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# Survey of Solid Minerals in Rocks of Ditera and Waltadi, Song, Nigeria

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**Abstract**

Rock samples from seven (7) locations (with mountains ranging between 1000-1500m above sea level) of Ditera (Kuba, Laba, Bwara and Batum) and Waltadi (Gbang, Gbang Kolora, & Tewozo) Districts of Song Local Government Area, Adamawa State, Nigeria were investigated for solid minerals and metallic oxides. X-ray diffraction spectrophotometer used in the identification of the solid minerals revealed the presence quartz, albite and phlogopite in Kuba, quartz, albite, rutile and fluorannite in Laba, marshite, covellite, otavite, quartz and calcite in Bwara, quartz, oyelite, covellite and tenorite in Batum, barite alone in Gbang, quartz, covellite, ulvospinel, montmorillonite, rutile, and marshite in Gbang Kolora, and found in Tewozo were; quartz covellite, albite and marshite. Of the thirteen different minerals identified in these locations, quartz is the most dominantly present. Further investigation in which the rock samples were analyzed for their constituent major and minor oxides using X-ray fluorescence spectrophotometer also revealed the presence of some oxides which both qualitatively and quantitatively confirmed the presence of the solid minerals in the rock samples analyzed.

**Keywords**: exploration, rocks analysis, solid minerals

## 1. Introduction

The world is currently undergoing a global recession which started in 2008 and has affected income generated from crude oil export by Nigeria. This is coupled with the crises in the Niger Delta in which the restless militant's youth continue to attack installations of the multinational oil companies operating in the area. Having critically assessed the potential danger this situation could pose to the economy of the country, advocates for an alternative means of sustenance through exploitation of natural resources that the country is largely endowed with, especially in the area of solid minerals such as limestone, barite, gypsum etc., becomes inevitable (Kashim, 2011).

Minerals are defined as naturally occurring substances that are solid and stable at room temperature. They are mostly inorganic with a fixed structure (Pipkin & Trent, 2001). Although the International Mineral Logical Association in 1995 adopted a definition as minerals being elements or compounds that are normally crystalline and has been formed as a result of geological processes (Nickel, 1995). Minerals originate through the processes of rock formation occurring in nature. A common phenomenon accounting for the origin is the cooling of molten rock material from the earth‘s interior (magma). The magma that reaches the surface is called the lava, and as these minerals crystalizes and grows (Pipkin, Trent, & Hazlett, 2005).

Each mineral has a particular chemical make-up. Most are compounds of two or more elements, e.g. gypsum ($CaSO_4.2H_2O$), calcite ($CaCO_3$); some are a single element, e.g. gold (Au), silver (Ag) and copper (Cu) and these are referred to as native element minerals and occur in nature in relatively pure form (Manroe & Wicander, 1998). Those that are found in combined state in the earth's crust and mantle are the following in order of predominance, Oxygen 46.6%, Silicon 27.7%, Aluminum 8.1%, Iron 5.0%, Calcium 3.6%, Sodium 2.8%, Potassium 2.6%, Magnesium 2.1%, all others put together are 1.5%. These elements combine in various proportions to form the rocks of the earth which are the parent materials with differences in structure, composition and rate of decomposition (Ballhaus & Glickson, 1995, Blatt & Robert, 1996).

As a result of the need for technological advancement, the modern world cannot proceed meaningfully without solid mineral resources (Ajakaiye, 1985). Also, industrial advancement cannot be enhanced without the availability of solid minerals. The most important products of solid minerals from the earth's crust are gold, copper, aluminum, mercury, zinc, lead, iron, platinum and silicon among others (Ballhaus & Glikson, 1995). The rare earth elements like uranium, plutonium, and thorium are used in nuclear reactors and war heads (Ajakaiye, 1985). Rock products such as granites and limestone constitute minerals used for infrastructural development. Minerals are distributed in different locations and in varying amounts all over the world (Abaa & Najime, 2006).

The solid mineral identity and constitutional information of the rocks in Ditera and Waltadi districts in Song local government area of Adamawa state, Nigeria, has never been studied and revealed despite the fact that the area is highly mountainous. This therefore prompted this study. The study also aims to give potential information on possible exploration and mining of minerals in this location. This may improve the economic gallantry of the Nation.

## 2. Material and Methods

### *2.1 Materials Required*

The equipment and apparatus used for the analysis include the following, X-ray Diffraction Spectrophotometer, X-ray Fluorescence Spectrophotometer, Hand anger, Hammer, Chisel, polyethene bags, oven, pestle and mortar, spatula, weighing balance, hydraulic press, platinum crucible, stearic acid.

### *2.1 The Study Area*

The area of the study covered Detera and Waltadi districts of Song local government, Adamawa State. These two districts occupy the western part of the local government sharing a long boundary with Shelleng local government area. It is the greatest potion of what is today called the Yungur land. The area lies between latitude $9^o$ 44”- $9^o$ 52” and longitude $12^o$ 13” -$12^o$ 28” and is very mountainous.

### *2.3 The Sampling Locations*

The rocks studied were collected from seven (7) selected locations, all within Ditera and Waltadi districts of Song local government area. The coordinates of the sample locations are as follows:

1. Kuba latitude $9^0$ 51.5" longitude $12^0$ 27”
2. Laba latitude $9^0$ 51” longitudes$12^0$ 24”
3. Bwara latitude $9^0$ 51” longitude $12^0$ 22”
4. Batum latitude $9^0$ 51.5” longitude $12^0$20”
5. Gbang latitude $9^0$ 51” longitude $12^0$16”
6. Gbang kolora latitude $9^0$ 50 " longitude $12^0$ 14”
7. Tewozo latitude $9^0$ 49” longitude $12^0$ 15”

### *2.4 Sample Collection and Treatment*

The rock sample was obtained by adopting the method by (Alexander, Maina, Barminas, & Zira, 2011), in which hammer and Chisel were used to break and obtain the fresh or un-weathered rocks. The rock samples were wrapped in paper; rubber bounded and packed in polyethene bags. About 300g of the sample was randomly collected, five from each location. The rock samples were continuously dried for about 12 hours and then crushed and ground to fine powder. The obtained powder was sieved to achieve particle size homogeneity.

### *2.5 Analysis of Rock Samples*

#### 2.5.1 Identification of the crystalline nature of minerals in the rock samples using X-ray diffraction spectroscopy (XRD)

The samples were analyzed using a Pan Analytical Empyrean Rayons X-Ray Diffraction Spectrophotometer (XRD) at the National Geoscience Research Laboratories Centre Kaduna, Nigeria. A standard technique reported by Dutrous and Clark, 2009 was adopted as follows; 0.35g of the ground rocks samples was introduced into the sample container and then illuminated with the X-rays. The intensity of diffracted X-rays was recorded continuously as the sample and detector rotate through their respective angles. A peak intensity occurs when the mineral contains lattice planes with d-spacing appropriate to diffract X-rays at that value of Θ. Although each peak consists of two separate reflections (K1 and K2), at small values of 2Θ, the peak locations overlap with K2 appearing as a hump on the side of K1. At higher values of Θ greater separations occur. The combined peaks are treated as one and at 80% peak height the 2 λ position of the diffraction peaks was measured as the center of the peak. Most of the time, the results are presented as peak position at 2Θ and X-ray counts (intensity) in the form of a table or X-ray plot. The intensity (I) can be either presented as peak height intensity, the intensity above background, or as integrated intensity, i.e the area under the peak. The d-spacing of each peak will then be obtained by solution of the Braggs equation using appropriate value of λ i.e. $n \lambda = 2d\sin\Theta$ . When all the d-spacing of the unknown minerals are obtained, then they are compared with those of the known minerals. Since all the minerals have unique d-spacing, this provides an identification of the unknown samples.

2.5.2 Analysis for the Major and Minor Elements in the Rock Samples Using X-ray Fluorescence Spectroscopy (XRF)

An X-ray fluorescence method was adopted for the determination of both major and minor elements in the rock samples as reported by Magili and Maina, (2010) as follows; 2.0g of powdered rock samples mixed with 0.4g stearic acid which acts as a binder so as not to allow the sample to disperse or scatter and pressed with a hydraulic press. This fused tablet was X-rayed and counted to determine quantitatively the major and minor elements present in oxide form in the rock sample.

## 3. Result and Disscusion

### *3.1 Qualitative Analysis of Rock Samples*

3.1.1 Determination of Minerals Components of Rocks using X-Ray Diffraction

X-ray diffraction (XRD) has been identified to be specifically useful in the mineralogical determinations of material components as well as qualitative and quantitative phase analysis of multiphase mixtures (Sagar & Singh, 2007). Figures 1 to 7 presents the XRD spectra of the rock samples collected.

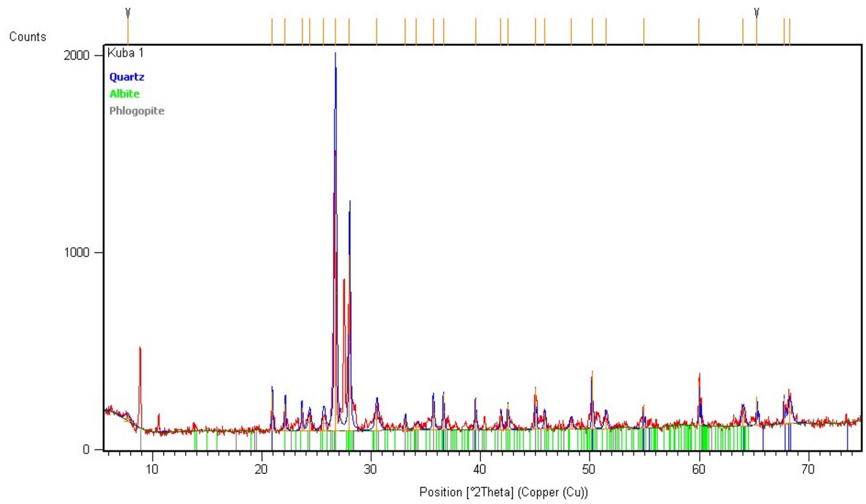


Figure 1. XRD Spectra of Rock Sample from Kuba

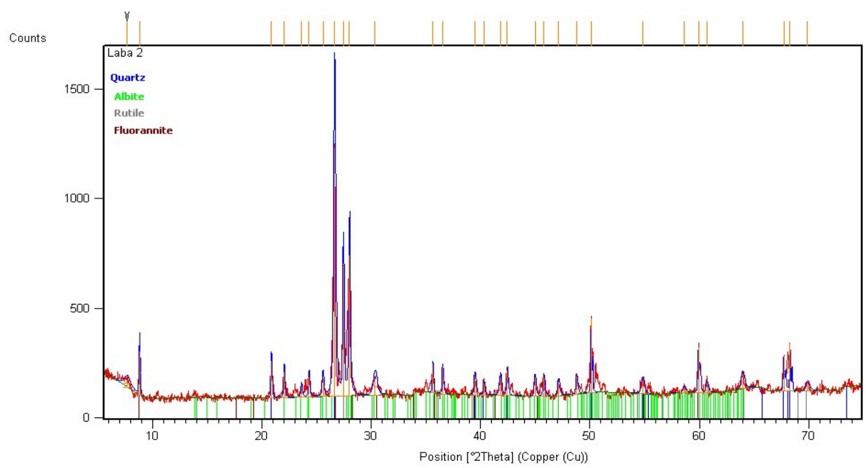


Figure 2. XRD Spectra of Rock Sample from Laba

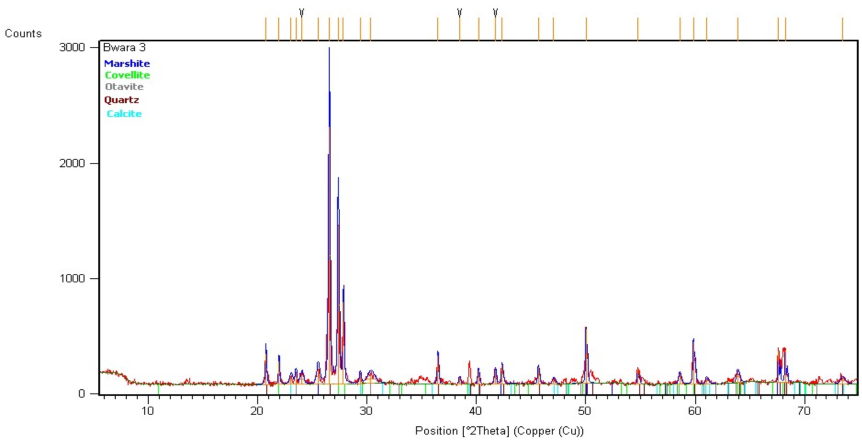


Figure 3. XRD Spectra of Rock Sample from Bwara

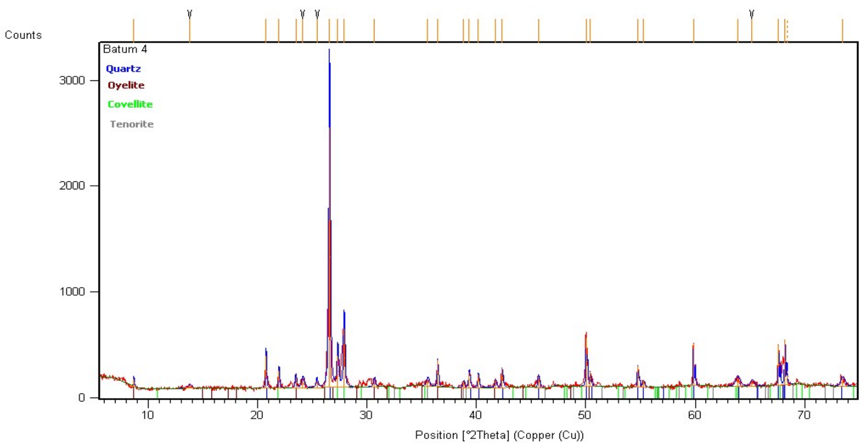


Figure 4. XRD Spectra of Rock Sample from Batum

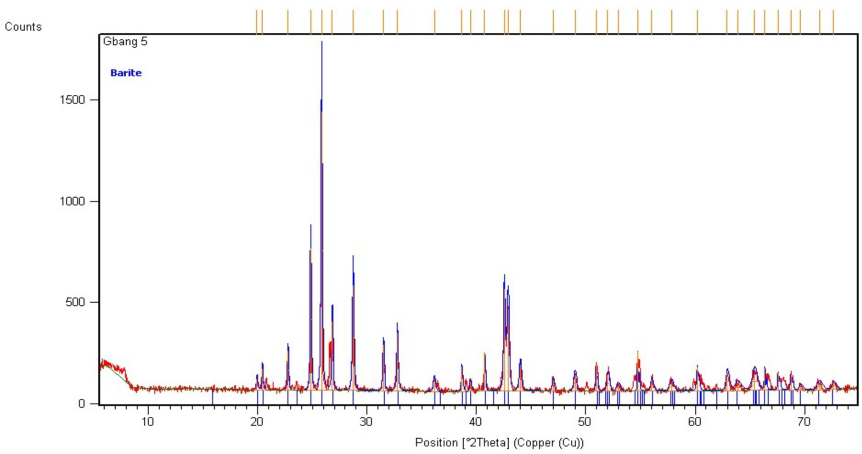


Figure 5. XRD Spectra of Rock Sample from Gbang

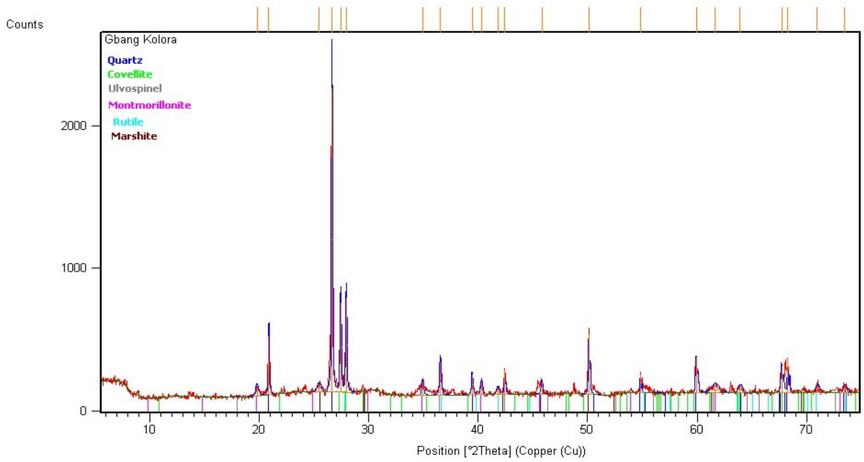


Figure 6. XRD Spectra of Rock Sample from Gbang kolora

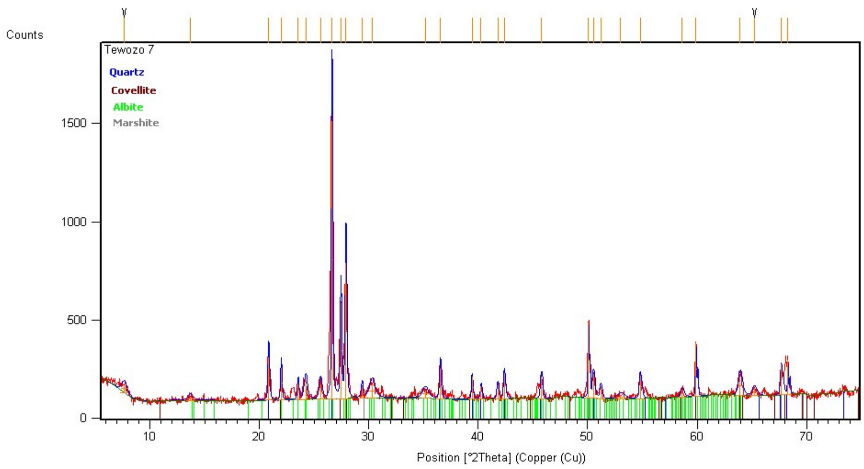


Figure 7. XRD Spectra of Rock Sample from Tewozo

Table 1 presents the mineral identified, the constituent compound name, chemical formular and crystal system. Together, minerals identified in the rocks analyzed includes; covellite, rutile, albite, phlogopite, marshite, otavite, oyelite, tenorite, barite, ulvospinel, montmorillonite, calcite, fluoranite, and quartz.

Covellite vary in stoichiometry, composition and morphology, giving it the interesting optical and electrical properties and hence its potential applications in various fields such as absorbers for solid state solar cells and in photocatalytic reactions (Page, Niitsoo, Itzhaik, Cahen, & Hodes 2009). Rutile is one, and the most stable of the three crystalline polymorphs of titanium oxide ($TiO_2$), others being anatase and brookite (Dai et al., 2010). It is used as pigment material (Shen et al., 2008; Kim, Na, Yang, & Kim, 2010). Albite has been reported to be a source of elemental sodium (Malaza & Zhao, 2009). Phlogopite is a mineral from the mica group. It is a source of elemental potassium, and has been reportedly used as a slow-potassium-release fertilizer in agriculture (da Silva et al., 2008). Copper (I) iodide sourced from marshite has been used in the production of table salt from which dietary iodine is cheaply obtained. It has also been reported to be used as a coating in cathode ray tubes and as a catalyst in organic reactions (Reich et al., 2013; Gao Li, Jia, Jianga, & Zeng, 2010). Otavite is the principal natural resource for mining cadmium, which finds its main application in the production of Ni–Cd batteries (Minch et al., 2010). Oyelite constitute similar chemical composition as tobermorite, but these two are different from each other in boron contents and the Ca/Si ratios (Kusachi, Henmi, & Henmi, 1984). Tenorite has reportedly found applications as a selective solar absorber (due to its high solar absorbency and a low thermal emittance) (Johan, Mohd Suan, Hawari, & Ching, 2011). Its p-type semiconductivity made it an important functional material used for gas sensors, magnetic storage media, solar energy transformation, electronics, semiconductors, varistors, and catalysis (Alabi et al., 2013). Barite also known as Barytes is used in such industrial applications as, drilling mud in oil industries, production of homogenized glass, paint, and concrete aggregate in construction industries (Raghu, 1998).

Ulvospinel represents an important mineral in nature because it is an essential carrier of the remnant magnetism in rocks (Bosi, Halenius, & Skogby, 2009). It belongs to the titanomagnetite series, and it is very important in the studies of the magnetism of terrestrial and extraterrestrial materials, and in planetary science applications, it has an additional advantage in that it enables remote measurement (Zinin et al., 2011). Montmorillonite has been comprehensively reported by Hartwell (1965) to be of very wide range of industrial applications including; pharmaceuticals, oil refining, sugar refining, catalysis, etc. Quartz appears in varieties of colours and it is the main component of many types of rock. It is used as a window in optical instruments, production of glass, as an abrasive, cut into gemstones and employed in oscillators and pressure sensing-devices (Northam and Baranoski, 2008). Calcite is the most stable polymorph of calcium carbonate ($CaCO_3$). In its crude and refined forms, it has reportedly found applications such as; production of cements and several construction materials, an active ingredient in commercially available antacid tablets and efficient filler in printing inks and papermaking industry (Montes-Hernaandez et al., 2008).

Table 1. Minerals Identified in the Rock Samples by X-Ray Diffraction Spectrometer

| Location | Mineral Identified | Compound Name | Chemical formula | Crystal System |
|---|---|---|---|---|
| Kuba | Quartz | Silicon Oxide | $SiO_2$ | Hexagonal |
| | Albite | Sodium Aluminum Silicate | $Na( AlSi_3O_8)$ | Anorthic |
| | Phlogopite | Potassium Magnesium Aluminum Silicate Hydroxide | $K Mg_3(Si_3Al)O_{10}(OH)_2$ | Anorthic |
| Laba | Quart | Silicon Oxide | $SiO_2$ | Hexagonal |
| | Albite | Sodium Calcium Aluminum Silicate | $(Na_{0.98}Ca_{0.02})(Al_{1.02}Si_{2.98}O_8)$ | Anorthic |
| | Rutile | Titanium Oxide | $TiO_2$ | Tetragonal |
| | Fluorannite | Potassium Iron Aluminum Fluoride Silicate | $KFe_3AlSi_3O_{10}F_2$ | Monoclinic |
| Bwara | Marshite | Copper Iodide | Cu I | Cubic |
| | Covellite | Copper Sulfide | Cu S | Hexagonal |
| | Otavite | Cadmium Carbonate | $Cd(CO_3)$ | Rhombohedral |
| | Quartz | Silicon Oxide | $SiO_2$ | Hexagonal |
| | Calcite | Calcium Carbonate | $CaCO_3$ | Rhombohedral |
| Batum | Quartz | Silicon Oxide | $SiO_2$ | Hexagonal |
| | Oyelite | Calcium Borate Silicate Hydrate | $Ca_{10}B_2Si_8O_{29}12.5\ H_2O$ | Orthoxobic |
| | Covellite | Copper Sulfide | CuS | Hexagonal |
| | Tenorite | Copper Oxide | CuO | Monoclinic |
| Gbang | Barite | Barium Sulfate | $BaSO_4$ | Orthorhombic |
| Gbang Kolora | Quartz | Silicon Oxide | $SiO_2$ | Hexagonal |
| | Covellite | Copper Silfide | CuS | Hexagonal |
| | Ulvospinel | Iron Titanium Oxide | $Fe_2TiO_4$ | Cubic |
| | Montmorillonite | Sodium Magnesium Aluminum Silicate Hydroxide Hydrate | $Na_{0.3}(AlMg)_2Si_4O_{10}OH_2.6H_2O$ | Hexagonal |
| | Rutile | Titanium Oxide | $TiO_2$ | Tetragonal |
| | Marshite | Copper Iodide | Cu I | Cubic |
| Tewozo | Quartz | Silicon Oxide | $SiO_2$ | Hexagonal |
| | Covellite | Cupper Sulfide | CuS | Hexagonal |
| | Albite | Sodium Calcium Aluminum Silicate | $(Na_{0.98}Ca_{0.02})(Al_{1.o2}Si_{2.98}O_8)$ | Anorthic |
| | Marshite | Cupper Iodide | CuI | Cubic |

Table 1 also compares the minerals identified in the rock samples obtained from the different locations. Quartz is present in all the locations except Gbang. The dominant presence of quartz in most samples of the rocks agrees with the report by Alexander et al. (2011). The presence of barite is however revealed in Gbang which is the location of rock samples without quartz. Albite was identified to be present in Kuba, Laba and Tewozo. Rutile was identified in rock samples obtained from Laba and Gbang kolora. Covellite was found in rock samples obtained from Bwara, Batum, Gbang kolora and Tewozo, Marshite in Bwara and Tewozo, Fluorannite in Laba only, Phlogopite in Kuba alone, Otavite and Calcite in Bwara alone, Oyelite and Tenorite in Batum alone, and finally Ulvospinel and Montmorillonite in Gbang Kolora alone.

The variations in the mineral compositions of the rock samples obtained from these locations can however be due to some geographical, biological, physicochemical and experimental factors. Variation in the minerals material sample (even from the same source) has been attributed to depth-wise variation based on the distribution of minerals in the bulk sample (Bhattarai et al., 2006). The rocks exposure to moisture and carbonic acid (i.e. from organic sources) at ordinary temperature has also been reported to be able to weather, decay or transform some of the original minerals in the rock, however, some like quartz and white mica are relatively stable and remains unaffected (Badmus, Olurin, Ganiyu, & Oduleye, 2013). This may be the reason why quartz remain predominantly present in majority of the rock samples. The intimate adhesion of lichen thalli to the rock surface and the penetration of the hyphal in less coherent area of the rock cause a physical degradation and fragmentation of the mineral surface. This also initiates chemical effects such as biosolubilization and transformation of rock minerals by organic acids (majorly oxalic acid) and a group of polyphenolic compounds (called "Lichen acids") contained in the excretory product of the lichens (Adamo & Violante, 2000). In general, Ebrel, (1984) reported climatic factors such as; temperature, pressure, rainfall, evaporation and drainage, and chemical factors such as the primary chemical composition and their reaction time, as possible causes of variation in the weathering environment (surface layer) of rocks.

3.1.2 Quantitative Analysis of Elemental Oxides in the Rock Samples

Using X-ray fluorescence (XRF), the elemental oxides constituted in the rock samples were quantitatively analysed. The predominant existence of element in their oxide forms has however been attributed to the reactivity and the relative abundance of oxygen. Some are however very stable in the oxide form, thereby suggesting the quantitative analysis of their oxides in their natural sources.

Table 2. Percentage composition of the major Elemental Oxides in the rock samples

| Location | $SiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | CaO | MgO | $SO_3$ | $K_2O$ | $Na_2O$ | L.O.I |
|---|---|---|---|---|---|---|---|---|---|
| Kuba | 46.24±0.0300 | 18.25±0.0320 | 8.24±0.0300 | 9.06±0.0600 | 1.26±0.0600 | - | 8.33±0.2400 | 1.24±0.0600 | 5.48 |
| Laba | 48.80±0.0400 | 15.78±0.0500 | 5.90±0.3200 | 6.66±0.0300 | 0.98±0.0600 | - | 9.67±0.0600 | 1.76±0.0500 | 8.25 |
| Bwara | 55.74±0.0300 | 16.52±0.0300 | 2.84±0.0300 | 1.68±0.0300 | 0.05±0.0200 | - | 10.10±0.3500 | 1.56±0.0200 | 10.5 |
| Batum | 65.00±1.5811 | 11.01±0.0200 | 5.02±0.0158 | 4.68±0.0158 | 0.85±0.0158 | - | 06.45±0.0255 | 0.48±0.0158 | 4.87 |
| Gbang | 19.70±0.0158 | 2.01±0.0158 | 3.16±0.0158 | 0.096±0.0016 | - | 17.90±0.0158 | 0.07±0.0158 | - | 1.5 |
| Gbang kolora | 46.5±0.0158 | 18.21±0.0194 | 6.30±0.0255 | 3.50±0.1581 | 0.41±0.0158 | - | 7.76±0.0158 | 1.42±0.0158 | 12.5 |
| Tewozo | 55.30±0.0158 | 16.01±0.0158 | 4.24±0.0158 | 3.69±0.0158 | 0.02±0.0158 | 0.75±0.0158 | 9.39±0.0158 | 1.50±0.0158 | 7.52 |
| Range | 19.70±0.0158 | 2.01±0.0158 | 2.84±0.0300 | 0.096±0.0159 | 0.05±0.0200 | 0.75±0.0158 | 0.07±0.0158 | 0.48±0.0158 | 1.5 |
| | 65.00±1.5811 | 18.25±0.0320 | 8.24±0.0300 | 0.06±0.0600 | 1.26±0.0600 | 17.90±0.0158 | 10.10±0.3500 | 1.76±0.0158 | 12.5 |

Range = limits between values L.O.I = lost on ignition.

Table 2 presents the percentage composition of the major elemental oxides in the rock samples. Results indicate that silicate ($SiO_2$) is present in all the locations with the highest concentration in Batum (65.00 %) and the lowest in Gbang (19.70 %). It is the most abundant compound at all locations and this affirms the dominant presence of the mineral quartz, except in Gbang. The low silicate concentrations in Gbang (19.70 %) signals the reason why quartz was not identified in the rock samples obtained from the locations. This result is however comparable to those by Plummer, McGeary & Carlson (2003), for some igneous rock samples. The result also agrees with sand sample analyzed around some of these locations (Alexander et al., 2011). However, rock from Gbang was found to have relatively high sulfur oxide ($SO_3$) (17.90%) which is either in trace or absolutely absent in other locations.

Aluminum oxide ($Al_2O_3$) was detected in all the locations with the highest concentration in Kuba (18.25 %) and the lowest in Gbang (2.01 %). Its concentration range however shows that it is the next in abundance to silica. This can be interpreted from the report by Pandey, Singh & Hasnain, (2001) in which he described Aluminum as a less mobile element in sedimentary rocks and clays in which it's generally locked up especially in aluminosilicate minerals. This simply presents a possible reason why the concentrations of $Al_2O_3$ in the samples are still relatively high over time. The component Iron oxide ( $Fe_2O_3$) was also detected at all the locations with the highest concentration in Kuba (8.24 %) and the lowest in Bwara (2.84 %). Calcium oxide (CaO) concentration was found highest in Kuba (9.06 %) and the lowest in Gbang (0.096 %). Potassium oxide ($K_2O$) was found highest in Kubta (10.10 %) and the lowest in Gbang (0.07 %). Magnesium and sodium oxides (MgO and$Na_2O$) were found to be generally very low ranging from places where they were not detected at all to the highest concentrations of 1.26 % at Kuba and 1.76 % at Laba respectively. Averagely, the concentrations of the elemental oxides obtained for the rock samples were found in a decreasing order of SiO2 > Al2O3> K2O>Fe2O3 >CaO with Na2O and MgO comparable. This however agrees with the sediments analysed in these locations (Alexander et al., 2011).

Table 3. Percentage composition of the minor Elemental Oxides in the rock samples

| Location | PbO | $TiO_2$ | MnO | BaO | $V_2O_5$ | $Cr_2O_3$ | $CeO_2$ | $In_2O_3$ | CuO | ZnO |
|---|---|---|---|---|---|---|---|---|---|---|
| Kuba | - | 1.15±0.1400 | 0.19±0.0300 | 0.45±0.0320 | 0.006±0.0020 | 0.012±0.0030 | - | 0.001±0.0010 | - | - |
| Laba | - | 1.42±0.0300 | 0.21±0.0300 | 0.48±0.040 | 0.004±0.0030 | 0.003±0.0030 | 0.001±0.0008 | 0.0006±0.0003 | - | - |
| Bwara | - | 0.45±0.0200 | 0.068±0.0300 | 0.24±0.0300 | - | - | 0.001±0.0002 | - | - | - |
| Batum | - | 1.06±0.0255 | 0.09±0.0158 | 0.27±0.0158 | 0.009±0.0016 | 0.006±0.0016 | - | 0.004±0.0016 | - | - |
| Gbang | - | 2.84±0.0158 | - | 61.60±0.0158 | - | | - | 0.001±0.0.0003 | - | - |
| Gbang kolora | - | 2.56±0.0158 | 0.03±0.0158 | 0.60±0.0255 | 0.009±0.0012 | 0.005±0.0016 | 0.17±0.0087 | - | - | - |
| Tewozo | - | 1.00±0.0158 | 0.087±0.0016 | 0.45±0.0255 | 0.008±0.0023 | | 0.0042±0.0016 | 0.005±0.0016 | - | - |

Table 3 presents the percentage composition of the minor elemental oxides in the rock samples. Result show that barium oxide (BaO) was found in relatively large quantity in Gbang (61.60%). This agrees with the (XRD) result which indicates that the location is highly dominated with barite ($BaSO_4$) a very important industrial mineral. Titanium oxide ($TiO_2$) was found in an appreciable quantity at all the locations, while rutile was only found in Gbang Kolora. The recorded absence of rutile mineral from the locations where $TiO_2$ is quantitatively identified is due to impurities associated with the compound (Kolenko, Burukhin, Churagulov & Oleyni- kov, 2003).

Manganese oxide (MnO) was detected in all locations except Gbang. The highest concentration was in Laba (0.21 %) and the lowest in Gbang Kolora (0.03 %). Vanadium oxide ($V_2O_5$) was detected in all locations except Bwara and Gbang. The highest concentration was recorded for Batum and Gbang (0.009%) and lowest for Laba (0.004 %). Chromium oxide ($Cr_2O_3$) was found in decreasing order in Kuba (0.012%), Batum (0.006 %), Gbang Kolora (0.005 %) and Laba (0.003 %) respectively. Cerium oxide ($CeO_2$) was absent in Kuba, Batum and Gbang. Its highest concentration is however recorded for Gbang Kolora (0.17 %), while the least was in Laba and Bwara (0.001 %). Indium oxide ($In_2O_3$) was absent in Bwara and Gbang Kolora. For other locations however, its concentration is highest in Tewozo (0.004 %) and least in Laba (0.0006 %). Copper oxide (CuO) and zinc oxide ZnO were recorded to be absent in all location, and this may be due to the combination of these compounds with high level of impurities (Kolenko et al., 2003). Results obtained in this study are comparable with those reported for granitic rocks in Sulawesi Island, Indonesia, although there are slight variations in the concentrations of the compounds (Maulana, Yonezu & Watanabe, 2014). Progressive variation in the chemical compounds composition of rocks has been basically attributed to weathering and the rate of the process (i.e. weathering index and profile). This continuously cause the leaching of these compounds and possible transformations at favorable environmental conditions (Price and Velbel, 2003; Maulana et al., 2014). Variation can also be due to a complex distribution (i.e. heterogeneity) of elements in the rock samples (Georgieva, Cherneva, Hekimova, & Petrova, 2009; Amare &

Koeberl 2006). The variation in the metallic constitution of the rock samples also reflects variations in textural and/or carbonate and organic material content in the samples (Rubio, Nombela, & Vilas, 2000).

### 4. Conclusion

Minerals are very profitable natural resources. This fact demands the efficient exploration of our basic environment for their availability. The analysis of the rock samples from some mountainous locations including; Kuba, Laba, Bwara, Batum, Gbang, Gbang Kolora and Tewozo of Ditera and Waltadi districts of Song local government, Nigeria, has revealed the presence of some minerals as presented in this study. Information such as the constituent compound name, chemical formula, crystal system, uses and applications of these minerals were also presented in the study. This study furthers to a more fundamental analysis of this rock samples by determining the major and minor oxides therein. This however serves as a confirmatory analysis with respect to the minerals identified to be present in the rock samples. The minerals identified in the various locations vary and consequently are the major and minor oxides. This study therefore has been able to present the constitutional information of the rock samples in the analysed location, thereby potentially initiating a profitable mining of this mineral which may significantly improve the nations' economy.

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