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AN INVENTORY OF MINERAL RESOURCES IN CROSS RIVER STATE, SOUTH EASTERN NIGERIA

B. G. AKPEKE

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ABSTRACT

The Geology of Cross River State is dominated principally by the basement complex of the Oban massif, which extends from the Central Region to the southeastern part and the Obudu Plateau of the Northeast. The sedimentary terrain comprises rocks of the lower Benue Trough and Calabar Flank. The area has been subjected to periods of tectonism, magmatism and regional metamorphism leading to the development of fractures, faults and folds creating favourable sites for mineralization. Cross River State is highly blessed with great potentials in economic mineral deposits. While more than twenty different minerals have been discovered and located in the area, detailed investigations of the traces of other minerals like Gold, Mangenese, Rutite, Mica etc are yet to be carried out to establish exploitability. Few chemical analysis done have confirmed that most minerals discovered are of high quality. The state holds a "trump card" for industrial revolution of Nigeria from the mineral searching perspective. In spite of the rich mineral endowments of Cross River State, mining activities have been restricted to only limestone, barite and granite. This paper tries to share information on location, quantity, quality and uses of some of the minerals discussed here and hope that it would serve as a guiding tool for researchers. Investors should avail themselves of these great opportunities and invest in Cross River State.

KEYWORDS: Minerals, Inventory, Potentials, Qualities

INTRODUCTION

Following a reconnaissance survey of Cross River State, it has been discovered that countless sporadic clusters of Dimension stones and pegmatite veins occur in this largely unexplored area of the country for reasons of inaccessibility and terrain ruggedness. It is interesting to note that these pegmatites host high concentration of "specialty" metals/rare metals and industrial minerals. To say that Cross River State is rich in mineral resources cannot be an overstatement. This is because over 25 different mineral resources have been identified to occur in the state; although their actual locations, quantities, qualities are in most cases not clearly known.
Many potential investors have always hinted that information and data on mineral potentials of Cross River State are not readily available (CRSDMDE Memo, 2005). Information on this sector in both government agencies and private firms have been scanty. Some private organizations restrict information found to their private use since they funded such research. This situation has robbed the State of investment opportunities in this sector of its economy. The main objective of this paper is therefore to trigger off intensive research from both academic scholars, private firms and all tiers of Government to make speculations on reserve figures in this area, a thing of the past. This is also to stimulate researchers into better ways of exploring and marketing these God-given resources for the benefit of Cross River State in particular and Nigeria in general.

LOCATION AND ACCESSIBILITY

Cross River State occupies the southern fringes of Nigeria and constitutes one of the 36 States of the Federal Republic of Nigeria. The State has an area of approximately 23,000km^2 and extends from the Atlantic ocean (in the Southern part) between latitude 4^0 00' and 7^0 00' north of the Equator and from longitude 8^0 00' to 8^0 30' east of the Greenwich Median.

Two giant spurs make up the basement of Southeastern Nigeria namely, the Oban Hills and Obudu Plateau all in Cross River State and are the only Precambrian basement outcrops in Southeastern Nigeria (Figure 1). These spurs are the western prolongation of Cameroon Mountains into the Cross River plains of Southeastern Nigeria. The Oban-Obudu Massif is flanked on the south by the Cameroun Volcanic line and on the Northwest by the Benue trough which are believed to be complementary structural features (rift, Cretaceous- Tertiary Sedimentary rocks (Fitton, 1987). It is situated at the boundary of Nigeria and the Cameroun Republic and lies closer to the Gabon-Congo Craton than any other part of Nigeria.

The vegetation is typically Equatorial Rain Forest towards the south and slightly Savannah up north. The thick vegetation hinders easy access to most geological features and structures in some parts of the State. There is little or no topographic change marking the geological boundaries. The only distinguishing features between areas developed on different geological formation appear to be in the form of Hills.

The hills in the sedimentary terrains are flat-topped as a result of lateritic capping while the rocks that survive erosion form hills of crystalline area and appear to be dome-shaped. The plains are well-drained by rivers originating from the highly fractured, deformed highlands. The main river that runs almost the entire length of the State is Cross River that takes its rise from the Cameroon Mountains to the east. Many tributaries and distributaries flow southwards and westwards to join Cross River.

THE GEOLOGY OF CROSS RIVER STATE

Geologically, Cross River State can be subdivided into four units for ease of description (Figure 1). These are:
(i) The Oban Massif
(ii) The Calabar Flank
(iii) The Mamfe Embayment
(a) The Obudu Plateau.

The Geology is dominated principally by the basement complex of the Obudu plateau of the northeast and the Oban Massif, which extends from the central region to the southeastern part. The sedimentary terrain comprises rocks of the lower Benue Trough and the Calabar Flank. Unlike the basement areas, the sedimentary rocks have been extensively studied.

The mapping of the rocks of the Oban Massif revealed rocks similar to the well-established occurrences in southwestern Nigeria. According to Ekwueme, (2003) they fall within the already established groupings of the Nigerian Basement Complex namely,
(a) Schist belts
(b) The Migmatite – gneiss complex
(c) Charnockitic rocks

B. G. Akpeke, Department of Geology, University of Calabar, P. M. B. 1115, Calabar, Cross River State, Nigeria.

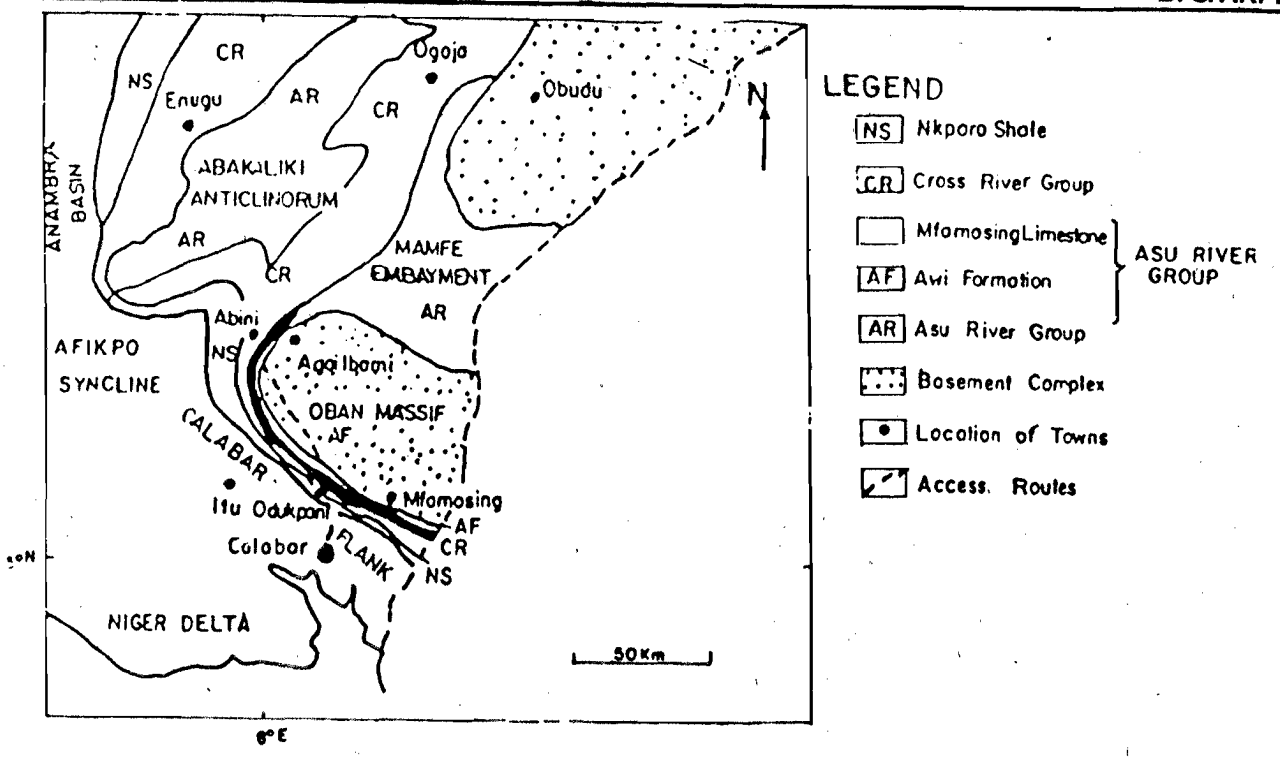

Fig. 1: Geological Sketch Map of southeastern Nigeria (After Ekwueme, 2005)

(d) Gabbro and doleritic rocks
(e) Older granites with Amphiboles
(f) Syenites, basic and acidic intrusive rocks like granodiorites, pegmatites and quartz veins.

The inaccessibility of the terrains is a major factor hindering exploration.
The Obudu Plateau belongs to the Precambrian and include metamorphic rocks as well as intermediate and acidic igneous rocks intruding them. These rocks include the gneisses, Amphibolites, Schists, Charnockites and meta-ultramafic rocks.

The Calabar Flank represents that part of the Southern Nigerian Continental Margin bounded in the North by the Oban Massif and by the Calabar Hinge line delineating the Niger Delta Basin to the West. It has Early Cretaceous deposits followed by the first marine incursion that resulted in the deposition of, the platform, the Mfamosing Limestone during the middle Albian (Petters, 1982). During the Cenomanian and Turonian, subsidence of faulted blocks resulted in widespread deposition of shales with minor Calcareous intercalations. These sediments are uncomformably overlain by a dominantly shale lithology with occasional mudstone and thin gypsum beds during the Campanian to Mastrichtian (Nyong & Ramanthan, 1985).

The Mamfe Embayment situated between the Oban Massif and the Obudu Plateau is predominantly fluviatile clastic sequence that exhibit point bar-fining upward cycles and over bank mud cracks (Ekwueme et al; 1995). This formation belongs to the Asu River Group. Rocks associated with the sedimentary rocks of the Mamfe rift are Basaltic, abundantly found around Ikom bridge.

MINERAL RESOURCES IN CROSS RIVER STATE

Although over 25 different mineral resources have been identified to occur in Cross River state, reliable information on their location, quantity, quality and uses has been, before now, rarely available to prospective investors. Prominent geologists who worked for many years in Oban-Obudu massif are highly disturbed by this situation and decided to organize an "International Geological Field Conference", first of its kind to enable stake holders as well appreciate the role of geologists in these God given resources. The conference was field-oriented since good geologists have little business with classroom or paperwork. It is in view of this that visits to selected sites were embarked upon. It is hoped that this approach will encourage curious investors to go into further site investigations to confirm available information in order to avoid economic losses occasioned by presumptive mining approach.

A list of mineral resources identified to occur in Cross River State are shown in Fig. 2 and their locations listed in table 1 & 2.

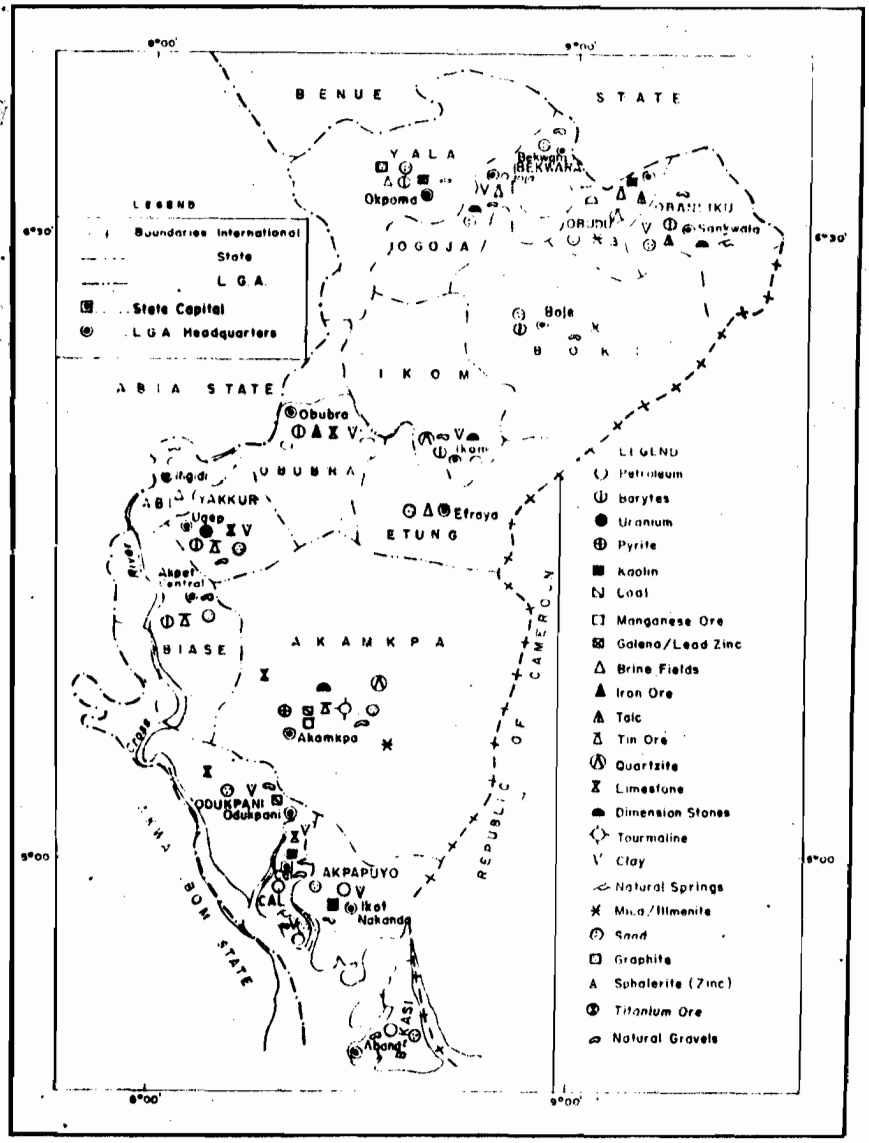

Fig. 2: Mineral map of Cross River State, Nigeria

Table 1: Identified Minerals and their locations in Cross River State.

S/N	MINERAL	L.G.A	LOCATION	REMARKS
1.	Gold	Obudu Akamkpa	Okorotcng Hills (Traces in crystalline basement). *Oban Hills (Massif) and Ogor*	Detail investigation required
2	Uranium	Yakurr Boki	Agoi Ibami, Idomi Butatong/Bufa	- do-
3.	Iron Ore	Akamkpa Ikom	Mfamosing, Nsan Nyaje	- do-
4	Tin Ore	Akamkpa Obudu Biase Yakurr Ogoja	Oban Hills Kutia Akwairani, Abinit (N6° 14 68' E008° 42 51') Agoi Ibami Ogoja Town,	- do-
5	Manganese	Yala Obudu Akamkpa Ogoja	Around Ijegu, Utuawana Oban Rubber Estate, Neghe, Onrel and Nkpot Road (Oban Massif) Equi in Bansara	- do-
6	Titanium	Akamkpa	Nyaje – Oban Hills	- do-
7.	Limestone	Akamkpa Odukpani Ikom Obubra Ogoja	Mfamosing, Uwet Akpa, Akaraum Etankpini, Abiati Emsudor Ofat, Ochong-Isabang Road Ahabene-Omune Road Ogoja	The Mfamosing limestone has been investigated in detail

		Biase Yakurr	Ikot Ana Ugep, Agoi Ibami	
8.	Salt	Yala Etung Obubra Abi	Okpoma, Gabu, Ijegu, Oba Olochor, Woda Ijama, Abia-Ejajam Lake, Akparabong (4.8 Km From Akparabong Village) Ibene In Ababene Egbokoriko, Ogono and Onyi	40km in length and reaches its greatest width of 112.8km at Gabu/Echimoga. In the Okpama vicinity, it is at Abakiliki/ Afikpo road. The relief of the area is mild. Salt is produced in most of these areas traditionally or locally.
9.	Coal	Akamkpa Odukpani Ikom	Eastern part of Akamkpa between Ibum and Mkpat Itu Road Agbaragba	Detail investigation required.
10.	Mica (Muscovite)	Obudu Obanliku Boki Akamkpa Biase	Ohong, Alege Bendi (near the road to Wula), Obudu Cattle Ranch Nsadop and Boje Axis Akamkpa Area Akpet Area	- do -
11.	Kaoline	Obudu Obanliku Akpabuyo Calabar Minicipality	Alege Village (N 036. 205 and E009^{O} 06.080'), kutiang, Ohong, Betukwel and Bebuabong Idundu, Qua Town, Ikot Omini, Esuk Utan.	Deposits are being exploited by natives.
12.	Crude Oil	Bakassi	Off-shore	Off-Shore Mining
13.	Galena (Lead Zinc) PbS	Yala Obubra Ogoja Biase	Gabu and Alifokpa Ibene road Ababene Eja Abakiliki Road	A metallic mineral that occurs in lobes associated with blende, calcite, quartz and other minerals, often filling fracture zones. Also deposited in joints and fissures in limestone. It is the chief ore of lead and an important source of silver.
14.	Feldspar	Akamkpa Boki	Oban Hill Iso Bendeghe	

15.	Quartz	Akamkpa Obanliku Obudu Ikom Obubra	Oban Hills, Mfamosing Around Sankwala Between Obudu and the Ranch. Okorotong Hill Ikom town, Ibene. Edondon and Iyamayong	It occurs in veins and granitic rocks. Sands and sandstones are largely composed of grains of quartz.
16.	Baryte (Ba SO4)	Yala Biase Ikom Obubra Yakurr Obanliku	Oshina-Gabu, Aliforkpa (Sheet 290), Okpoma Akpet, Sheet 314, Okurike, Ibogo, Ugbem Ekukunnela, Sheet 315, Nde, Nkarasi Iyamitet, Edondon, Okokori Ugep, Sheet 314, Okumirete, Agoi Ibami North, Agoi Ibami Forest Reserve, Itu Agoi Nwekwete	A non-metallic mineral generally associated with Calcite (and sometimes Barium Carbonate, Witherite). Sometimes in Ore veins carrying zinc blade and galena.
17.	Diamond	Etung	Eyeyeng – Etara Onughi Hills	Details studies required.
18.	Graphite	Yala Etung Obanliku	Aliforkpa Eyeyeng – Etara Onughi Hills	It is a soft black and greasy to the touch. It can sometimes be mistaken for lead or Talc but lead is much denser.
19.	Pyrite (false Gold) (FeS2)	Akamkpa	Mile 8, after Odukpani Junction on the way to Awi	Exist in sedimentary layers like Ore Veins in shale and salty rocks. Also as accessory mineral in some igneous rocks. It is pale-brassy yellow in colour.
20.	TALC Schist	Obudu Obanliku	Ohong Village Okwel Osa mountain Near Sankwala market about 15km South East of Obudu.	G.PS value N6^0 – 34.7^1 and E90^0 9.5^1 . it is soft & somehow soapy or greasy to the touch. It is white, green or dark green. It can be scratched with the fingernail since it has the lowest hardness of 1 (Moh's scale of

				hardness).
21.	Rutile (TiO2)	Ikom Obanliku	Abiati Bagga	Detail. investigations required. Occurs in pegmatites.
22.	Tourmaline	Akamkpa	Nsan-Oban, Pegmatites intruding granodintes, Iwuru pegmatites.	It is accessory mineral in granites and vein rocks like pegmatites which fill tissues where steam and vapours containing Boron and Fluorine have been active.
23.	Amethyst	Obubra	Iyamitet ($N6^0$ 36.205^1 & $E90^0$ 06.080^1)	It is a genstone of a purple or bluish-violet colour.
24.	Spring water H2O	Calabar Municipality Yakurr Obudu, Obanliku Calabar south	Essien Town Bayatong Obudu Cattle Ranch Bottom Hill Uwanse stream	Can sustain large scale water bottling project.
25.	Hard stones ("Granite")	Akamkpa Boki Obudu Obubra Yala Obanliku	Old netim, Obung Nsan Injua Bano, Katchuan Irruan, Kanyang Okorotong, Kutiang, Betukwel Bebi, Sankwala	They are mined as crushed stone for construction purposes.
26.	Bentonite	Obubra	Ogurude	Contain 60% Montomorillonite
27.	Clay	Obanliku Ogoja Akpabuyo Obubra Calabar Municipality Calabar South	Bendigie, Bukumaya Ishibori Idundu and Qua Town Ogurude, Ovunum and Iyamitet. The Apiapum, Ofumbongha-one clay are highly siliceous Ikot Omin, Ikot Ansa, Essien Town and Okuanibang. Ekondo, Anantigha River Bank and Uwanse Creek	Detail Studies required.
28.	Iron Ore (Hermatite-Fe_2O_3)	Obubra	Ogoiji in Isobo Yala beach Obubra Urban deposits are lateritic Mfamosing village.	It is black, brownish or dark red in colour but a

		Akamkpa		fresh scratch on hematite mineral is blood red. Cross River State Iron Ore has 62% geothite
29.	Sharp Sand	Calabar Municipality Calabar South	Ikot Omin, Ikot Effanga, Kasuk Town, Obutong Old Town, Ikpai Efut Uwanse, Efut Abua	Occurs in all Local Government areas of Cross River State.
30.	Cassiterite (Tin Ore) Sn O2	Biase, Yakurr Obudu, Ogoja	Akwaninai Agoi-Ibami Obudu town Ogoja town Abiniti (N 6^0 14.68^1 E008^0 42.51^1	
31	Tantalite	Akampka	Akwa Ibami	Intensively being mined.

Table 2: Uses, Some Quantities and Qualities of Minerals Occurrences in Cross River State.

S/N	MINERAL	USES	QUANTITY	QUALITY	REMARKS
1.	Gold	As foreign exchange, jewelry, ornaments, production of coins (coinage as money)	Not yet determined	Not declaimed	Occurs in ore deposits of sulphides
2.	Uranium	Atomic energy, curative medicine, detection of flaws in metals, give yellow to brown colour	Not yet determined		Details studies recommended
3.	Iron Ore (Hematite)	As an alloy with manganese, nickel etc in high quality Steel production, metallurgical uses in homes, farms, cities, machines, automobiles, trains and ships	Not yet determined		-do-
4.	Tin Ore (Cassiterite)	In tin plating for food canning and decorative industries, Hardening of copper and lead in alloys, lining of cooking utencils, tin roofing, tubing alloys.	-do-		-do-
5.	Manganese	Dry bateries, glass industries, paints, dyes, pigments, fertilizer and metallugical purposes	-do-		-do-
6.	Titanium	Makes whitest of all paints, very high opacity, toilets artificial silk, coloured glass, pottery glaze, tinting artificial teeth, dyeing, metallugical purposes	-do-		-do-
7.	Limestone	Cement production, Hydrated lime, production of fertilizer, asbestos, As industrial fillers, flux, ceramics, in the iron and steel industry, as aggregates in the construction industry, in the pharmaceutical industry	The mfamosing limestone has been quantified to be over 100 million tons. All other deposits are also in commercial quantities	The quality ranges from 68% CaCO3 – at Mfamosing	Obubra deposit is 70% CaCo3 C.R.S limestone ranks among the best in the world.

8.	Salt	Table Salt; In the food industry as a seasoning for food; In the chemical industry to produce sodium and chlorine products for the manufacture of paper, plastics, pesticides, cleaning fluids and anti freez and other automotive fluids As a deicer when mixed with ice to reduce the melting point of ice. It is often spread on roads and highways to melt snow and ice. About 20% of salt in U.S is used for this purposes. Pharmaceuticals, caustic soda	Covers length 40km & width 112 8km at Gabu/Chimoga but detail quatitative analysis is required	-	Details studies recommended.
9.	Coal	Primary source of heat and powder, Automobile power generation/ locomotion	Not yet determined	-	-do-
10.	Mica (Muscovite)	For electrical insulation in condensers, tubes, radio, socket fuses, filler in rubber, plastic wall papers, paints, lubricants, roofing, materials.	-do-	-	-do-
11.	Kaoline	Moulding China ware, coating printing papers, fillers in rubber, paints, used in white ware pottery, refratories, chalk.	-do-	-	do
12.	Galena (lead Zinc)	Used in metallic industries, electrical cable covering, storage battery, solder pipe, Ammunition bearing metals, pigment in paint and ceramic industries.	-do-	-	-do-
13.	Feldsper	Used in ceramics for making potteries, enamels for household utencils, tiles, porcelain, sanitary ware, ingredient in scouring soaps, abrasives, roofing materials and false teeth.	-do-	-	-do-
14.	Quartz	Used for jewelry and for windows in deep-sea diving vessels.	-do-	-	-do-
15.	Baryte	As a weighting agent in drilling mud, filler in paints, plastics, papers, for dressing poor quality calico.			
16.	Diamond	Precious stone, jewelry ornament and foreign exchange.	-do-	-	-do-
17.	Graphite	Production of pencils, foundry facings, electrodes, dry battery, glazing powder, pipe cement, crucibles, lubricants, paints, dynamo brushes, stone polish It is used to build tanks that store strong acids since it cannot dissolve easily.	-do-	-	-do-
18.	Tourmaline	In the study of polarized light crystals in radio transmittens, production of jewelry. Since it becomes electrically charged when subjected to charges in heat or pressure, it is used in various kinds of electrical instruments.	-do-	-	-do-
19.	Spring water	Source of good table water	-do-	-	-do-
20.	Talc	Filler in paints and rubbers, in plasters, foundry facings and lubricants, paper and textiles, crayons and soap making, pharmaceutical, toilet (Talcum) powder.	-do-	-	-do-
21.	Granite & Laterite	For Road Construction and buildings	-do-	-	-do-
22.	Amethyst	Use in jewelry production	-do-	-	-do-
23.	Rutile	Pigments, Titanium metal and water proofing agents.	-do-	-	-do-
24.	Pyrite	Can be used instead of flints in fire arms.			Exist in sedimentary layers
25.	Bentonite	As an efficient materials for drilling mud (because of the gel-like suspension it forms			

		in water), As bleaching clay in oil refining, filtering, clarifying and decolorizing. As filtering agent for clarifying wine, beer and trating waste water As ingredients in cosmetics, Animal feeds and pharmaceuticals. As soil conditioner, carrier of insecticide/ pesticides coating for seeds and mineral additive in agriculture. As coating on some types of computer papers and on no-corbon required multiple copy papers. As cracking catalyst, beading agents, fillers and as dissociating agents in petroleum refining and chemical industries. As additive to ceramic raw materials to increase plasticity and enhance the strength As fire retending materials. As foundry sand bond in iron and steel founderies. As water impedance, where it prevents seepage loss from reserviors irrigation ditches and waste disposal ponds.			
26.	Crude oil	Refined for petrol, Gas, engine oil, grease, kerosene etc.	In commercial quantity.	Has less of sulphur	-do-
27.	Mica	As insulators against heat and electrical conduction in electrical electronic industry. In vacuum tube capacitors and communication devices. In dry ground roofing. Jolt cement and paint. West ground paint, rubber and wall paper	-do-		-do-
28	Sharp sand	In the construction industry for building of houses, roads etc.			

CONCLUSION

The rich geology of Cross River State is responsible for the high quality and quantity of the Mineral Resources already identified in this area. There are however, a lot more not yet explored due to lack of detailed studies and inaccessible terrain.

The mining of those identified is in most cases constrained by the lack of modern mining equipment and high-level technology and control. Most of the ores require a highly technical beneficiation process that are not easily available or are capital intensive. These constraints make the operations of some local mining companies with rich deposits, so crude and cumbersome. This paper may therefore expose these rich Mineral potentials of the State to attract both local and foreign investors with the required equipment and technical know-how into the sector to partner with the Local Miners.

RECOMMENDATIONS

Attention should be given to the rich geology of the State in predicting some other minerals that are likely to be present but have not been explored probably due to lack of detailed investigations by committed professionals. This can be achieved by the State and Federal Governments in collaboration with the private professionals/Stakeholders to produce a detailed Mineralogical/Geological map of Cross River State.

Foreign investors with more advanced technical know-how and control in the mining industry are hereby called to assist Cross River State in the area of exploration of terrains that have not been explored.

Since some of our Ore minerals require a highly technical and Capital-intensive beneficiation methods, investors with such facilities like South Africa should invest in Cross River State Solid Mineral Sector.

Training opportunities should be made available to our Local professionals by the State Government and South African investors so as to update their knowledge to meet the present realities and advancement in the Solid Minerals Sector

(v) There should be stable and transparent regulations which clearly spell out the rights and obligation of the investor and the government, a competitive and well structures fiscal regime which provides an adequate return to investors and a fair share to the government, assured access to foreign exchange at market rates for dividend repatriation as well as operational needs. and effective support and monitoring of private mining of well organized government institutions.

Cross River State should take a cue from Countries like Botswana, Gabon, Ghana, Guinea and Niger where new mining development has been successful mainly due to the formation of joint ventures between the private sector and Government. These joint ventures are managed by the private partner who generally operates under an investment agreement, which provides the private investor with explicit guarantees against unreasonable government interference. Mining development has also been successful in Namibia, Sierra-Leone and Zimbabwe where major mining companies are fully owned and operated by private investors

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