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Identification of Special Stones in Some Part of Bali Local Government, Taraba State, Nigeria

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Abstract
A gemstone is a physical material that has intrinsic value and possesses fundamental qualities such as beauty, durability and rarity. Gemstone identification might seem like a niche skill, relegated to the world of gemologists and jewelers. However, understanding how to identify gemstones is far more relevant than one might think. Identifying gemstones helps to protect one against fraudulent purchases to appreciating the natural beauty of the Earth's treasures. The ability to distinguish between genuine and synthetic stones, or even identify different varieties of the same gemstone, adds depth to our understanding of materials and enhances our critical thinking skills. To scientifically identify different precious stones found around Zagga Bali Local Government of Taraba State, the physical properties such as specific gravity, cleavage, hardness, durability or toughness, twinning, crystal habit, crystal system and colour were used in analyzing selected special stones. The results were compared to other precious stones found in the literature. This research work verified and authenticated the presence of the ten (10) special stones within Bali Local Government of Taraba State. These gemstones are rich in Lithium which could be used in the production of batteries and even applied in optical technology.

Keywords*: Gemstone, specific gravity, cleavage, hardness, durability, crystalline, non-crystalline*

1.0 Introduction

Gems are some kinds of minerals and the most important characteristic of a mineral is the possession of structurally homogeneous solid of definite chemical composition formed by the inorganic process of nature. A gem stone is a material that has intrinsic value and possesses three fundamental qualities such as beauty, durability and rarity. Colour contributes to the beauty of gem and it is one of the major factors for grading and evaluating gemstones. It is an important property for identification of gemstones (Kyaw *et al*., 2002). These gemstones are rarely found in the world especially among countries with rich mineral resources.

The existence of rich natural resources played a major part in the development of nation's economics. Nigeria being a significant producer of gemstones over the years, the deposit of these minerals should not be left out of the global rush to explore these minerals to salvage the economics of the nation (Finelib.com, 2017). Mineral resources play an important role in the development of both resources, employment, revenues generation, foreign exchange earnings and meeting up with the technology and the energy demand of most countries. So, there is need to explore these minerals using scientific knowledge and techniques to have an indigenous knowledge of our God given treasure.

The gemstones in Nigeria are found in different basalt related localities. Most of them are located within the central and eastern part of the country. Sapphires gemstones are one of the popular gem mines in the country and are verily deposited across the country. Some of the sites that are under mining are located near Jos at Gidan Waya in Kaduna State, Bokkos Plateau and Bogoro in Bauchi State, Gunda and Gulde in Yobe State and Borno, Ganye in Adamawa state and Kurmi in Taraba State, Gembu on Mabila Plateau near the border with Camaroon in Taraba State (Michelou, 2007).

Taraba State is one of the states in Nigeria that is endowed with mountainous nature enriched with minerals. The Mabila plateau of Taraba State is one among the area where such precious stones are deposited. Recent report shows that the parcel of gem stone in Mabila plateau has a similar appearance as that of Thailand and Sri-lanka which attract several foreign merchants from across the globe (Vincent *et al*., 2014).

Also, report has shown a new discovered mining ground of gemstone in Bali LGA around a small mountain area called Zagga which attract a lot of critical miners. One among the newly discovered gemstones contains lithium. Lithium is one of the best raw materials used for production of batteries for storage of energy. Lithium is an extract of gemstone called the lapidolite. The geologist, have not yet listed them among the gemstone but the gemologist has approved lapidolite as gemstone. To many geologists, lapidolites are considered minerals and not gemstones. However, most gemologists consider lapidolite as mineral semi-precious gemstone. This lapidolite is one among the gemstone discovered around Zagga in Bali. This has proved that Taraba State is endowing with the most precious stones leveraging future resources for sustainable development. Lapidolite is a pale rose of lovenda grey mica mineral lithium and rare metallic like cesium and rubidium among Mica mineral. Lapidolites are one of the most common gemstones. They are better for being secondary sources of Lithium and helium which is a fore runner to renewable energy. Due to the enriched mineral deposit in Nigeria, a recent submit in Dubai where several country's investors and mining companies where represented, a foreign company called Tesla approached Nigeria with a proposal of investing in the mining sector to enable them export Nigeria lithium for the manufacturing of battery for electric cars that the Government reject the offer (*https://thenational.net/whynigeriareject-telsas-bib-to-raw-lithium/29-1-2023*).

This research work is to verify and authenticate the presence of the ten (10) special stones within Bali Local Government of Taraba State. This is done by analysing the physical properties of selected special stones around Zagga Bali Local Government of Taraba State. Also, to scientifically identify different precious stones found and compared to other precious stones found in the literature.

2.0 Classification of Gemstones

Gemstones can be classified as either amorphous or crystalline. Amorphous gemstones are characterized by; no orderly internal atomic structure, no naturally-occurring characteristic shape, products of rapid cooling and physical properties constant in all directions. The examples of amorphous gemstones include: Glass, Amber, Jet, Opal, etc. whereas, crystalline gemstones are characterized by; a definite & regular internal atomic structure, geometrical external forms, directional properties, products of slow cooling and identical in all crystals of a given species. All crystalline gemstones can be classified into Cubic, Tetragonal, Hexagonal, Trigonal, Orthorhombic, Monoclinic and Triclinic crystal systems (Ayeni *et al*., 2022).

3.0 Physical Properties of Gemstones

The identification of gemstones relies on their unique physical, chemical, and optical properties. Most gemologists who handle gemstones every day can identify gem by purely looking at it based on their physical properties. These include: Specific gravity, Cleavage, Hardness, Durability or Toughness, Twinning, Crystal habit, Crystal system and Colour (Shen and Lu, 2011).

Specific gravity

The specific gravity of the gemstones measures its density. This relates to how heavy a certain size gemstone feels. This technique is known as "heft" and can be practiced by picking up different gemstones every day and just feeling how heavy it is compared to how big it is. One can pick up something like an opal; feel how heavy it feels in the palm of the hand, bounce it up and down and get a feeling for it. Then pick up any other gemstone and do the same. The variation in their specific gravity can then be compared. Opal is very light (specific gravity of 1.45), so even larger opals feel light compared to smaller coloured gemstones (Olade, 2021).

Cleavage

Cleavage refers to a property in some gemstones where there is an atomic weakness along certain planes in the gemstone. These planes can cause the gemstone to break easily when exposed to mechanical shock. It is the tendency of a crystalline substance to split parallel to certain definite directions (when force is applied) producing more or less smooth surfaces. Some of the examples of gemstones that undergo cleavage include; Diamond, Fluorspar, Kunzite, Topaz and Calcite.

Hardness

Hardness is the resistance of a gemstone to scratching or abrasion when a pointed fragment from another material is drawn across its surface with insufficient force to cause cleavage. It is measured on a scale called the Moh's scale. The Moh's Hardness scale is commonly used to measure the hardness of gemstones using ten minerals with a predetermined hardness. Gemstones with higher numbers have the ability to scratch gemstones with a lower number. Moh's hardness scale ranges from: Talc, Gypsum, Calcite, Fluorspar, Apatite, Feldspar, Quartz, Topaz, Corundum and Diamond (140 to 1,000 times harder than corundum) (Olade, 2021).

Durability or Toughness

This is a very important property of gemstones. Durability can relate to many aspects such as resistance to corrosion, resistance from chemical attack (perfume etc), resistance to mechanical shock (Resistance to crushing or breakage) and resistance to exposure to light.

Twinning

This is defined as a change in crystal growth direction within a gemstone. This twining plane can be seen inside a cut gemstone which gives a good indication of the gemstone being natural. Quartz has twining (known is penetration twinning), as can be seen by most Quartz specimens.

Crystal Habit

This is the physical shape of how the gemstone crystals grow. Diamond and Spinel have a crystal habit of Octahedral. Corundum has what is known as the bi-pyramid hexagonal crystal habit.

Tourmaline has a round triangle appearance and Garnet is a rhombic dodecahedra. All gemstone habits can be modified and sometimes do not resemble the official crystal habit at all.

Crystal System

This is how the atoms inside the crystal lattice are structured. This property can determine how hard the gemstone is, how the gem reacts to light (refraction of light, transparency and the amount of light reflected from its surface (luster) and even the gemstones durability).

4.0 Methods of Gemstone Identification

There are several methods used in identification of gemstones. They include; virtual examination, hardness, specific gravity measurement, advanced techniques and UV fluorescence, Synthetics and Treatments (Kayode, 2018).

4.1 Visual Examination

The first step in gemstone identification is a careful visual examination. This involves assessing several key characteristics as colour, clarity, cut and polish (Ndaja, 2021).

Color

This is often the most striking feature, but it is crucial to remember that colour alone is not enough for identification. Many gemstones come in a wide variety of hues. For example, emeralds range from deep green to yellowish-green, while sapphires can be any color except red (rubies are a type of corundum, the same mineral family as sapphires). Note the overall tone (e.g., warm, cool), saturation (intensity of color), and hue (the pure color).

Clarity

This refers to the presence of inclusions (internal flaws) and blemishes (external flaws). While perfectly flawless stones are rare and often command high prices, inclusions can be diagnostic – providing clues to a stone's origin and formation. For instance, the presence of needle-like inclusions is characteristic of some emeralds, while "silk" inclusions (fine, parallel lines) are common in moonstones. Using a loupe (a small magnifying glass) can significantly aid in observing these details (Ross, 2018).

Cut and Polish

The way a gemstone is cut and polished influences its brilliance, fire (dispersion of light), and overall appearance. A well-cut gemstone will display more brilliance than a poorly cut one, even if they are of the same material and quality. The symmetry, proportions, and overall polish of the stone is observed. A poorly polished stone might appear dull or lackluster. Examining inclusions under a loupe might reveal differences in their internal structure (Raw Material and Development Council, 2010).

4.2 Testing Hardness

This refers to a gemstone's resistance to scratching. The Mohs Hardness Scale is a commonly used system, ranging from 1 (talc) to 10 (diamond). A simple scratch test using a known material (like a steel knife or glass) can provide a rough estimate of hardness. A diamond, for example, will scratch glass, while glass will scratch quartz (Humphries, 2013).

4.3 Specific Gravity Measurement

This measures the density of a gemstone relative to water. By weighing the stone in air and then in water, you can calculate its specific gravity. Different gemstones have different specific gravities. A gemological balance is needed for accurate measurement, but even a rough estimate can be helpful.

4.4 Advanced Techniques

For more precise identification, professional gemologists utilize specialized instruments such as refractometers and spectroscopes (Pardieu, 2009).

4.4.1 Refractometer

This instrument measures the refractive index of a gemstone. That is, how much light bends as it passes through the stone. Each gemstone has a unique refractive index, making this a valuable tool for identification. However, it is not always definitive as some stones have very similar refractive indices.

4.4.2 Spectroscope

This instrument analyzes the light that passes through a gemstone, revealing its absorption spectrum. This spectrum, a unique pattern of dark bands, can be used to identify specific elements and therefore the gemstone type. Different gemstones have different spectral fingerprints.

4.5 UV Fluorescence

Many gemstones fluoresce (glow) under ultraviolet light. The color and intensity of this fluorescence can be a helpful diagnostic tool. For example, some diamonds emit blue under UV light.

4.6 Synthetics and Treatments

It is crucial to be aware of synthetic gemstones and treatments that can alter a gemstone's appearance. Synthetic gemstones are lab-created materials with the same chemical composition as their natural counterparts. Treatments, such as heating or irradiation, are used to enhance the color or clarity of natural gemstones. Ethical and responsible gemstone dealing requires full disclosure of any synthetic or treatment processes (Gemological Institute of Nigeria, 2023).
The figure 1 below shows the various gemstones identified by SluiceBoy Prospecting’s report.

Figure 1: Source, SluiceBoy Prospecting's Report (2024)

In this study, the visual examination of gemstone is adopted using the physical properties to identify the gemstones around Zagga, Bali Local Government Area, Taraba State and compared with the properties of some of the already known gemstones as shown in Figure 1.

5.0 Result and Discussions

5.1 Results

The results are shown in Figure 2 to Figure 11 (Source, Field Work, 2024.

Figure 2: SP1: Tourmaline, Muscovite, Feldspar and Quartz

Figure 3:SP2: Lithium , Feldspar and Quartz

Figure 4:SP3: Gneiss with chloritization

Figure 5: SP4: Pegmatite Rock

Figure 6: SP5: Quarze with Weathering (Hematization

Figure 7: SP6: Pegmatite with Lithium

Figure 8: SP7: Quartz with feldspar ionizations

Figure 9: SP8: Schist

Figure 10: SP9: Gabbro with Iron content

Figure 11: SP10: Quartz with stain of Feldspar

Discussions

The gemstones were identified using the physical properties of the stones. From Figure 2, gemstones were identified to be a tourmaline, Muscovite, Feldpar and Quartz (SP1). This is because the stone has characteristic trigonal crystal form, perfect cleavage with optical properties indicating the presence of tourmaline, Muscovite, Feldpar and Quartz. The identified gemstone tourmaline has a range of colors, including pink, green, and black. The Muscovite has silver-white or pale yellow, while feldspar and quartz have a range of colors.

Figure 3, shows the presence of gemstone which is made up of lithium, Feldspar and quartz (SP2) minerals. Lithium minerals such as spodumene and petalite were identified by their characteristic crystal forms and optical properties. The stone also showed characteristic cleavage similar to Feldspar crystals. Quartz crystals were identified by their characteristic hexagonal crystal form and optical properties. The colours of Lithium minerals are in a range of pink, white, and gray. Feldspar could be pink, white, or gray, while quartz is often clear or white.

The gemstone in Figure 4 is Gneiss with Chloritization (SP3). This is due to the fact that Gneisses often have a banded or foliated texture and there is presence of chlorite. The Chloritization is characterized by the presence of chlorite minerals. This Chloritization often results in the alteration of original minerals such as biotite and amphibole. The gemstone is also identified as Gneisses with chloritization because they are known for their greenish or yellowish tint due to the presence of chlorite.

Figure 5 is a gemstone identified as Pegmatic rock (SP4). This is because of the coarse-grained texture of the gemstone. The Pegmatites have a characteristic coarse-grained texture with the presence of rare minerals such as tourmaline, apatite, and garnet. Also, Pegmatites often have high concentrations of incompatible elements such as lithium, cesium, and tantalum and it has a variety of colors, including pink, white, gray, and black.

From Figure 6, a gemstone called Quartz Weathering (Hematization) (SP5) was identified. It has the presence of iron oxide minerals. Iron oxide minerals such as hematite and magnetite could be identified by their characteristic crystal forms and optical properties. Also, Hematization often results in the alteration of quartz minerals leading to a red or yellow coloration of the quartz. Hematized quartz can have a range of colors, including red, yellow, and brown.

Figure 7, is a Pegmatite with Lithium (SP6). It has presence of lithium minerals such as spodumene and petalite was identified by their characteristic crystal forms and optical properties. It was identified by their coarse-grained texture with high concentration of lithium. Lithium minerals have a range of colors, including pink, white, and gray.

Figure 8, is a gemstone called Quartz with Feldspar Ironization (SP7). It has the presence of iron oxide minerals such as hematite and magnetite were identified by their characteristic crystal forms and optical properties. Ironization often results in the alteration of feldspar minerals. The presence of quartz was also noted. Iron oxide minerals have a range of colors, including red, yellow, and brown.

Figure 9 is a gemstone identified as Schisst (SP8). They are usually black, due to its mineral composition with layered or flaky texture, often with visible mineral grains or foliation (layering).

Figure 10, shows a Gabbro with Iron Content (SP9). Due to the presence of iron minerals such as pyroxene and olivine it was identified by their characteristic crystal forms and optical properties. Gabbros with iron often have a dark coloration and also a coarse-grained texture.

Figure 11 is a gemstone which is made up of Quartz with stain of Felder (SP10). It is hard, white or colorless quartz crystal structure with hexagonal crystal formation. It has presence of a patch or spot of pink, white, or gray feldspar within the quartz crystal.

As compare to Figure 1, these identified gemstones have similar characteristics both in beauty, durability and clarity.

From Table 3; Tourmaline, books of muscovite, feldspar and quartz (SP1) has thermal conductivity of 0.064W/mK with an electrical conductivity of 0.05 W/mK. This lower thermal conductivity is due to presence of muscovite, which has low thermal conductivity generally. Lithium, feldspar, and quartz (SP2) has thermal conductivity of 0.057 W/mK with an electrical conductivity of 0.12 W/mK. This is moderate to high thermal conductivity due to presence of quartz and feldspar. Gneiss with alteration chloride (Chloritization) (SP3) has thermal conductivity of 0.076W/mK with an electrical conductivity of 0.03 W/mK. The high thermal conductivity is due to alteration and presence of chlorite.

Pegmatic Rock (SP4) has thermal conductivity of 0.048W/mK with an electrical conductivity of 0.08 W/mK.

The thermal conductivity of Quartz weathering (hematization) (SP5) is 0.059 W/mK with an electrical conductivity of 0.02 W/mK. The moderate thermal conductivity is due to weathering and presence of hematite.

Pegmatite with lithium (SP6) has thermal conductivity of 0.045 W/mK with an electrical conductivity of 0.15 W/mK. The moderate thermal conductivity is as a result of the presence of lithium-rich minerals.

Quartz with feldspar ironization (SP7) has a thermal conductivity of 0.057W/mK with an electrical conductivity of 0.10 W/mK. This also indicates high thermal conductivity due to presence of iron-rich minerals and quartz.

Schist (SP8) has lower thermal conductivity value of 0.044 W/mK with an electrical conductivity of 0.01 W/mK.

Gabbro with iron content (SP9) has a thermal conductivity in the range 0.044 W/mK with an electrical conductivity of 0.06 W/mK. This lower value of the thermal conductivity is due to presence of iron-rich minerals and gabbroic mineralogy.
Quartz with stain of feldspar (SP10) has thermal conductivity between 0.057 W/mK with an electrical conductivity of 0.09 W/mK. The high thermal conductivity is due to presence of quartz and feldspar.
As compare to Figure 1, these identified gemstones have similar characteristics both in beauty, durability and clarity.

6.0 Conclusion

Gemstone identification is not a simple process as it requires a combination of visual observation, simple tests, and potentially specialized instruments. The key characteristics of ten (10) different gemstones around Zagga, Bali Local Government Area, Taraba State were identified. These gemstones are rich in Lithium which could be used in the production of batteries. Some of these gemstones could be applied in optical technology.

Recommendation

i. Developing new spectroscopic techniques can help to improve the accuracy and efficiency of gemstone identification.
ii. Further studies should be done on developing machine learning algorithms to analyze gemstone data and improve identification accuracy.
iii. Also, the testing for the thermal conductivity, resistivity and specific heat capacity of these identified gemstones could help in optical technology advancement.

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