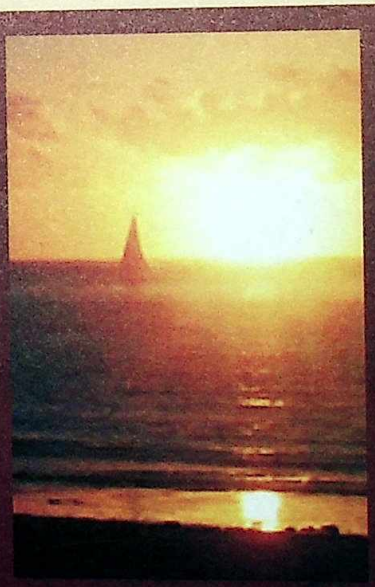
Ondo STATE
IṢẸ LOÒGÙN ÌṢẸ



An **INVESTMENT MANUAL** on the **MINERAL RESOURCES** of Ondo State, Nigeria.


STICKER-MARK ®
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foreword

Ondo State of Nigeria is naturally and richly endowed with immense and economically viable mineral deposits viz; Oil and Gas, Bitumen, Glass-sands, Limestone, Coal, Granite, Dimension-stones, Iron ore, Kaolin and Clay deposits among others.

These veritable resources occur in virtually the 18 Local Government Areas of the State and constitute valuable sources of raw material for industrial development. The exploitation and development of these vast mineral resources will offer tremendous economic and investment opportunities to aspiring local and foreign investors.

The State is strategically located with an expansive shore line, a deep water sea port and free trade zone especially for export oriented businesses. It is about five hours drive from Abuja, the Capital of the Federal Republic of Nigeria and three hours from the southern part of Lagos, the commercial nerve centre of the Country.

In demonstration of the State Government avowed commitment to rapid industrialization, most especial in the mineral sector, the Government evolved some strategies in its 12- points agenda aimed at promoting trade and investment opportunities in all the sectors of the economy. Some of these include: easy access to land, provision of modern infrastructural facilities and encouraging private sector participation in the industrial development of the State.

I therefore seize this opportunity to invite both local and foreign investors to participate in the oil & gas and solid minerals development programme of the State. Let us harness these abundant resources, create and use wealth for the ends of individual happiness and make the State the cynosure of all eyes of which everyone shall be proud.

Dr. Olusegun Mimiko.
Governor, Ondo State.

Ondo State
the sunshine state

contents

3.3	Glass Sands	19
3.3.1	Igbokoda Sands	21
3.3.2	Filter Sands	21
3.4	Dimension stones	21
3.5	Iron Ore (Magnetite)	23
3.6	Coal	23
3.7	Marble	23
3.8	Other Reported Mineral Resources	23
3.9	Tar Sands	23
3.9.1	Historical Perspectives of Tar Sand	23
3.9.2	Geology of Ondo Tar Sand	24
3.9.3	Textural Properties	24
3.9.4	Physical and Chemical Properties	24
3.9.5	Importance of Tar Sands	26
3.10	Petroleum and Gas	27
4.0	Ondo State Industrial Policy	28
5.0	National Policy on Solid Minerals	28
5.1	Incentives	29
5.2	Role of Government and the Private Sector	30
5.3	Environment, Health and Safety	30
6.0	Procedure for Obtaining a Mining Licence	30
7.0	Conclusion	31
REFERENCES		32

List of **Figures**

Figure 1	Map of Nigeria showing the Location of Ondo State	7
Figure 2	Administrative Map of Ondo State	7
Figure 3	Geological Map of Ondo State	10
Figure 4	Mineral Map of Ondo State	11
Figure 5	Block diagram of Omialafara Kaolin deposit	17
Figure 6	Fence diagram of Abusoro Kaolin deposit	17
Figure 7	Fence Diagram of Ute Clay Deposit	17
Figure 8	Sections across Okeluse Limestone deposit	20
Figure 9	Location Map of Igbokoda Glass Sands	22

List of **Tables**

Table 1	History of Mineral Exploration in Ondo State (1970-95)	8
Table 2	The Local Government Areas of Ondo State	8
Table 3	Mineral Based Investment Opportunities in Ondo State	12
Table 4	Summary of Clay Deposit in Ondo State	18
Table 5	Physico-Chemical Properties of Selected Samples of Tar Sands deposits in Ondo State, Nigeria	25
Table 6	Industrial Applications of Major Products from Tar Sands	27

1.0 ONDO STATE

Introduction

Ondo State *is indeed, a microcosm of Nigeria nation. Like Nigeria (the largest Black Nation on earth) of which she is a part, Ondo State is blessed beyond imagination with natural resources, which beg for exploitation. Her people literally sit on wealth, but ironically suffers thirst at the source of a spring! The State is blessed with a perfect 12-hour diurnal range, a moderate, year-round temperature average of 25°C; three vegetation zones stretching from mangrove to derived savannah; the longest coastline bordering the Atlantic Ocean; good soil conditions, large drainage basins and an array of exploitable, economic mineral resources such as kaolin, bitumen, dimension stones, glass sands limestone, oil and gas among others.*

The history of mineral exploration in Ondo State dates back to the beginning of the last century when bitumen was first discovered in Agbabu in 1907. For over nine decades now, the large bitumen deposit (reported to be the second largest in the world, next to Canada) has remained unexploited.

Mineral exploration work by Government started in the mid-seventies when in 1974, a survey was commissioned to explore for suitable glass sands at Igbokoda, Ilaje Local Government, the result of which is now the Oluwa Glass factory. Subsequently, various private companies have been commissioned to carry out general and specific exploration work on the numerous mineral resources in the state. In addition, private entrepreneurs have on their own, carried out exploration work on some of these minerals. Table 1 shows the history of exploration activities in Ondo State in the last 25 years.. This manual, prepared from the results of previous studies on the mineral survey of the state, provides an up-to date information on the mineral deposits in the state. It also focuses on the mineral deposits of the state and the State Government's industrial policy. The Federal Government of Nigeria's new policy on solid minerals and the procedure for obtaining a mining lease right are also highlighted in this profile. It is envisaged that this manual will serve as a guide to entrepreneurs who may wish to explore, exploit and process any of the economically viable minerals that abound in Ondo State.

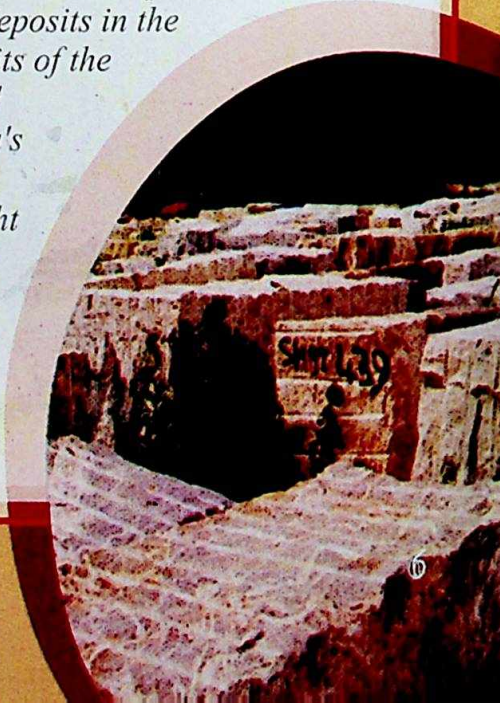


Figure 1:
Map of Nigeria showing the location of Ondo State

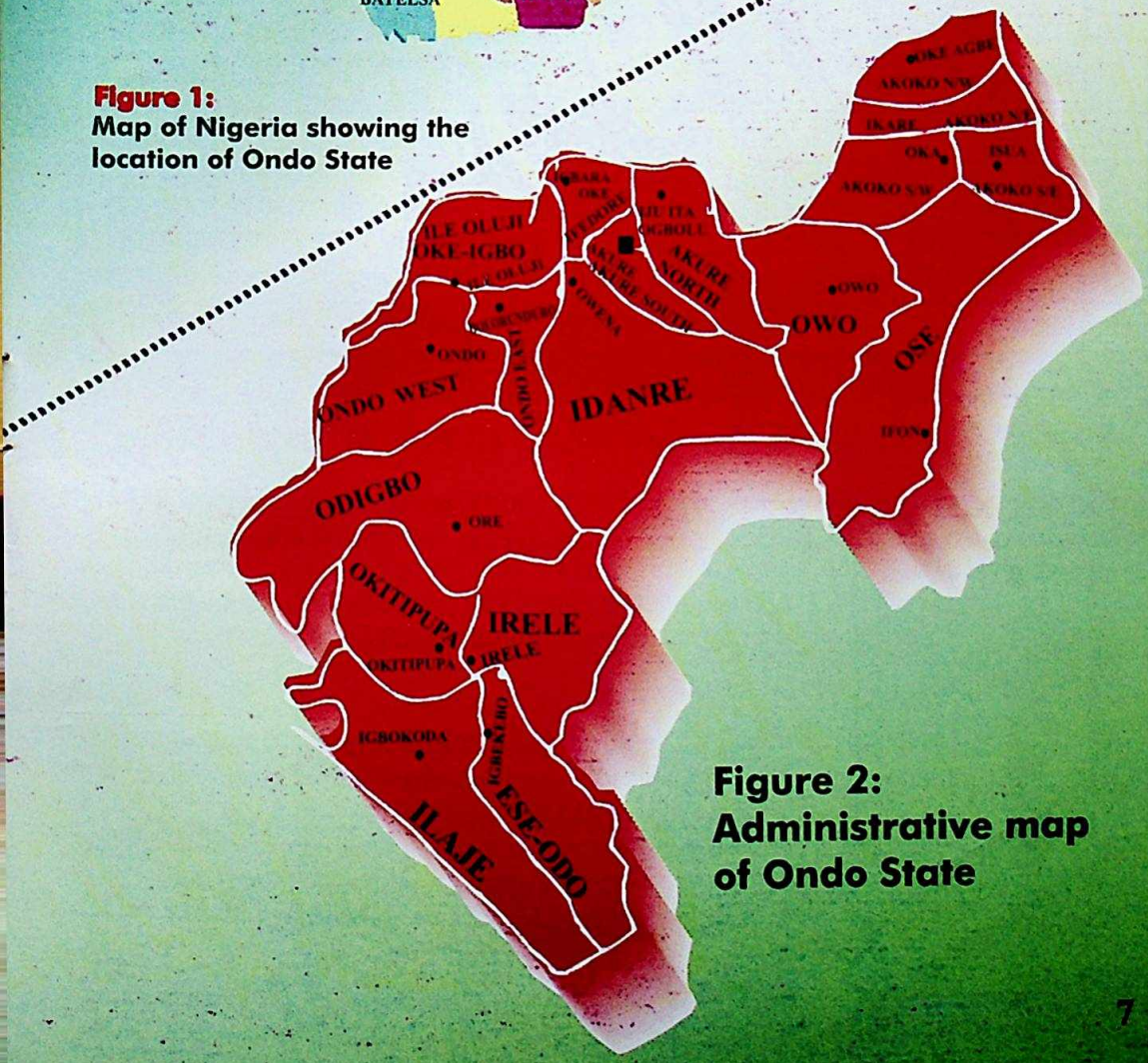


Figure 2:
Administrative map of Ondo State

TABLE 1: HISTORY OF MINERAL EXPLORATION IN ONDO STATE (1970-75) After odeyemi 1998

No	Mineral/rock Explored	Client	Consultant Major	Minor
1.	Glass Sands, Igbokoda	Western Region Government	Geological Consultancy Unit O.A.U. Ile-Ife 1975	—
2.	Tar Sands	Ondo State Government	Geological Consultancy Unit O.A.U. Ile-Ife 1976	—
3.	Limestone, Okeluse	Ondo State	Geological Consultancy Unit. O.A.U. Ile-Ife 1978	—
4.	Ifon Ceramic Clays	Ondo State Government	University of Ibadan Geological Consultancy 1976	—
5.	Okeluse Limestone	Federal Govt. of Nigeria	Geological Survey Department 1970	—
6.	Okeluse Limestone	Western Region Government	Metals & Minerals 1976	—
7.	Okeluse Limestone	Ondo State Government(TFI)	FUTA Consults, Akure 1988	Odeyemi I. B
8.	All Minerals	Ondo State Government	Brink Jones Co. Ltd. 1989	Odeyemi I. B
9.	Tin	Ondo State Government	Brink Jones Co. Ltd. 1991	Odeyemi I. B
10.	Glass Sands	Debo Industries	UNILAG Consults 1984	Odeyemi I.B
11.	Refractory Quarzites	National Steel Council	Steel Raw Minerals Exploration Agency 1991	—
12.	Granites	Julius Berger	Julius Berger Plc. 1991	—
13.	Granites	Pan Fedam G&M Ltd.	ODEYEMI I.B. 1992	—
14.	Granites, Supare	Crushed Rock Industries	IRG Consultants 1992	—
15.	Granites	GEMS (Nig)Ltd.	ODEYEMI. I.B.1995	—

TABLE 2: The local Government Areas of Ondo State

S/N	Local Govt. Area	Local Govt. Hq.
1.	Akoko North East	Ikare
2.	Akoko North West	Oke-Agbe
3.	Akoko South East	Isua
4.	Akoko South West	Oka
5.	Akure North	Iju/Itaogbolu
6.	Akure South	Akure
7.	Ese Odo	Igbekebo
8.	Idanre	Owena
9.	Ifedore	Igbara-Oke
10.	Ilaje	Igbokoda
11.	IleOluji-Okeigbo	Ile Oluji
12.	Irele	Irele
13.	Odigbo	Ore
14.	Okitipupa	Okitipupa
15.	Ondo East	Bolorunduro
16.	Ondo West	Ondo
17.	Ose	Ifon
18.	Owo	Owo

2.0 GENERAL INFORMATION

2.1 Location

Ondo State is located in the Southwestern part of Nigeria (figure 1). It lies between longitudes 4.00°E and 6.00°E and latitudes 5.45°N and 8.15°N (Fig.2). It covers an area of over 14,595 square kilometers. Ondo State is bounded by Kwara, Kogi and Ekiti State in the north, Edo and Delta in east, Ogun, Oyo and Osun in the West and, by the Atlantic Ocean in the south. (Fig. 2)

Ondo State is carved into 18 Local Government Areas (Table 2 and Figure 2) and three senatorial districts, namely:

i. Ondo Central
ii. Ondo South
Iii. Ondo North

The people are mostly Yoruba, made up of Akure, Akoko, Ondo, Ilaje and Owo sub-ethnic groups. The inhabitants include Arogbo Ijaw and Apoi.

2.2 Physiography, Climate and Vegetation

Over 60% of the State is underlain by basement migmatites, gneisses and granites which form rugged hills and rolling plains. At Idanre and Ikare, where these rocks assume batholithic dimensions, they form impressive out crops which tower hundreds of meters above the surrounding low lands. They are the major tourist attractions in the state. The southern 40% of the state is underlain by flat-lying sedimentary rocks. The riverine areas are underlain by mudflats and creeks.

The climate is tropical, with two sharp seasons: the dry and the rainy seasons. The rainy season commences in March and ends in October with a peak in July/August, while the dry season which is hot and dry, occurs between October and March. During the rainy season, up to 2000mm of rainfall may be experienced in the coastal areas of the south, diminishing to 1500mm in the hinterland. The temperature varies from 21°C to 29°C throughout the year, with an average value of 25°C. The state is also blessed with a near perfect, 12-hour diurnal range.

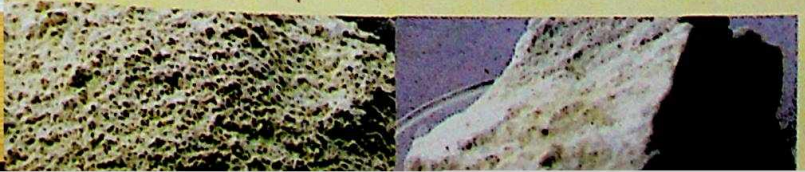
The vegetation pattern varies in accordance with the climate and rainfall. Basically, three major vegetation zones exist: a mangrove forest zone in the south, a tropical rain forest zone and a derived savannah zone as one moves to the north.

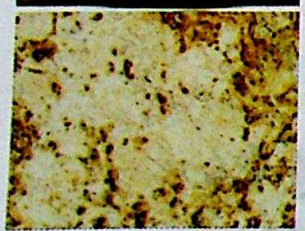
2.3 Geology

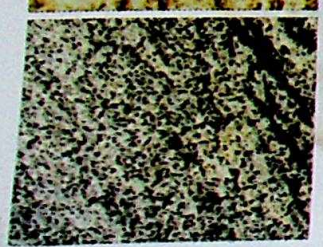
Ondo State is underlain by two major rock groups: the basement complex of precambrain (3000 m.y-500m.y.) age and sedimentary rocks of cretaceous to recent age (120 million years to present). (Fig 3). The basement complex underlies the northern 60% of the state and is made up of three groups of rocks, namely the migmatite gnesiss complex; the metasediments and the older granites. The southern 40% of the state is underlain by sedimentary rocks, consisting of sands, sandstones, shales, clays and limestone.

3.0 THE MINERAL RESOURCES OF ONDO STATE

Three types of minerals exist in Ondo State: metallic, non-metallic minerals and mineral fuels. The metallic minerals which include tantalite and cassiterite are reported to occur around Igbara-Oke whereas non-metallic minerals (industrial minerals) occur extensively throughout the state. Mineral fuels, such as coal, lignite, bitumen and petroleum exist mainly within the sedimentary belt of the state around Odigbo, Okitipupa, Ilaje, Ese-Odo and Ose Local Government Areas (Table 3 and figure 4).







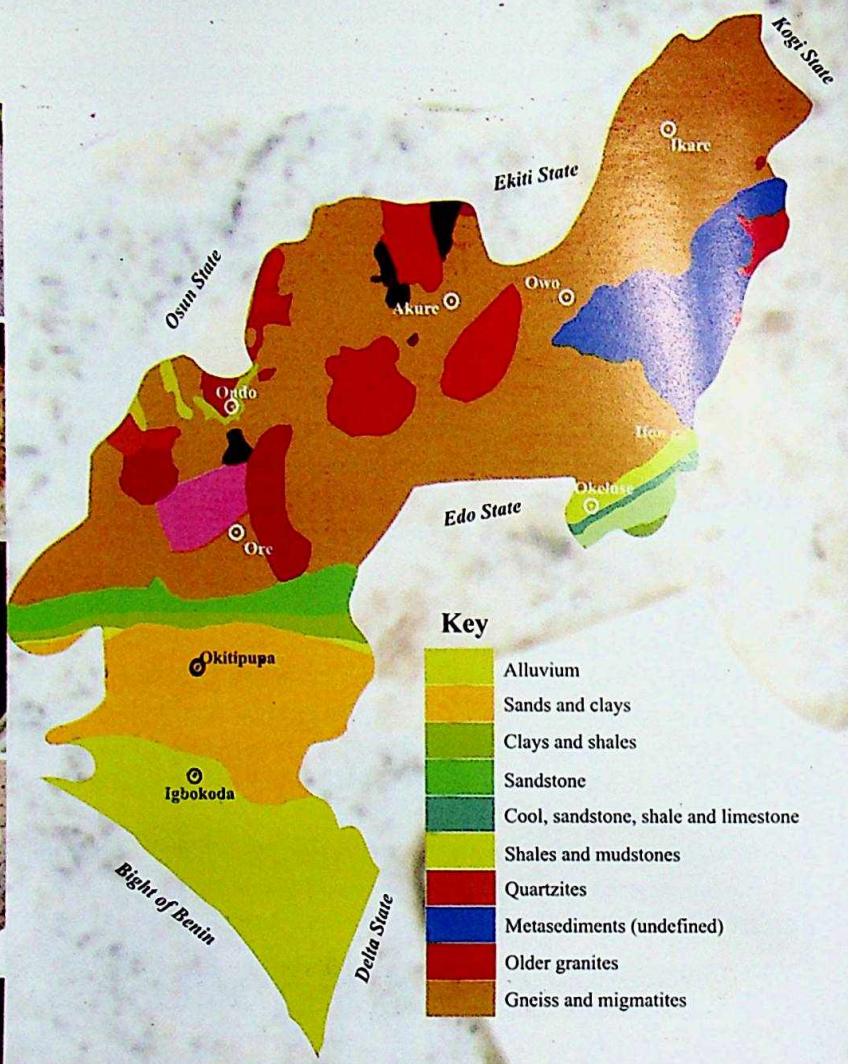


Figure 3:
Geological Map of Ondo State

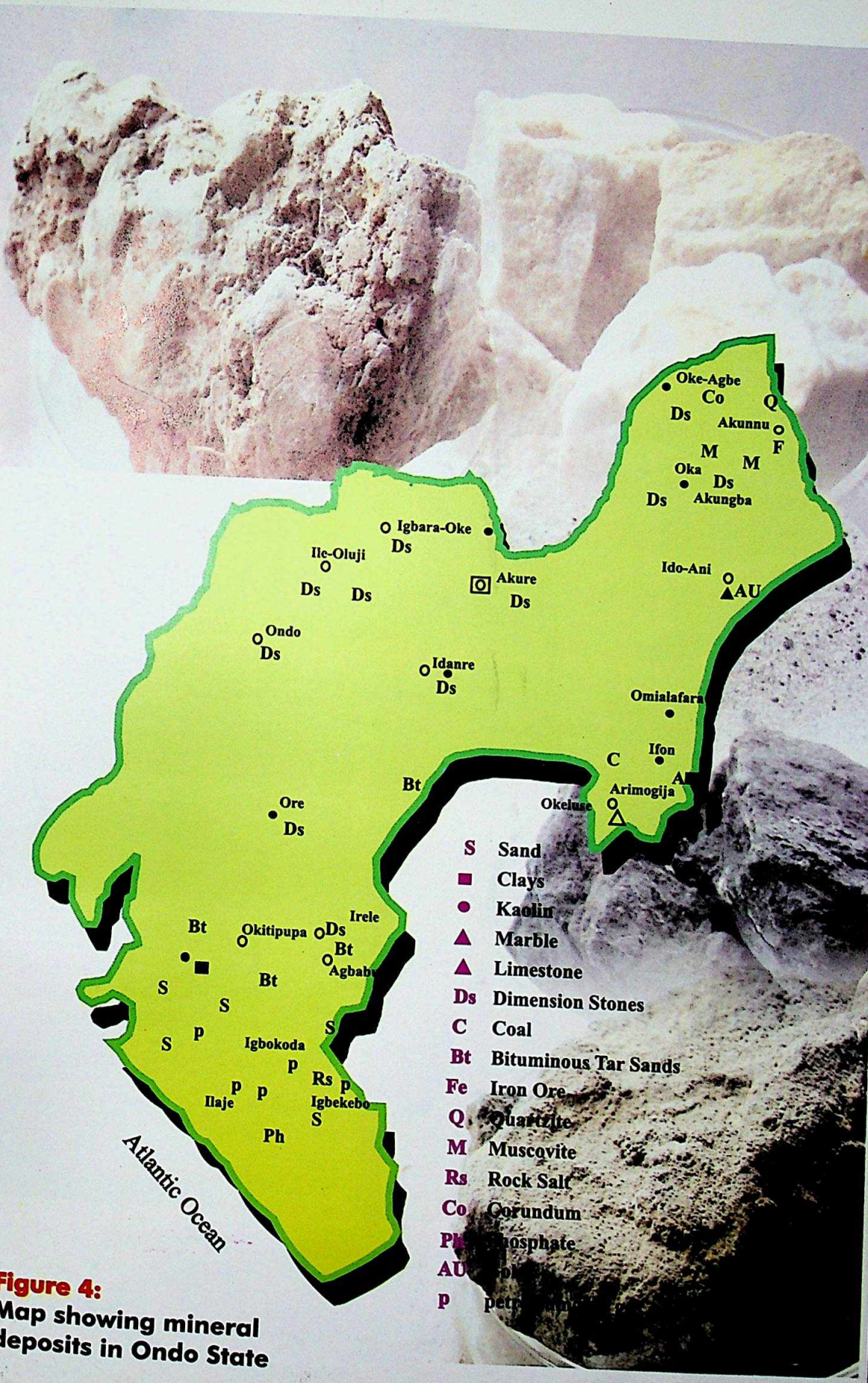
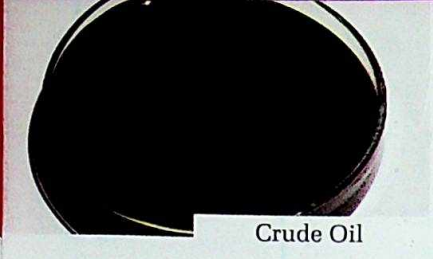


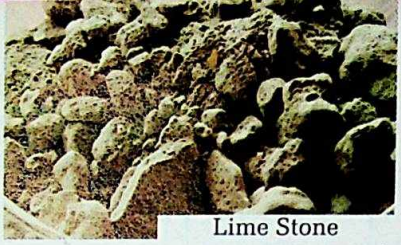
Figure 4:
Map showing mineral deposits in Ondo State

TABLE 3: MINERAL BASE INVESTMENT OPPORTUNITIES IN ONDO STATE

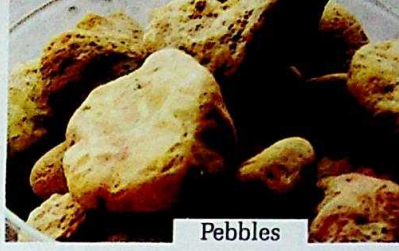
Mineral/ Rock	Occurrence	Estimated Reserve	Products	Existing Processing Capacity	Opportunities
Crude oil	Ilaje and Ese Odo Local Govt. Areas	Nigerian Estimated Reserve 23 billion barrels of oil with more than 10% in Ondo State	Natural gas, liquefied petroleum gas, gasoline, petroleum ether, kerosene, jet-fuel, dissel, fuel oil, lubricating oil, petroleum jelly, paraffin wax, asphalt and carbon black.	No refinery	-Petroleum refinery -Petrochemical industry. -Plastic industry
Natural Gas	Ilaje and Ese Odo Local Govt. Areas	Nigerian Estimated Reserve 124 billion Cu. Ft.	Liquefied Natural gas - Fertilizers - Methanol	No processing Plant	- Liquefied natural gas (LNG) - Chemical industry - Fertilizers-Methanol
Bitumen	Agbabu, Ofosu, Looda, Lonla, Lamudifa, Atijere, Mahintedo, Okitipupa, ode Aye, Araromi-Obu, Igbekebo	Over 42 billion barrels	Heavy oil, synthetic crude, diesel, kerosene, motor fuel, fuel oil, grease, wax, asphalt, sulphur, sulphric acid, pitch, vanadium, nickel, petro chemicals, phenols.	No commercial exploitation yet	- Asphalt plant for road surfacing -Petrochemical Industry. - Bitumen refinery - Pharmaceu-tical industry. -Textile Industry. Plastic Industry
Silica Sand	Igbokoda, Akata, Agbala, Aboto, Agerige, Zion Pepe	29.6×10^7 metric tones	Glass limesand, aerated bricks	Oluwa Glass Plc (ailing) with 8 million m^2 per annum.	- Sheet glass - Bottle glass - Other glass products
Kaolin	Omialafara, Ewi, ode-Aye, Omifun, Abusoro	1,040 million metric tones	Ceramics, tiles, bricks, medicine, insecticides, food additives and refactory products.	Low level mining and processing. - Golden Ceramic products Ltd, Ifon (ailing) with 77,000m^2 tiles per annum	- Ceramic industry - Paint industry - Chalk industry



Crude Oil



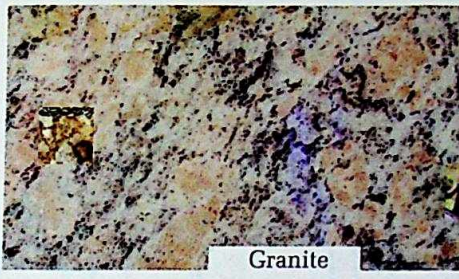
Lime Stone



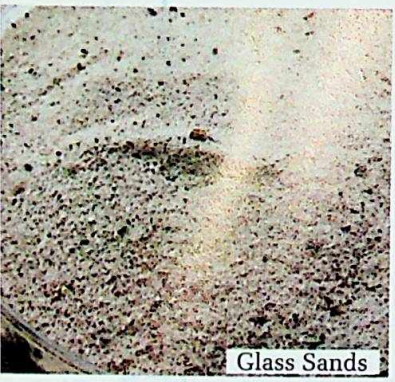
Pebbles

Quartz

Kaolin



Granite



Glass Sands

Bitumen

Sea Shells

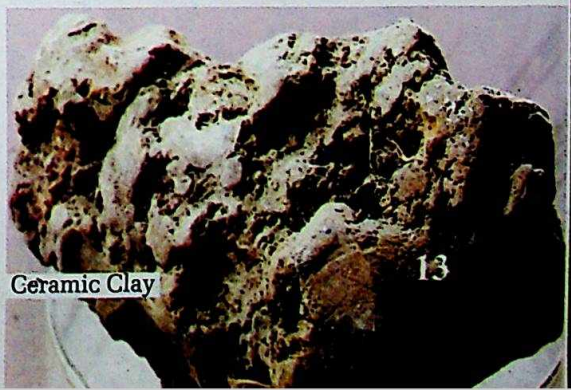
Coal

Filter Sand

Fossils

Tar Sand

Quartzite



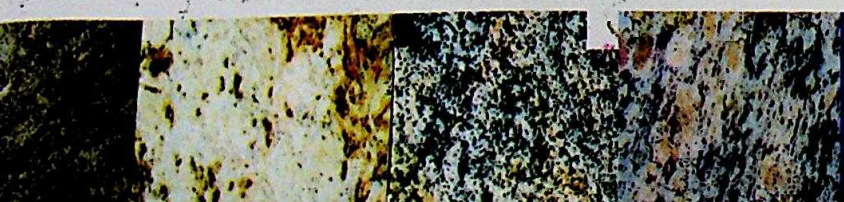
Ceramic Clay

Mineral /Rock	Occurrence	Estimated Reserve	Products	Existing Processing Capacity	Opportunities
Bulk Clay	Erusu Akoko Oranyin River Ute Arimogija Ifon	49.1 million metric tones	Pottery, Ceramics	Low level utilization- Electric porcelain factory	- Welding - Wire factory -Bricks factory -Polished metal factory - Tiles industry.
Limestone	Okeluse Arimogija	Over 7.25 million metric tones	Cement and Lime	None	- Cement - Hydrated line production
Salt	Ilaje Local Govt. Area	Extensive area with sea water	Salt	Not utilized	- Salt production
Granites	Supare,Iwaro,Oka , Afo, Igbara Oke, Idanre, Ile-Oluji, Ondo, Akure, Ore, Ilaramokin, Akungba	Over 100 million metric tones	Paving blocks, - dimension stones - aggregates, - stone dust	Crushed Rock Industries(Nig) Ltd. Gems 3000 cm^2 per annum of dimension stones	- Granite slabs, tiles, aggregates, stone dust.
Iron Ore	Akunu, Akoko Oba Akoko, North Ase,East LGA. Ase Auga- Road Lokuakua, Ondo West Lamu LGA	N/A	Steel Wrought Iron	None	Iron and steel industry

3.1 CLAY

Clay can be defined as a natural earthy fine grained material. It is composed of hydrous silicates mainly silica, alumina and water. The extremely fine particle size usually varies from 2 to 4 microns. Clays are important industrial minerals and do occur as kaolin, bentonite, ball clay, haloysite, refractory clays, and fuller's earth. The clay deposit in Ondo State are mainly kaolin with the mineral kaolin forming over 70% of their composition. The classification of clays can be found in the table below:

TYPE	CHIEF USE	MAIN CHARACTERISTICS
Kaolins, China Clay and Paper Clay	White ware porcelain fillers, Paper Making	High grade, fine grained, whiter burning
Bulk Clay	White ware mixing Refractories	White burning, High Alumina
Fire Clay, Flint Clay, Diaspore Clay	Refractories	
Stoneware Clay, Paving and Sewer type	Stoneware, paving bricks, Sewer pipes	Dense burning
Brick and Tile Clay	Brick and Tile	Common Clays
Bentonite	Iron & Steel Works Filtering, Drilling Mud	
Fuller's earth	Filtering	Absorptive qualities



3.1.1 KAOLIN

Kaolin is a general whitish clay mineral formed by the alteration or weathering of the granitic rocks most especially as a feldspar. In its natural form, it usually occurs as quartz, mica, feldspar and iron oxide.

When kaolinite is the dominant mineral in an assemblage, the clay body is called kaolin. In its relatively pure form kaolin is an extremely versatile industrial mineral useful as;

(i) Paint: as an extender
(ii) Detergent
(iii) Steel
(iv) Glass
(v) Ceramics
(vi) Agriculture: in the manufacture of fertilizer
(vii) Rubber: as a filler or extender
(viii) Paper: as filler

Kaolin deposits occur in Omialafara (Ose LGA), Abusoro (Okitipupa LGA) Ewi camp (Okitipupa LGA), Ode Aye (Okitipupa LGA), and Omifun (Irele LGA), Kaolin is useful in industry as a filler in plastic, paper, adhesive, oil cloth and rubber manufacturing; as an extender in paint industries; in ceramic materials including china wares, tiles and some face bricks; as a source of alumina in glass industries; as adsorbent; in catalytic preparation medicines, insecticides, cement and food additives.

3.1.1.1. Omialafara kaolin

The Omialafara kaolin deposit is located on a small, low, domal ridge, nine kilometers northeast of Ifon, along the Akure - Benin highway. The clay deposit is residual, having been formed by the weathering of the basement material. The deposit is buried beneath a shallow overburden which varies from 0.5metres to 2 metres (Fig 5) It is predominantly whitish in colour with tints of pink, yellow, red and brown. The deposit underlies an area of about 0.6 hectares with a mean thickness of 6 metres and estimated reserve of 50,000 metric tonnes of kaolin

3.1.1.2. Abusoro Kaolin

Abusoro kaolin is located 5 kilometres north of Igbotako in Okitipupa Local Government Area of Ondo State. The clay deposit occurs as two horizons within dominantly sandy formation (fig. 5) The upper horizon, intercepted at a depth of 12 metres, is 3 metres thick. Its light brown coloration is due to the staining of the originally white kaolin with organic matter and laterite. The lower horizon is about 1.5.metres thick, and is purer than the upper horizon. It is white to creamy white and also fire white. The total estimated reserve of kaolin over a 10 hectare area is 180,000 metric tonnes.

3.1.1.3. Omifun Kaolin

Omifun village is located along the road to Ode-Irele from Ore. The kaolin deposit is exposed along the banks of Moifun river, northwest of Omifun village and is currently mined locally for white wash. The deposit is dirty white in colour and fires cream white: It has low apparent density, low binding, moderate plasticity and good virification. The clay deposit can be used in porcelain ware and as glazing material. Estimated reserves, using a 4 metre mineable depth above the static water level, and a 5 hectare surface extent, is about 20,000 metric tonnes.

3.1.1.4. Ewi Kaolin

This is located 9 kilometres north of Igbotako in Okitipupa Local Government Area. The kaolin deposit occurs beneath overburden layers of sand and laterite. It has been heavily stained by iron oxide and organic matter as a result of which it is variously grayish brown,light grey, black and cream white. The only white portion of the deposit occurs between 9.7 and 11.7 metres depth. While the white portion will be useful in filler, glazing and refractory applications, the brownish section will be of use only for bulk purposes such as ceramics and bricks. The estimated reserve over a 5 hectare area and an average thickness of 5 metres is 75,000 metric tonnes. This is sufficient to sustain a small scale industry.

3.1.1.5 Ode Aye Kaolin

Ode Aye Kaolin deposit located South of Ode Aye has good nitrification, durability and mouldability. The main areas of application are in the area of porcelain wares, glazing, fillers, pharmaceuticals and manufacture of refractory bricks. The overburden is relatively thin and the reserve is estimated at 840,000 metric tonnes

3.1.2. Bulk (Ceramic) Clays

Large volumes of bulk clays exist in various parts of the state. They have been explored in Arimogija (Ose LGA), Ute (Ose LGA). Ifon (Ose LGA), Erusu (Akoko North West LGA) and Oranyin River (Irele LGA). The Ute clay deposit (fig 6) is a loose, creamy white to pinkish and light brown sandy clay with an average thickness of 7 metres. It covers an area over 80 hectares with an estimated reserve of about 5 million metric tonnes . The clay fires brown, has low apparent density, low binding and low plasticity.It can be used for ceramic products and bricks. The Ifon clay deposits occurs in two layers separated by a ferruginous sand unit. The upper layer is brownish to grayish, with a thickness of 2.4 metres while the lower layer, which is light grey to creamy white, has an average thickness of 7.5 metres. It is an extensive deposit (2kmsqare) with an estimated reserve of 15 million metric tonnes.

Bulk clays are useful mainly in the manufacture of vitreous chinaware; in the production of electrical porcelain, floor and wall tiles; as a source alumina in cement production; as a fluxing mate rial in arc welding, in thermoplastic wire plating, in refractory products; as an abrasive for polishing metals and in brick making.

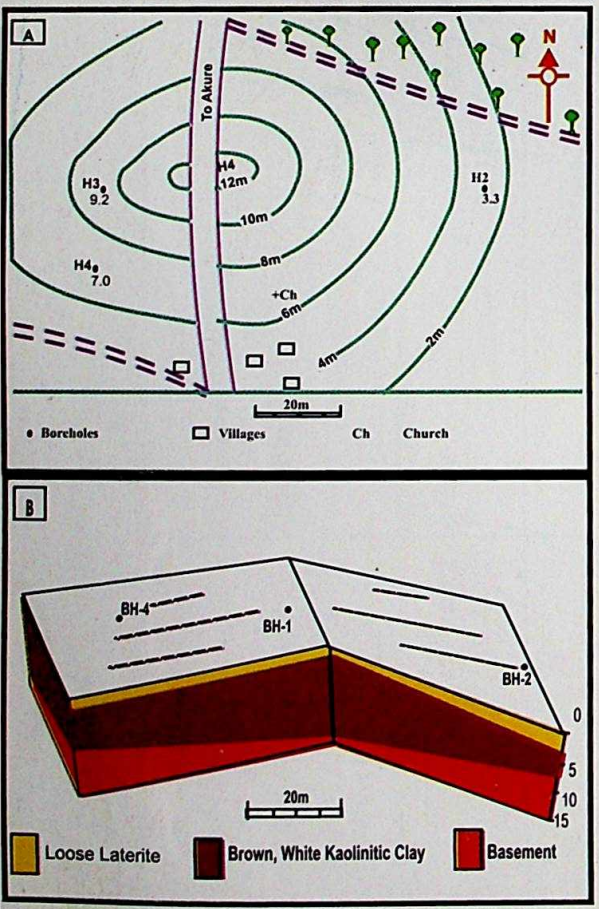


Figure 5 Block Diagram of Omialafara Kaolin deposit

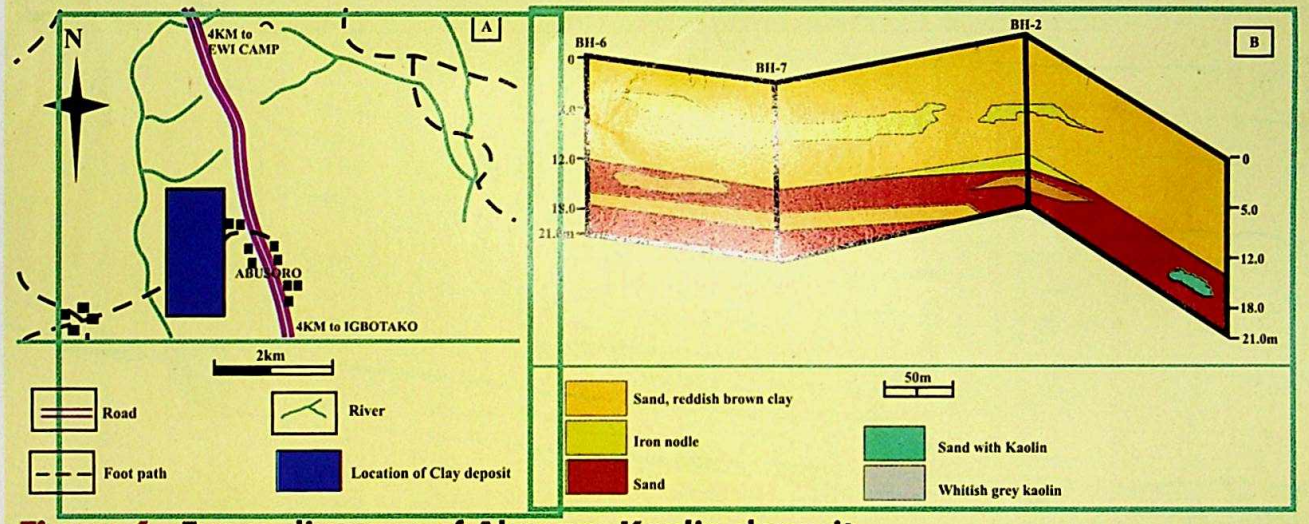


Figure 6 Fence diagram of Abusoro Kaolin deposit

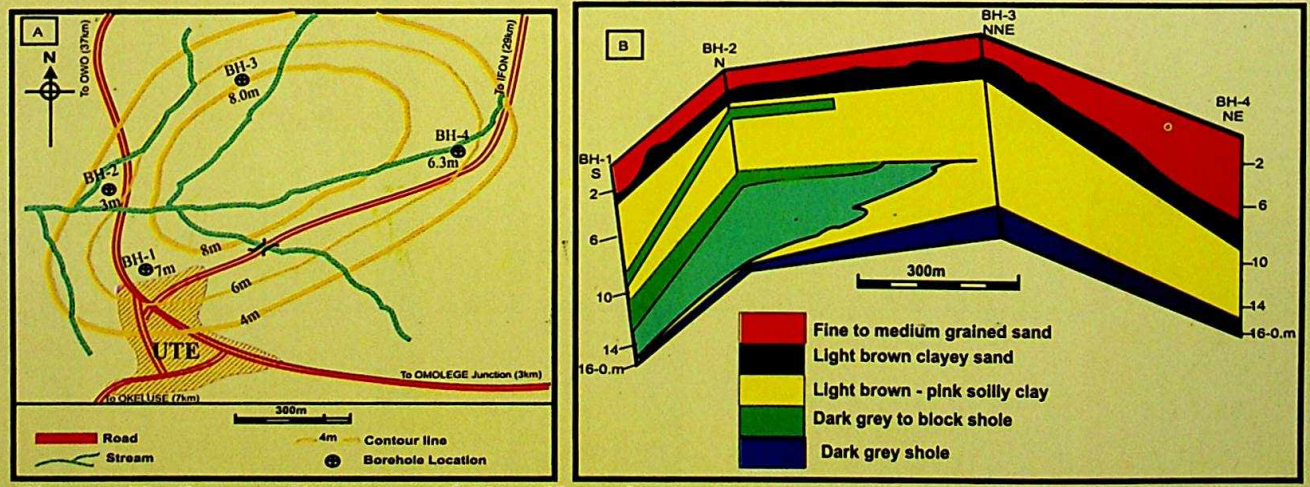


Figure 7 Fence diagram of Ute Clay deposit

TABLE 4: SUMMARY OF CLAY DEPOSITS IN ONDO STATE.

LOCATION	LG AREA	COLOUR	PLASTIC	POTENTIAL USES
Omialafara	Ose	Dirty white but stained red	Low	Suitable in filler, pharmaceuticals and glazing except when blended with other clay types.
Abusoro	Okitipupa	Light brown (upper layer)	Medium	For use in the body of porcelain ware, in glazing materials in Fillers
Ewi	Okitipupa	Cream white	Moderate	For use in filler, glazing and refractory application.
Ode Aye	Okitipupa	Dirty white	Medium	For use in the body of porcelain ware, glazing materials and fillers. Pharmaceuticals and manufacture of refractive bricks.
Omifun	Okitipupa	Dirty white	Medium	For use in the body of porcelain ware, in glazing materials in fillers, in pharmaceuticals and in manufcture of refractive bricks.
Erusu	Akoko North East	Greyish brown	Medium to High	Good for ceramic products such as earthwares and in manufacture of refractive bricks.
Orayin River	Okitipupa	Brownish grey	Medium	Can find application only for purposes such as in ceramic bodies and bricks.
Ute	Ose	Cream white to pinkish and light brown Low		Requires blending before it can be used for ceramic wares and bricks.
Sobe	Ose	Greyish brown	High	Suitable for ceramic products such as earthwares and ceramic tiles.
Arimogija	Ose	Light grey with brownish tints	Low to Medium	Suitable for ceramic products such as earthwares and ceramic tiles
Ifon	Ose	Grey to creamy white	Medium	Suitable for ceramic products such as earthwares and ceramic tiles. With some bleaching it can be useful for filler purposes. It can be used in the manufacture of refractive bricks.

3.2 Limestone Deposit

Limestone are basically sedimentary rocks containing more than 50% of calcium carbonate (CaC03). In Ondo State, limestone outcrops have been mapped from Ogbese River in the West to Sobe in the east through Okeluse, North Omolege Arimogija and the Sobe to Ijagba areas. The broad area has been investigated by the Geological Survey of Nigeria , Metal and Minerals Nig. Ltd. Obafemi Awolowo University consultancy unit in association with Austroplan of Vienna and Brink Jones Nigeria Limited.

A lot of survey carried out in Okeluse and Arimogija about limestone deposits revealed a discontinuous band, with thickness ranging from a few centimeter to a maximum of 3 metres. The concentration of limestone in Arimogija area gave values of over 84% Ca0 and less than 2% Mg0 with cumulative thickness of 6.4 metres. Limestones are the basic building blocks of the construction industry. They are raw materials from which cement, lime, calcium carbide and building stones are made. Limestone is used as a flux, as a raw material for glass, as fillers, abrasives, soil conditioners; in paint manufacture and in refractories. Limestone deposits in this area can be crushed into different sizes as required by the end users. The Rolex milling is a 30 metric tonnes capacity crushing plant that can reduce boulders into very fine products. This technology is as well applicable to kaolin and marbles.

3.2.1 Okeluse Limestone

The limestone deposit in Okeluse area is variously exposed to the west, southeast and east of Okeluse town. A total of 20 pits sunk in the area indicate that the limestone is relatively thin, with an average thickness of 3 metres and is buried beneath shallow overburden (fig 6). The rock is grey, hard and flinty with a gentle dip of 4 degree to the southeast. The results of the chemical analysis of the limestone pit and surface samples indicate that the rock is made up largely of high calcium limestone, with a few dolomitic varieties.

3.2.2. Arimogija Limestone

The limestone deposit outcrops in Arimogija are found to the south of the village. The rock is similar in all respects to Okeluse limestones deposit with which is laterally continuous. The deposit is also thin, with an average thickness of 2.5 metres.

In general, a volume of 7.25 million metric tones is estimated for the limestone deposit over an area 1km x 1km and a thickness of 2.9 metres. With an estimated 60% recovery rate, the volume would be 4.35 million tones/kilometer square or 4.5 tonnes per square metre, (to a depth of 3 metres). A more detailed drilling programme is required to have a final confirmation of the reserves.

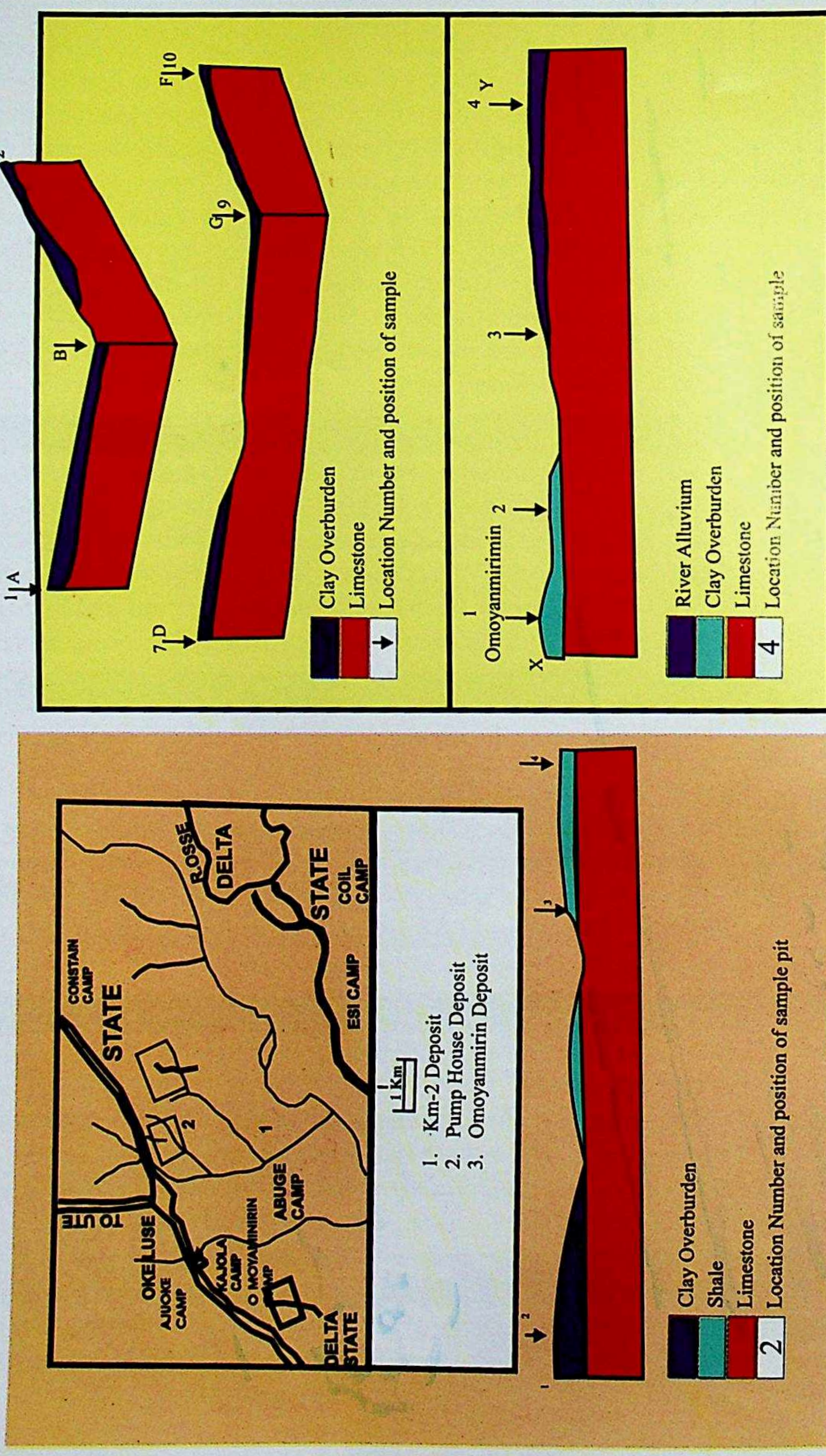
3.3 Glass Sands Deposits

The size of Glass Sands range from 0.0074mm aperture to 4.76mm which is the maximum size referred to as gravel.

Glass sand is the most important raw material needed for the production of glass, lime-sand and aerated bricks, where the sand deposit alone constitutes between 60% and 90% of the total raw materials requirement. In glass production, the other raw materials required are lime, soda, boron oxide, lead, etc, depending on the type of glass. In the production of aerated bricks, only small quantities of lime (10%), cement (5%), aluminum powder (1 %) and water are required. Glass products include windows, bottles, mirrors, optical instruments, pipes, doors, cloth, crucible, boats, aircraft bodies, etc. Lime-sand bricks are used in the building industry and as insulators to line furnaces and autoclaves. Aerated bricks are used in the construction of skyscrapers due to their very light weights and considerable fire resistance.

The physical and chemical parameters of sands would have to be considered before using it for the production of a particular product. The degree of purification required varies with the type of glass to be manufactured.

Figure 8 Sections across Okeluse limestone deposit



The occurrence of glass sands of top quality is restricted to the coastal areas of Ondo State. The result of an earlier investigation led to the establishment of the Oluwa Glass Company Plc. At Igbokoda deposit is the most famous and is being presently quarried. Others include Atijere, Zion-Pepe, Akata-Agbala, and Agerige, Orereara, Ipare, Ode Etikan and Aboto sand deposits. The characteristics of the sands are very similar. The approximate reserves of the sand bodies are given below:

Igbokoda Zion Island	7.4×10^7 metric tonnes
Atijere	6.1×10^7 metric tonnes
Akata Agbala	5.2×10^7 metric tonnes
Aboto	6.4×10^7 metric tonnes
Agerige	2.0×10^7 metric tonnes
Zion Pepe	2.0×10^7 metric tones

3.3.1. Igbokoda Sand Deposits

It occurs in large amounts to the north and east of Igbokoda covering an area of about 42 square kilometers over the alluvial plains of the Oluwa and Igbokoda rivers. The sand deposit is essentially made up of high quality, white, medium to fine grained sands. Some sections are underlain by "brown to grey, peaty sands of low quality, while in others a clayey section is intercepted.

In Igbokoda area alone, the estimated reserve for the sand over 37kmsquare at 1 metre thickness is 74 million metric tones. Other reserve include Atijere (61 million), Akata-Agbala (52 million) Zion-Pepe (25 million), Agerige (56 million) and Aboto (64 million). Of these, the projected consumption rate of Oluwa Glass Company is 10,000 metric tones per year.

3.3.2 Filter Sands

Two localities, Ode-Aye and Abusoro in Okitipupa Local Governemnt Area have been identified as having sands that potentials for being processed into filter media sand. The Ode-Aye sands cover an area of more than 25 hectares with a reserve estimate of 1.5 million metric tones while the Abusoro filter sands have an estimate of 1.8 million metric tones. Filter sands can be used as filter media in water treatment plants. Oil companies also use them in oil well completion .

3.4 Dimension Stones (Granites, Charnockites and Banded Gneisses)

Dimension stones occur extensively in Ondo State. These are granites, charnokites and banded gneisses. The granites are light to medium grey while the charnokites are dark green. Banded gneisses, when they are durable, fresh and multicoloured, are also used as dimension stones.

Dimension or cut stones are important for their beauty and durability in the construction of monuments. They can also be used for lining kilns and mills, as paving blocks, laboratory, furniture and sinks, as pavements in institutional buildings, tombstones, chairs, tables and as roofing slates. The important factors, which determine the usefulness of any stone for cutting and polishing, are durability, polish ability, homogeneity, colour, jointing and hardness. Highly priced dimension stones usually have bright and beautiful colours. Blackstones (Nero Africa "Nero Assoluto," "Labrador") are expensive. Over 100 million metric tonnes of dimension stones occur in the State.

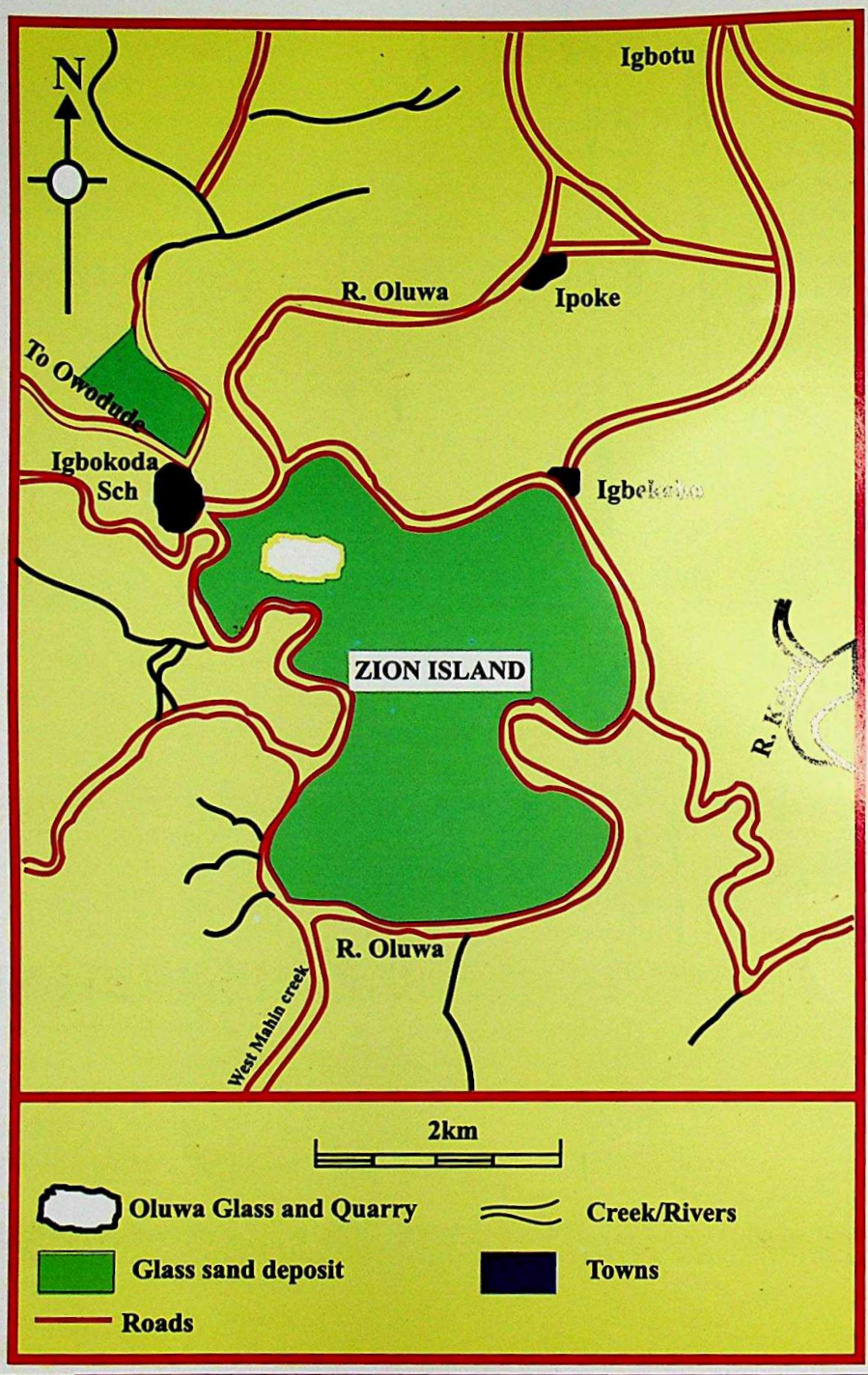


FIGURE 9 LOCATION MAP OF IGBOKODA GLASS SANDS

3.5

The occurrence of iron ore around Akunnu (Akoko North East LGA) has been reported for several years. The region has been mapped intensively. Results show that the surface consists of dark float iron samples, which are strongly magnetic with a metallic luster. A subsequent geomagnetic survey of the entire region identified three anomalies with peaks at Boropa , Ase Auga and Akunnu. The contrasts of these anomalies are fairly high (up to 0.160 cgs), thus suggesting the presence of iron-rich rocks beneath the overburden in the region. A systematic drilling programme could be necessary to determine the volume and quality of the ore.

3.6

The only known coal deposit in the state occurs at Ute (Ose LGA). It is lignite in grade and buried under a 4 metre-thick overburden. The deposit appears to be too, thin (0.9m) to be of any economic value.

3.7

Reported occurrences of marble have been found at both Idoani and Idogun (Ose LGA). The deposit is a continuation of the large deposit of marble in nearby Edo State. Unfortunately, this deposit has not been adequately explored. Marble is a major source of lime and lime products. Also it is useful as dimension stones, for cutting and polishing as murals, table-tops, wall and floor tiles, pulpits, etc.

3.8

Besides the major solid minerals listed above, most of which have been explored in detail, there are others whose occurrences have been reported but which have not been confirmed by detailed geological exploration.These include Muscovite, reported to occur around Supare, (Akoko Southwest LGA), and around Epinmi (Akoko Southeast LGA); Tantalite and Cassiterite around Igbara-Oke (Ifedore LGA); Rock Salt in some parts of Ilaje Local Government Area; Phosphate around the coastal areas (Ilaje LGA), Gold around Idoani (Ose LGA); Iron Ore around Leyowo (Okitipupa LGA), Corundum found at Akunnu , Afin and Oke-Agbe (Akoko Northwest LGA), and Gemstones around Ondo (Ondo West LGA), Gypsum and Dolomite found at Ilaje and Ese Odo areas. These will require adequate and detailed geological and geographysical mapping as a pre-investment step.

3.9

Tar sand is composed of sand, heavy oil and clays that are rich in minerals and water. The heavy oil in tar sand is commonly called Bitumen. In the raw state, bitumen is a sticky, viscous black substance. In Ondo State deposit, bitumen or heavy oil constitutes about 12% weight of the tar sands.

Also, tar sands are known to occur naturally as a complex mixture of hydrocarbon with macromolecular and heterocyclic units in the subsurface as seepages within porous or fractured media. The hydrocarbons are essentially the unsaturated and aromatic types with large molecular mass.

3.9.1.

Tar sand deposits have been known to occur in parts of Ondo, Ogun, Edo and Lagos States since the early part of the twentieth century. The bitumen belt streches for over 120km in the southwestern part of Nigeria. In Ondo State, the belt stretches through Okitipupa, Irele, Idanre, Odigbo, Ilaje and Ese Odo Local Government Areas.

The first attempt at commercial exploitation of the bitumen was by the defunct Nigerian Bitumen Corporation (NBC) between 1908 and 1914. Since then, both foreign and indigenous institutions as well as experts have been invited to conduct various types of researches and studies on the bitumen deposit between 1907 and 1990. The results of the studies show that the Ondo State tar sand deposits hold over forty two (42) billion barrels of recoverable hydrocarbon. This ranks Nigeria alongside Egypt and Madagascar as the three leading countries in Africa with potentials in oil sand and heavy oil resources.

A recent study carried out on the Ondo State bituminous tar sand deposit by Adewakun, 1998 covers detailed physicochemical properties of the tar sand in relation to its exploration, exploitation and development. It also focuses on the economic potentials and industrial applications of this veritable resources. Besides, the investigation has shown that the tar sand in Ondo State conforms generally in physical and chemical characteristics with samples from other parts of the world such as Athabasca in Canada and Utah in United States of America.

3.9.2. Geology of Ondo State Tar Sands.

The Ondo State tar sand belt occurs in southwestern Nigeria along the Eastern Dahomey (Benin) basin, a marginal pull-apart or margin-sag basin. The tar sands outcrop in an East-West belt, approximately 120km long and 4-6km wide more or less parallel to the coastline (fig.10).

3.9.3. Textural Properties Of The Tar Sands

The bitumen occurs mostly in sands and clay. The oil fills the pore-spaces between the sand grains. A thin film of water envelopes each sand grain, separating it from the oil (that is, it is water-wet). The water content is about 1-5%. It is the occurrences of this thin film of water around each grain that permits the oil to be readily extracted from the sediments in the Canadian hot water extraction method. This is the only method of extraction that has been successfully tested and used commercially.

The Ondo State deposit has very low clay content, ranging between 2% and 7%, with an average of 5%. This low clay content is a great advantage. It means that there will be less environmental problems to cope with during oil extraction than has been the case in Canada. The tailings pond will probably retain less oil and the water can therefore be recycled more frequently, thus removing the need to have several extensive tailing ponds.

3.9.4 Physical And Chemical Properties of The Tar Sand Oil

The physico-chemical data obtained from the laboratory analysis of the Ondo State bituminous tar sand deposits show that the heavy oil extracted from the Ondo tar sands has an API gravity ranging between 5.0 and 14.6 (Table 5).

The tar sands have physical properties such as softening point (44°C 52°C), ductility (0.1 mm -1.3mm) and penetration (80mm-100mm), which make them possess adequate consistency and rheological properties useful for road and highway constructions. Also, the chemical properties of the tar sands, which include hydrocarbon content (7.2% by wt. - 18.2% by wt; resins 32.0% by wt. - 34.0% by wt.,) and sulphur (5.00ppm to 10.0ppm), will enhance the recovery of major products from the bituminous tar sands. Furthermore, the bitumen possesses relatively large quantities of naphtenes, aromatics and asphaltenes that are similar to conventional oils (Adewakun, 1998).

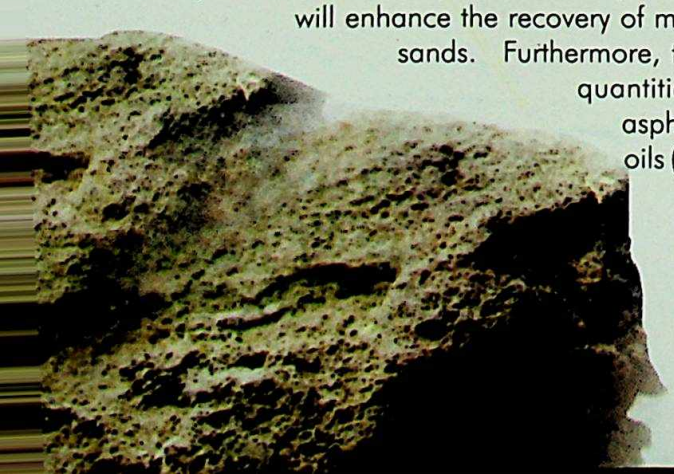


Table 5 Physico-chemical properties of selected samples of tar sands in parts of Ondo State Nigeria (After Adewakun, 1998)

NO	PARAMETERS	LOCALITIES WITHIN ONDO STATE			
		AGBABU	LOODA	ILUBINRIN	OFOSU
1.	Flash Point (oC)	300.0	380.0	280.0	400.0
2.	Softening point (oC)	47.0	47.0	52.0	44.0
3.	Breaking Point (oC)	-10.0	-10.0	-9.8	-9.9
4.	Drip Point (oC)	58.0	56.0	60.0	58.0
5.	Mean Oil saturation	12.0	11.8	12.0	12.0
6.	(% by weight) Specific Gavity	0.90	0.90	1.02	1.01
7.	API Gravity (°)	5.0-11.0	5.3-14.1	5.1-14.6	5.2-13.9
8.	Viscocity at 39oC	300,000.0	299,988.5	300,000.0	300,000.00
9.	Sulphate (Weight%)	1.2	2.5	1.4	1.6
10.	Asphaltenes (Weight%)	28.0	27.0	26.0	23.3
11.	Carbon residue (Weight %)	23.0	25.0	17.0	20.2
12.	Hydrocarbon content (% by weight)	10.2	14.8	7.2	18.2
13.	Bi carbonate (% by weight)	5.5	4.4	7.2	6.1
14.	Solubility (% by weight)	4.0	3.6	3.2	3.4
15.	Water Content (% by weight	3.5	3.0	3.2	3.4
16.	Clay Content (% by weight)	4.6	4.0	5.0	4.2
17.	Sand (% by weight)	72.4	76.6	70.6	70.0
18.	Ductility at 26°C (mm)	1.0	1.3	0.2	0.1
19.	Penetration at 26°C (mm)	100.0	92.4	80.0	88.2
20.	Naptenes (%by weight)	51.0	50.5	48.0	51.0
21.	Total Aromatics (% by weight)	38.9	35.7	37.7	37.3
22.	Resins (% by weight)	34.0	32.0	34.0	34.0
23.	Elemental Composition (% by weight)				
(a)	Carbon (C)	88.0	84.0	88.6	86.0
(b)	Hydrogen (H)	11.0	11.5	10.7	10.6
(c)	Nitrogen (N)	0.2	0.4	0.5	0.1
(d)	Chlorine (Cl)	0.04	0.08	0.1	0.1
(e)	Oxygen (O)	1.8	1.8	1.8	1.75
(f)	Sulphur (S) (Weight %)	5.0	6.2	8.2	10.0
24.	Trace metals (PPM)				
(a)	Sodium (Na)	7.7	7.7	8.5	8.0
(b)	Potassium (K)	11.0	9.0	10.0	8.0
(c)	Magnesium (Mg)	40.0	22.0	34.0	60.0
(d)	Copper (Cu)	1.2	1.5	5.2	2.2
(e)	Iron (Fe)	80.0	76.0	76.8	78.5
(f)	Zinc (Zn)	6.2	8.2	9.3	9.4
(g)	Chromium (Cr)	1.2	0.4	1.2	0.6
(h)	Cadmium (Cd)	0.01	0.06	0.02	0.04
(i)	Calcium (Ca)	30.0	24.0	20.0	27.1
(j)	Nickel (Ni)	34.0	36.0	29.1	27.1
(k)	Lead (Pb)	6.9	6.0	5.5	5.2
(l)	Titanium (Ti)	200.0	160.0	240.0	160.0
(m)	Vanadium (V)	38.0	35.0	28.0	30.0
(n)	Aluminum (Al)	500.0	450.0	425.0	400.0

3.9.5 Importance Of Tar Sands

The industrial applications of the various products derived from Ondo State tar sands {Table 6) are summarized as follows:

(1) The presence of relatively large amount of naphtenes, aromatic hydrocarbons and asphaltenes, that are similar to conventional oils, make the tar sand a very useful alternative source of petroleum hydrocarbons. Thus, bitumen can reduce the nation's sole dependence on the oil industry by providing an alternative source of fuel and energy. With an API gravity of between 5 and 15, the Ondo State tar sands can be a viable source for asphaltenic heavy oil suitable for upgrading as feed for a heavy oil refinery.
(2) Bitumen derived products such as naphtenes and aromatic hydrocarbons constitute a potential feedstock for the petrochemical industries, production of synthetic fibers, plastics and other petroleum-base products.
(3) Bitumen extracts can be used for road construction.
(4) It can serve as a source of foreign exchange, especially through sales to other counties.
(5) Nickel, which is a by-product from tar sands, can be used in the production of stainless steel, ferrous alloys and can also serve as industrial catalysts in the hydrogenation of vegetable oil in soap manufacturing.
(6) Vanadium, another by-product from tar sands, can be used for making steel alloys for metal springs and high-speed tools.
(7) Sulphuric acid, which can be obtained from tar sand, is relevant in the making of super-phosphate (NPK) fertilizer, paints pigments, steel picking, detergents, explosives and rayon.
(8) Sulphur, another important product from bitumen, can be used in pharmaceuticals and can also serve as raw materials in several other industries.
(9) Bitumen extracts can also be used to manufacture form coke for use in the iron and steel industry.

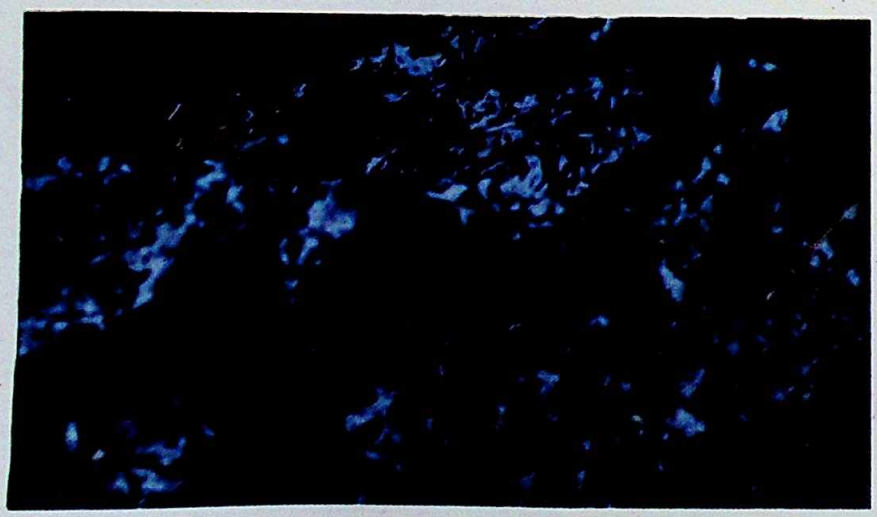
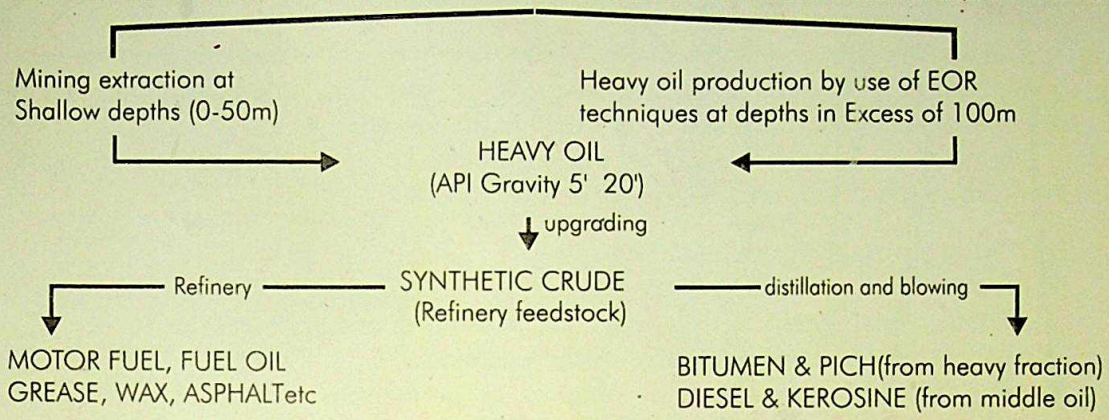


TABLE 6

INDUSTRIAL APPLICATIONS OF MAJOR PRODUCTS FROM TAR SANDS



INDUSTRIAL UTILIZATION APPLICATION OF THE MOST IMPORTANT BY PRODUCTS

1. SULPHUR (1.22%WT)
- sulphuric acid
- rubber vulcanization
- rayon, cellulose
- fungicide
- insecticide
- pharmaceuticals
- chemicals
- SO_2 gas for paper & pulp manufacture & paper & sugar bleaching
- refrigerants

2. SULPHURIC ACID
- phosphatic fertilizer (ammonium sulphate)
- paints, pigments
- steel picking
- detergents
- explosives
- rayon

3. PHENOL
- distinfectants & drugs
- benzene

4. PITCH
- electronic and
- pitch-boud coke for metallugical industry
- smokeless domestic charcoal Briquette

5. PETROCHEMICALS
- olefins & aromatics=90% of napha. Has promise of being the world cheapest sources of petroleum feedstock

6. VANADIUM
- steel alloy for springs and high speed tools

7. NICKEL
- stainless steel (88% Ni)
- ferrous alloys (Ni+Cu & Ni + Ag for coinage)
- Industrial catalyst in hydrogeneation of vegetable oil in soup manufacture

(After Adegoke et al 1980)

3.10 Petroleum and Gas

Petroleum is found in sedimentary rocks such as sandstones and dolomite. The presence of this mineral fuel may be shown at the surface by seepage of oil, or by pitch or bitumen deposits, the latter due to the evaporation and oxidation of the volatile hydrocarbons.

Petroleum is of organic origin, which derives from the decay of accumulations of organic material, possibly dominantly of vegetable origin. Under the name of petroleum are included liquids of a brown to blackish colour, often with a greenish tinge, generally somewhat lighter than water, and usually possessing a powerful and pungent odour.

By fractional distillation various oil, known as petroleum ether, petroleum spirit, benzene, etc, are separated, and are extensively used in internal combustion engines. The intermediate fractions of distillation are used for illumination, and the heavy products provide lubricating and fuel oils. Petroleum is the basis of the petrochemical industry.

Commercial quantities of crude petroleum oil and gas deposits abound in several parts of Ilaje and Ese-Odo Local Government Areas of the state. International Oil Companies such as Chevron Nigeria Limited, Exxon Mobil, Express/Conoco Gas and Cavendish/Allied Energy Resources Limited are currently operating in the Ilaje Local Government Area of Ondo State.

4.0 ONDO STATE INDUSTRIAL POLICY

The new policy is structured to address the short comings of the past and promote rapid human and material development required to transform Ondo State from its present rural and predominantly agrarian economy to an industrialized one.

Some of the investment incentives made available by the State Government to create the much needed favourable climate for investors are:-

(1) Good governance, peace and security.
(2) Provision of adequate infrastructure such as Education (skilled labour), Health, Roads, Water, electricity, Industrial park, Industrial estate and Free Trade zone.
(3) Reactivation and privatization of existing industries.
(4) Promotion of new Industrial ventures in partnership with local and foreign entrepreneurs but limit its participation at 20%.
(5) Provision of soft loans/investible funds to small and medium scale industrialists
(6) Free allocation of land to foreign and local investors wishing to establish in the rural areas of the State and sourcing their raw materials locally.
(7) Promotion of appropriate technology, technical information, advisory and counseling services on investment opportunities, preparation of pre-investment proposals and profiles.
(8) Promotion of value addition and capacity building
(9) Private public participation (PPP)
(10) Linkages at local, National and international levels.

Also, in recent years, a number of workshops, seminars and symposia on investment opportunities and development of Ondo State had been organized by various groups of companies, government ministries as well as private individuals for the benefit of entrepreneurs from the public and private sectors.

It is envisaged that the investment incentives enumerated above will encourage entrepreneurs to invest in the mineral sector of the development programme of the State.

5.0 NEW NATIONAL POLICY ON SOLID MINERALS

The new national policy on solid minerals evolved in 1998 and was re-enacted in year 2007. The objectives of the new policy include the following:

(a) Increasing public awareness on the endowment of mineral resources and their strategic role in the socio-economic and industrial development of the country;

(b) Acquisition and dissemination of detailed and reliable information on the geology of the country, establishing the quantity and quality of solid mineral endowments;

(c) Orderly development of these resources for real economic growth, improvement in the standard of living of the people and creation of a favourable investment climate;

(d) Diversification of primary mineral products through exploration and establishment of reserves;

(e) Enhancing the utilization of the mineral resources through research into efficient extraction methods and wider application and use of minerals as raw materials;

(f) Ensuring adequate supply of mineral resources for industrial development and for maintenance of national security;

(g) Encouragement of the private sector to take the leadership role in the expansion of the sector and being assured of reasonable returns on their investment;

(h) Encouragement of the acquisition of technology by indigenous operators for the overall development of the country's mineral resources ; and

(i) Accelerating the development and utilization of technical and professional manpower resources.

5.1 Incentives

The new national policy on solid minerals offers clearly defined incentives aimed at attracting large investments to the sub-sector. These incentives include;

(a) Three to Five years tax holiday;
(b) Deferred royalty payments depending on the magnitude of the investment and the strategic nature of the project;
(c) Possible capitalization of expenditure on exploration and surveys;
(d) Extension of infrastructure such as roads and electricity to mining sites; and
(e) Provision of 100% foreign ownership of mining companies or concerns.

5.2 Role of Government And The Private Sector

Government expected to give and provide all encouragement necessary for the private sector to play meaningful, effective and result-oriented roles on investment in this sub sector. It is pertinent to note that the new policy is now geared towards a private sector-led development of the vast solid mineral resources of the country with Government creating the enabling environment through provision of roads, power, water and telecommunication to the minefields.

The Government is also expected to allow concessionary duties on importation of mining equipment, tax holidays for the first few years of operation and such relief as; may be determined from time to time by Government depending on the type and strategic importance of the minerals concerned.

Furthermore, government will also facilitate and expedite the issuance of rights, exploration permits, visas, resident and work permits for foreign investors. Government will make available to private investors the results of its research into the most effective way of mining and processing of minerals.

Also, Government will give every encouragement to local processing of minerals prior to export. To this end, encouragement will be given to the establishment and full utilization for processing facilities to enhance value added to exports and uplift the acquisition of technology in the processing and handling of solid minerals.

The private sector on its part is expected to undertake most of the mining activities. For this reason, the private sector will be actively encouraged to establish testing centers for the evaluation of mineral resources with a view to continuously improving the technology, product design specification and the quality for the industries.

5.3 Environment, Health And Safety

Issues connected with environment, health and safety form an integral part of development policy and even more so, in the area of solid minerals development. At the level of the household, the use of solid mineral fuels like coal creates environmental and health hazards to the consumer and the householder. These can be moderated by technology in the development of low smoke emitting coal briquettes and stove design.

At the national level; the safety hazards associated with the handling of metals like lead and zinc, or the management of radioactive minerals, the erosion connected with quarrying for sand, laterite and clays and other degradation effects on the environment are well established. It follows therefore that the environmental impact, health and safety measures need to be incorporated from the beginning in any mineral development project.

6.0. PROCEDURE FOR OBTAINING A MINING LEASE

Under existing laws and regulation only the Federal Government has the power to authorize any mining activity. The miner however has to process his application through two layers of subordinate authorities; The local Government and the State Government. The detailed procedure for obtaining a mining lease is as follows;

(a.) A grant of a mining lease to a prospective company is subject to proof of economic reserve of the mineral commodity for which a concession is sought. The process involves the company first applying to the Minister in charge of Solid Minerals Development for certificate of entry into Mining Industry. The requirements for these include submission of the Company's Certificate of Registration, evidence of technical competence and of financial capability.

(b.) The next step is for the company to apply and obtain a Prospecting Right - Reconnaissance Permit/Exploration Licence to enable it carry out general and scientific prospecting for the categories of minerals within the prospecting right. If properly conducted, work on this right will guide the company towards zeroing in on a particular mineral within a specific land area.

(C.) **Mining Lease** - It is only after a company satisfies itself of the availability of the mineral in commercial quantity. on the EL(Exploration License) that it will apply for grant of Mining Lease over the whole or part of the area covered by EL(Exploration License.)

7.0 CONCLUSION

Ondo State is richly endowed with vast and varied mineral resources, These minerals which include one of the best quality glass sands and tarsands, granites kaolin, limestone, dimension stones, etc. are not only characterized by diverse industrial applications but also offer a lot of investment opportunities for prospective investors.

It is, however, unfortunate to note that, with the exception of petroleum, most of these economically viable mineral deposits are yet to be tapped. This seemingly low level of development, despite the fairly broad solid mineral base in the State, can be attributed to the high capital intensive nature and long gestation period of investment. These, coupled with problems of land acquisition for mining, the bureaucracy involved in processing mining rights and the inadequate infrastructures can be daunting to most entrepreneurs.

However, with the industrial incentives that have been put in place by the State Government, the recent evolution of the new national policy on solid minerals that is geared towards a private sector-led development of solid mineral resources as well as the favourable industrial climate that abound in the State, aspiring investors should come and set up industries for the exploration, exploitation and development of these minerals.

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ENQUIRIES TO:

1. **Hon. Commissioner, Ministry of Environment**, Alagbaka, Akure, Ondo State, Nigeria.
2. **The Permanent Secretary, Ministry of Environment,** Alagbaka, Akure, Ondo State, Nigeria.
3. **Hon. Commissioner for Commerce and Industry, Ministry of Commerce and Industries,** Alagbaka, Akure, Ondo State, Nigeria.