



Nigeria Gemstone: The Role of Geologists in the Value Chain

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ABSTRACT

Background: Gemstones (or gems) are a special class of non-metallic minerals that occur as well –formed crystals which are spectacular objects of beauty, valuable in their rarity, and sufficiently durable to give lasting pleasure to their owner. They can be found in geological environment, including igneous, hydrothermal, metamorphic and/or sedimentary. They are associated with certain rock types and suites of minerals. Gemstones in cut and polished forms are used to make jewelry or other adornments. Mining of gemstones in Nigeria is an old practice. Nigeria is known for the availability of different gemstones including corundum, beryl, quartz and its varieties, tourmaline, garnet, aquamarine and topaz. Gemstones occur in most major geological environments, and each environment tends to have a unique suite of gem materials.

Objectives: The scope of this paper is to examine the role of geologists in the value chain of Nigerian Gemstones.

Methods: The path of the value chain considered includes mineral scouting, exploration, exploitation, separation and sorting, washing, grading classification, beneficiation, jewelry mounting and finally end user marketing.

Results: The value chain is not without militating challenges like crude method of mining, inadequate geodata and insufficient capacity, lack of access to fund, outdated design and lack of international certified professionals.

Conclusions: This study meant to resurrect the inestimable role of geologists in the gemstones' value chain in Nigeria to enhance job creation, professionalism, generate revenue for the tiers of government and promote private sector linkages with major international mining organization.

Keywords: mining, gemstone, value chain, miner, artisanal and small-scale, jewelry

INTRODUCTION

Nigeria is known to have over 44 deposits of different solid minerals including gemstones in large quantity, yet the sector contributes less than 0.3% to the Gross Domestic Product (GDP) of the nation. Gemstones are known as a mineral crystal of precious stones found underneath the earth (Adesoji, A. and Stephanie, H. (2018). They are naturally formed as minerals or substance of beauty when cut and polished for jewelry and part of alternative and complementary medicine from pre-historic times. Gemstones all have something special and beautiful about them. The scope of this research is to analyze the role of geologists in

the path a gemstone takes from exploration, mining to the end users. This is to explore the rationale of gemstones path, value chain and their contribution to the economy of a developing nation in Nigeria. According to Read (2016), the locality of a gem deposit is the country or area where the gem exists; some parts of the earth seem to have been more blessed than others by geological conditions favorable to the formation of gemstone deposits. Gemstones form by geological processes in the rocks of the earth's crust and upper mantle. The rocks and gemstones we find nowadays on

the surface of the earth were buried for a long time (millions of years) deep in the earth's crust and mantle, where, conditions (temperature and pressure) enabled a formation and transformation of gemstones and rocks.

The Egyptians are known to import obsidian gemstones which they used in making weapons as well as jewelry around 4000 BC. In China around 3600 BC, gemstones were used to make tools as well as jewelries. Chinese were known with Nephrite Jade. Indians, Greece, Romans, Europeans, African and a lot of other places in the world used gemstones for numerous purposes especially in healing and ornaments up till the 21st century (finelib.com, 2017)

Conventionally, gemstones are of broad categories: Precious, Consisting of Diamonds, Sapphires, Ruby and a very green deep variety of beryl / emerald and the non-Precious, which include aquamarine, garnet, olivine, quartz, topaz, tourmaline, agate, garnet, zircon etc

If due to erosion a rock formerly buried is brought to earth's surface, we might find within this rock gem materials and ores. Strictly, a gem should possess the following characteristics: 1. Desirable colour. 2. Unique optical properties. 3. Rarity.

Some of the basic uses of gemstones include: 1. As jewelry, mostly worn as part of fashion or dress code. 2. As ornaments, mostly as other decorative materials and 3. As hard assets, since it commands very high price and rarely depreciates in value, thereby used as valuable assets, stocks or equity.

Geological Environments of Gemstones

Primary gemstones are minerals formed mostly by geological processes that occur at great depths under conditions of relatively elevated temperatures and pressures. Surficial processes only form a few gemstones but assist in recirculating already formed primary minerals through erosion and sedimentation. Gemstones can be found in several geological environments, and are typically associated with certain rock types and suites of minerals. The following geological environments and host rock associations are the most common for gemstones.

1. Plutonic-Hypabyssal (alkaline granites, syenites, pegmatites, lamprophyre, kimberlite)
2. Volcanic (Alkaline basalts)

3. Metamorphic (Regional and Contact Metasomatic)

4. Sedimentary (Placer)

5. Weathering and Supergene

In the context of the geological associations outlined above, the geology of Nigeria is characterized by the prevalence of Precambrian metamorphic and igneous rocks intruded by Jurassic alkaline ring dykes and overlain by Cretaceous to Quaternary sedimentary and volcanic rocks. Rock types within the Precambrian basement include Archean migmatites and gneisses, Proterozoic schists and metavolcanics that are intruded by Pan-African granitoids (Older Granites) and pegmatites.

2.1 Types of Gemstone Deposit

Based on the ore-forming processes, gem deposits can be classified into two major types: *primary* deposits and *secondary* deposits

2.1.1 Primary Gemstone Deposits

The gemstones are found in their original host-rock. The profitability of such a deposit is highly dependent from the concentration of gemstones (per ton of rock) and the weathering stage of the host-rock. **Primary deposits** are formed by the concentration of gem minerals by primary crystallization as a result of magmatic, hydrothermal, and metamorphic processes. Such deposits are found in igneous rocks mostly as disseminations, such as in kimberlites (diamond), lamprophyre dykes (sapphire), alkaline granites and syenites (fluorite, beryl, topaz, emerald, zircon, apatite), pegmatites (garnets, tourmalines, emerald, aquamarine, sapphire, ruby), alkaline basalts (sapphire, zircon, spinel), and hydrothermal veins (beryl, fluorite, amethyst, topaz). Regional and contact metamorphic and metasomatic rocks contain a variety of gemstones including garnets, kyanite, sillimanite, corundum, zircon, sapphire, ruby, spinel, and scapolite. Certain gemstones such as emeralds are nearly exclusively found, as gem-quality in primary deposits.

2.1.2 Secondary Gemstone Deposits

When a primary gemstones deposit is weathered or eroded, more durable gemstones such as diamond, corundum and other colored gemstone may be transported by water

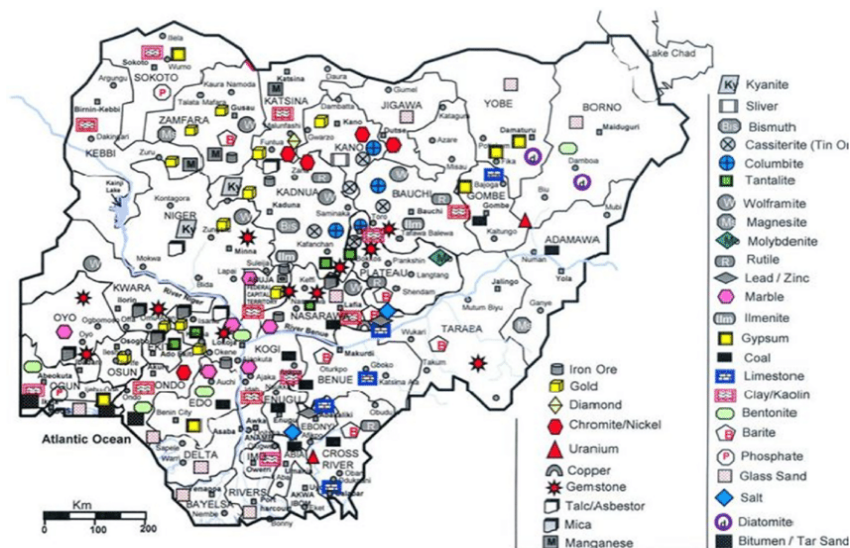


Fig. 1: Map of Nigeria showing availability of gemstones and precious minerals in the country (Delta Analyst Online, 2018) Source publication.

or wind energy and accumulated later in a secondary gravel deposit (sedimentary regime), e.g. along a river or in a delta. Such rich concentrations of dense rough gemstones are often called gem pockets. They are a great source of gemstones in many deposits in Sri Lanka, Madagascar, Tanzania and other regions. The majority of diamond and corundum gem (ruby and sapphire) deposits are found as eluvial and alluvial placers.

3.1 Geology and the Distribution of Gemstones in Nigeria

Nigeria, West Africa is not an exception when it comes to gemstones; the country is richly blessed with one of the world's most sought after semi-precious and precious stones. Most of the Gemstones found in Nigeria are hosted by a type of intrusive igneous rock geologically referred to as pegmatite.

Complex pegmatite type is a variety, occurring with Quartz vein that is valued for their ability to host Gemstones in the basement complex and younger granite. The pegmatite belt, known as "The Pegmatite of Central Nigeria" contain over 5000 veins in a broad belt that covers about 800 Kilometers long and 400 Kilometers wide mainly in the western half of Nigeria with interesting finds in the Oban and Obudu areas of the South-South. The Gemstones in Nigeria are hosted in quartzo-feldspathic veins, pegmatite dykes, stringers and veinlets and some rich elluvial deposits. These units usually truncate basement rock such as

Amphibolites, Gneisses and Schists. Embedded in this vast belt are also primary Tantalite, Tin and Columbite. A few other emerging pockets to this belt are still being discovered. Some of these Gemstones are considered below;

3.2 Tourmaline

Tourmaline leads in the list of most popular types of gemstones in Nigeria. This is because it is found in abundance, comes in many colors and it is readily available for buyers. The colors of tourmaline include blue, green, pink, watermelon, red and lots more. Tourmaline can be found in many locations in many states like in Oro, Lemo, Ora and Ndeji all in Kwara State. Also, they can be found in Saura, GidanKadiri, Keffi, Garaku, Anngwan Mayo, AngwanLele, Angwan Doka, AnngwanTudu etc, all in Nasarawa State. Certain regions such as Itasa, Komu, Budo Are, Idoko, and more in Oyo State also have tourmaline deposits. When it comes to Kaduna State, tourmaline can be found in places like GidanWaya, Kagarko and lots more. Other states with tourmaline deposit include Osun, Kogi, Bauchi and Taraba. Also important is Sarkin Pawa in Niger State, among others.

3.3 Sapphire

Sapphire ranks second in the list of most popular gemstones in Nigeria after tourmaline. Sapphire is a blue gemstone that is most valuable and costly. In Nigeria, it



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Fig.2: Tourmaline Crystals from the Ibadan Gemfield



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Fig. 3: (a) and (b) Blue Sapphire, Mambilla Plateau (c) Yellow/Blue Sapphire, Antan

comes in colors like pale green, rich blue, colorless, indigo blue and lots more. Nigeria is blessed with good quality Sapphire that are among the best in the world. Nigeria's Sapphire belt stretches from the North Central to the North East including Nasarawa, Plateau, Kaduna, Bauchi, Borno, Adamawa, Yobe and Taraba states. The average price of rough Mambilla Sapphire is #400,000 per gram. According to Kanis and Harding (1990), the first sapphires were discovered in Antan by a tin mining company, but the company ceased operations after a few months. Most of the sapphires found were too dark to market at that time and the commercial heat-treatment of sapphires was still unknown. Sapphires reported to be from this area excavated by artisans

appeared in the gem market in 1974. According to (Olade, 1978), The outpouring of Miocene- Quaternary alkali basalts and trachytes in the Biu-Mambilla Plateau, extending eastwards into the outpouring of recent lava flows in the Bamenda Hills and volcanic islands along the Cameroon Volcanic Line, represent the effects of hotspot tectonics on the domed lithospheric crust and incipient continental rifting. This is consistent with the view that these volcanic rocks and the associated gemstones were probably formed in the mantle or in the lower crust above a mantle plume (Coloum et al, 1996).



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Fig. 4: Blue- Green Aquamarine, Nasarawa (b) Aquamarine Crystal, Jos (c) Aquamarine, Okene



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Fig.5: (a) and (b) Light Green Emerald, Nasarawa Egon state (c) Green Emerald, Gwantu, Kaduna state

3.4 Aquamarine

Aquamarine is another widely known gemstone in Nigeria. It is sold in large quantity in the country. It comes in varieties ranging from the mineral beryl green-blue to blue colors. Aquamarine can be found in places like Isanlu and Okene in Kogi State; Akwanga; Igbo Ora, and Ijebu Igbo in Ogun State; Nasarawa; Ibadan in Oyo State; Jenta; Agwada and Igwo in Nasarawa State.

3.5 Emerald

Emerald is of the family of beryl mineral and it has a bright green color. Although the Nigeria Emerald does not have the rich variety green colour like the Columbian or Ethiopian Emeralds, it is still very economically viable due to the high prices it generally command in the international market. Nigeria Emerald deposits

are found in states like Niger, Plateau as well as Nasarawa Egon in Nasarawa State and at Gwantu in Kaduna State.

3.6 Garnet

Garnet is another gemstone found in Nigeria in large amount. Garnet comes in many colors ranging from orange to brown. In Nigeria, different varieties of garnet are mined with varieties including; Spessartite garnet found in Komu in Oyo state. This variety comes in colors like orange, orange brown, to deep red. Another variety of garnet popular in Nigeria is the Rhodolite garnet found in the axis of Jos-Bauchi. Another is green tsavorite garnet but this variety is usually confused to be tourmaline.



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Fig.6: Red (Rhodolite), Jos- Bauch (b) Orange Garnet, Spessarite, Oyo State

3.7 Zircon

Another gemstone common in Nigeria is Zircon. It comes in colors like yellow, white, brown, pink, white or even in a colorless form. Often times, this gemstone can be confused with diamond because they share almost the same features. Zircon deposits in Nigeria include kunzite zircon found in the mines of Komu, Oyo state. Other places include jos, Plateau state, Nisama and Antah in Kaduna state.

3.8 Topaz

Another attractive gemstone in Nigeria is topaz. It comes in colors ranging from white to blue and often times, it is used as a diamond substitute. Topaz can be sourced in Oyo State; Akwanga and Jenta in Nasarawa State; Bauchi; and Jos in Plateau State.

3.9 Amethyst

Amethyst in Nigeria is of very high quality and usually has a purple color. It is sourced in places like Nasarawa, Bauchi, Oyo, Kano, Kaduna, and lots more. Apart from these gemstones, other types of gemstones found in small quantity in Nigeria include; Kunzite, Ruby, Agate, Heliodor, Opal, Tanzanite, Goshenite, and Morganite. .

All gemstones photographs culled from M.A Olade (2021)

4.0. Gemstone Mining in Nigeria

Nigeria is endowed with eighty major groups of gemstones of semi precious to quality presently

being mined mostly via illegal means. The complex pegmatites were previously thought to be concentrated in central Nigeria but they are now found in the different part of the country. This implies that the gemstones and other minerals, which are associated with them, are more widespread than one was made to believe in the past. The mines Department of the Federal Ministry of mine and steel reported gemstones mined for 1994 to 1997 as 810kg, for 1995, 645kg, for 1997, 700kg. These figures are obviously inaccurate in view of the massive illegal mining and exportation that characterize the gemstones business in Nigeria.

In Nigeria, the mining phase is preceded by reconnaissance, for favourable location followed by exploration, a systematic search with the use of specialized equipment and tools to establish the viability of the gemstone. The gemstone mining location abound across Nigeria (Fig 1) with the major areas located within the Northern and South western axis. The mining operations are largely on a small scale by small time miners sponsored by marketers, dealers and behind the scene investors. The miners mostly sell directly to treaters, who are existentially very small in number and a growing number of professional cutters. Though the common practice is to deal rough to the marketing agents, who often smuggle the roughs to destination such as Srilanka, Thailand etc., the mining approach is mostly rudimentary and unorganized.



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(a) Zircon, Jemaa

(b) Red Zircon, Mambilla

(c) Kunzite Zircon



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Fig. 7: (a) White Topaz (b) Yello Topaz (c) Blue Topaz



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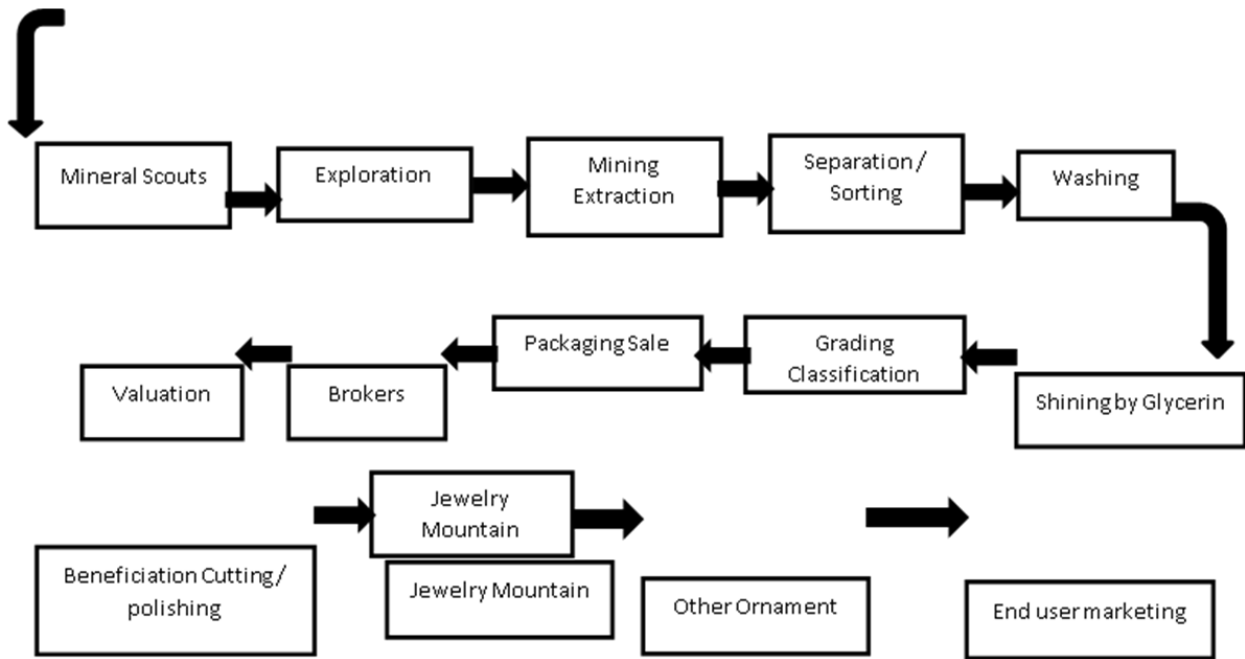
Fig.8: (a) Blue Amethyst (b) Amethyst from Jalingo (c) Amethyst, Jos Plateau

5.0 Gemstone Value Chain

According to Macfarlane (2013), value chain activities are a process that involves an integrated structure, which captures and assesses information on a concurrent base. For the gemstone to arrive at the final customer fit for jewelry, major steps which are included in the path are involved in the processing such as panning, cleaving, bruiting, polishing, and final inspection as gemstones in its natural state has a

highly irregular geometry and includes many contaminations (Gaywala and Surat, 2014).The gemstone value chain describes the range of activities that people perform to bring a gemstone from its origin to final use and beyond. This value chain includes: *Scouting, Exploration, excavation, Separation sorting, Washing, Shining, Grading Classification, Packaging, Brokers, Valuation, Beneficiation Cutting / Polishing,*

Value Chain



Jewelry Mounting, Other Ornaments, Marketing and marketing support to the consumer. The gemstone sector along with its wealth has much potential and should be regarded as a strategic National Asset that could contribute to the human and economic development of a country. Nigeria as a country has not been able to maximally tap the potentials and impact positively on the lives of those who operate around its value chain (Kayode, 2018). Gemstone beneficiation / processing stage is lacking in Nigeria, and it has contributed immensely to shortchanging the country. The gemstone value chain tends to provide an indication that enables economic growth, poverty reduction & vulnerabilities, and promote human capital development.

The gemstones path describes the process in which a gem passes through, from the mine to the customer. The process starts with the mining of the gems mostly done by ASM. The rough gems then pass through intermediaries, *brokers, traders and dealers* before they are cut and polished and sold to customers. Gemstones, such as diamonds, have a well-documented pipeline; the passage of the gem from mine to the client is relatively direct. The gemstone path is a process that can be

adequately analyzed and possibly used to determine the value added at each stage of the process. The path is comparable to the supply chain management that consistently plays a significant role in all sectors. The supply chain for rare earth minerals includes extraction, separation, refining, alloying and manufacturing (Humphries, 2013). Integrating the supply chain activities into the ASM sector reduces the adverse impacts of the mining process, as well as minimizes energy and material usage (Mudili et al., 2013). The variability and routes that a stone may take are dependent on the locality in which it was mined, the quantity and quality extracted from the mines, the type of mining, and the identity of the material if it is typically treated.

6.0 Role of Geologist

Elements occur in the earth as minerals. If local physical, chemical and structural conditions are conducive to concentrating these minerals to sufficiently high abundances in the earth's crust, a mineral deposit will form. If technology is available to extract gemstones or metals from the minerals economically, then you have a mineral resource that will be mined and processed.

Determining which minerals or precious stones are present and quantifying their abundances, textural characteristics (grain size and shape) and how they are inter grown with each other is the realm of the mineralogist. **Geologists** use this mineralogical data to understand how the mineral deposit formed, how to find high-grade zones within the deposit and where to find other mineral deposits. Metallurgists in case of metals and **geologist** for gemstones use this data to design, operate and optimize processing facilities to extract the gemstones from the rock. The types, quantity and precision/resolution of the mineralogical data required by geologists and gemologists are different, but are not mutually exclusive of each other. The understanding and the knowledge of **geologists** enable him to value gemstones based on factors commonly referred to as the four C^{’s} – **Clarity, Carat, Colour and Cut**. Though the first 3 features are intrinsic characteristics, the cut refers to the precision of faceting which emphasizes the shining, intensity of brilliance, depth and dispersion of colour. This simply implies quality gemstones, in terms of clarity, possess minimal flaws such as related to cloudiness, cracks and inclusions while the colour must be bright as much as possible. One of the most important tools of gem identification is the Light we use, as gem identification employs one sense above all else – Sight. Even the most expensive instruments will do us little good if they are used with incorrect light because the lighting itself influences what we see. Improper lighting can result in a more difficult or even incorrect identification. Interestingly, while you might think it would be the other way around, real gemstones are going to have flaws, while synthetic gems will look more perfect and fake gems tend to sparkle and shine better. The specific role of a geologist in the value chain is itemize bellow:

Mineral Scouting: Geologists observe rock samples and establish the relationship between it and the remote chances of mineralization in a particular location.

Exploration: Geologists conduct full scale exploration to determine geological relationship and establish economic viability of gemstones deposit on a locality by the use of appropriate professional tools and equipment.

Mining Extraction: A geologist rely on his knowledge of gemstones occurrences to advise on the best method of extraction to forestall

loss or damage to the gem.

Separation Sorting: In conjunction with the Gemologist, a geologist draws on his professional experience of Colour, Carat, Clarity and hardness to categorize recovered / mined gems by sorting.

Washing: Draw down on his knowledge of hardness of minerals to advice on best method to wash and prevent gem damage.

Shining with Glycerin: In conjunction with gemologist, a geologist selects the most desirable refraction liquids which possess high refractive indices (RI). This helps to distinguish & clearly identify inclusions and diffusion treatments.

Grading Classification: Apply knowledge of Gem physical characteristics and Optics to grade based on observation with appropriate instruments and experience.

Packaging sales: packaging gemstones based on the different observable properties and treatments. Also, between natural and synthetic gem, which are the same in terms of physical, chemical & optical properties, except that it has been made by humans.

Brokerage: Rely on professional expertise, in conjunction with gemologist, advise clients on quality including to differentiate between natural, fake, synthetic gems, simulated, made of a material with the appearance of a natural gemstone but with different physical and chemical properties and treated gems. Who will believe 95% of natural Rubies and blue Sapphires have been heat-treated!

Valuation: In conjunction with gemologist, Geologists value gemstones to ensure they are correctly priced according to quality, size and projected market value based on knowledge of the 4 C^{’s}.

Beneficiation cutting /polishing: Work with the gemologist, applying knowledge of gem optics to advice on best geometric cut to optimize light dispersion to enhance beauty and value of the gem.

Jewelry mounting / other ornament: In Conjunction with gemologist applying knowledge of metals and gemstones properties to ensure perfection in the craft for durability. This also apply to other ornaments such as in fabrics, accessories, cuff links, bracelets, buttons, watches and other selections.

End user marketing: The geologist relies on the knowledge of gemstones to promote the marketing armed with intelligence of optics, birthstones, hardness, geometry of cut etc.

7.0 Operating context

The Nigeria gem industry is operating in an embedded way of doing business. The sector is dominated by Artisanal and Small-Scale Miners that excavate the gems and sell rough to dealers; Nigeria gems are literarily smuggled out of the country as raw materials. The opportunities in this sector such as employment generation, increase in internally generated revenue, reduction in poverty and the enhancement of foreign exchange earnings are not fully harnessed. This is as a result of the sector being undeveloped and neglected due to over-dependence on oil. It is essential to review the Nigerian Mining laws so that ASM activities could be guided; miners should have regulated titles, and licenses and operations should be carried out under due diligence. The present operating context of the sector in Nigeria lacks sufficient geological data, cooperative federalism, limited infrastructure and weak institutional capacity. There is the need for research and development, and the use /application of science, technology, as well as innovation within the sector (Devex, n.d).

7.1 Capacity Development

Capacity development of miners, brokers, gem dealers and customers are essential to ensure maximization of the gemstone value-chain. Accordingly, government should as a matter of policy designate, encourage, and support the private sector to provide the necessary framework and policy. The government cannot provide enough training platform for skills and capacity development in the sector, hence the need to collaborate with the organized private sector. Therefore, it is essential for the gemstone sector to be sustained through the involvement of the private sector. Players in the gemstone value chain can be organized through the creation of associations and involvement of

the Nigeria Chamber of Mines in overseeing the gemstone value-chain. The Gemological Institute in Nigeria (GIN) was established by private stakeholders to enable capacity development of interested Nigerians (Adesoji and Stephanie, 2018).

8.0 Militating Challenges

There are myriad of challenges militating against the proper development of Nigeria development Gemstones. Some of these include:

- (a) Inadequate Geodata on mine deposits and insufficient capacity.
- (b) Conflicts with the local community and lack of infrastructure
- (c) Lack of access to funds
- (d) Insufficient skills by miners and gem dealers, and absence of functional gems exchange
- (e) Low tech, old machinery, and outdated designs
- (f) Influx of foreigner who illegally trade without the statutory royalty payments, leading to revenue loss
- (g) There is also the inability to properly identify and value stones smuggled through our borders by Customs official at the border post.
- (h) Lack of Certification of professionals by internationally recognized gemstones sector bodies such as Gemological Institute of America (GIA).

9.0 Conclusion

To develop this value chain, geologists' role is inestimable. Sufficient geodata is very imperative as a pathfinder before mining exercise. We must strategically and deliberately shift from current low level technology, mining with proper geo-education to a modernized exploration, exploitation and beneficiation of our gemstones promoting private sector linkages with major international mining organization and participation in international conferences and exhibition.

Also, the notion of legal artisanal mining should be redefined to include the present state of miners after a simple means of registration. This will enable the Mining Cadastre Office (MCO) to have an exclusive record of those who are mining gemstones

in the country. It will also encourage the miners to be open, and there will be increased revenues as royalties meant for government coffers will be paid. Geologists with the aid government should be engaged to train the existing gemologists and artisanal miners in the prerequisites before engaging in gemstones mining.

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