summarized thus:

- "Of the total amount of gas produced by Sole/Independents Oil Companies 12.8% was utilized and 87.2% flared; Marginal Fields Operators utilized 44.5% and flared 55.5%; Production Sharing Companies utilized 77:21% and flared 22:79%; Joint Venture Operators utilized 84.28% and flared 15.72%; Dubri Oil utilized 1.24% and flared 98.76%; Platform Petroleum utilized 3.2% and flared 96.8%; Pillar Oil utilized 11.03% and flared 88.97% while six Companies namely, Seplat, First Hydrocarbon, ND Western, Express Petroleum, Energia and Midwestern Oil & Gas, all flared 100% without utilizing any quantity mined".

This unfortunate scenario of abuse, misuse and depletion of associated gas resources has to stop. For Nigeria to actually achieve her economic goals, it should focus on accelerated development of its gas resources. This will enable the country to power economic initiatives because a stable power is a catalyst for the growth of every sector of the economy. Since Nigerian has some of the best gas reserves in the world but what the country needs now is not just the best technology but good skilled hands to manage the technology in the oil and gas sector.

## 6. Mineral Resources Conservation Measures

The preceding section of this paper has argued that mineral resources are being depleted through associated gas flaring, abuse and misuse. Although the ongoing mining cannot be stopped completely, but certain measures can be taken to minimize over-consumption and prolong the existence of the resources. To this effect, the paper strongly recommends the following approaches as measures to forestall continued depletion.

### 6.1. Protection of Existing Mineral Deposits

Most of the mineral deposits are usually left as such at the mercy of agencies of weathering, decay and dissemination after extraction of good quality elements. As the best grade mineral ores deplete, it is likely that low quality ores which were once discarded as waste material could be in demand again. The reclamation of mining site which involves restoration of deposits, original plant and soil cover should be made a statutory responsibility of every miner. Apart from preventing wastages of resources, the practice shall also curb a number of pollution problems.

Astanin and Blagosklonov (1983:75) analyzed the complex nature of how some minerals occur (which incidentally are in abundance in Nigeria) as follows:

- “Iron Ores often contain titanium, vanadium, cobalt, copper, zinc, phosphorus, and sulphur; Polymetallic ores contain tin, copper, nickel, cobalt, tungsten, molybdenum, gold, silver, platinoids and a whole range of rare metal; Oil drilling by products include gas, sulphur, iodine, bromine and boron; Gas deposits yield condensates, helium, sulphur and nitrogen; and Coal has pyrite, sulphur, germanium, aluminum, oxide and so on.”

This implies that places where for instance, tin were heavily mined could likely have deposits of many associated mineral elements hence there is need to reclaim what seemingly have been considered ‘waste’ in order to protect the rest of associated minerals for future use. It is possible to extend supplies of non-renewable mineral resources even more dramatically than recycling and re-use because it reduces the need to extract more resources; thus reducing the impact of extraction and processing on the environment.

### 6.2. Search for New Deposits

Although we are into the era of science and technology however, we do not yet have all the knowledge about the rock formations; hence earth’s treasures are still unknown to science (Asthana and Asthana, 2006: 119). An intensive search is expected to reveal a number of deposit which shall naturally enlarge our resources and save the ones being heavily exploited now from total depletion. The main shortcoming in mineral resource exploitation in Nigeria is incomplete and non-comprehensive extraction of useful products from the deposits. By-products requiring additional separation process are also dumped as waste. There is need for government to ensure mining of primary mineral must go with the conservation of what is seemingly considered as waste for further research and discovery.

### 6.3. Reducing Unnecessary Waste

Most of the mineral products here in Nigeria are cheap and plenty of subsidies in the form of cheap power, subsidized fossil fuels and large loans granted to mining companies, hence many industrialized nations of the world take advantage of that and ensure continued access to these cheap mineral supplies from Nigeria through the international trade and policies. Thus the lure of large revenues, generous industrial products, arms and other necessities is forcing Nigeria to increase production and sell their mineral wealth at cheap price. Therefore, in order to prolong supplies of the present mineral resources the views of Asthana and Asthana (2006:118) can be upheld that a little restriction and taxation could make the mineral to be expensive which in turn shall curtail over consumption.

### 6.4. Make Finished Products Long Lasting

The attitude of ‘use and throw away’ of some Nigerians after a product has lost its primary utility is a wasteful practice. For instance, the metal components in the products are usually discarded and wasted. Metal containing products should be so manufactured as to last longer and be repairable to be used again or its component parts. To make a mineral product last longer, there is need to prevent it from corrosion, wear and tear as well as irrecoverable losses. All metallic materials should be lubricated regularly and covered with paints to prevent chemical weathering from reducing its quality. The principle works thus: the more durable the metallic product, the less the pressure on the raw material and the less the degree of depletion of the mineral raw material.

### 6.5. Replacement of Mineral Raw Materials with Cheaper Substitutes

The problem with mineral resources is that once they are used up they are gone forever. One solution to this is to find other materials to take the place of minerals. For example, large amounts of steel are used in car engines; steel is an alloy of iron and several other metals including chromium and nickel (Maton, et al 1995:728). There is urgent need for our scientists to work hard to replace some parts of these metal engines with plastic parts. If plastic parts and other materials can replace some minerals, supplies of these resources will certainly last long. Synthetic plastics offer a promising opportunity which are becoming cheaper every year in place of metal buckets, metal bowls, metal plates, metal seats and chairs.

### 6.6. Re-Use and Recycling of Metals

The principles involve the use of mineral products more efficiently again and again. It is easier to recycle copper, brass, bronze and aluminum objects. A machine having brass components for instance can be slashed apart and its components used to make another objects of utility as it is being practiced in developed countries where Asthanin and Blagosklonov (1983:78) posited that more than half of the steel produced in Britain is made of scrap metal. The scrap business in Nigeria needs to be given support where ‘aluminum, metal and copper scraps are being picked from dumpsites and mechanical workshops and sold to blacksmiths who in turn produce

goods of utility' (Mohammed, 2011:49). The metal policy of the Federal Government should be geared towards the need to develop a vibrant metal sector where government should play the role of sole administration and regulator with the private sector as owner-operator with a view to enabling the country become a major producer of aluminum and steel products. The recycling and reuse of metallic products should be encouraged because it benefits the environment greatly: extends the supply of minerals by reducing the amount of materials that must be extracted; requires less energy than extraction; causes less pollution and land disruption; reduces waste disposal costs and prolong the life of landfills by reducing the volume of solid waste (Dhameja, 2006:69).

## 7. Conclusion

Mining has been going on in Nigeria long before 1880s with locales using local equipment. However, the advent of the European colonialists with their sophisticate mining equipment led to expanded exploitation of such mineral resources like tin, columbite, coal, iron ore, limestone, crude oil and natural gas. Although exploiting these resources has helped in meeting the needs of many Nigerians by way of improved welfare, increased employment, income and revenue generation, development of transport network and towns, but the trends have obviously shown that in some few years to come, most of these mineral resources will be no more to meet the needs of the present and incoming generations. The paper has recommended such conservation measures that should be taken like recycling and re-use of metals, manufacturing of durable mineral-based products to last longer, researching into cheaper substitutes to minerals as raw materials, reduction of unnecessary waste through subsidy removal and increased taxation for miners and protecting the remaining mineral resources through efficient, economic and comprehensive mining. The position of this paper is that when these proactive approaches are enforced by the relevant authorities, the rate at which Nigeria's mineral resources are depleting will be minimized and there would be continues supplies to meet the needs of not only the present generation but he generations yet unborn.

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