

Geology and Mineral Resources of Kogi State, Nigeria

Fatoye Felix Bamidele

Department of Mineral and Petroleum Resources Engineering, Kogi State Polytechnic, Lokoja, Nigeria

Abstract– Kogi State is located in the north-central Nigeria. It is popularly called the Confluence State because the confluence of Rivers Niger and Benue is at its capital, Lokoja, which is the first administrative capital of modern-day Nigeria. The State lies between longitudes 6° 42' and 6° 70' E and latitudes 7° 30' and 7° 50' N. It has a landmass of 29,833 square kilometres. The geological setting of Kogi State is unique in view of the occurrence of the two major components of Nigerian geology (Basement Complex and Sedimentary Basin). Approximately, half of the State, the western flank, is covered by crystalline Basement Complex of Precambrian age while the other half, the eastern flank, is covered by Cretaceous to Recent sediments. The Basement Complex is made up of Migmatite-Gneiss Complex, the Schist Belts and the Older Granites and the sedimentary area, which is the Anambra Basin, consists of sedimentary rocks that form part of Cretaceous to Recent sediments of Nigeria. Kogi State is richly endowed with mineral resources. Over twenty mineral resources have so far been reported in the State by the Geological Survey of Nigeria Agency (GSNA). Mineral deposits of economic significance that occur in the two geologic segments of Kogi State among others include; beryl, cassiterite, clay, coal, columbite, feldspar, fire clay, garnet, gold, granite, iron ore, kaolin, magnetite, marble, mica, muscovite, silica sand, quartz, talc, tantalite and tourmaline in alphabetical order.

Keywords– Basement Complex, Confluence State, Sedimentary Basin and Mineral Resources

I. INTRODUCTION

Kogi State popularly known as the Confluence State is located in north-central geopolitical zone of Nigeria. The State was created on 27th August, 1991 by the then Head of State, General Ibrahim Gbadamosi Babangida from part of Kwara State and Benue State and it has twenty one (21) Local Government Areas. The State is the only State in Nigeria which shares boundary with ten (10) other States (Fig. 1). It is bordered to the north by the Federal Capital Territory and Niger State; to the north-west by Kwara State; to the north-east by Nasarawa State; to the west by Ondo and Ekiti States; and to the east by Benue State. It also shares boundary with Anambra State to the south; Edo State to the south-west and Enugu State to the south-east.

There are three (3) main ethnic groups and languages in Kogi State: Igala, Ebira, and Okun (a Yoruba group) with other minorities like Bassa (a small fraction of Nupe), Ogori

Magongo, Oworo (a Yoruba group), Ogugu (subgroup of the Igala), Gwari, Kakanda, and the Eggan community.

Kogi State is blessed with abundant mineral resources distributed fairly in the two geological segments of the State (Fig. 2). According to reports by the Geological Survey of Nigeria Agency (GSNA), the State has over twenty (20) known major mineral deposits distributed in its twenty one (21) Local Government Areas and offers considerable attraction for investors. Kogi State is home to the largest iron and steel industry in Nigeria known as Ajaokuta Steel Company Limited. One of the largest cement factories in Africa, Dangote Cement Factory is built in the State.

This paper therefore attempts to update the knowledge on geological setting and mineral resources of Kogi State in Nigeria.

II. GEOLOGICAL SETTING

The geological setting of Kogi State is unique in view of the occurrence of the two major components of Nigerian geology (Basement Complex and Sedimentary Basin). Approximately, half of the State is covered by crystalline Basement Complex while the other half is covered by Cretaceous to Recent sediments.

The Basement Complex are predominantly underlain the western flank of the State. They are made up of Migmatite-Gneiss Complex which include rocks of migmatites, gneisses and granite-gneisses; the Schist Belts (metasedimentary and metavolcanic rocks) which include phylites, schists, pelites, quartzites, marbles and amphibolites; and the Pan-African Older Granites consisting of granites, granodiorites, syenites, monzonites, gabbro and charnockites. The crystalline complex contained economic minerals such as iron ore, gemstones, quartz, feldspar and other associated minerals, while the Pan-African Older Granite contained cassiterite, tantalite, columbite, gemstones and other associated minerals [5].

The eastern flank of the State is on the alluvium (youngest and most recent sedimentary rocks) and other sedimentary rocks, which form part of Cretaceous to Recent sediments of Nigeria. This area lies within the Anambra Basin and the geology is the same with the geology of the Lower Benue Trough, through south of the Benue River. It is mainly made up of different Formations of Nkporo, Mamu, Ajali and

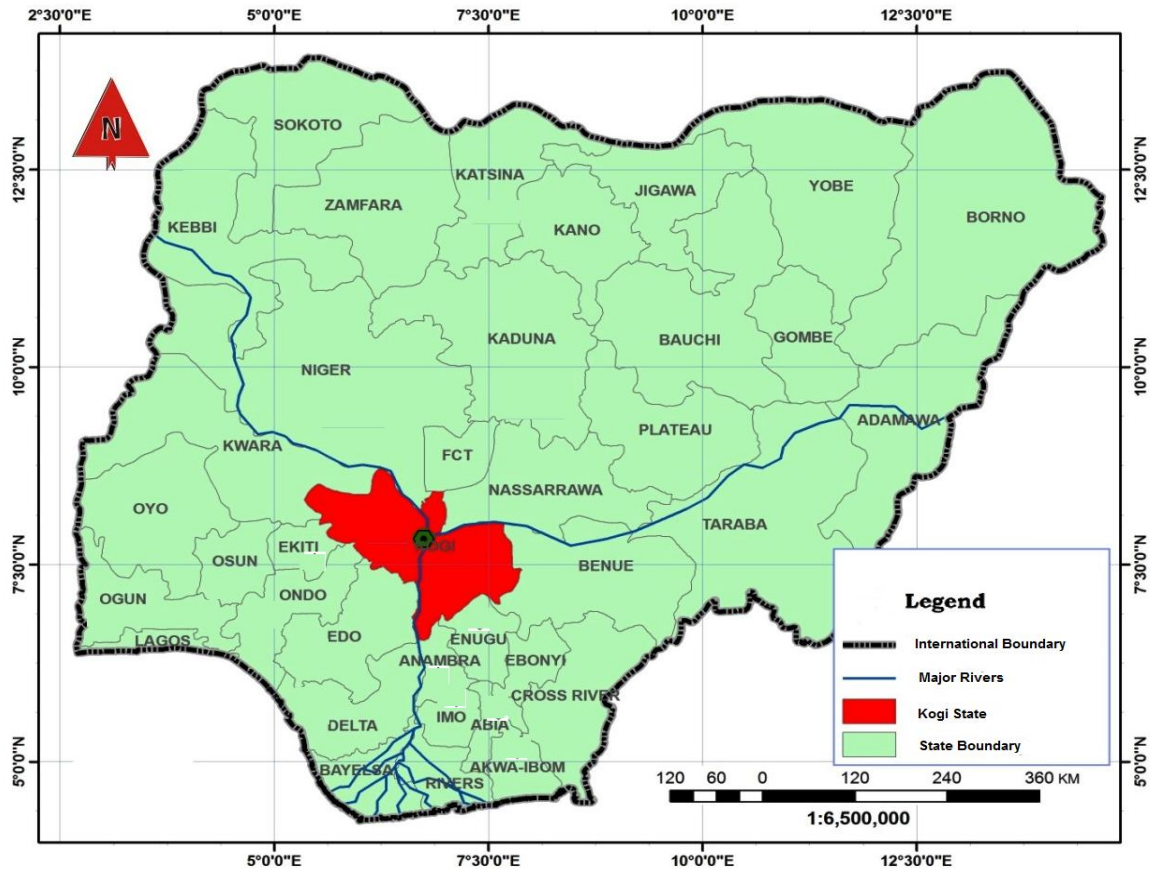


Fig. 1. Map of Nigeria showing Kogi State (modified from [9])

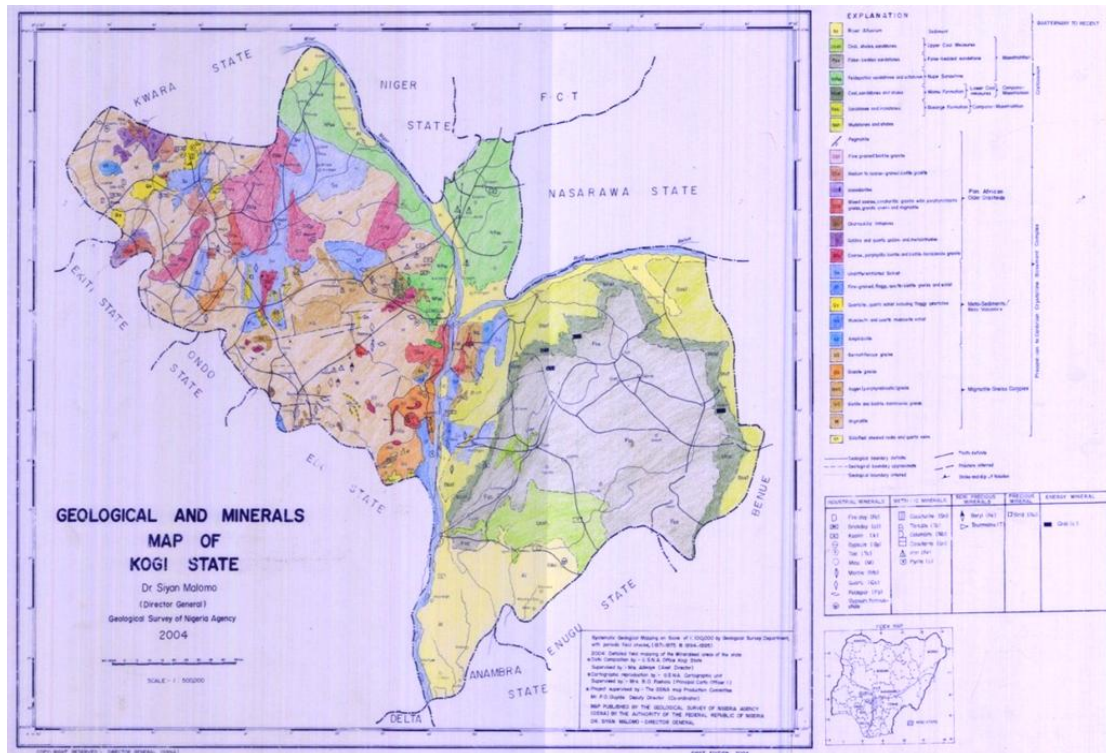


Fig. 2. Geological and Minerals Map of Kogi State (after [8])

Nsukka [4]. These Formations are inter-bedded with sandstones, siltstones, carboniferous-shale, coal, sandstones of fluvial marine nature with distinct across beddings and laterite. These Formations control the localization of coal, kaolin, clay, sandstones, limestone, gemstones, slate, phosphate, gypsum and other associated minerals.

III. MINERAL RESOURCES

Geological Survey of Nigeria Agency (GSNA) has played an active role in the exploration for mineral deposits in Nigeria. Kogi State like other States in Nigeria is found to be endowed with mineral resources. The mineral resources so far reported in the State by the Geological Survey of Nigeria Agency are discussed below:

Beryl: Beryl is a hard, crystalline mineral, composed of beryllium aluminum silicate that occurs in white, yellow, pink, green, or blue forms. In other words, it is a hexagonal mineral, $\text{Be}_3\text{Al}_2\text{Si}_6\text{O}_{18}$, from which beryllium is extracted; its principal occurrence is in granite pegmatites. Beryl is a major gemstone; when green, it is emerald, when blue or bluish-green, aquamarine, and when pink, morganite.

Beryl is found at Ikoyi in Ijumu Local Government Area (LGA) and Aku in Adavi LGA. Both areas are underlain by migmatites. The mineral is used as gemstone.

Cassiterite: Cassiterite is a dark-coloured mineral consisting of tin oxide, SnO_2 , the major ore of tin. Otherwise known as tin ore cassiterite belongs to the class of metalliferous minerals. It is associated with hydrothermal veins and pegmatites. Some deposits also occur in placers as well as in granite. The area in the State where the mineral is found is Okoloke in Yagba West LGA.

Tin is a widely sought metal and is used in hundreds of industrial processes throughout the world. In the form of tinplate, it is used as a protective coating for copper vessels, various metals used in the manufacture of tin cans, and similar articles. Tin is important in the production of the common alloys bronze (tin and copper), solder (tin and lead), and type metal (tin, lead, and antimony). It is also used as an alloy with titanium in the aerospace industry and as an ingredient in some insecticides. Stannic sulphide, known also as mosaic gold, is used in powdered form for bronzing articles made of plaster of paris or wood. Its compounds are used in dyeing and fire-proofing.

Clay: Clay is naturally occurring material composed primarily of fine-grained minerals, which show plasticity through a variable range of water content, and which can be hardened when dried and/or fired.

Clay is found all over the 21 Local Government Areas of the State. The uses of clay and clay products are too numerous to list completely. In domestic life clay is used in pottery, earthenware, china, cooking ware, vases, ornaments, plumbing fixtures, porcelain stoves, tiles, fire kindlers, oilcloths, linoleum, wall-paper, scouring soaps, and polishing bricks. It even finds a place as an adulterant in foods and

medicine. In buildings it is used for building bricks, vitrified and enameled bricks, building and conduit tiles, tiles for floors, walls, and drains, copings, flues, chimneys pots, sewer pipes, and foundation blocks. In electrical industry it is used for conduits, cleats, sockets, insulators, and switches. In refractory ware it is used for fire brick, furnace linings, chemical stoneware, crucibles, retorts, glass-melting equipment, and saggar. Other important uses are for furling cloth, foundry sands, terra cotta, emery wheels, rubber crucibles, water conduits, paving bricks, septic tanks, railroad ballast, Portland cement, filtering oils, paper making, and innumerable minor purposes.

Coal: Coal is a carbon-rich, combustible, stratified organic sedimentary rock composed of altered and/or decomposed plant remains of non-marine origin, combined with varying minor amounts of inorganic material. Coal deposits in the State are restricted to the eastern flank which lies within the Anambra Basin.

Mineable coal deposits in the State are found at Odokpono, Okobo and Odagbo (Okaba) in Ankpa LGA and at Ogboyaga in Dekina LGA.

The coal deposits in Kogi State are of medium quality, non-coking and sub-bituminous. These put together suggest that they do not possess some coking qualities suitable for coke making blends. However, the coals are suitable for electric power generation and as domestic fuel. They are also rich in resinous and waxy materials and are therefore suitable raw material for the chemical industry and also for use in the manufacture of plastics, when fractionally distilled. The coals are also good producer of gas fuel, and are suitable for complete gasification using the oxygen enriched steam blast process. They can also be processed to produce automotive fuel [3].

Columbite: Columbite is an iron black, often iridescent, orthorhombic mineral oxide of niobium, tantalum, iron, and manganese $(\text{Fe,Mn})(\text{Nb,Ta})_2\text{O}_6$, with varying proportions of niobium and tantalum. When the proportion of tantalum exceeds that of niobium, it is called tantalite. Columbite is the principal commercial source of tantalum and niobium. In most cases, columbite in the State occurs in association with tantalite. Most of the columbite in the State is concentrated in alluvial deposits. Few deposits occur with tinstone in granite and pegmatite.

Columbite is found at Isanlu-Esa, Okoloke, Odo Eri and Ejiba in Yagba West LGA; Iddo and Takete-Isao in Yagba East LGA; and Idibo in Ajaokuta LGA. Columbite is used in the production of dental and surgical instruments, niobium metals, electrodes and alloys.

Feldspar: Feldspar is an aluminosilicate mineral containing varying proportions of calcium, sodium, potassium, and other elements. It is the most important group of rock-forming minerals that make up about 60% of the Earth's crust. Feldspars are essential constituents of most igneous rocks; the kind and amount of feldspar present is used in classification. They frequently occur in metamorphic rocks and in many

sedimentary rocks, more commonly in the arenaceous rocks than argillaceous. The type of feldspar most common in the State is potassium-rich feldspar (K-feldspar).

Large deposits of feldspar occur at Isanlu-Esa and Egbe in Yagba West LGA; Osara, Aku and Zariaji in Adavi LGA; and Lokoja the State Capital. Feldspar is used in glass, pottery, ceramics, filters in plates and paints.

Fire Clay: Fire clay also known as refractory clay is a durable clay that can withstand great heat. In other words, it is a clay that can withstand high temperatures without disintegrating or turning pasty. They are non-plastic clays, composed dominantly of kaolinite with illite, quartz and carbonaceous material. Fire clays from where surface conditions permit most minerals, except kaolinite and illite, to be leached out.

Fire clay is found at Ahoko-Koto in Kogi LGA. The mineral is rich in hydrous aluminum silicate and is used widely to manufacture clay crucibles, fire bricks and furnace linings, and as a binder in molding sands.

Garnet: Garnet is a variously coloured crystalline silicate mineral. In other words, it is a mineral that belongs to the family of silicates of iron, magnesium, aluminum, calcium, manganese, and chromium, which are built around independent tetrahedral and appear commonly as distinctive 12-sided, fully developed crystals. It is common in metamorphic rocks (gneisses and schists and some types of contact metamorphism) and is stable across a wide range of temperatures and pressures. It occurs in some mantle xenoliths. Garnet has a vitreous luster and is found in all colours but blue.

Garnet is found at Isanlu and Takete-Isao in Yagba East LGA and Odo-Ara in Yagba West LGA. It is widely used as a gemstone.

Gold: Gold is a soft, heavy, corrosion-resistant, yellow metallic element that is highly valued, found in underground veins and alluvial deposits.

It occurs principally as a native metal but may also be alloyed with silver, copper and other metals. Gold occurs in hydrothermal veins with quartz and various sulphides; disseminated in submarine massive effusive and in placers or nuggets, fines, and dust. Although a rare element, gold is widely distributed in nature.

Gold occurrence in the State is restricted to the schist belt. Most gold deposits in the State occurs as a native gold (gold dust) – concentration as placer along or close to old river beds. Few deposits also occur in quartz-veins and in pegmatites and in some areas underlain by the Basement Complex.

Large deposits of gold occur at Okolom, Dogondaji and Odogbe in Yagba East LGA; Okoloke and Ejiba in Yagba West LGA; and Katcha Katcha in Omala LGA. Gold is used in coinage, jewelry, alloys, decoration, dental work, plating, and for coating certain space satellites. It is a standard for monetary systems in many countries.

Granite: Granite is a coarse-grained igneous rock composed of feldspar (usually potash feldspar and oligoclase) and quartz with a small amount of mica (biotite and muscovite) and minor accessory minerals, such as zircon, apatite, magnetite, ilmenite, and sphene. Biotite and/or hornblende are common mafic minerals. It is the most extensively occurring igneous rock.

Large deposits of granite are found all over the western flanks of the State. Granite is used in road and building construction, office and home furnishing, ornamental and monumental purposes.

Iron Ore: Iron ore is a ferruginous rock containing one or more minerals from which metallic iron may be profitably extracted. The principal ore of iron ore found in the State are hematite and magnetite. They are dark grey to black heavy oxide of iron. They occur within the Basement Complex region of the State. They are mostly localized within the gneiss-migmatite-quartz complex.

Areas in the State where iron ore are found include Itakpe and Ajagbanoko in Adavi LGA; Agbado-Okudu, Agbaja, Oshokoshoko and Tajimi in Lokoja LGA; Ebiya in Ajaokuta LGA; and Koton-Karfi in Kogi LGA. Iron ore is used in the manufacture of industrial machines, alloys, tools, civil and construction works, ship building, rails, automobiles, air crafts, office and household products.

Kaolin: Kaolin is aluminous mineral of the kaolinite-serpentine clay mineral group. The mineral is soft and white in colour. It has tendency of becoming plastic when wet and hardened when dried or fired.

Kaolin occurs at Agbaja Plateau and Emu in Lokoja LGA; Agbaja Hill in Bassa LGA; and Angba in Igalamela/Odolu LGA. The mineral is used in ceramics, medicines, coated paper, tooth paste, cosmetics, paint, rubber, adhesives, chalks and fertilizer. It is also used as drilling mud in petroleum industry.

Magnetite: Magnetite is iron oxide, Fe_3O_4 black and strongly magnetic mineral. It is an ore of iron, although it can be found in the form of octahedral steel-black crystals with a metallic luster, it occurs more commonly as compact and granular masses. It is a common accessory mineral in igneous rocks and can be concentrated by magmatic segregation forming large orebodies, often with a high titanium content and is plentiful in contact metasomatic conditions.

Magnetite is found at Agbaja Plateau, Tajimi Ridge and Patti Ridge in Lokoja LGA; Gboloko in Bassa LGA; Akpogu in Mopa Muro LGA; and Ebiya in Ajaokuta LGA. Magnetite is a major source of iron.

Marble: Marble is a fine- to coarse-grained metamorphic rock consisting mainly of recrystallized calcite ($CaCO_3$) and/or dolomite [$CaMg(CO_3)_2$]. It is a metamorphosed limestone. It has colourless streaks resulting from impurities such as quartz or dolomite in the original limestone, which result in the formation of minerals such as forsterite (or serpentine). Marble deposits in the State are localized within

the highly metamorphosed metasediments of the Basement Complex [2].

Large proved reserves of marble deposits occur mostly in the western flank of the State at Oyo-Iwa and Jakura in Lokoja LGA; Okoloke in Yagba West LGA; Ekinrin-Adde in Ijumu LGA; Osara and Ubo in Adavi LGA; Itobe in Ofu LGA; and Mopa in Mopa Muro LGA. Marble is used in the manufacture of glass, paints, lime, cement, ceramics, iron and steel refining, bleaching powder, calcium carbide, chemical and pharmaceutical products, fertilizer, rubber and plastics, soap and detergent. It is also used in agriculture for life stock concentrates and land fertility, building and furnishing, wall cladding, paladiana, monumental and ornamental items.

Mica: Mica is a group of monoclinic phyllosilicate minerals characterized by their platy habit, perfect basal cleavage and the elastic properties of the cleavage flakes. The principal mica minerals are muscovite, biotite, phlogopite and lepidolite. Micas occur in a wide range of igneous and metamorphic rocks and some sedimentary rocks. Large crystals of mica are typically mined from granitic pegmatites. Two types of mica commonly found in the State are muscovite (white) and biotite (black). They are characterized by perfect cleavage, readily split into thin elastic plates.

Mica is found at Egbe and Isanlu-Esa in Yagba West LGA; Idofin in Yagba East LGA; Zariaji and Aku in Adavi LGA; and Lokoja the State capital. The mineral is widely used in electrical and heat insulators, lamp shield, lubricant, paints, Christmas trees snow and filters in plastics, ceramics, wall papers and decorations.

Muscovite: Muscovite is a common mica mineral consisting of potassium aluminum silicate. It also known as white mica or potassic mica. Muscovite is a mineral of mica group, $KAl_2[AlSi_3O_{10}](OH)_2$, colourless and transparent in thin cleavage flakes but translucent silvery or pale shades of yellow, brown or green in thicker crystals. Muscovite is a widespread and common rock-forming mineral, especially in pegmatite, granite and low-or medium- to high- grade metamorphic rocks (greenschist and amphibolites facies).

Areas in the State where muscovite is found are Isanlu-Esa in Yagba West LGA; Idofin in Yagba East LGA; and Aku and Zariaji in Adavi LGA. Muscovite is used as insulating material in the manufacture of electrical apparatus, particularly vacuum tubes. Scrap mica, obtained as waste material in the manufacture of sheet mica, is used as a lubricant when mixed with oils and as a fireproofing material.

Quartz: Quartz is a hard, usually colourless and transparent crystalline mineral. It is second most common of all minerals, composed of silicon dioxide, or silica, SiO_2 . It is distributed all over the world as a constituent of rocks and in the form of pure deposits. It an important rock-forming mineral and is an essential constituent of igneous rocks such as granite, rhyolite, and pegmatite, which contain an excess of silica. In metamorphic rocks, it is a major constituent of the various forms of gneiss and schist; the metamorphic rock quartzite is composed almost entirely of quartz. Quartz forms veins and

nodules in sedimentary rock, principally limestone. Sandstone, a sedimentary rock, is composed mainly of quartz.

Quartz is found all over the western flank of the State mostly at Isanlu-Esa in Yagba West LGA; Idofin in Yagba East LGA; Aku in Adavi LGA; and Lokoja the State capital. The mineral is used in electronic equipment (radio oscillation), glasses, lenses, prisms, refractory materials, porcelain, oscillation plate and in building construction.

Silica Sand: Silica Sand is a sand containing a high percentage of quartz. Large concentrations of silica sand occur all over the State mostly along river channels both in the western and eastern flanks of the State. Silica sand is used in road and building constructions, ceramics and glass among others.

Talc: Talc is very soft mineral consisting of hydrated magnesium silicate, $Mg_3Si_4O_{10}(OH)_2$, with a hardness of 1 on the Mohs Scale, that feels soapy when handled. It occasionally occurs as pale apple green, grey or white triclinic crystal but more commonly is compacted, forming foliated, fibrous or granular masses; in soapstone it is dark grey or dark green. It is an alteration product of magnesium silicates or ultramafic rocks and is also formed by metasomatism in pure dolomitic marbles.

Large deposits of talc are found at Ejiba in Yagba West LGA; Okolom, Odogbe and Iye in Yagba East LGA. Talc is used in cosmetics, ceramics, paper, paints, pharmaceuticals, plastics, rubber, and textiles, among others.

Tantalite: Tantalite is a reddish black mixed oxide mineral, $(Fe,Mn)Ta_2O_6$, containing tantalum, iron, and manganese. It is the principal ore of tantalum. Tantalite is isomorphous with columbite and occurs in pegmatites. It is highly resistant to corrosion.

Large concentrations of tantalite in the State occur in certain alluvial deposits associated with columbite. It occurs at Idofin in Yagba East LGA. Because of its resistance to corrosion, tantalum is used in surgery for skull plates and in air craft building. It is also used in the manufacture of special alloys, electrodes and tantalum metals.

Tourmaline: Tourmaline is a silicate mineral of boron and aluminum with sodium, calcium, fluorine, iron, lithium, or magnesium formed at high temperatures and pressures through agency of fluids carrying boron and fluorine. In other words, it is a group of hexagonal borosilicates minerals with variable chemical composition occurring as prismatic crystals or aggregates of parallel or radiating individuals. Tourmaline is a common accessory mineral in igneous and metamorphic rocks, and very common in pegmatites, where it sometimes occurs in crystals of enormous size. This diachronic gemstone comes in many different colours.

Tourmaline is found at Okoloke and Odo-Eri in Yagba West LGA; and Idibo in Ajaokuta LGA. The mineral is used in electronics, optics and as gemstone.

IV. CONCLUSION

The minerals discovered so far in Kogi State occur across the entire State both in the Basement Complex and the Sedimentary (Anambra) Basin. Every of the 21 Local Government Areas of the State has at least two mineral deposits. Most of these minerals occur in commercial quantities and are easily accessible. In view of the favourable geological environment in which these mineral resources are contained, mining and quarrying are easily workable. Of equal importance is that the physical and chemical properties of the minerals portend their suitability for processing.

These minerals encompass a wide variety of materials from metallic minerals like iron ore to non-metallic minerals like coal. Some are found on the surface, while others are found within the earth and can be exploited through underground mining. The minerals are at various stages of exploration and exploitation.

The exploration and exploitation of these minerals will increase tremendously the revenue generation capacity of the State, aside the considerable multiplier effects it will serve as a major foreign exchange earners and a source of raw material to local and international industries.

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Table I: Summary Table of Mineral Resources in Kogi State [7]

S/n	Mineral	Location	Local Govt. Area	S/n	Mineral	Location	Local Govt. Area
1	Beryl	Ikoyi	Ijumu	12	Kaolin	Agbaja Plateau	Lokoja
		Aku	Adavi			Emu	Lokoja
2	Cassiterite	Okoloke	Yagba West			Agbaja Hill	Bassa
3	Clay	All over the State				Angba	Igalamela/Odolu
4	Coal	Odokpono	Ankpa	13	Magnetite	Agbaja Plateau	Lokoja
		Okobo	Ankpa			Tajimi Ridge	Lokoja
		Odoagbo (Okaba)	Ankpa			Patti Ridge	Lokoja
		Ogboyaga	Dekina			Gboloko	Bassa
		Okpakiri	Dekina			Akpogu	Mopa Muro
		Dekina	Dekina	14	Marble	Oyo-Iwa	Lokoja
5	Columbite	Isanlu-Esa	Yagba West			Jakura	Lokoja
		Okoloke	Yagba West			Okoloke	Yagba West
		Odo-Eri	Yagba West			Ekinrin-Adde	Ijumu
		Ejiba	Yagba West			Osara	Adavi
		Iddo	Yagba East			Ubo	Adavi
		Takete-Isao	Yagba East			Itobe	Ofu
		Idibo	Ajaokuta			Mopa	Mopa Muro
6	Feldspar	Isanlu-Esa	Yagba West	15	Mica	Egbe	Yagba West
		Egbe	Yagba West			Isanlu-Esa	Yagba West
		Osara	Adavi			Idofin	Yagba East
		Aku	Adavi			Zariaji	Adavi
		Zariaji	Adavi			Aku	Adavi
		Lokoja	Lokoja			Lokoja	Lokoja
7	Fire Clay	Ahoko-Koto	Kogi	16	Muscovite	Isanlu-Esa	Yagba West
8	Garnet	Isanlu	Yagba East			Idofin	Yagba East
		Takete-Isao	Yagba East			Aku	Adavi
		Odo-Ara	Yagba West			Zariaji	Adavi
9	Gold	Okolom	Yagba East	17	Quartz	Isanlu-Esa	Yagba West
		Dogondaji	Yagba East			Idofin	Yagba East
		Odogbe	Yagba East			Aku	Adavi
		Okoloke	Yagba West			Lokoja	Lokoja
		Ejiba	Yagba West	18		Silica Sand	All over the State
	Katcha Katcha	Omala	19	Talc	Ejiba		Yagba West
10	Granite	All over the western flank of the State.					Okolom-Isanlu
11	Iron Ore	Itakpe	Adavi			Odogbe-Isanlu	Yagba East
		Ajagbanoko	Adavi			Iye-Isanlu	Yagba East
		Agbado-Okudu	Lokoja	20	Tantalite	Idofin	Yagba East
		Agbaja	Lokoja	21		Tourmaline	Okoloke
		Oshokoshoko	Lokoja		Odo-Eri		Yagba West
	Tajimi	Lokoja		Idibo	Ajaokuta		
	Ebiya	Ajaokuta					
	Koton-Karfi	Kogi					