

Research Article

Unveiling the Mineral Wealth of Kogi State, Nigeria: A Comprehensive Inventory and Assessment

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Abstract

Kogi State, Nigeria, is a remarkable repository of mineral resources, yet its potential remains largely unrecognized. Strategically located between latitude 6°30' N and 8°45' N and longitude 5°18' E and 7°53' E, Kogi is bordered by several states and covers approximately 30,345.74 km². It comprises three Senatorial Districts and twenty-one Local Government Areas, making it a vital hub for mineral exploration. In response to the urgent need for economic diversification, the Kogi State Government has initiated a comprehensive geological investigation aimed at unlocking the wealth of solid minerals. This endeavor began with an extensive desk study that reviewed geological maps, airborne geophysical data, and satellite imagery to identify promising areas for field exploration. Following this, meticulous fieldwork was conducted in collaboration with local communities to gather insights and samples from various terrains, including abandoned mines and active quarries. A total of 244 samples were collected for laboratory analysis, ensuring a thorough understanding of the mineral landscape. Kogi State is endowed with a diverse array of minerals: metallic resources such as iron ore and tantalite; industrial minerals including kaolin, gypsum, and marble; precious minerals like gold; and energy resources such as coal. As living standards rise, so does the demand for these essential resources across sectors such as agriculture, construction, and energy. The state aims to attract investment by focusing on eight key minerals with significant economic potential. The vision for Kogi State is clear: fostering private sector involvement in the mining and processing industries can catalyze rapid industrialization. This strategic approach will not only enhance local economies but also create much-needed job opportunities for the youth eager for employment. The development of industries ranging from steel production to ceramics manufacturing will elevate Kogi's economic profile. In conclusion, Kogi State stands at a pivotal juncture where its abundant mineral resources can be harnessed for sustainable growth. Through strategic investments in exploration and development, Kogi can transform its mineral wealth into a beacon of prosperity for its people and the nation as a whole.

Keywords

Kogi State, Mineral Resources Industrial Development, Geological Investigation Economic Potential, Sustainable Growth

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1. Introduction

Rocks and minerals play a major role in industrial development of any nation and improvement of the quality of life of people [1]. Most people do not know or are not just aware of how many minerals form an essential part of their lives, from agriculture to the materials for building their homes, their household devices, gadgetry, automobile and even their toothpaste [2]. As our personal demands and those of the world population become greater, the demand for minerals becomes greater too.

One of the cardinal efforts of the Federal Government's reform agenda is to shift focus from petroleum and gas to other sectors of the economy [3]. The development and utilization of investment opportunities in solid mineral resources is one area that has been appropriately identified as deserving priority. Kogi State is endowed with various mineral resources including metallic minerals, industrial minerals, precious minerals and mineral fuels, but their characteristics are not fully known yet [4]. For the State to prosper, these mineral resources must be developed and to develop we must invest.

The investment based prosperity that would accrue from the metals and minerals sector will allow the government to achieve goals as diverse as stopping further decline in minerals production and facilitating manpower development, stimulating development of supportive infrastructure, enhancing industrial growth through capacity utilization, increasing foreign exchange earnings through increased exports, increasing foreign exchange saving through import substitution and the nation's Gross Domestic Product (GDP) as well as providing much-needed employment opportunities for our teeming populace. The need therefore, to explore, develop and exploit Kogi state and nation's abundant mineral resources becomes imperative [5].

In recognition of the above fact, Kogi State Government under the leadership of His Excellency, Captain Idris Wada, Governor of Kogi State was eagerly desirous to carry out comprehensive geological investigation of mineral resources (mineral inventory) of Kogi State with a view to authenticate many reported occurrences of mineral resources in the State and discover new ones, if any, that will bring about investments in the State.

In pursuance of the realization of its desire, the Kogi State Government through its then Ministry of Special Duties, Sciences and Technology (hereinafter referred to as 'Employer') invited the National Steel Raw Materials Exploration Agency (NSRMEA) (hereinafter referred to as 'Contractor') which has modern exploration equipment and expertise in mineral exploration to participate in the bidding for execution of comprehensive geological investigation of mineral resources (mineral inventory) of Kogi State.

The Contractor responded to this invitation by submitting its quotation and expressing its willingness to carry out the work and studies to the satisfaction of Kogi State Govern-

ment.

Upon completion of the bidding processes, the Contractor emerged as the winner of the contract. Consequently, on 15th June, 2012, the Contractor was awarded the contract to execute comprehensive geological investigation of mineral resources (mineral inventory) of Kogi State by the Employer with completion period of twelve months. It is however, important to note that shortly after the award of the contract, the Office of Special Adviser to His Excellency on Special Duties through its Department of Mineral Resources then oversees the Monitoring and Supervision of the entire project.

2. Methodology

2.1. Desk Study

An extensive and careful literature review of relevant reports, literature and existing geological, topographic, geochemical maps, airborne geophysics, satellite imagery, aerial and satellite photographs of Kogi State was carried out. This provided an insight into the study areas and indicated the most significant geochemical anomalies and promising areas for field check out. Superimposition of the new airborne geophysical data on geological maps resulted in thematic maps, which allowed the Contractor to select the right geological context for ground exploration.

2.2. Field Work

Before starting the field work, series of meetings were held to ensure correct procedures are followed. The local authorities and officials were contacted. It was helpful to have a number of local people to help with transport where there was no road for vehicle and field work but for their local knowledge. Geological mapping, pitting and sampling were carried out. Several traverses were undertaken in and along primary and secondary roads, footpaths and streams across the State. Visits to abandoned mines and active quarries were made; and discussions with local experts were conducted. Assessment of existing mining-related infrastructure (rail and road connections, supply of electric power, water, manpower, etc.) in the promising mineral deposits was made. Study of drill core (especially iron ores) from previous exploratory drilling in some parts of the State was carried out. All observations made during investigation were properly documented. Two hundred and forty-four (244) samples were collected for hand specimen examinations and laboratory analyses. All the basic information required for the compilation of the report was obtained and assembled during the course of the investigation.

2.3. Office Work

Upon completion of the field work, the exploration team returned to Lokoja and finally Kaduna to elaborate the Mineral Potential Assessment Report of Kogi State in cooperation with specialized experts at the Contractor's Head-Office. The works carried out at the Contractor's Head-Office include compilation and processing of accumulated field data and samples; laboratory analyses of selected samples; systematic appraisal and evaluation of processed field data; defining and identifying the mineral resources whose economic potential are attracting attention for further detailed exploration, digitization of maps and compilation of Mineral Potential Assessment Report of Kogi State.

2.4. Location

Kogi State is located between latitude $6^{\circ} 30' \text{ N}$ and $8^{\circ} 45' \text{ N}$ and longitude $5^{\circ} 18' \text{ E}$ and $7^{\circ} 53' \text{ E}$. The State is bordered by the following States: Enugu (South East), Benue (East), Nasarawa (North East), Niger (North), FCT (North), Kwara (North West), Ondo (South West), Edo (East), Anambra (South) and Ekiti (South West) with a total landmass of about 30,345.74 Km. sq. and its headquarters in Lokoja. It has three (3) Senatorial Districts namely: - East, Central and West and twenty-one (21) Local Government Areas. [Figure 1](#) is map of Nigeria showing the location of Kogi State.

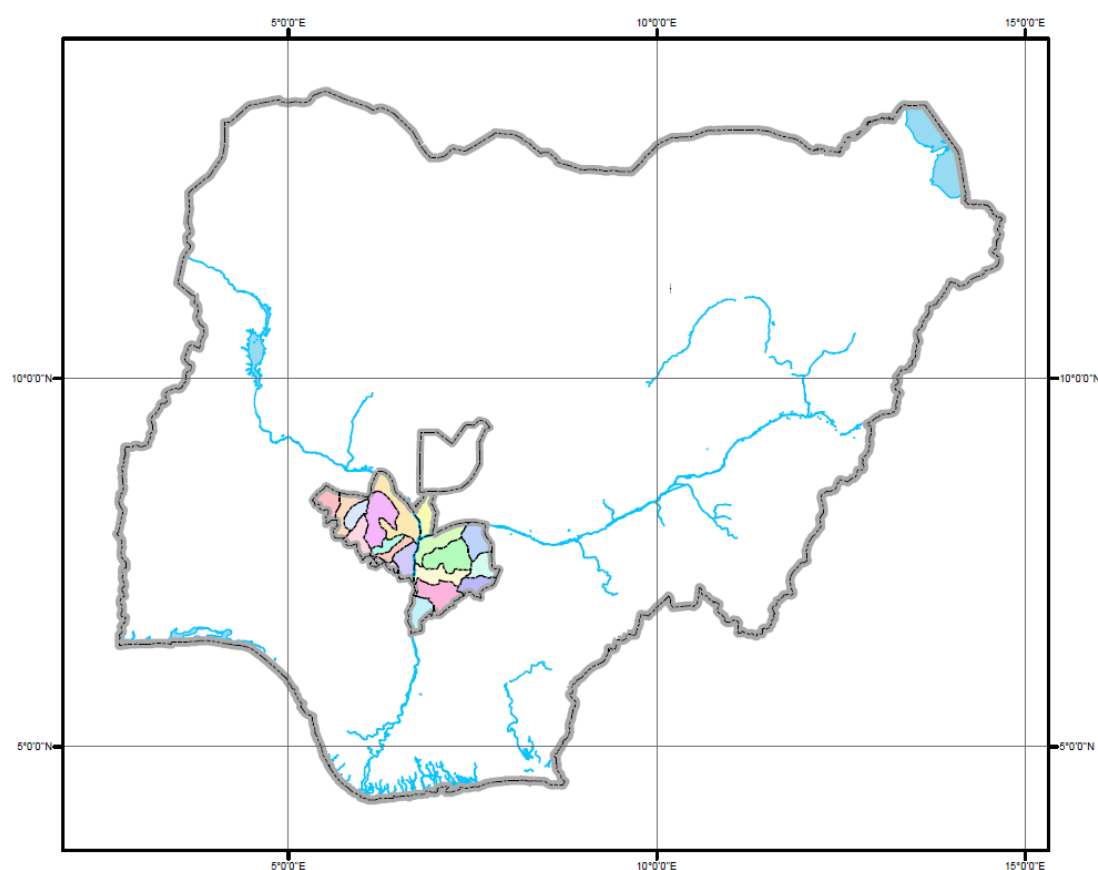


Figure 1. Is map of Nigeria showing the location of Kogi State.

Accessibility

The main towns of the State are connected by a network of all-season motorable roads. Generally most parts of the State are fairly accessible, except its large forest reserves.

2.5. Geomorphology

Kogi State is dominantly of high relief ranging from the flood plains of River Niger with elevation as low as 30 metres to high ridges as high as 509 metres east of the Niger

and 654 metres at Eganyi, west of the Niger River [6]. Prominent features include the Aforo hills, Akpatatum ridges and plateau and Ugwalawo – Ibredu ranges in the east of the State, and Eganyi-Adogo, Okene-Ego hills in the west and Agbaja-Kotonkarfi plateau in the north. The plains of River Niger and Benue with their tributaries, with elevation varying from 30m to 43m constitute the lowest parts of the State. [Figure 2](#) shows the topographic map of Kogi State, while [Figure 3](#) shows the satellite images of the State.

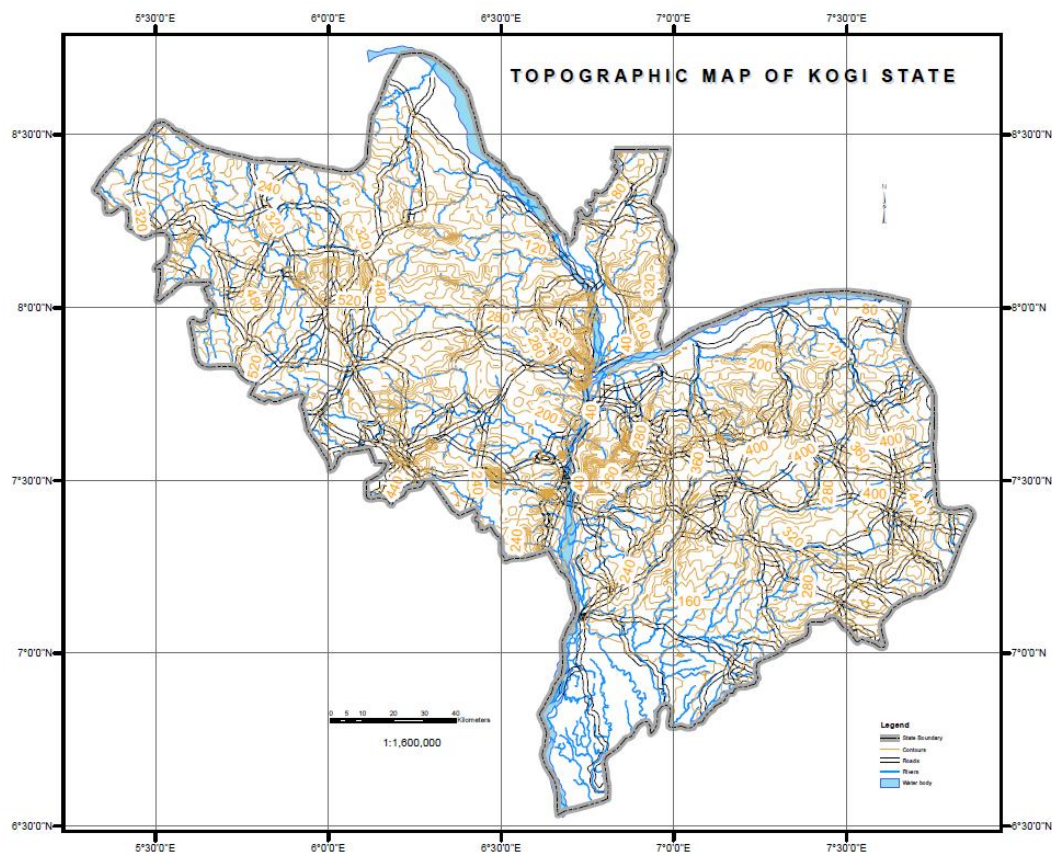


Figure 2. Topographic Map of Kogi State.

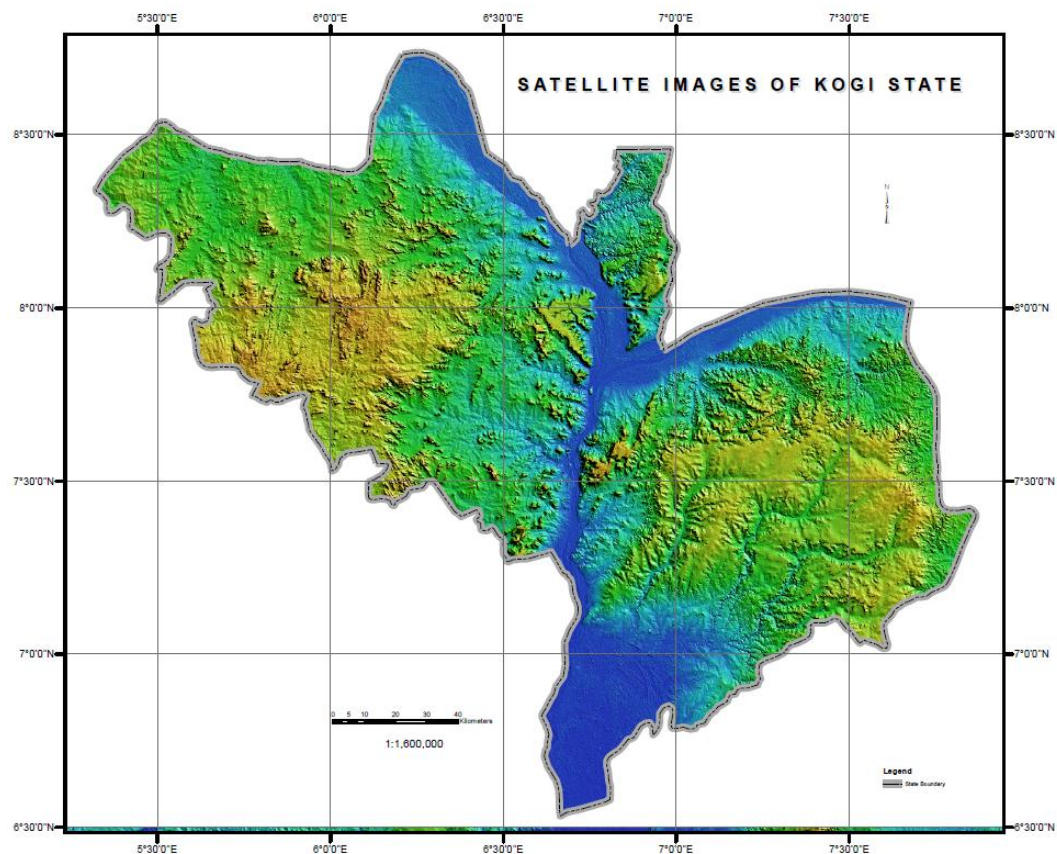


Figure 3. Satellite Image of Kogi State.

Drainage

The State is drained by the southwards flowing River Niger with its major tributary River Benue and other tributaries. In the eastern part of the State, the Anambra River constitute a major component of the drainage system with River Okpo, River Okulu and River Ofu constituting the major tributaries of Anambra River which empties into River Niger at Onitsha. In the western part of the State, the drainage is dominated by River Ecigik and River Oyi, flowing northwards, River Epu,

River Adankolo, River Mimi, Osara River and River Ubo flowing eastwards to empty into the River Niger. A watershed runs southwards from Odenyi through Taketa, Abocho, Alogi and east of Ugwolawo; while in the western part, a major watershed also runs southwards from north-east of Kabba through Obele, west of Okaito and Okene to Ogori areas. The drainage system in general is dense and rectilinear and believed to be controlled by the dominant joint system. Figure 4 shows the drainage system of Kogi State.

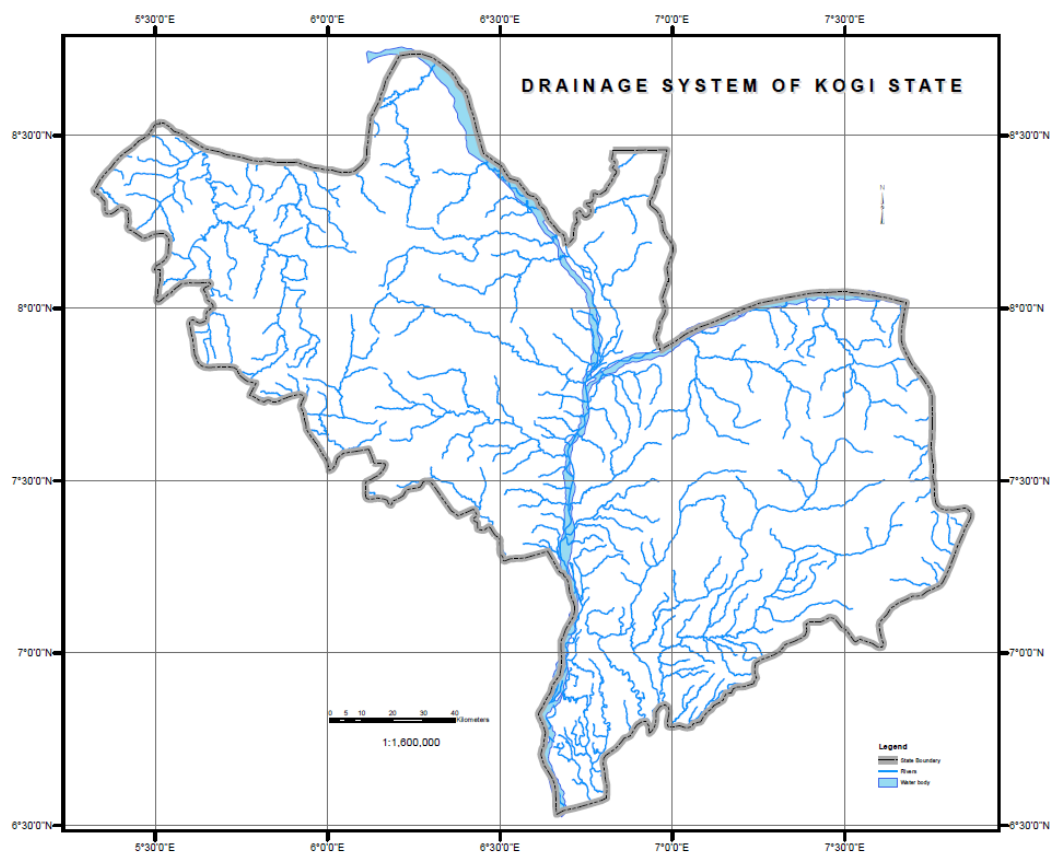


Figure 4. Drainage System of Kogi State.

2.6. Climate

The State is characterized by two seasons – rainy season from April to October and dry season from November to March. The rainy season is associated with the south westerly trade winds from the Atlantic, while dry season is brought by the north easterly trade wind from the Sahara [7, 5]. The annual rainfall ranges between 1100mm and 1300mm, with the peak registered in October. Kogi State has an average maximum temperature of 33.2 °C and an average minimum temperature of 22.8 °C. Lokoja the State Capital is generally hot throughout the year with an average relative humidity of 68-70 percent.

2.6.1. Vegetation

Kogi State lies in the rain forest belt and guinea savannah zone of Nigeria characterized by densely forested areas especially along the major rivers [8]. The rain forest belt is characterized by trees like iroko, mahogany and palms, while the guinea savannah is characterized by fewer trees, shrubs and tall grasses.

2.6.2. Forest Reserves

There are also many forest reserves in the State which include Osara, Ajaokuta, Akpatakum, Agbaja, Gbedege, Bunu, Oinyi and Chokochoko forest reserves.

2.7. Geology of Kogi State

The geology of Kogi State is very unique for the fact that it hosts the three major geological formations of Nigeria.

These are the Basement complex which is of Precambrian and upper Palaeozoic age, the sedimentary formation of Bida and Anambra Basins of Cretaceous and Tertiary age and the younger granites [9].

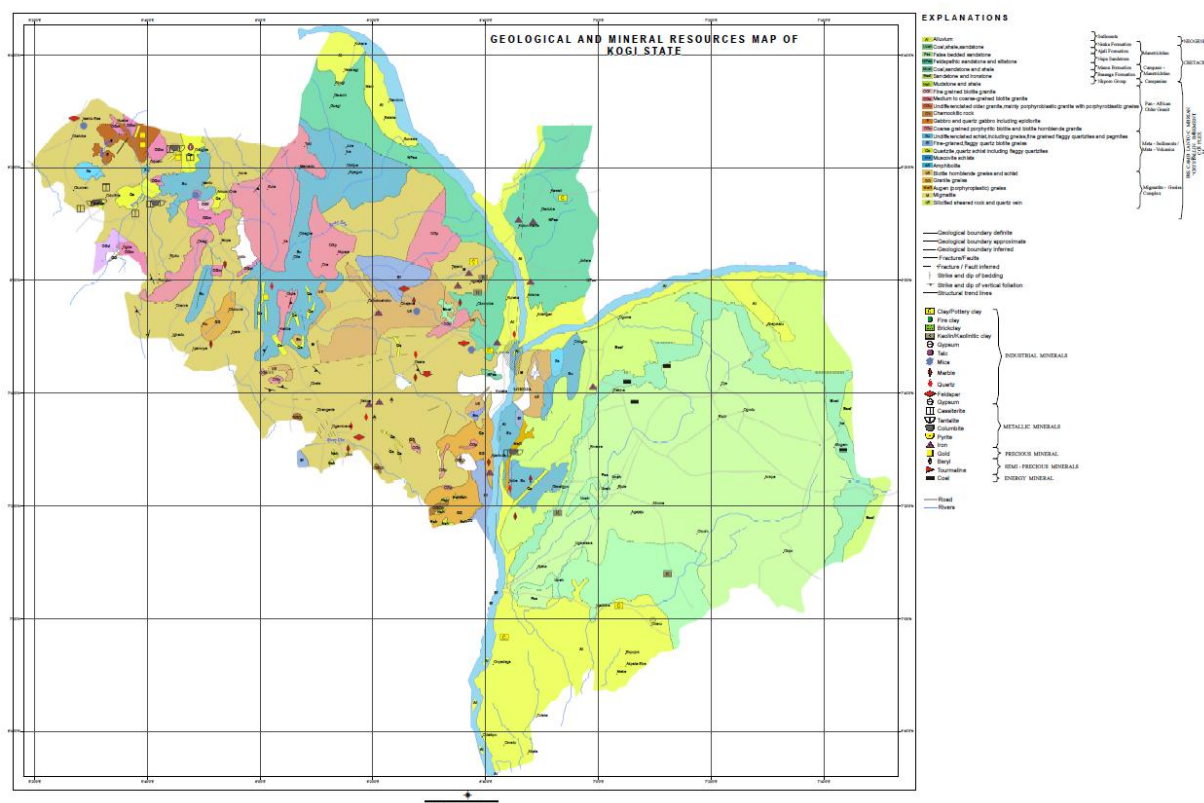


Figure 5. Geological and Mineral Resources Map of Kogi State (Courtesy of NGSA).

Half of the State, the western part of River Niger is covered by crystalline Basement complex rocks and older/younger granites. The Western and Central Senatorial Districts which lie within the western flank of the State are underlain by Precambrian and younger granites, constituting migmatites, granites, charnockites, gabbros, gneisses, schists, amphibolites and quartzites.

The other half which is the eastern and northern parts of the River Niger is covered by sedimentary formation with cretaceous to recent sediments (Figure 5). The geological setting here is similar to that of the lower Benue Trough in the South of Benue River. It is principally made up of Mamu, Ajali and Nsukka formations which are inter-bedded sandstones, siltstones, clays, mudstones, shales, carbonaceous material, coal, and limestones.

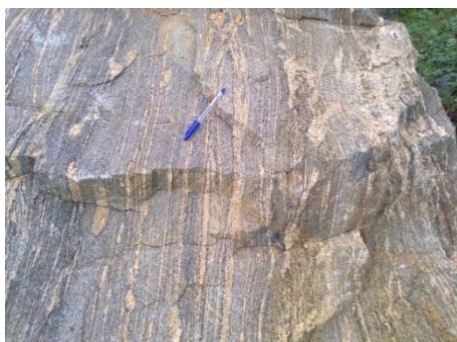
2.7.1. Basement Rocks

The entire western half of the state is underlain by the basement complex rocks with the exception of the areas where it is bounded along the River Niger by sandstone and alluvium. The basement complex is dominantly migmatites which constitutes about 50% [10]. These rocks are found in

Isanlu, Iyara, Mopa, Obele, Obangede, Osara, Tajimi and Okene areas of the state. The other half of the basement is made up of other rocks including metasediments into which granites, gabbro and charnockites have intruded. However, basement complex rocks are also found immediately east of River Niger at Itobe and Gadoma. Some of these rocks found in the field are shown in plate 1.



Figure 6. Gneiss, Okehi LGA.



Banded Gneiss, Itakpe

Figure 7. Typical Basement Rocks.

2.7.2. Sedimentary

Feldspathic and false bedded sandstones and siltstone with ironstone beds are found to the north of River Niger and Benue confluence. Medium to coarse grained sandstones overly the basement around Lokoja area. The eastern half of the state is dominantly made up sedimentary rocks, belonging to the Anambra Sedimentary Basin. The area is mostly made up of sandstone, siltstone, shale, carbonaceous matter and coal formation while the southern part is covered by alluvium. Some of these rocks found in the field are shown in plate 2.

**Figure 8.** Coarse grained Sandstone (Near Lokoja).**Figure 9.** Fine-medium grained Sandstone (Near Ahoko).**Figure 10.** Typical Sedimentary Rocks.

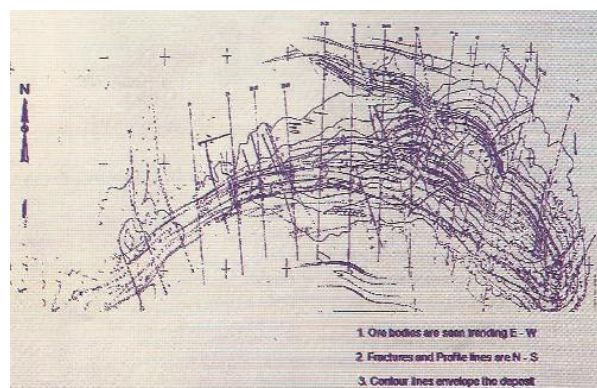
Inter-bedding of clay, siltstone, and black carbonaceous shale (Near Ahoko)

2.8. The Previous Work

Geological Survey of Nigeria started geological traversing in parts of present Kogi State as far back as 1905, culminating in the publication of geology of sheets 62 and 63 on a scale of 1:250,000 [11]. Subsequently, more detailed geological work has been carried out in Kogi State by the Contractor, Nigeria Geological Survey Agency, universities and individual scholars. Since early seventies, the Contractor has carried out and is still carrying out intensive exploration for steel related minerals in the State. Some results of its exploration activities in the State are summarized as follows:

2.8.1. Itakpe Iron Ore Deposit

Itakpe hill deposit is located in Okehi LGA, Kogi State, with geographical coordinates of $7^{\circ}36'20''N$, and $6^{\circ}18'35''$ and with hematite and magnetite as the main ore minerals. The deposit forms a ridge with a strike length of 3km within the Pre-Cambrian crystalline rocks (See Figure 11). The deposit which has absolute elevations ranging from 310-410 m has more than 25 layers of 1-40m thick of ferruginous quartzites. Iron content ranges between 15% and 65%. It has an average SiO_2 content of 44%, Al_2O_3 content of 9.6%, phosphorus content of 0.05% and sulphur and phosphorus minerals are within tolerable levels.

**Figure 11.** Geological Map of Itakpe Iron Ore Deposit, Kogi State.

2.8.2. Ajabanoko Iron Ore Deposit

This deposit located about 4.5km northwest of Itakpe hill, in Okehi LGA lies within latitudes $7^{\circ}37'25''$ and $7^{\circ}38'35''$ N, and longitudes $6^{\circ}15'50''$ and $6^{\circ}16'50''$ E. Iron ore minerals are mainly hematite and Magnetite. The Ajabanoko iron ore deposit occurs as banded ferruginous quartzites in highly metamorphosed Pre-Cambrian basement rocks in association with schists, gneisses, marble, amphibolites, granites and

pegmatites. There are four major bands of ore bodies ranging from 1 to 5m in thickness and made up of hematite and magnetite. With an average iron ore content of 36.4%, iron ore reserves is put at 62.104 million tons with 36.152 million tonnes in category C_1 , (indicated) and 25.952 million tons in category C_2 (inferred). [Figure 12](#) shows the geological map of Ajabanoko iron ore deposit.

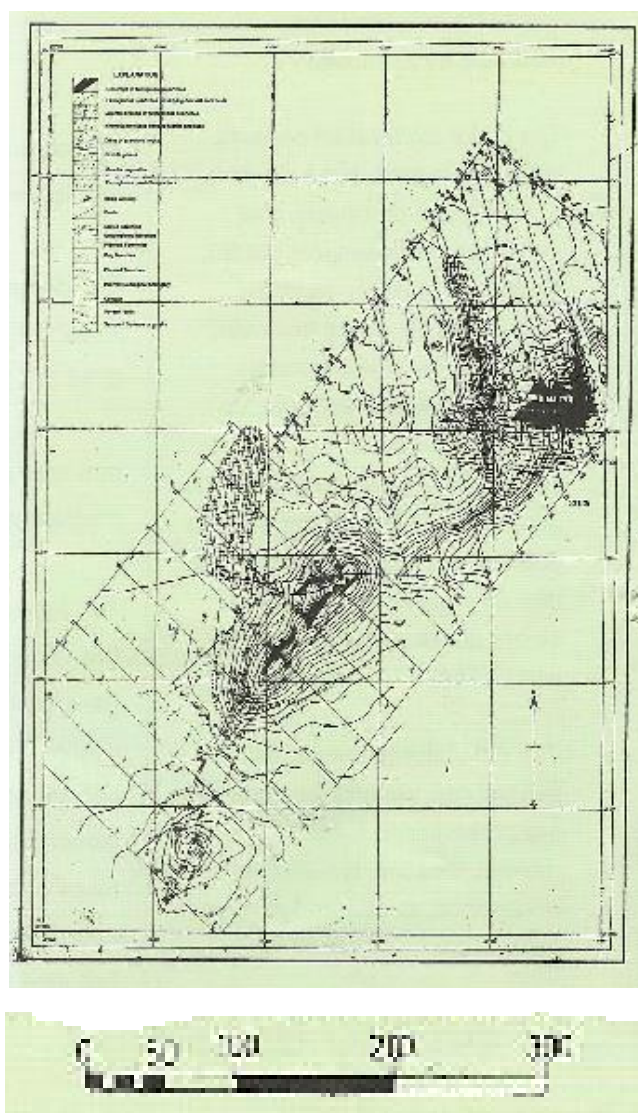


Figure 12. Geological Map of Ajabanoko Iron Ore Deposit.

2.8.3. Agbado-Okudu Iron Ore Deposit

Agbado-Okudu, about 16km northeast of Obajana lies between latitudes $7^{\circ}25'29''$ and $8^{\circ}00'23''$ N, and longitudes

$6^{\circ}28'12''$ and $6^{\circ}28'23''$ E. Iron ore minerals are mainly hematite and magnetite. Preliminary evaluation carried out by NSRMEA put inferred reserves at 60 million tons. [Figure 13](#) shows the geological map of Agbado-Okudu iron ore deposit.

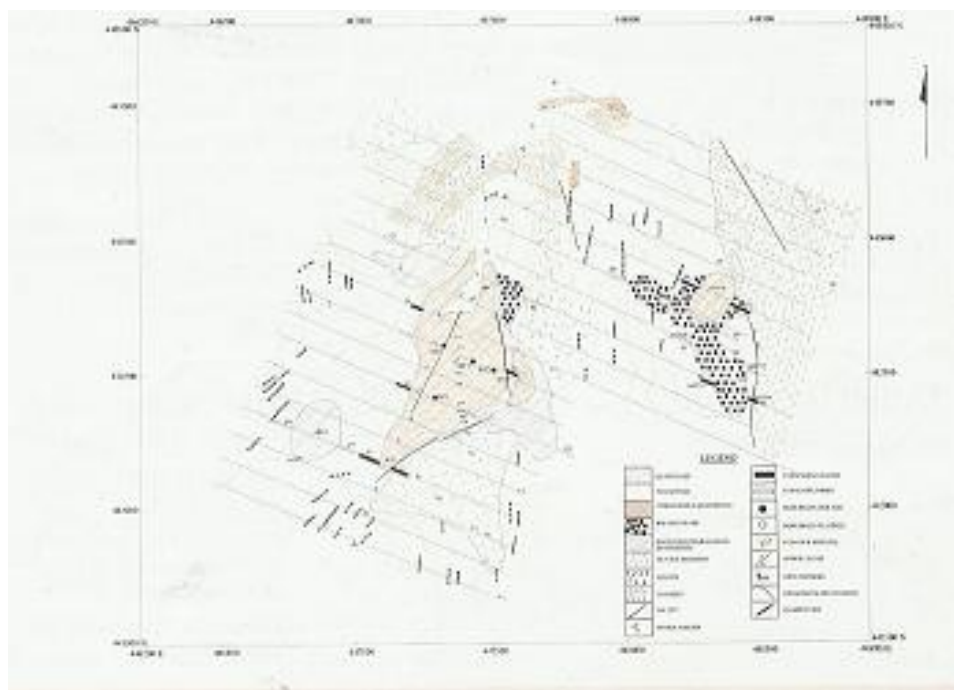


Figure 13. Geological Map of Agbado-Okudu Iron ore Deposit Kogi LGA, Kogi State.

2.8.4. Iwaa (Chokochoko) Iron Ore Deposit

This deposit, is located in Oyo-Iwa between Jakura and Chokochoko village, and it occurs as ferruginous quartzites bands within gneisses and amphibolites. Iron ore minerals

are mainly hematite and magnetite. With an average iron content of 35.7%, the inferred reserve is put at 12million tons. **Figure 14** shows the geological map of Lokoja- Okene Iron ore Area.



Figure 14. Geological Map of Lokoja- Okene Iron ore Area.

2.8.5. Tajimi Iron Ore Occurrence

The occurrence is located in Tajimi, Lokoja LGA, and bounded by the coordinates $7^{\circ}55'30''$ - $7^{\circ}55'50''$ E and $6^{\circ}30'22''$ – $6^{\circ}30'36''$ N. The ore are mainly hematite and magnetite. The ores which occur as banded ferruginous quartzite, are fine to medium grained with hematite and magnetites as the main ore minerals while preliminary reserves estimation is put at 20 million tons with iron content ranging from 22-40%.

2.8.6. Ebiya Iron Ore Deposit

The deposit is located at Ebiya, Ajaokuta LGA, with coordinates $6^{\circ}21'42''$ - $6^{\circ}25'20''$ N and $7^{\circ}25'58''$ - $7^{\circ}31'35''$ E. The ores, occurring within the banded ferruginous quartzites ridges within the basement complex rocks, trend for over 1km in NE-SW orientation. The ore, mainly made up of hematite and magnetite, has an average iron content of 34%.

2.8.7. Agbaja Iron Ore Deposit

This deposit is located at Agbaja, Lokoja LGA, with coordinates $6^{\circ}37'12''$ - $6^{\circ}41'20''$ E and $7^{\circ}59'13''$ – $8^{\circ}0'18''$ N. The deposit occurs as sedimentary ores of oolitic and pisolitic iron ore with limonite, magnhemite, goethite, hematite, magnetite and siderite. With over 10m thick zone of iron band, an overburden of 5.62m, and an iron content of 46.8%, the inferred reserves are put at 1,150 million tons. However, the high phosphorus content of 2.1% is a major problem.

2.8.8. Koton-karfi Iron Ore Deposit

This deposit also a sedimentary ore is located at Koton-karfi LGA and bounded within longitudes coordinates $6^{\circ}00'12''$ - $6^{\circ}55'00''$ and $8^{\circ}00'18''$ N. The iron ore minerals are limonite, maghemite, goethite, hematite, magnetite, and siderite. The deposit is characterized by over 13m thick zone of ironstone with an overburden of 6.73m, an iron content of 51.6% and phosphorus content of 2.35%, while the reserve is put at 850 million tons. Figure 15 shows the geological map of part of Lokoja 247NE- Okofi, Gbarada, Odah, and Dangeri Oolitic Iron ore Deposits in Koton Karfe LGA, Kogi State.

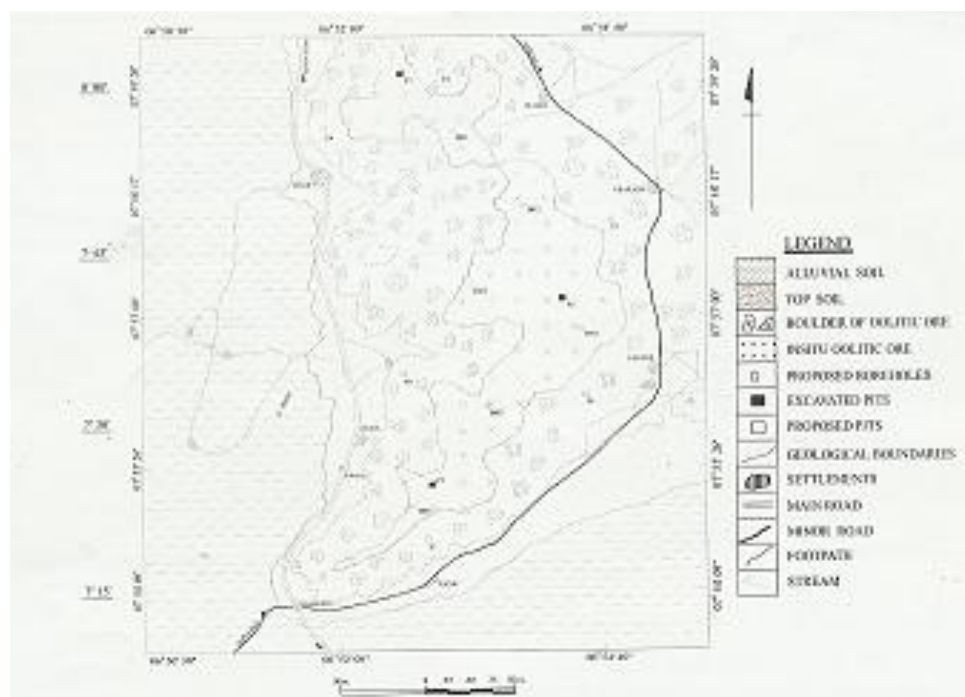


Figure 15. Geological Map of Part of Lokoja 247NE hosting Oolitic Iron ore Deposits.

The airborne geophysical survey of Nigeria was recently conducted in two phases by Fugro Airborne Surveys for Nigerian Geological Survey Agency (NGSA) [12]. This project was financed by the Federal Government and supported by the World Bank Intervention. The airborne geophysical surveys and geochemical survey carried out across the country including Kogi State produce considerable geo-scientific data which are important to exploration geology.

Kogi State Ministry of Solid Minerals Development, Lokoja also made a substantial contribution to knowledge through its publication titled “Kogi State Solid Minerals Investment Prospects”.

There are some notable contributions from private individuals especially on sulphide mineralization at Egbe by Bafore, (1981). The contribution of JAO – GEOTECH Limited, Okene is also acknowledged [13].

2.9. Airborne Geophysical Survey

The airborne geophysical survey provides visual clues that give insight into the spatial character of a landscape and its underlying geology [12]. Of course, multispectral remotely sensed imagery not only includes spatial information, but, due to the fact that it is collecting information at various spectral wavelengths, it is able to contribute to characterizing

the chemical composition of the surface by providing spectral information. In view of the importance of airborne geophysical survey to mineral exploration, the Contractor acquired and interpreted 16 map sheets of Total Magnetic Intensity covering the entire Kogi State from NGSA. These maps helped to quickly identify exploration targets which were checked out in the field. Figure 16 shows the Air-borne Geophysical (Magnetic) Map of Kogi State.

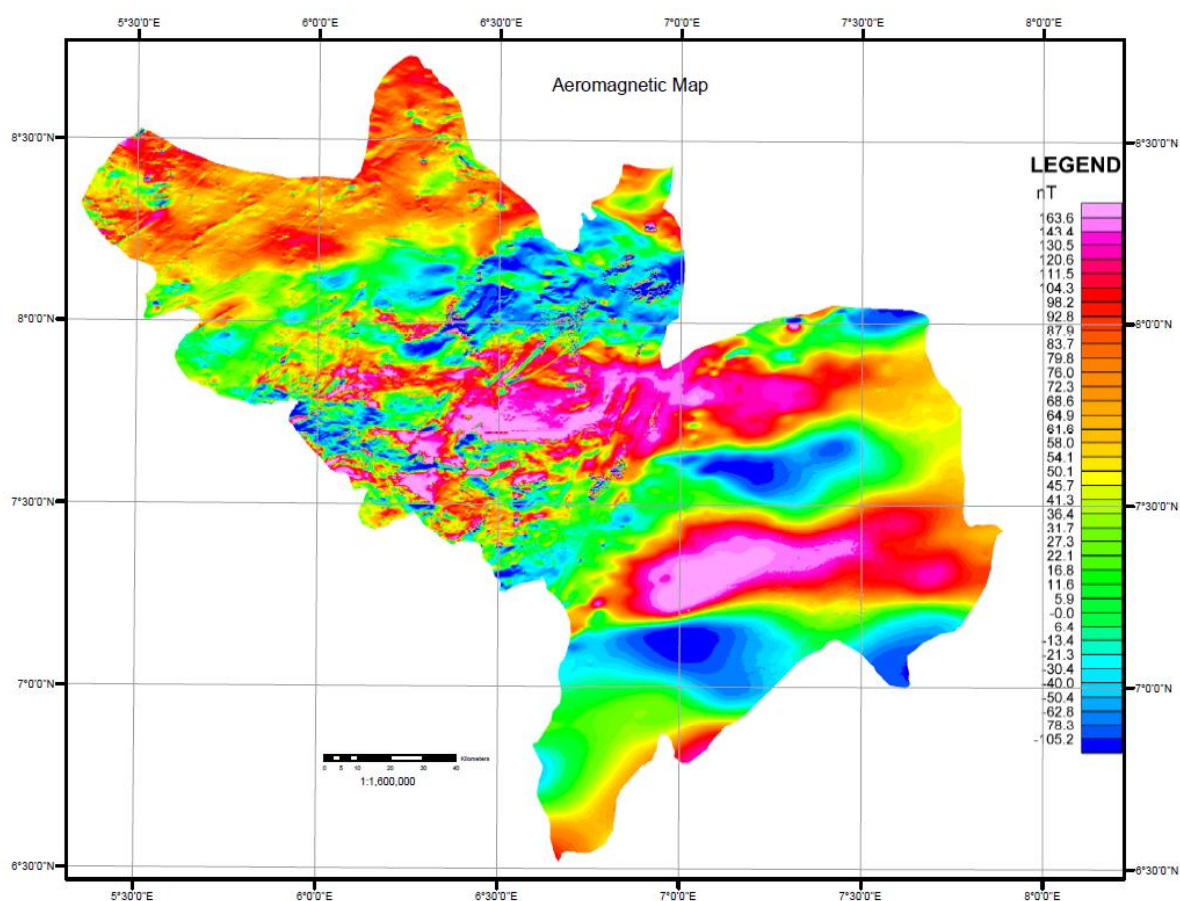


Figure 16. Airborne Geophysical (magnetic) Map of Kogi State.

The acquired and interpreted map-sheets covering various parts of Kogi State were Lafiagi Sheet 51, Baro sheet 52, Akure Sheet 61, Lokoja Sheet 62, Ayangba Sheet 63, Onitsha Sheet 71 and Enugu Sheet 72.

The interpretation of these map-sheets (Figure 17) shows numerous base metals and industrial minerals prospects, specifically gold, tantalite, tourmaline and marble in Lafiagi Sheet, while Kaolin and clays prospects are found in the Bida basin of the Baro sheet with associated marble and gold.

Akure Sheet contains base metals and industrial minerals prospects associated with basement rocks. Lokoja sheet contains base metals and industrial minerals (marbles, feldspars, kaolin) and magnetite prospects. Ayangba Sheet contains coal, kaolin and clays prospects in the sedimentary basin. The marked areas (circled) are promising areas that have high exploration prospects and were checked out by the field geologists to confirm the mineral type and mode of occurrences.

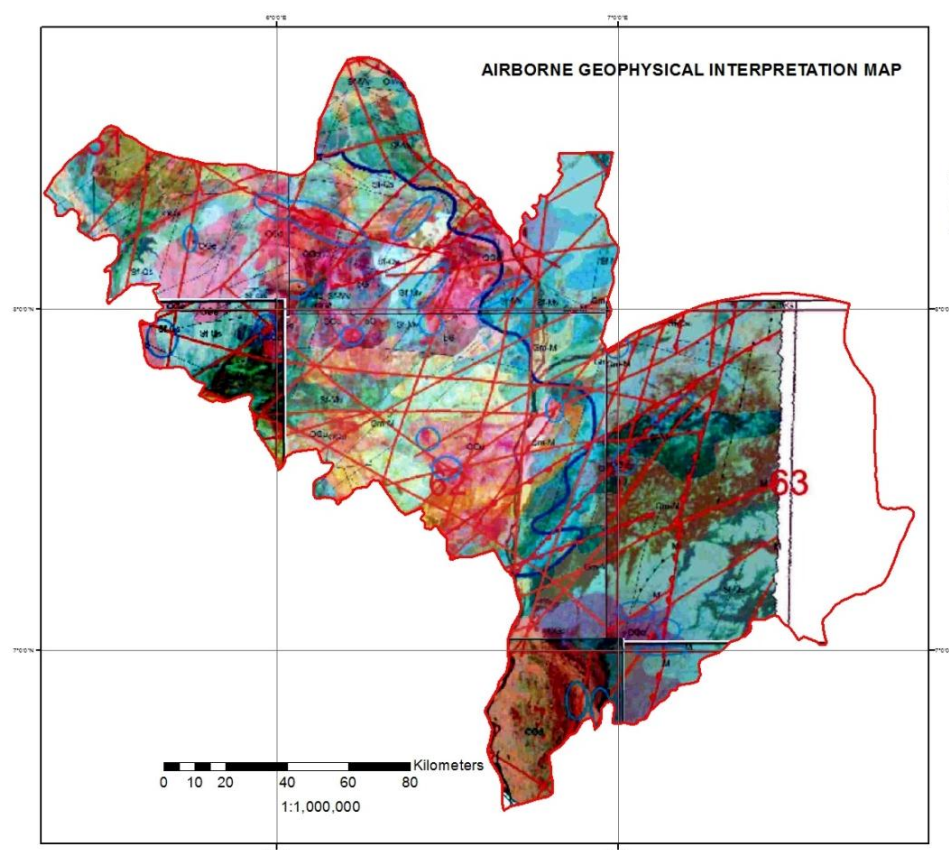


Figure 17. Airborne Geophysical Interpretation Map.

3. Results

3.1. Nigerian Mining Industry

The Federal Government is turning to the solid minerals sector which has emerged as a major economic potential to diversify its revenue base. Since late 1980's the Federal Government has been repositioning Nigeria as a mining (some believe exploration) destination to attract investment to solid minerals sector of the national economy [13, 14].

The Minerals and Mining Act 2007 which is internationally competitive without excessive concessions has been put in place to guarantee free access to solid mineral sector and stimulate exploration and mining investments [15]. In addition to this, attractive economic incentives were introduced for foreign investment to flood in. Nigerian Geological Survey Agency (NGSA) and National Steel Raw Materials Exploration Agency (NSRMEA) have been repositioned for effective service delivery, the former aiming to foster basic geological survey and regional mapping and the latter to carry out detailed exploration that will attract investment to the country.

Ministry of Mines and Steel Development is responsible for all matters relating to exploration and mining. The tasks of the Ministry include but are not limited to the following:

to promote the mining industry, regulate and control it, and provide baseline geoscientific data/information.

As a result of the Federal Government's reform policies and initiatives in the minerals sector, many prospective mineral investors have shown interest to invest in this sector and consequently the Federal Government granted Mineral Titles to a good number of them.

3.2. Mining Titles Granted in Kogi State

Over three hundred (300) Mineral Titles have been granted by the Federal Government to mining and quarrying operators in Kogi State. The list of these operators has been obtained from Mines Cadastral Office.

3.3. Minerals Resources of Kogi State

The Contractor, using various exploration techniques has diligently authenticated many reported occurrences of mineral resources in Kogi State and discovered new ones. Documentation of all minerals/rocks found in the field was made in terms of their location, accessibility, co-ordinates, altitude, degree of exposure, tectonic settings, geological setting, host rock, available infrastructure, dimension of outcrops etc. The results of the mineral resources inventory of Kogi State, covering three senatorial districts (East, Central and West), comprising twenty-one (21) local government areas are given. For ease of ref-

erence the mineral resources in Kogi State have been classified into metallic minerals, industrial minerals, precious stones, precious metals and carbonaceous minerals. The coal outcrops found in fourteen (14) locations in the East Senatorial District suggests that the entire LGAs in this district maybe underlain by coal bearing formation. Kaolin and clays are also found to exist in almost every LGA in the East Senatorial District. The West and Central Senatorial Districts are rich in iron ores, gold, tantalite amongst others. There is no LGA in the Kogi State that does not have at least three (3) mineral types. Some of these minerals were captured by photographs in their natural locations as shown in plate 3.



Figure 18. Contact between Feldspar and Granite.



Figure 19. Marble at Uyoso.



Figure 20. Tantalite sample from Odovi.



Figure 21. Gold Panning at Offi-Ejibo.



Figure 22. Coal Outcrop at Ebeje.



Figure 23. Feldspar Outcrop in Ofu LGA.



Figure 24. Kaolin at Emewe Efopa.



Figure 25. Silica Sand near Ayingba: Outcrops of some minerals encountered.

In the course of the investigation of mineral resources of

Kogi State, the Contractor recorded the existence of active and abandoned mines and quarries in sixty-five (65) locations. These mines and quarries were mining various mineral resources including feldspars, marble, gold, coal, Beryl, Mica, Tantalite, Tourmaline, Columbite, Manganese, Quartzite, Topaz, and Amethyst. Most of the industrial and semi-precious minerals are found in pegmatitic bodies in the basement complex. Construction materials like granite, laterite, sand and gravel are quarried in all parts of the State.

National Iron Ore Mining Company set up by Federal Government to mine the iron ores in Itakpe and Ajabanoko is currently not operational but its mining facilities are intact. Twenty-nine (29) different types of mineral ores, occurring in 262 locations, spreading over the State were uncovered during the course of the mineral inventory of Kogi State comprising three senatorial districts (East, Central and West) (See Table 1). Figure 26 shows the mineral resources map of Kogi State.

Table 1. Number of Locations of Mineral Occurrences in Kogi State.

MINERAL TYPE	NUMBER OF LOCATIONS OF MINERAL OCCURRENCES IN THE SENATORIAL DISTRICTS			TOTAL NUMBER OF OCCURRENCES
	WEST	EAST	CENTRAL	
Beryl	4	-	7	11
Clay	8	2	-	10
Coal	-	14	-	14
Columbite	4	-	-	4
Dolomite	-	1	1	2
Feldspar	18	3	4	25
Gold	10	-	-	10
Iron ore	17	8	3	28
Kaolin	8	15	1	24
Manganese	11	-	-	11
Biotite	1	-	-	1
Muscovite	11	-	3	14
Quartz/Quartzite	22	1	3	26
Precious Quartz	5	-	-	5
Tantalite	11	1	2	14
Tourmaline	6	-	3	9
Tin	5	-	-	5
Talc	6	-	-	6
Marble	10	-	4	14
Granite	2	1	3	6
Silica sand	1	3	-	4
Brine	-	2	-	2

MINERAL TYPE	NUMBER OF LOCATIONS OF MINERAL OCCURRENCES IN THE SENATORIAL DISTRICTS			TOTAL NUMBER OF OCCURRENCES
	WEST	EAST	CENTRAL	
Zircon	-	1	-	1
Garnet	-	1	-	1
Kyanite	4	-	-	4
Laterite	2	2	-	4
Chromite sand	-	1	-	1
Amethyst	1	1	-	2
Rutile	4	-	-	4
Petroleum	-	1	-	1
TOTAL	171	58	33	262

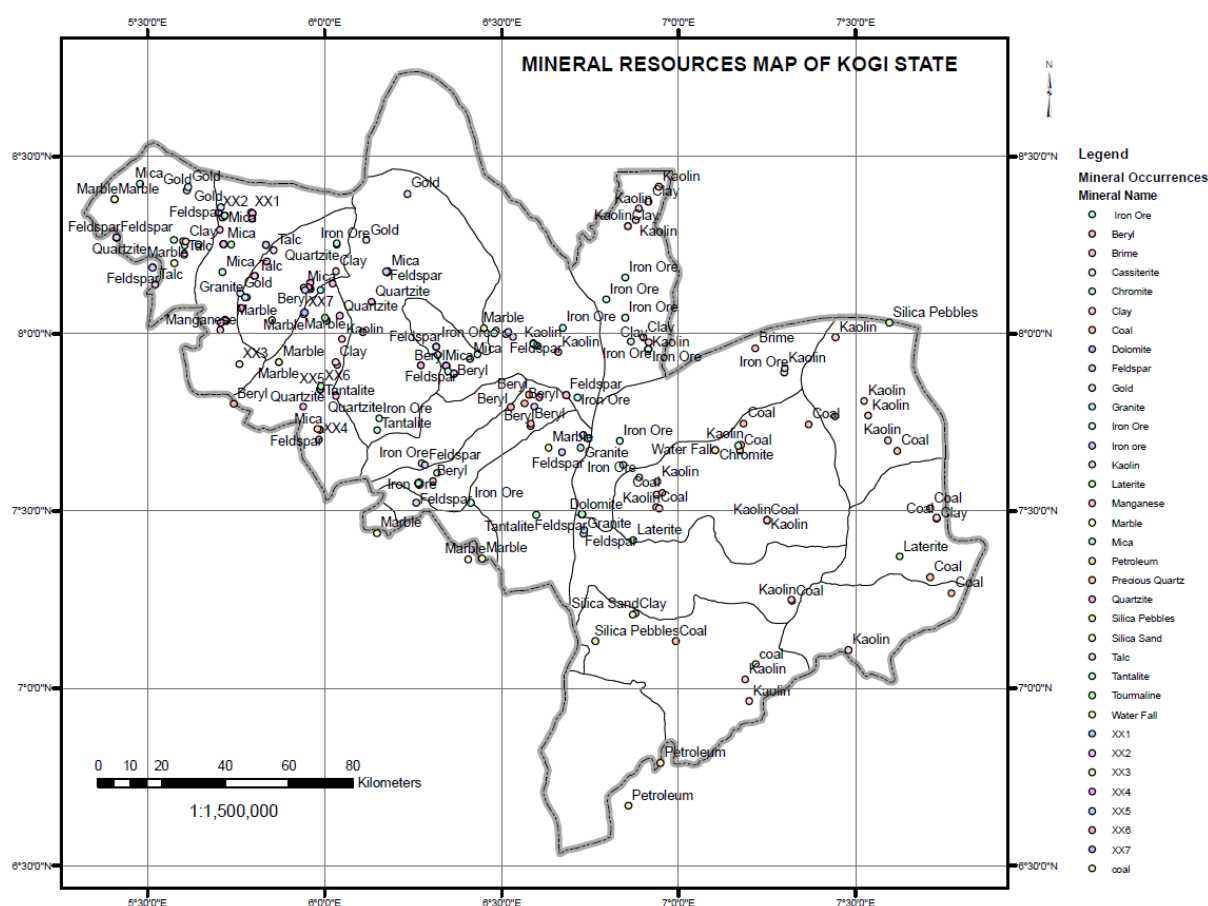


Figure 26. The Mineral Resources Map of Kogi State.

are given in Appendix II. This confirms the possible occurrences of petroleum resources in Kogi State.

3.4. Petroleum Resources

In the course of intensive geological traversing of the state, two (2) abandoned exploration oil wells (Figure 27) were observed at Odeke in Ibaji LGA, the coordinates of which



Figure 27. The Portal of Oil Well at Odeke, Ibaji LGA.

3.5. Water Resources

The various hydro-geological conditions that are likely to affect the surface and ground water in mines and their immediate communities were assessed during the course of this study. A major aquifer leakage at Bassa that gives rise to a spring can be harnessed for commercial production of bottled water, while the water fall at Odu-Ajibella in Dekina LGA (Figure 28) can be harnessed to provide mechanical energy and then converted into electricity for man's use. The importance of hydroelectric energy cannot be over emphasized. It is an important part of large electric power systems because of its reliability and flexibility; it can be a catalyst in developing other resources and creating opportunities for improving human conditions in remote areas while this vicinity can also be developed into tourists' attraction.

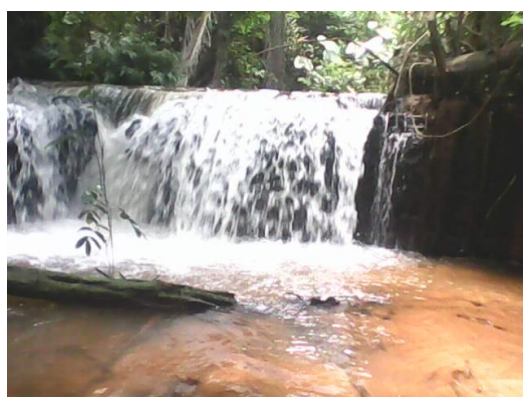


Figure 28. Water Fall at Odu-Ajibella, Dekina LGA.

3.6. Laboratory Work

Two hundred and forty- four (244) samples obtained from the field were duly prepared and analyzed using modern analytical equipment such as X-Ray Diffraction, X-Ray Fluorescence etc. These analyses were aimed at characterizing the chemical composition of those samples. The results of some of the analyzed samples are attached.

3.7. Digitized Maps

In order to facilitate field work and reduce costs and time of investigation, the Contractor acquired relevant digitized maps. These include:

- 1) Geological Map of Kogi State.
- 2) Airborne Geological (Magnetic) Map of Kogi State.
- 3) Satellite imagery of Nigeria.

With the aid of GIS technology and ArcGIS software, the project maps were digitized by the Contractor. These include:

- 1) Map of Nigeria Showing the Location of Kogi State.
- 2) Political Map of Kogi State.
- 3) Carved out Satellite Imagery of Kogi State from the Satellite Imagery of Nigeria.
- 4) Mineral Resources Map of Kogi State.

3.8. Uses and Economic Importance of Identified Minerals

The uses and economic importance of identified minerals in State are summarized in Table 2.

Table 2. Uses and Economic Importance of Identified Minerals.

MINERAL	USES
AMETHYST	Ornamentals
BERYL	Ornamentals
BIOTITE MICA	Electric and Heat insulation, Lubricants and paints etc.
BRINE	Chemical, food
CHROMITE SAND	Ferro-alloys
CLAY	Construction, refractories, ceramics
COAL	Power & steam generation, chemical and metallurgical
COLUMBITE	Ferro-alloys, production of Niobium metal, electrodes for welding
DOLOMITE	Flux, Glass, in Ceramics, calcium carbide, and pharmaceutical products etc
FELDSPAR	Glass, ceramics, abrasive, soaps, Earth/sanitary wares and as filters
GARNET	Ornamental, abrasive
GRANITE	Construction, decorative
GOLD	Jewelry, electroplating, dentistry, in Aerospace
IRON ORE	Iron & steel, cement, heavy media, paint, livestock feeds
KAOLIN	Paper, paint, rubber, plastics, ceramics, drugs, soap and detergent

MINERAL	USES
KYANITE	Primarily in refractoriness and ceramics products like porcelain plumbing fixtures and dishwares. Also in electronics, electrical insulators and abrasives
LATERITE	Road construction
MANGANESE	Steel making, as a deoxidizer in chemical Industries and Ferro alloy
MARBLE	Cement, steel, sugar, chemicals, construction, refractory
MUSCOVITE MICA	Window glass, insulator, as additives, as dusting medium etc.
PRECIOUS QUARTZ	Ornamental
QUARTZ/QUARTZITE	Optical, glass, refractory, concrete, porcelain, in electronic equipment etc.
RUTILE	Refractory ceramic, paints, plastics, welding electrode covering
SILICA SAND/PEBBLES	Glass, concrete, silicon semi-conductor
TALC	Ceramics, paints, paper, chemicals, cosmetics, filler, adsorbents
TANTALITE	Electronics, metal working, machinery, superalloys
TIN ORE	Steel, electrical/electrical, construction, chemical
TOURMALINE	Therapeutic, hair straighteners, natural insecticide
ZIRCON	Foundry, paints, bricks, chemical, alloys

3.9. Mineral Resources Profile of Kogi STATE

Kogi State is endowed with many solid mineral resources. These are metallic minerals including iron ores, columbite, tantalite, cassiterite and pyrite; Industrial minerals available include clays, kaolin, talc, marble, feldspar, mica and quartz. The precious minerals include gold, beryl and tourmaline while the energy mineral includes coal [16].

Twenty-nine (29) different types of mineral ores, occurring in 265 locations, spreading over the State were uncovered. The results of the study show that there is no LGA in Kogi State without at least three (3) different mineral types. The mineral resources profile of the State is discussed below.

3.9.1. Amethyst

Occurs in two (2) locations of the State. One location each is found in the West and Dogongbagi in Bassa LGA of East Senatorial district. Amethyst is used mainly for ornamentals.

3.9.2. Biotite Mica

Mica occurs in two forms in the state, biotite and muscovite, a large colourful Biotite Mica occurs in Ogidi in Ijumu LGA. It is a hydrous Alumina silicate type and a constituent of granites, Diorite, Mica schists and gneisses. It is characterized by perfect cleavages and can readily split into thin elastic parts. Biotite Mica can be used for Electric insulators, as additives and fillers in electrical and Heat insulators, Lamp shield, lubricants and paints.

3.9.3. Beryl

Beryl occurs in four (4) locations in the Western Senatorial District of the State and seven (7) locations in the Central. It occurs in the migmatite, gneisses and pegmatite of Irepeni-Idi-Odange, Zariagi and Irepeni villages of Adavi LGA in the Central Senatorial District. The area of coverage of beryl ranges from about 100m x 100m to 2km x 1km. It occurs in association with other precious stones, Mica and sometimes with Kaolin. Beryl also occurs in Oshokoshoko/Iwaa of Lokoja LGA, Aiyede Amuro of Mopa-Muro LGA, Idofin and Igbagun of Yagba East in the Western Senatorial District. The industrial application of beryl is mainly for ornamentals.

3.9.4. Brine

Brine occurs in only two (2) riverine locations in the East Senatorial districts. It could be used for chemicals and food.

3.9.5. Chromite Sand

This occurs in appreciable quantity in only one (1) location in the State, Odu-Ajibela in Dekina LGA. It is mainly used for production of Ferro-alloys and in foundries. The chemical assay is stated in the table below:

Table 3. The chemical assay.

Parameters	Fe ₂ O ₃	Cr ₂ O ₃	Al ₂ O ₃	MgO	CaO	SiO ₂
Value	28.9	46.8	12.6	8.3	0.1	0.65

3.9.6. Clays

Clay occurs in 10 locations in the State but largely in the West and East Senatorial Districts. It occurs in Igbaruku, Takete, Mokpa, Gbarada, Chikara, Omoko, Odagbo, and Ofudu, usually found associated with Sandstone and as a product of deep weathering of granitic rocks. Clay is used mainly in architecture and agriculture, in manufacturing of bricks, tiles, porcelain, and earthen ware and pipes for drainage. The high absorbent form is used in oil industries as filtering and deodorizing agents in refining of petroleum as well as drilling muds. It is also used in making of fillers, sizing and dressing in construction, clarifying water and wine, in purifying sewage and in paper, ceramic, plastic and rubber industries.

3.9.7. Coal

The coal outcrop found in fourteen (14) locations in the East Senatorial District suggests that the entire LGAs in this district may be underlain by coal bearing formation. The Coal is Sub-Bituminous and had its origin from the accumulation and partial decomposition of vegetation. It is localized within the sedimentary Basin in the Eastern flank of the State. The coal is hosted by Manu shale and fall within the lower Benue trough of Nigeria. The locations of the coal outcrops are Odu Okpakili, Odu-Ogboyaga, in Dekina LGA, Ankpa, Olamaboro, Igalamela/Odolu, Ofu, and Omala LGA. Mining of the coal is in progress at Olokwu, Omala LGA, Okaba and Odogbo-Okaba in Ankpa LGA. There is potential for the domestic uti-

lization of the Nigerian coals as indicated by the following industries: Ajaokuta Steel Plant, proposed coal-fired power generating plants, Kogi cement factory and coal carbonization/briquetting plants. It could substantially contribute to future energy supplies, and also reduce the risk of possible gaps between supply and demand in energy. There are other ways in which coal will be used: through fluidized bed combustion, in the industrial market and through gasification to replace natural gas for domestic use and to drive gas turbines; and through the liquefaction and conversion of coal in a coal refinery to produce liquid fuels and petrochemicals replacing naturally occurring oil while many chemicals are obtained from coal when it is heated to a certain temperature.

4. Discussion

4.1. Proximate Analysis of Some Coal Samples from the Kogi East Senatorial District

Table 4. Result of Proximate Analysis of Some Coal Samples From the Kogi East Senatorial District.

SAM- PLE ID	LOCATION	MOISTURE CONTENT (%)	ASH CONTENT (%)	VOLATILE MATTER (%)	FIXED CARBON (%)	SULPHUR CONTENT (%)	HIGH HEAT- ING VALUE (HHV)
3944	Imane, Olamaboro LGA	5.50	17.40	39.50	37.42	0.18	19.25MJ/Kg or 4597.87Kcal/Kg
3945	Okaba, Ankpa LGA	4.00	9.00	40.20	46.80	0.50	22.75 MJ/KG or 5431.62K cal/Kg.
3946	Ebeje Dekina LGA	9.20	18.90	35.50	36.40	0.28	18.26MJ/Kg or 4360.03Kcal./Kg.
3948	Enewe-Efopa, Dekina LGA	7.50	5.10	41.10	46.30	0.45	22.74 MJ/KG or 4403.35K cal/Kg.
3949	Akpoli, Olam- aboro LGA	6.20	22.40	33.55	37.85	0.30	18.44 MJ/Kg or 4403.35K cal/Kg.
3959	Ibobo, Dekina LGA	5.30	16.50	36.30	41.90	0.40	20.35 MJ/Kg or 4858.70K cal/Kg.
3960	Odu-okpakili, Dekina LGA	4.30	8.20	40.50	47.00	0.45	22.87 MJ/Kg or 5461.16K cal/Kg.
3972	Ogbolimi, Igal- amela/odolu LGA	6.00	21.80	32.70	39.50	0.30	18.90 MJ/Kg or 4512.15k cal/kg.

4.1.1. Columbite

Columbite occurs in four (4) locations in the Western senatorial district of Kogi State. It occurs in association with Cassiterite. Columbite is a by-product of the Calc-Alkaline younger granite of orogenic origin that host many metallic minerals like Cassiterite, tantalite, wolframite, Ilmenite, rutile and spinel. It occurs in the Jurassic Alkaline granites

usually concentrated in the weathered gneissic areas. It can also be found in the quartz veins and pegmatites in Pre-Cambrian Migmatites. Columbite is largely found in Ofere as well as Odo-Ara, Odo-eri and Igbaruku in Kabba/ Bunu and Yagba West LGAs respectively. It is largely used as Ferro-Alloys, and for production of Niobium Metals, Dental and Surgical instruments, and Electrodes for welding. The typical chemical assay of columbite is shown below.

4.1.2. Columbite Sample From Isanlu-Esa, Yagba West LGA

Table 5. Columbite Sample From Isanlu-Esa, Yagba West LGA.

Compound	SiO ₂	K ₂ O	CaO	TiO ₂	V ₂ O ₅	Cr ₂ O ₃	MnO	Fe ₂ O ₃	Rb ₂ O	Nb ₂ O ₅	Ag ₂ O	BaO	Ta ₂ O ₅
Conc. Unit	8.0%	0.17%	0.369%	0.736%	0.062%	0.014%	4.30%	13.22%	3.0%	54.9%	2.15%	0.16%	12.9%

4.1.3. Columbite Sample From Koji, Bassa LGA

Table 6. Columbite Sample From Koji, Bassa LGA.

Compound	SiO ₂	K ₂ O	CaO	TiO ₂	V ₂ O ₅	Cr ₂ O ₃	MnO	Fe ₂ O ₃	Rb ₂ O	Nb ₂ O ₅	In ₂ O ₃	BaO	Ta ₂ O ₅
Conc. Unit	15%	0.27%	0.387%	0.3%	0.058%	0.025%	5.05%	5.87%	17%	8.86%	0.51%	0.17%	47.2%

4.1.4. Dolomite

Dolomite occurs in the State within the meta-sediments of the Basement complex Region. The geological setting is very similar to that of Marble deposit but harder and finer textured and of higher magnesium content. There are two (2) major dolomite deposits within the State and these are Osara in Adavi LGA, and Alo in Ofu LGA.

The industrial uses and application are similar to that of Marble. It is used as flux, and for glass manufacturing, ceramics, bleaching powder, calcium carbide, chemical and pharmaceutical products, and fertilizers. It is also used as filter in rubber and plastic, soap and detergent making as well as in agriculture for livestock concentrates, land fertility, building and furnishing.

4.1.5. Dolomite Sample from Osara, Adavi LGA

Table 7. Dolomite Sample from Osara, Adavi LGA.

Compound	SiO ₂	MgO	CaO	Al ₂ O ₃	Na ₂ O	LOI	MnO ₂	Fe ₂ O ₃
Conc. Unit	0.45%	21.61%	30.59%	0.19%	0.12%	46.72%	0.04%	0.34%

4.1.6. Feldspar

Feldspar occurs in abundance in the State, occurring in twenty-two (22) locations spread through all the 3 Senatorial districts. The locations are Ajaokuta Junction in Okene LGA., Ajabanoko in Okehi LGA, Emiworo in Ajaokuta LGA, Irepni Airstrip area in Adavi LGA, Ichapa in Ofu LGA, Dodogbagi in Bassa LGA, Egbe and Okunran in Yagba west LGA, Olagbara Aiyedayo in Mopa-Moro LGA, Oshokosho-

ko in Lokoja LGA, Aiyede Amuro and Aiyeteju in Mopa Moro LGA, Isanlu in Yagba East, Agbadu in Kabba/Bunu LGA, and Jakura in Lokoja LG of the State. In Kogi State, the most common of them are the whitish pinkish Potash rich feldspar orthoclase.

The industrial applications of feldspar include use in glass, ceramics abrasives and soaps. It is also used in the manufacturing of Earth Wares, sanitary wares and fillers in plates.

4.2. Chemical Analysis of Some Feldspar Deposits in Kogi State

Table 8. Chemical analysis of some feldspar deposits in kogi state.

% Oxide	Aiyedayo-Ologbara, Mopamoro, LGA	Koji, Bassa LGA	Isanlu, Yagba East LGA	Oshokoshoko/ Iwaa Lokoja LGA	Ike, Kabba/ Bunu LGA	Irepini, Ada- vi, LGA
Al ₂ O ₃	22.8	21.2	21.3	-	45.8	38.2
SiO ₂	66.1	65.0	64.2	77.2	49.9	46.1
K ₂ O	10.33	13.32	14.09	21.25	0.669	10.51
PbO/ZnO	-	-	-	0.97	-	0.017
TiO ₂	0.034		0.023	0.003	0.492	0.076
V ₂ O ₅	0.003	0.003	0.005	0.003	0.0225	-
Cr ₂ O ₃	0.020	-	0.0099	0.019	0.048	-
MnO	0.022	0.014	0.016	0.025	0.017	0.084
Fe ₂ O ₃	0.573	0.301	0.120	0.392	2.215	4.66
CuO	0.011	0.0085	0.0094	0.015	0.009	0.0074
GeO ₂	-	-	0.006	-	-	-
Ga ₂ O ₃	0.015	0.004	0.003	0.026	0.013	0.070
Eu ₂ O ₃	0.02	-	-	-	-	0.058
BaO	-	0.049	-	0.13	-	-
Ln ₂ O ₃	-	0.083	0.90	-	-	-
Ta ₂ O ₅	0.058	-	-	-	-	0.18
HgO	-	-	0.15	-	-	-
Pr ₂ O ₃	-	-	0.003	-	-	-

4.2.1. Garnet

Garnet occurs in appreciable quantity in only one (1) location at Dodogbagi. Bassa LGA, though it is a constituent of many of the rocks. The Industrial use of Garnet is for ornaments and abrasives.

4.2.2. Granites

Granites occur in all the Senatorial Districts and although the West and the Central zones are dominantly underlain by granitic rocks, the outcrops are being quarried in only six locations. These are in Lokoja-Ajaokuta road, Jimbe, and Kporoko village in Ajaokuta LGA, Ichapia in Ofu LGA, Omi in Yagba West, Ejuku in Yagba East, Ekirimadde in Ijunu LGA and Kabba, Aiyede-Bunu, and Odo-ape in Kabba/Bunu LGA. They occur within the Basement complex region of the State. They constitute the central core of major Hills and ridges. Granites principally consist of quartz, feldspar, Mica and Hornblend. They serve as host to many min-

erals in the State, including marble, quartzites, Mica, Tantalite etc. The major Industrial usage of granites alongside gneisses and pegmatite is in the road and building construction as stone aggregates. It is also used for floor tiles and finishings in buildings.

4.2.3. Gold

Gold is found in at least six (6) locations in the Western Senatorial District of the State. These include Ofere, Sukukiri and Ike in Kabba-Bunu LGA, Ejuku in Yagba East and Ejiba and Okoloke in Yagba West LGA. The gold is found within the schist belt (NE-SW) of the Basement complex of Nigeria which had been remobilized and got concentrated during Orogenic Episode. It is characterized by its purity, softness, heaviness and yellow colours. The gold is concentrated as placer (alluvial) deposit along river beds and as primary ore in the schist, quartz and associated with Moscovite and quartz bearing veins. Gold is used in many applications including;

- 1) Jewelry.

- 2) Used as financial backing for currency.
- 3) In the manufacture of electronics.
- 4) Used in standard desktops or laptop computers.
- 5) Dentistry – used for fillings, crowns, bridges and orthodontic appliances.
- 6) Medical – used as a drug to treat medical conditions such as rheumatoid arthritis. Its radiation also treats certain cancers.
- 7) Aerospace – It is circuitry because it is a dependable conductor and connector.
- 8) Awards of symbol of status – It is a metal of choice for awards and honour.
- 9) Glass making – used in making specialty glass for climate controlled buildings and cases.
- 10) Gold gilding on picture frames and as Gold leaf on the external and internal surfaces.

4.2.4. Iron Ore (Banded and Oolitic)

The State hosts two types of iron ores, the Banded Iron Ore of Basement origin and the oolitic/pisolitic Iron ores of

the sedimentary origin. The banded ore occurs in form of Oxides as magnetite (Fe_3O_4) and Haematite (Fe_2O_3). The Oolitic/pisolitic ore is made up of goethite, Limonite ($2\text{Fe}_2\text{O}_3 \cdot 3\text{H}_2\text{O}$) and Siderite (FeCO_3). There are twenty-seven (27) locations of occurrences of Iron ores of various types in the State. The distribution is seventeen (17) locations in the West, seven (7) in the East and three (3) in the central. Some of these locations include Ebiya in Ajaokuta LGA, Itakpe, in Okehi LGA which are Banded type, Agada in Dekina, Egeneja and Wussa in Bassa LGA. Agbaja and Enegbaki in Koton Karfe LGA, Ilafin in Yagba East (Oolitic), Okedayo, and Suku-kiri in Kabba Bunu, Okofi and Okpareke, in Koton Karfe LGA, and Oyo-iwa in Lokoja LGA. The iron occurrences of commercial interest are well documented, notable among them being Itakpe, Ajabanoko, Agbaja and Kotonkarfi earlier stated. The Industrial uses of Iron Ore are varied but mainly for Steel manufacture, Industrial machines, Alloys and Tools. The various applications include: Railway line, Civil and Building construction works, ship building and automobiles, office and household utensils.

4.3. Chemical Analysis of Some of Iron Ore Deposits in Kogi State

Table 9. Chemical analysis of some of iron ore deposits in kogi state.

%oxide	Ebiya Ajaokuta LGA	Odu- Okpakili Dekina LGA	Jakura Lokoja LGA	Gbarada Koton- karfi, LGA	Iyara Ijumu LGA	Emu- Lokoja LGA	Ene- baki Koton- karfi LGA	Basang e, Ko- ton- karfi LGA	Koji, Bassa LGA	OhagiMo pamuro LGA	Ko- ton Karfe	Ilafin Yagba East LGA	Oshoko- shoko/ Iwaa, Lokoja, LGA
Al_2O_3	54.2	14	-	1.4	4.2	18	5.6	8.2	1	19	12	19	2.4
SiO_2	-	11	69.9	1.4	4.3	25.2	3.8	7.1	1.9	31.4	8.5	25.0	3.9
K_2O	-	0.044	0.092	-	0.22	0.05				0.44		0.503	0.22
CaO	0.673	0.265	0.01	-	0.091	0.13	0.16	0.14	0.11	0.13	0.13	0.15	0.17
TiO_2	-	-	-	-	4.81	0.962				0.634		0.821	10.0
V_2O_5	-	0.11	-	-	0.20	0.18	0.089	0.080	0.047	0.087	0.11	0.11	0.34
Cr_2O_3	0.027	0.040	0.031	-	0.036	0.096		0.044	0.040	0.056	0.033	0.081	0.01
MnO	0.041	0.33	0.036	-	0.12	0.028	0.057	0.437	0.17	0.016	0.11	0.25	0.621
Fe_2O_3	43.61	72.50	28.37	93.0	83.59	52.5	85.63	81.38	93.80	46.77	76.13	52.04	70.15
CuO	0.024	-	0.023	-	-	0.02			0.70			0.028	
BaO	-	-	-	-			0.086			0.03		0.11	
Ag_2O	1.41	-	1.33	1.29	1.46	1.4	1.27	1.31	1.53	1.29	1.31	1.37	1.39
Eu_2O_3	-	-	-	0.26		0.25	0.28	0.04	0.39		0.33	0.33	0.54
ZnO	-	0.04	-	0.04	0.075		0.067				0.043		0.077
Ln_2O_3	-	0.04	-	-									9.9
Bi_2O_3	-	-	-	-									0.09
La_2O_3	0.062	0.11	0.065	0.18			0.17	0.12	0.12		0.16		

%oxide	Ebiya Ajaoku ta LGA	Odu- Okpakili Dekina LGA	Jakura Lokoja LGA	Gbarada Koto- karfi, LGA	Iyara Ijumu LGA	Emu- Lokoja LGA	Eneg- baki Koton- karfi LGA	Basang e, Ko- ton- karfi LGA	Koji, Bassa LGA	OhagiMo pamuro LGA	Ko- ton Karfe	Ifafin Yagb a- East LGA	Oshoko- shoko/ Iwaa, Lokoja, LGA
P ₂ O ₅	-	1.1	-	2.2	0.40	0.94	2.7	0.40	0.31	0.52	1.3	0.48	0.24

4.3.1. Kaolin

Kaolin occurs in about twenty-six (26) locations throughout the state but more in the Eastern Senatorial District than any other. It is mainly whitish or nearly whitish, soft and moldable with low porosity.

The major occurrences of Kaolin are Ojuwo Olijo in Ofu LGA, Emewe-Efopa and Udene-Onioma, Odu-Okpakili, and Odu-Ajibella in Dekina LGA, Odogumu Ofante, Ogugu and Odolu Efu in Olamaboro LGA, Olla, Iyogbo and Udagba Aji in Igalamala/Odolu LGA, Ofejiji, Igalawo, Ajaji, and Iga

Onife of Omala LGA, Emu and Agbaja, in Lokoja LGA, Ayeh Abedde in Ijumu LGA, Gbarada, Chikara and Aseni in Koton Karfe LGA, Kiri, and Ike-kiri in Kabba/Bunu LGA.

4.3.2. Industrial Uses of Kaolin

There are various Industrial uses of Kaolin. It is used in manufacture of paper, paints, rubber, plastics, ceramics, cosmetics, chalks, chemicals, pharmaceuticals, detergents and textiles. It is also an important raw material in refractory applications, catalysts, and concrete and fibre glass. Kaolin is used also in fertilizers, Pesticides and related products.

4.4. Chemical Analysis of Some Kaolin Deposits in Kogi State

Table 10. Chemical analysis of some kaolin deposits in kogi state.

%oxide	Udane- Obiom Dekina LGA	Odu- Ajibela, Dekina LGA	Ajaja, Omala LGA	Takete-Isaa, yagba East LGA	Ojodu Ofu LGA	Odolu- Efu, Dekina LGA	Ojuwo- Olijo Ofu LGA	Iga- Onife, Omala LGA	Ahoko Koton- karfe	Odu- Okpakili Dekina, LGA	
Al ₂ O ₃	31.3	27.7	22.5	-	30.8	36.5	33.8	22.4	21.0	35.7	1
SiO ₂	62.0	65.6	69.7	74.8	63.5	56.7	62.2	67.3	71.4	58.5	
K ₂ O	0.316	0.133	2.29	-	0.340	0.344	0.455	1.84	1.74	0.283	
CaO	0.136	0.128	-	4.42	0.148	0.133	0.122	0.268	-	0.148	
TiO ₂	1.99	2.13	2.07	0.19	1.92	3.07	2.23	3.07	1.74	2.32	
V ₂ O ₅	0.075	0.065	0.071	0.028	0.069	0.12	0.082	0.10	0.058	0.028	
Cr ₂ O ₃	0.019	0.020	0.013	0.880	0.018	0.027	0.020	0.020	0.015	0.023	
MnO	0.014	0.011	0.017	0.252	0.016	0.014	0.011	0.026	0.021	0.013	
Fe ₂ O ₃	1.26	1.21	1.45	18.61	1.07	1.50	1.00	2.792	1.03	0.995	
CuO	0.004	0.049	0.0059	-	0.003	0.0065	0.0057	0.0054	0.003	0.052	
SeO ₂	-	0.094	0.068	-	0.084	-	0.063	-	0.0093	0.049	
Ag ₂ O	1.38	1.29	1.31	-	1.28	1.31	-	1.33	1.26	1.31	
Eu ₂ O ₃	-	0.043	0.042	-	-	-	-	0.058	0.034	-	
PbO	0.69	0.62	0.50	-	-	-	-	-	-	0.55	
Re ₂ O ₇	-	-	-	-	-	0.057	-	0.058	-	-	
Bi ₂ O ₃	0.75	0.94	-	-	0.70	-	-	0.60	0.99	-	
Ga ₂ O ₃	0.10	-	-	-	0.005	0.009	0.012	-	0.0093	-	

%oxide	Udane-Obiom Dekina LGA	Odu-Ajibela, Dekina LGA	Ajaja, Omala LGA	Takete-Isaa, yagba East LGA	Ojodu Ofu LGA	Odolu-Efu, Dekina LGA	Ojuwo-Olijo Ofu LGA	Iga-Onife, Omala LGA	Ahoko Koton-karfe	Odu-Okpakili Dekina, LGA
NiO	-	-	-	0.525	-	0.003	-	-	-	0.011

4.4.1. Kyanite

Kyanite occurs in only 3 locations at Ike-Kiri in Kabba/Bunu LGA where it is associated with Gold and tantalite, LGA, Ejuku and Odogbe in Yagba East LGA.

Kyanite is a metamorphic mineral occurring in schists, gneisses and granite pegmatites. It is associated with quartz, feldspar, mica, garnet, corundum and staurolite. It occurs as bladed and tabular crystals. When there is manganese inclusion, it may orange coloured but generally blue, blue-green and brown with vitreous luster.

Kyanite is primarily used in refractoriness and ceramic products like porcelain plumbing fixtures and dishware. It is also used in electronics, electrical insulators and abrasives.

4.4.2. Result of Chemical Analysis of Some Kyanite Deposits in Kogi State

Table 11. Result of chemical analysis of some kyanite deposits in kogi state.

%oxide	Ejuku, Yagba East LGA	Odogbe, Yagba East LGA
Al ₂ O ₃	26.3	16
SiO ₂	63.25	47.77
K ₂ O	5.74	0.612
SO ₃	0.095	-
TiO ₂	0.295	1.54
V ₂ O ₅	0.017	0.12
Cr ₂ O ₃	-	0.12
MnO	0.026	0.294
Fe ₂ O ₃	3.943	18.21
CuO	0.0054	0.01
BaO	0.16	-
Ag ₂ O	0.05	0.05

%oxide	Ejuku, Yagba East LGA	Odogbe, Yagba East LGA
Eu ₂ O ₃	0.059	0.24
PbO	-	-
Au	0.052	0.01
Bi ₂ O ₃	-	-
Ga ₂ O ₃	0.0014	-
CeO ₂	-	-
CaO	-	14.6
NiO	-	0.023
ZnO	-	0.021
MoO ₃	-	0.16
In ₂ O ₃	-	0.01
Ta ₂ O ₅	-	0.03
HgO	-	0.43

4.4.3. Laterite

Laterite, a product of deep weathering is widespread in the State but occurs massively in four (4) locations in West and East Senatorial districts. These locations are in Arukpa, Achigili in Ofu LGA and Dakina LGA.

Quarrying is taking place on many of them, some of whose thickness range from 100 to 300m.

Laterites are used for road and building constructions.

4.4.4. Manganese

Manganese occurs as oxides and as manganiferous quartzites in about eleven (11) locations mainly in the Western Senatorial District, including Apobitan Aiyedayo in Mopamuro LGA, Takete Isao, and Odogbe in Yagba West LGA, Ijowa, Ajinmi, Aginmi, Ejuku Ido-Ijesa and Jege in Yagba East LGA. Psilomelane which occurs in Oyo-Iwa, Lokoja LGA, is the barium bearing variety of manganese.

Manganese is mainly used in steel making as a deoxidizer and ferro alloy and in chemical industries.

4.5. Analysis of Some Manganese/Manganiferous Quartzites in Kogi State

Table 12. Analysis of some manganese/manganiferous quartzites in kogi state.

% Oxide	OYO-Jwa Lokoja LGA	Takete-Isaa Yagba East LGA	Ijowa. Yagba-East LGA	Ejuku Yagba East LGA	Agbada Yagba East LGA	Iddo-Ijesha Yagba East LGA	Kabba – Bunu LGA
Al ₂ O ₃	3.9	-	-	18	-	14	9.1
SiO ₂	4.5	45.0	59.5	35.0	65.4	26.5	63.0
P ₂ O ₅	0.78	1.70			-		
K ₂ O	0.13	0.02	0.060	0.070	0.03	0.082	0.028
CaO	0.521	2.12	1.37	1.18	1.47	0.909	1.72
TiO ₂	0.54	0.460	0.420	0.357	0.385	0.10	0.508
MnO	58.03	8.82	5.13	7.28	2.49	11.0	10.75
Fe ₂ O ₃	7.70	40.24	31.73	37.43	29.56	44.78	13.23
NiO	0.058		-	-			
ZnO	0.085		-		0.041	0.02	
SeO ₂	0.58		-		-	0.02	
Ag ₂ O	1.61	1.50	1.55		-	1.48	1.39
BaO	20.3	0.15	0.12	0.14	0.093	0.45	0.11
Yb ₂ O ₃	0.06		-				-
Re ₂ O ₇	0.30		-		0.09	0.1	-
Ta ₂ O ₃	0.9		-		-	-	-
V ₂ O ₅		0.02	0.019	0.016	0.017	-	0.047
Cr ₂ O ₃		0.017	0.031	0.031	0.031	0.008	0.021
CuO	-	-	0.026	0.025	0.046	0.037	0.046
In ₂ O ₃				0.03	0.13	-	-
SO ₃					0.20	-	-
Nd ₂ O ₃						0.02	

4.5.1. Marble

The occurrence of Marble in the State is widespread especially the West and Central Senatorial Districts, occurring in fourteen (14) locations which include Adegu village, Uhuodumi, and Ajaokuta - Okene in the Okene LGA, Yyoso Uguden in Ogori Magongo LGA, Okoloke in Yagba West LGA, Oyo-iwa, Iyelu, and Jakura in Lokoja LGA, Mopa in

Mopa-moro LGA, and Iluhagba in Ijumu LGA.

Marble is notable in the Industrial manufacture of cement, hydrated lime, Bleaching power, Fertilizer, Detergents, Calcium Carbide, Glass, Paint, Ceramics, Chemical and pharmaceutical products as well as in Iron roofing, steel production as flux, and for interior decoration.

4.5.2. Result of Chemical Analysis of Some Marble Deposits in Kogi State

Table 13. Result of chemical analysis of some marble deposits in Kogi state.

% Oxide	Mopa, Mopa Muro LGA (1)	Mopa Mopa Moro LGA (2)	Apa, Kabba/Bunu LGA	Iyelu, Lokoja LGA	Oyo-Iwa, Lokoja LGA	Okoloke Yagba West LGA
Al ₂ O ₃	1.6	1.4	1.3	2.4	2.0	4.1
SiO ₂						9.52
K ₂ O						0.51
CaO	95.67	95.97	95.63	95.10	95.21	81.17
TiO ₂	0.02	0.02	0.060	0.055	0.04	0.37
V ₂ O ₅	0.005					0.02
Cr ₂ O ₃					0.01	
MnO	0.01					0.020
Fe ₂ O ₃	0.15	0.19	0.459	0.17	0.20	1.82
CuO						
Ag ₂ O	1.72	1.65	1.66	1.71	1.69	
Ln ₂ O ₃						1.4
La ₂ O ₃	0.080	0.06	0.06	0.07	0.06	
P ₂ O ₅						
CeO ₂		0.04	0.06	-		
Y ₂ O ₃	0.61	0.59	0.73	0.4	0.69	0.57
BaO	0.09	0.07	-	-	0.08	
Sm ₂ O ₃	0.05	-	0.06	0.03	0.04	

4.5.3. Muscovite Mica

Muscovite, commonest of the Micas in Kogi State is mainly located in the West and Central Senatorial District of the State. Large deposits of Muscovite Mica are found in Ogbom in Yagba East, Oshokoshoko in Lokoja LGA, Okoloke in Yagba West, Aiyedaju in Ijumu LGA, Idofin in Yagba East,

Ofere in Kabba Bunu, and Irepini in Adavi LGA.

Its industrial application is similar to that of Biotite Mica in addition to being used in paints, wall papers, Acoustic Board, as electrical condenser and as insulator in electrical appliances, as dusting medium to prevent asphalt tiles from sticking to each other, and utilized in optical instruments.

4.5.4. Analysis of Some Mica Deposits in Kogi State

Table 14. Analysis of some mica deposits in Kogi state.

% Oxide	Oshokoshoko/Iwaa I Lokoja LGA	Okoloke Yagba West LGA	Ofere, Kabba-Bunu LGA	Oshokoshoko/Iwaa II Lokoja LGA
Al ₂ O ₃	35.7	39.4	38.1	36.3
SiO ₂	43.2	46.3	45.6	45.2
K ₂ O	11.0	11.22	10.92	11.33

% Oxide	Oshokoshoko/Iwaa I Lokoja LGA	Okoloke Yagba West LGA	Ofere, Kabba-Bunu LGA	Oshokoshoko/Iwaa II Lokoja LGA
Se ₂ O ₂	0.020	0.011	0.014	0.056
TiO ₂	0.12	0.11	.	0.543
MnO	0.017	0.027	0.098	0.041
Fe ₂ O ₃	9.602	2.568	5.005	6.090
CuO	0.0081	0.0067	0.0071	0.010
Ca ₂ O ₃	0.009	0.036	0.046	0.070
BaO	0.14	0.01	-	-
CeO ₂	0.008	-	-	-
Eu ₂ O ₃	0.11	0.058	0.074	0.066
InO ₂	0.068	-	-	-
Au	0.06	0.01	-	0.03
Ta ₂ O ₃	-	0.18	-	0.24
V ₂ O ₅	-	0.004	-	0.000
Cr ₂ O ₃	-	0.015	-	0.0083
Re ₂ O ₇	-	0.058	0.04	
ZnO	-	0.024	0.080	
La ₂ O ₃	-	-		0.079

4.5.5. Precious Quartz

Precious quartz occurs in 5 locations in the State, mainly in the west Senatorial Districts. They are coloured quartz in shades of colours as Milky quartz, smoky quartz and Rose quartz.

This semi precious stone is found around Oshokoshoko in Lokoja LGA, Ogidi and Iyara in Ijumu LGA. The industrial application of the mineral is ornamental.

4.5.6. Quartz/Quartzite

Quartz and Quartzites minerals are widely spread in Kogi State especially in the West and Central senatorial districts. These locations include Eika-Ohizeyin in Okehi, Zariagi in Adavi, Okunran, Ejiba, in Yagba West, Oshokoshoko in Lokoja LGA; Aiyede-Amuro in Mopa Muro, Ejuku, Aginmi

and Ido-Ijesha, in Yagba East, Iyara, Okoro, Aiyegunle in Ijumu LGA, Iluogun, Ofere, Olle, and Agbadu in Kabba Bunu LGA, Lokoja and Oyo-iwa in Lokoja LGA and Gbarada in Koton Karfe LGA.

The Quartz/Quartzites occur as massive bodies in many of these locations while some are found in association with Igneous and Metamorphic bodies as well as in Sandstone and veins. It is classified as purely crystalline silica, essentially monomineralic (contain mainly quartz). It is white or near white in colour, medium to coarse grained with smooth texture, hard and brittle. In some places it is ferruginous.

Its industrial application is mainly in optical, glass, refractory, concrete, prisms, Electronic equipment (as in radio oscillation), Porcelain, oscillation plates, refractories and in building constructions.

4.6. Result of Chemical Analysis of Some Quartzites/Quartz Deposits of Kogi State

Table 15. Analysis of some mica deposits in kogi state.

% Oxide	Ofi, Yagba, West LGA	Olle, Kabba/ Bunu LGA	Obajana, Lokoja LGA	Oyo-Iwa, Lokoja LGA	Olle, Kebba/Bu nu	Ike, Kab- ba/ Bunu LGA	Aiyele, Nopa- Moro LGA	Igbayun, Yagba West LGA	Takete-Isaa Yagba East
Al ₂ O ₃	-	17.7	-	-	37.1	11	-	23.0	
SiO ₂	95.2	76.6	69.60	99.5	37.9	49.3	97.61	73.0	74.8
K ₂ O	0.117	2.53		-	0.073	0.021	0.038	0.002	
CaO	0.164	0.860	0.236	0.198	0.703	2.15	0.399	0.428	4.42
TiO ₂		0.011	-	-	0.4429	-			0.19
V ₂ O ₅	-	-	-	-	0.019	0.023		0.014	0.028
Cr ₂ O ₃	0.047	0.020	0.032	0.031	0.088	0.017	0.032		0.880
MnO	0.032	0.338	0.030	0.0052	0.344	5.09	0.016	0.016	0.252
Fe ₂ O ₃	0.972	1.84	30.03	0.220	20.18	31.08	0.183	1.681	18.61
CiO	0.957	0.0064	0.020	0.012	-	0.025	0.0074	0.012	
SeO ₂	-	-	-	-	-	-	-	-	
Ag ₂ O	-	-	-	-	2.04	1.42	1.18	1.51	
Eu ₂ O ₃	-	0.054	-	-	-	-	-	-	
PbO	0.68	-	-	-	-	-	0.60	-	
Bi ₂ O ₃	-	-	-	-	-	-	-	-	
Re ₂ O ₇	-	-	-	-	-	-	-	0.066	
Gu ₂ O ₃	-	-	-	-	-	-	-	0.014	
NiO	0.0067	0.0083	-	0.0083	-	-	0.0062	-	0.525
ZnO	0.171	-	-	-	0.11	-	-	0.029	0.004
In ₂ O ₃	-	-	-	-	-	-	-		
La ₂ O ₃	-	-	0.046	-	-	0.081	-	0.036	
P ₂ O ₅	-	-	-	-	0.63		-		
CeO ₂								0.198	

4.6.1. Radioactive Mineral

Radioactive was reported to occur at olle in Kabba/Bunu LGA on a hill of 528m above the sea level. However, this has not been confirmed by our recent geological study of the area.

4.6.2. Rutile/Ilmenite

Rutile/Ilmenite occur in association with Bismuth in three (3) locations mainly in the West Senatorial Districts. These locations include Isanlu-Esa, Aginmi, and Eika.

It is industrially used as refractory in Ceramics, Paints and plastics, welding electrodes covering.

Typical example of some analyses is given in the table below.

4.6.3. Sample KG-YGW-ISE-RTL-002- Isanlu-ESA, Yagba West

Table 16. Sample KG-YGW-ISE-RTL-002- Isanlu-Esa, yagba west.

Compound	Al ₂ O ₃	SiO ₂	CaO	TiO ₂	V ₂ O ₅	Cr ₂ O ₃	MnO	Fe ₂ O ₃	ZnO	Ag ₂ O	Eu ₂ O ₃	OsO ₄	Bi ₂ O ₃
Concentration Unit %	19	25.2	0.708	19.21	0.49	0.016	0.22	24.85	0.045	1.51	0.23	0.34	8.2

Table 17. Sample 4110 Bismuth: Location – Aginmi, Yagba East Lga.

Compound	SiO ₂	K ₂ O	CaO	Sc ₂ O ₃	Cr ₂ O ₃	MnO	Fe ₂ O ₃	CuO	TiO ₂	Bi ₂ SO ₃
Concentration Unit %	96.68	0.023	0.117	0.004	0.036	0.013	0.265	0.0096	0.34	2.5

Table 18. Bismuth sample: location – eika.

Compound	SiO ₂	CaO	Cr ₂ O ₃	MnO	Fe ₂ O ₃	NiO	CuO	TiO ₂	Bi ₂ SO ₃
Concentration Unit %	96.81	0.140	0.035	0.019	0.181	0.0048	0.0098	0.64	2.2

Table 19. Niobium sample kg-ygw-ise-t&c-001- isanlu-esa, yagba west.

Compound	SiO ₂	K ₂ O	CaO	TiO ₂	V ₂ O ₅	Cr ₂ O ₃	MnO	Fe ₂ O ₃	Rb ₂ O	Nb ₂ O ₅	Ag ₂ O	BaO	Ta ₂ O ₅
Concentration Unit %	8.0	0.17	0.369	0.736	0.062	0.014	4.30	13.22	3.0	54.9	2.15	0.16	12.9

Table 20. Nickel sample KG-YGE-TKI-TLC-001 - Takete-Isaa, yagba east.

Compound	SiO ₂	SO ₃	CaO	TiO ₂	V ₂ O ₅	Cr ₂ O ₃	MnO	Fe ₂ O ₃	NiO	ZnO	Re ₂ O ₇
Concentration Unit %	74.8	0.12	4.42	0.19	0.028	0.880	0.252	18.61	0.525	0.004	0.17

4.6.4. Tantalite

Tantalite is found mainly as alluvial deposition and also within the older granites and cross-cutting pegmatites. They occur as oxides of Tantalum-Niobium, Iron and Manganese. Tantalites are grey to black or dark brown in colour.

Tantalite occurs in all the three (3) Senatorial Districts but mostly in the West. It exists in about fourteen (14) locations throughout the State which include Eika-Odumi in Okehi

LGA, Odovi in Ajaokuta, Dodogbagi in Bassa LGA, Odo-ara, Odo-eri and Idofin in Yagba West LGA, Iyara in Ijumu LGA, and Kakun, Ihale and Ofere in Kabba-Bunu LGA.

Tantalite is used as furnace construction materials, in aerospace and electronic Industries for manufacture of components like capacitors and high powered resistors. Most importantly it is used in the manufacture of steel alloys, dental and surgical equipments, and electrodes for welding.

Table 21. Tantalum Sample KG-BAS-KJI-TTL-001 Koji, Bassa.

Compound	SiO ₂	K ₂ O	CaO	TiO ₂	V ₂ O ₅	Cr ₂ O ₃	MnO	Fe ₂ O ₃	Rb ₂ O	Nb ₂ O ₅	In ₂ O ₃	BaO	Ta ₂ O ₅
Conc. Unit	15%	0.27%	0.387%	0.30%	0.058%	0.025%	5.05%	5.87%	17%	8.86%	0.51%	0.17%	47.2%

4.6.5. Talc

Talc occurs in 6 locations mainly in the West Senatorial District. These locations are Odo-ara, Ogbe, Ijowa, and Takete Isao in Yagba Weest LGA.

The Talc which is moderately pure and soft, light grey, of soapy and greasy feel and rich in magnesium, occurs within the Basement complex of the State.

Table 22. The Industrial uses are in the manufacture of Paints, Ceramics, Cosmetics, Paper, Textile and Rubber.

Compound	SiO ₂	K ₂ O	CaO	TiO ₂	V ₂ O ₅	Cr ₂ O ₃	MnO	Fe ₂ O ₃	NiO	ZnO	Eu ₂ O ₃	Re ₂ O ₇	HgO
Conc. Unit	64.9%		7.90%	0.250%	0.044%	1.04%	0.383%	24.35%	0.444%	0.03%	0.30%	0.09%	0.3%

Table 23. Talc occurs in 6 locations mainly in the West Senatorial District.

KG-YW-ARA-TLC-002	SiO ₂	61.9%	Talc
Odo-Ara, Yagba West	CaO	5.00%	
	TiO ₂	0.203%	
	V ₂ O ₅	0.038%	
	Cr ₂ O ₃	0.511%	
	MnO	0.466%	
	Fe ₂ O ₃	30.80%	
	NiO	0.299%	
	ZnO	0.059%	
	Eu ₂ O ₃	0.40%	
	Re ₂ O ₇	0.0%	
	HgO	0.3%	

4.6.6. Tourmaline

Tourmaline is found in Pegmatites in association with many other Precious minerals in about nine (9) locations mainly in Western Senatorial District. These locations in-

clude Odovi in Ajaokuta LGA, Ologbara-Aiyedayo and Aiyede-Amuro in Mopa Muro LGA. Idofin in Yagba East LGA, Iyara and Iyah of Ijumu LGA and Ofere in Kabba-Bunu LGA.

Table 24. The Industrial application is in Therapeutic, hair straightness and natural insecticides.

KG-MPA-AYD-TML-51	Al ₂ O ₃	17.8%	Toumaline
Aiyede, Mopamoro LGA	SiO ₂	39.1%	

KG-MPA-AYD-TML-51	Al ₂ O ₃	17.8%	Toumaline
	SiO ₂	0.05%	
	CaO	22.25%	
	TiO ₂	0.219%	
	V ₂ O ₅	0.12%	
	Cr ₂ O ₃	0.042%	
	MnO	0.12%	
	Fe ₂ O ₃	17.17%	
	Y ₂ O ₃	0.73%	
	Ag ₂ O	1.35%	
	In ₂ O ₃	0.03%	
	Eu ₂ O ₃	0.14%	
	Au	0.24%	
	HgO	0.66%	

4.6.7. Tin Ore

Tin Ore occurs in Oxide form cassiterites in association with columbite or Tantalite in the older granites. It is characterized by its dark-brown to black colour. Kogi state tin ore has a very bright metallic lustre and is of high grade.

The Cassiterite is located in five (5) areas mainly in the Western Senatorial District including Odo-ara, and Odo-eri in Yagba West, Ofere in Kabba –Bunu LGA and Igbaruku of Yagba West LGA.

The Industrial application of cassiterite includes Soldering, coating, canning, dyeing, and printing. It is also used in the manufacture of Tin, Plates, Ball-metals, Bronze and other metal containers.

4.6.8. Silica Sand

Silica Sand occurs in various quantities across the State and prominently in four 4 locations within mainly the West and East Senatorial districts. These locations are Iyogbo and Ofudu in Igalamala/Odolu LGA, Bagana in Omala LGA, Ochadamu and Dekina in Dekina LGA.

Silica sand, pebbles and gravels are commonly localized along river channels and stream beds and in the sandstone formations. It is characterized by small to medium sized grains and angular to rounded grained quartz.

Silica sands are used in construction and building industries, in glass making and ceramics, Silicon and Semi-conductors.

Table 25. IYOGBO, Igalamela/Odolu LGA.

Compound	SiO ₂	K ₂ O	CaO	TiO ₂	V ₂ O ₅	Cr ₂ O ₃	MnO	Fe ₂ O ₃	Rb ₂ O	Nb ₂ O ₅	Ag ₂ O	BaO	Ta ₂ O ₅	SO ₃
Conc. %	97.1	0.007	0.143	0.101	0.0099	0.029	0.021	1.23	0.013	-	1.21	0.02	-	0.11

Table 26. BAGANA, Omala LGA.

Compound	SiO ₂	GeO ₂	CaO	TiO ₂	Sc ₂ O ₃	Cr ₂ O ₃	MnO	Fe ₂ O ₃	CuO	Ag ₂ O	NiO	Eu ₂ O ₃	Pr ₂ O ₃	SO ₃
Conc. %	98.21	0.022	0.140	0.015	0.0009	0.031	0.041	0.265	0.0092	1.20	0.006	0.02	0.034	0.11

4.6.9. Zircon

It occurs in one (1) location in the East, in Dodogbagi, Bassa LGA.

Zircon is used in foundry, paints, bricks, chemicals and alloy.

4.7. Current Status of Kogi State Mineral Inventory

Table 27. Some of the notable mineral occurrences and their status are shown below.

S/N	LOCATION	STATUS/REMARKS
a. IRON ORES		
1.	Itakpe	Exploration work completed by NSRMEA. Deposit being mined by NIOMCO.
2.	Ajabanoko	Advanced stage of exploration by NSRMEA to prove the reserves.
3.	Ebiya	On-going work by NSRMEA. Determination of reserves outstanding.
4.	Tajimi	On-going work by NSRMEA. Occurrence confirmed.
5.	Oshokoshoko/Iwaa	On-going work by NSRMEA. Occurrence confirmed.
6.	Agbado-Okudu/Jakura	Exploration almost completed by NSRMEA to prove reserve.
7.	Agbaja	Large reserves of oolitic iron ores. Confirmed.
8.	Koton-Karfi	Large reserves of oolitic iron ores. Confirmed.
b. MARBLE/LIMESTONE		
9.	Jakura/Iwaa	Large deposit being mined and used by Dangote Cement Company.
10.	Ubo	Large deposit, part being used by Ukpilla Cement Company.
11.	Itobe/Allo	Dolomite of large quantity for the proposed Kogi Cement factory
12.	Iyamoye-Iyara South of Mopa	“ “ “
c. CLAY/FIRE CLAY/KAOLIN		
13.	Igadoba	Yet to be fully explored and developed.
14.	Onyedega	“ “ “
15.	South of Giwaligyo	“ “ “
16.	Agbaja /Emu	“ “ “
17.	Tajimi Area	“ “ “
18.	Kawari	“ “ “
d. CASSITERITE, COLUMBITE AND TANTALITE		
19.	Ode-Ere	More detailed investigation necessary.
20.	Egbe	“ “ “
21.	Odugba	“ “ “
22.	East of Ajaokuta (North of Itobe)	“ “ “
e. MICA		
23.	Isanlu, Isanlu-Esa, Irepeni.	More detailed investigation necessary.
f. FELDSPAR		

S/N	LOCATION	STATUS/REMARKS
24.	Isanlu-Esa	More detailed investigation necessary.
25.	Okene	“ “ “
26.	Osara	“ “ “
27.	Ubo	Part being exploited by Ukpilla Cement.
g. DOLOMITE		
28.	Osara	Exploration work completed by NSRMEA.
h. COAL		
29.	Odagbo, Okaba	Mining in progress
30.	Okobo, Ankpa	Mining in progress
31.	Ikeffi, Igalamela/ Odolu	Mining in progress
32.	Olokwu, Ofu	Mining in progress
GOLD		
33.	Okolom-Dogondaji Yagba west	
34.	Taki, Kabba/ Bunu	Active mine
35.	Okoloke, Yagba West	Active mine
36.	Isanlu-Esa, Yagba West	Active mine

4.8. Mineral Resources Recommended for Immediate Attention

This work has been able to recommend eight (8) mineral resources including coal, marble, gold, iron ore, feldspar, kaolin, talc, and muscovite which need immediate attention because of their abundance in the state economic potential.

4.8.1. Coal

Coal is the most attractive considering the recent emphasis on use of coal for power generation by the Federal Government. Energy is at the heart of social and economic development worldwide. Development and exploitation of coal resources in Kogi State could move the State towards energy independence and provide a boost to its industrial and employment efforts.

4.8.2. Cement

Cement raw materials are plentiful particularly in Kogi State. The biggest cement plant in Africa is sited in Kogi State and its sustainability depends on sustainable supply of marble from Oyo-Iwa near Obajana. The cement plant would provide revenue and adly needed jobs for the teeming youths.

4.8.3. Gold

Gold occurrences have been reported in at least ten (10)

locations in Kogi State. Modern exploration methods would easily increase the number of prospects. Apart from being one of the commodities more likely to attract large investors, small gold deposits may form the base for the development of an entirely Nigerian industry. Geologically, the favourability for small, comparatively high-grade deposits is excellent.

4.8.4. Iron Ore

Iron ore is another mineral resource that calls for attention. There is massive hunger for iron ore worldwide driven by the desire of developing countries particularly, India and China to bring their standards of living and economies up to those of the developed world. Immediately after hydrocarbon, iron ore is Nigeria's best-documented mineral resource. Many of the Iron deposits occur in Kogi. The resources of this area are estimated at over two billion MT ore at 15-65% Fe. These resources include Oolitic iron ore but with a high phosphorous content (2.35%). Sustainability of Ajaokuta Steel Plant can only be guaranteed by availability of cheap iron ore. Because of their nearness to Ajaokuta Steel Plant, iron deposits in Kogi State can be developed to produce cheap iron ore.

4.8.5. Feldspar

Feldspar Kogi State has a good number of feldspar deposits calling for attention as demand for feldspar for glass, ceramics, abrasive, soap and chemicals continued to grow.

4.8.6. Kaolin

Kaolin is another mineral whose demand for paper, paint, rubber, plastics, ceramics, and drugs continued to grow. Fortunately, Kogi State has many kaolin deposits that require further investigation to make them attractive to investors.

4.8.7. Talc

A good number of talc deposits is found in Kogi State and demand for talc for ceramics, paints, paper, chemicals, cosmetics, filler, adsorbents continued to grow.

4.8.8. Muscovite Mica

Muscovite Mica has been reported in many locations in Kogi State and its demand for window glass and insulator has continued to grow.

5. Conclusion

From the previous and present work, Kogi State is confirmed to be endowed with many solid mineral resources. These are metallic minerals including iron ores, columbite, tantalite, cassiterite and pyrite; Industrial minerals available include clays, kaolin, talc, gypsum, marble, feldspar, mica and quartz. The precious minerals include gold, beryl and tourmaline while the energy mineral includes coal. As the living standard of our people increases, demand for mineral resources for food, agricultural, transportation, building, power, and pharmaceutical industries increases too. Fortunately, Kogi State has abundant mineral resources and this mineral endowment can be made available for utilization only through sustained investment in systematic exploration, development, mining, and processing.

The Government of Kogi State is in right direction by carrying out mineral inventory of its State. The next step is to give special attention to eight recommended mineral resources (Coal, Marble, Iron ore, Gold etc.) because of their economic potential. The development and exploitation of the mineral resources- the iron ore, marble, clays, coal and other mineral deposits is recommended to be private sector driven. This exercise has made geological and exploration data on the identified mineral resources available including mode of occurrence, quality and probable quantity, it is hoped that this will help to attract investors to the mineral and metal sector of the economy of the State and the nation at large.

The development and exploitation of various minerals in Kogi State will bring about rapid industrialization especially in setting up industries like steel, cement manufacturing, electrical and electronic components manufacture, paint, refractories, soap and detergents, ceramics, bricks, electricity generation, jewelry among others. This will eventually boost the economy of Kogi State and provide the much-needed job opportunities for the teeming youth.

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Conflicts of Interest

The authors declare no conflicts of interest.

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