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SUGGESTING AREAS FOR DETAILED INVESTIGATION OF MINERAL OCCURRENCES IN NIGERIA FOR NATIONAL RESOURCE DATABASE

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ABSTRACT

The economy of Nigeria is not solid minerals driven like that of a country like South Africa. Although several mineral occurrences have been identified in the country, their actual mode of occurrence, mineralogical composition and reserves are not known. This article reviewed the pattern of occurrence of the presently known mineral ores in Nigeria with a view to suggesting a pattern for detailed investigation for accurate chemical and mineralogical compositions and ore reserve estimation for easy investment planning. The results revealed a specific pattern of occurrence of some minerals or group of minerals in some geographic locations in the country. The presently known mineral ores are drawn in maps to present a pictorial view of their pattern of occurrence. It is found that this known pattern could be used to undertake a less expensive detailed investigation of these mineral deposits to create a reliable database of their actual compositions and reserves.

Keywords: mineral deposits, reserves, pattern, occurrences, investigation, compositional analysis, exploration, inventory, Nigeria.

INTRODUCTION

Minerals are the foundation for economic and industrial development of any nation. Machinery for manufacturing and other applications, production of chemicals for various industrial and domestic uses, energy generation, drugs for medical applications, research into new possibilities; in fact all aspects of human living is affected by minerals (Runge 1996; Vogley 1985). Thus it appears that the economies of nations driven by minerals are self sustaining. According to Runge, (1996) and Vogley, (1985) materials used by humans are derived from two major sources, namely; agriculture and mining; but mining alone accounts for about 70 percent of the total. In fact all metallic materials - without which no industrial or technological development can take place - are obtained through mining. Petroleum, bitumen and coal account for over 85% of materials for energy generation (Onyemaobi, 2001; Ogbonna, *et al*, 1999; Runge, 1996; Vogley, 1985) and these too, are obtained through mining. It is therefore obvious that the first step towards economic and technological development of a nation is the exploration, exploitation and processing of its mineral resources - solid and fuel (Ashley, 2002; AGS, 1997)

Although a nation may import minerals to fill these important needs, it is more economical if the minerals are sourced within the country. Since nations are not equally blessed wit deposits of minerals by nature, it becomes important that in planning for her national economic development a nation should first give consideration to how much of mineral reserves she has. This implies that adequate funding for purposeful exploration of minerals is very important (Vogley 1985). A purposeful or detailed exploration of mineral deposits should provide information on the actual mode of occurrence of any identified mineral ore, its peculiar chemical and mineralogical composition, and the reserve. With this information in a country database, investment planning for national economic development becomes easier (Onyemaobi, 2001; Runge, 1996). The Nigerian economy is driven by oil and not by solid minerals like that of South Africa and few other African countries. Although several solid mineral occurrences have been identified in the country, these appeared to be either indicated or inferred as their actual mode of occurrence, chemical or mineralogical composition, and reserves are not accurately known since no detailed exploration of these mineral deposits has been carried out. Investment planning with mineral deposits requires definite information about the composition and reserves of the ore. Thus, it is always better for a nation to have proven reserves of her mineral deposits in her database.

Detailed exploration to create proven mineral reserve database is a very expensive and risky investment, and thus is done systematically in stages. Such detailed exploration usually stars with a regional aerial survey for gravimetric, magnetic or geo-electric anomalies followed by ground truthing geological detailing. The modern geographic information system (GIS) with its versatile computer software, global positioning system and satellite imagery is especially very useful in modern exploration. These tools, with improved technology in modern exploration equipment and a well planned field work will certainly ensure a less expensive detailed exploration of identified minerals in Nigeria. The objective of this study is to review the pattern of occurrence of the presently known mineral ores in Nigeria with a view to suggesting a pattern for detailed investigation for accurate chemical and mineralogical compositions and reserve estimation.

MINING AND MINERAL EXPLORATION IN NIGERIA

Mining is one of the oldest economic activities in Nigeria dating back to prehistoric times when man crudely exploited iron and clay, and perhaps other metals for the production of his cosmetics, crude implements and utensils (MSMD, 2003; FMPMR, 1993). The early European explorers, mainly German, Spanish and British, located and mined tin, galena, gold, and other minerals for export to their home countries. Records show that organised exploration activities in Nigeria commenced in 1903 and 1904 when the Secretary of State for Colonies inaugurated mineral surveys of the Southern and Northern Protectorates respectively (MSMD, 2003; FMPMR, 1993). The principal mineral occurrences discovered by the survey teams included lignite deposits at Asaba, lead-zinc ores at several locations, tin and columbite in the south-east, monazite, limestone and lead-zinc ores at Abakaliki district. Others were coal at Enugu, brine springs at Arufu and Awe, galena in Jos area, iron ore deposits in Niger and Kwara districts and marble deposits in Jakura. Mining activity in controlled form, however, commenced in the country in 1915 with the production of coal at the Enugu mines. Nigeria was impressively sustained by agriculture and few solid minerals known at the time, namely coal, tin, columbite and gold prior to the discovery of petroleum. Coal, for example, met fully the needs of our railway system and electricity supply while tin yielded substantial foreign exchange earnings for the nation. In addition, these minerals also offered employment opportunities and possibilities of development of indigenous technology in mining and minerals engineering (MSMD, 2003; FMPMR, 1993).

Identified mineral ores in Nigeria

Although few solid minerals were known in the late colonial era and early independence days, by 1994 however, when the Nigerian government canvassed a private sector-led economic revival programme in solid minerals, agriculture and manufacturing as a means of diversifying the nation's economy and the Ministry of Solid Minerals Development (MSMD) was created, improved geological data helped to identify about 34 solid minerals in Nigeria against the 37 indicated by the geological survey concluded in 1987. Thirteen (13) of these minerals are being actually mined, processed and marketed. They are coal, kaolin, baryte, limestone, dolomite, feldspar, glass sand, gemstones [haphazard], gold [in small quantities], iron minerals (MSMD,2003; Onyemaobi, 2002 and 2001; Akande *et al*., 1988; Anthony, 1993), lead-zinc, tin and its associated minerals and recently gypsum. The remaining twenty-one [21] minerals, though in demand are untapped (MSMD, 2003). Our investigations actually revealed that although these mineral deposits are known and some are even been mined yet their reserves and average compositions are not fully known thus resulting in huge economic loss. Carrying out detailed exploration of identified mineral deposits in Nigeria will not be as costly as searching for new mineral deposits because the presently known occurrences present patterns that will make such exploration less expensive. Some of these minerals and their locations are shown in the Tables and maps that follow according to their general classification in the Inventory of Minerals, Mines and Miners produced by the Ministry of Mines and Power in 1993 and updated in 2003 by the Ministry of Solid Minerals Development (MSMD).

Pattern of occurrence and suggested areas for detailed exploration

The identified mineral occurrences shown in Tables 1 to 4 below are sketched in maps to give a pictorial view of their pattern of occurrence. A closer look at the maps in Figures 1 to 5 shows that some of these minerals cluster around some geographic locations in the country. Although the minerals are sketched in a map of scale 1: 250,000, their appearances in the sketches are not their actual geographic positions but an indication of states and region where they occur. We have deliberately avoided describing the mineral occurrences by the geologic environment where they occur so as present the real picture of the spread of the different mineral types in their identified locations by state.

For instance, uranium ores are found around the eastern border states of Cross River, Taraba and Aadamawa and extends a little inwards to Plateau, Bauchi and Kano states, while gold occurrences are common around the western ends in Sokoto, Niger, Kwara and Osun and also extends inwards to Edo, Kaduna and Kano states (Figures 1 and 2). This obviously implies that detailed exploration for national reserve database for these minerals could be intensified within these states and the immediate neighbouring states within Nigeria as suggested by the marked area in Figures 8 and 10.

Iron ores are wide spread but are obviously concentrated in the central states from north to south (Figure-1) and detailed investigations for more reserve of these minerals may yield good results within the marked area in Figure-6. This large area is suggested because of the strategic importance of iron minerals in today and tomorrow's technology. Ishiagu, a town in Ebonyi state is the name most popular with the lead-zinc ore in Nigeria whereas occurrence of this ore spreads almost consistently from the south eastern part of the country to the north eastern end along the Benue trough while molybdenum ores are concentrated in the center states of Kogi, Kwara, Ondo, Niger and Nasarawa (Figure-1). Thus the areas marked out in Figures 7 and 9 are suggested for detailed exploration of these minerals.

Several industrial minerals that are in great demands in the country are also observed to occur in specific area from the available mineral inventory in the country. For example Figure-3 shows that barites deposits are located mainly around the Benue trough to the eastern border with the republic of Cameroun covering states such like Adamawa, Cross River, Taraba, Benue, Plateau and Enugu while dolomite deposits can be found around states like Niger, Benue, Plateau, Edo, Ondo, Delta, Kaduna,

Kwara and the FCT. The areas marked in Figures 13 and 14 are therefore suggested for intensive search for these minerals.

Like iron ores, limestone occurrences are wide spread but these definitely are absent in the far north-east and part of south-south region while gypsum deposits are found mainly in the south central states (Figure-3). The areas of influence marked in Figures 11 and 12 are therefore suggested for detailed exploration of these minerals.

Nigeria coals are largely of sub-bituminous type are common within Anambra and Benue sedimentary basins of the eastern half of Nigeria (Olaleye, 2003). Bitumen or tar sands deposits are indicated in an extensive belt of about 120km long stretching from east of Ijebu-Ode in Ogun State to east of Ofosu in Edo State with an average N-S width of about 5km. As shown in Figures 5 and 15, there is definitely a contact region between coal bitumen and crude oil occurrences in Nigeria though these occur at different depths and geologic conditions.

Table-1. Location of metallic minerals in Nigeria.

#	**Mineral**	**Location**
1	Iron-Ore	Plateau, Sokoto, Kaduna, Oyo, Osun, Bauchi, Borno, Benue and Kogi states
2	Chromite	Sokoto and Katsina States
3	Columbite	Kaduna, Plateau, Kano, Ondo, K wara and Bauchi States and Abuja
4	Tantalite	Plateau, Bauchi, Niger, and Sokoto States.
5	Tin-Ore (Cassiterite)	Plateau, K wara, Benue, Niger,and Sokoto States.
6	Zinc-Lead	Enugu, Cross River, Abia, Adamawa, Kaduna, Kano, Ebonyi and Plateau States.
7	Uranium Ores	Cross River, Bauchi, Adamawa, Taraba, Plateau, and Kano States.
8	Manganese Ore	Cross River state
9	Bismuth ore	Plateau state
10	Bauxite	Plateaau, Ondo, Ekiti and Adamawa states.
11	Molybdinite	Kogi, Kwara, Ondo, Nasarawa and Niger states
12	Wolframite	Bauchi and Plateau states

Table-2. Location of precious metals and gemstones in Nigeria.

#	**Mineral**	**Location**
1	Gold	Osun, Kwara, Niger, Kaduna, Sokoto, Edo and Kano states
2	Copper	Plateau state
3	Gamet	Plateau State
4	Tourmaline	Niger, Plateau and Ekiti States.
5	Emerald	Plateau State
6	Topaz	Plateau State
7	Aquamarine	Kaduna, Oyo States
8	Ruby	Kaduna State
9	Sapphire	Kaduna State
10	Amethyst	Katsina and Bauchi States

Table-3. Location of some industrial minerals in Nigeria.

#	Mineral	Location
1	Limestone	Ogun, Sokoto, Cross River, Kwara, Benue, Niger, Bauchi, Adamawa, Enugu, Kogi, Abia and Edo States and Abuja
2	Marble	Kogi, Oyo States
3	Dolomite	Abuja, Kwara, Niger, Benue, Oyo, Plateau, Edo, Delta, Kaduna and Ondo States
4	Quartz	Plateau and Borno States.
5	Talc	Osun, Oyo, Ekiti, Kwara and Niger States.
6	Barites	Benue, Plateau; Sokoto, Adamawa, Enugu, Cross Rivers, and Taraba states
7	Bentonite	Borno, Delta, Edo, lmo, Yo be and Abia States.
8	Gypsum	Sokoto, Imo, Anambra, Ogun, EdD, Delta and Yo be States.
9	Phosphate	Ogun, Imo and Sokoto States.
10	Feldspar	Plateau, Kaduna, Niger, Kogi, Benue, Osun, Ekiti, and Sokoto States and Abuja
11	Kaolin	Enugu, Anambra, Imo, Kano, Plateau, Kaduna, Katsina, Ogun, Sokoto, Abia, Akwa-Iborn, Bauchi and Cross River States.
12	Diatomite	Borno State
13	Monazite	Plateau, Kaduna, Kano and Bauchi States.
14	Trona (Soda ash)	Borno, Adamawa, Taraba and Katsina States.
15	Silica sand	Enugu, Niger, Sokoto, Edo, Delta, Lagos, Ondo, Benue, Imo, Plateau, and Katsina States.
16	Graphite	Kaduna, Bauchi, Plateau and Katsina States.
17	Salt	Abia, Benue, Anambra, Enugu, Cross River and Taraba States.
18	Asbestos	Kaduna State
19	Mica	Niger, Benue, Kwara, Kogi, Plateau, Bauchi, Cross River and Katsina states.
20	Fluorspar	Imo, Kano, Niger and Plateau States and Abuja
21	Sulphur	lmo, Delta and Ondo States.

Table-4. Fuel minerals and their locations in Nigeria.

#	Mineral	Location
1	Coal	Enugu, Benue, Plateau, Bauchi, Kogi, Kwara, Adamawa, Abia, Delta, Nasarawa, Anambra, Ebonyi, Edo, Imo and Ondo states
2	Bitumen	Ogun, Ondo and Edo States.
3	Petroleum	Abia, Akwa-Ibom, Bayelsa, Cross River, Delta,Edo, Imo, Ondo and Rivers states

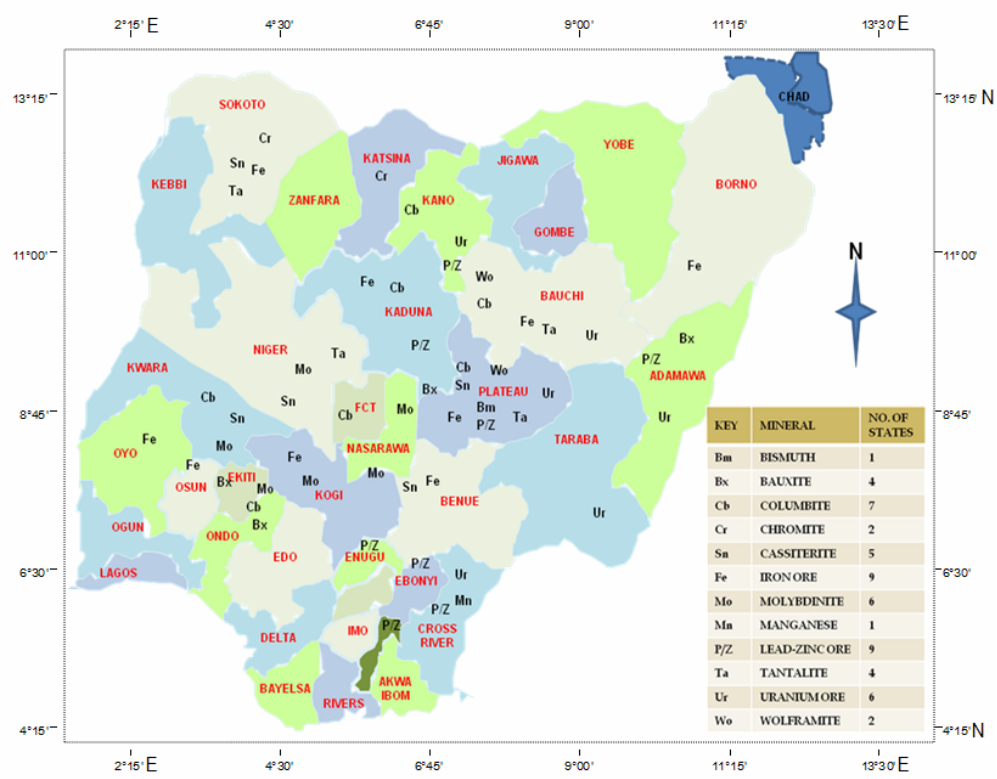

Figure-1. Identified metallic minerals in Nigeria.

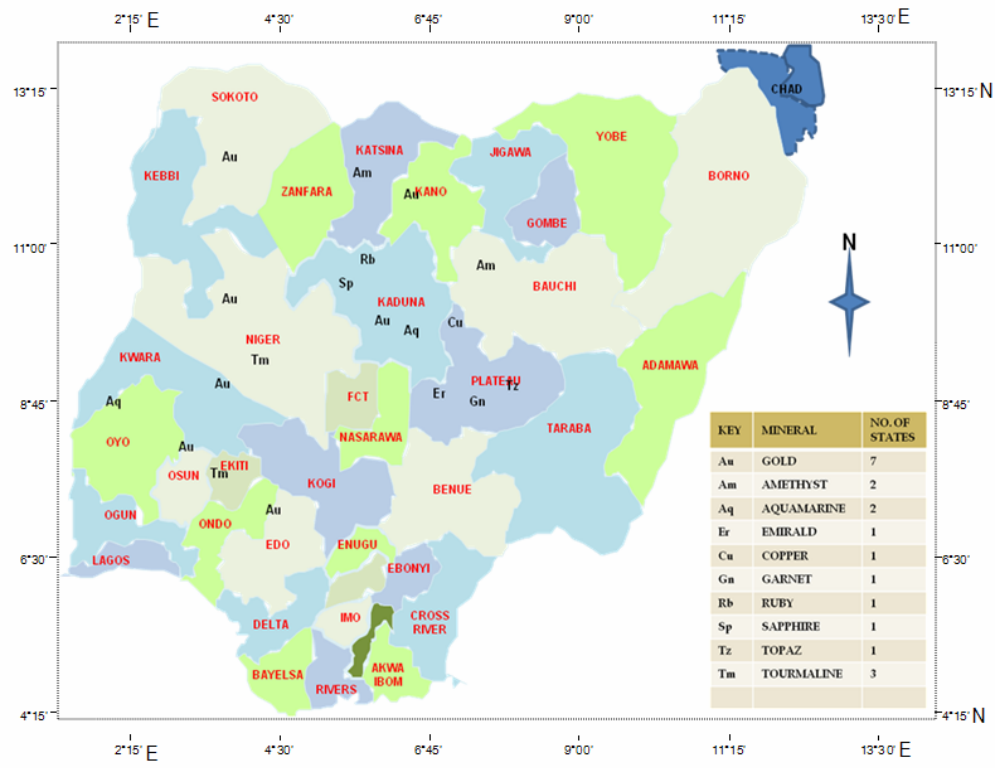

Figure-2. Precious metals and gemstones in Nigeria.

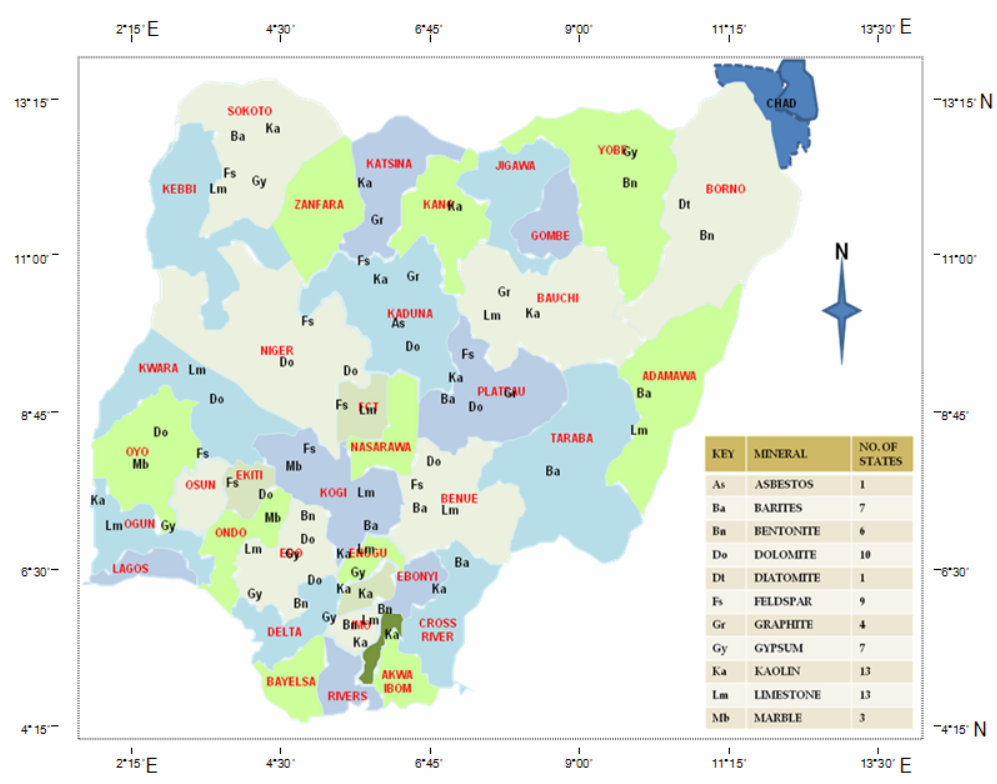

Figure-3. Some industrial minerals in Nigeria

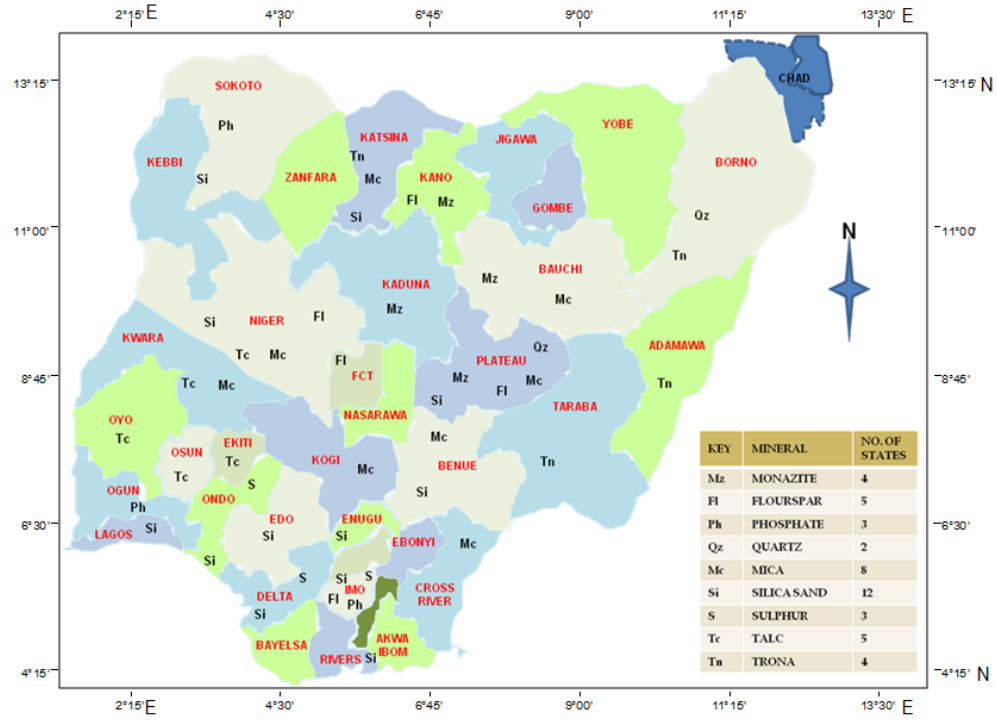

Figure-4. Some industrial minerals in Nigeria (Contd).

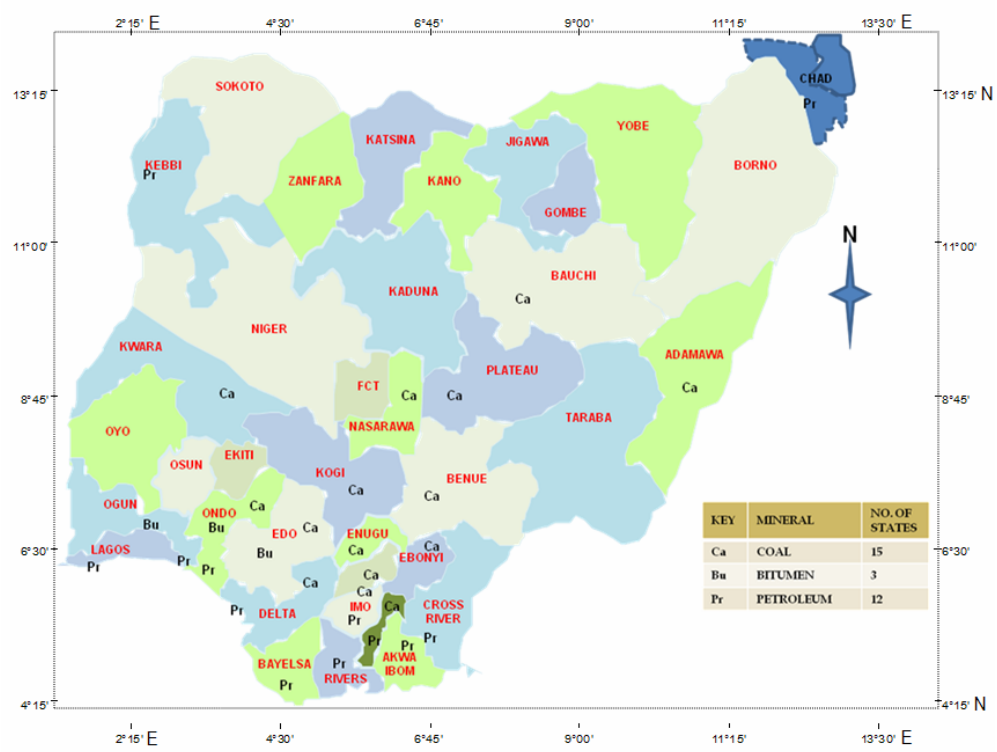

Figure-5. Fuel minerals in Nigeria.

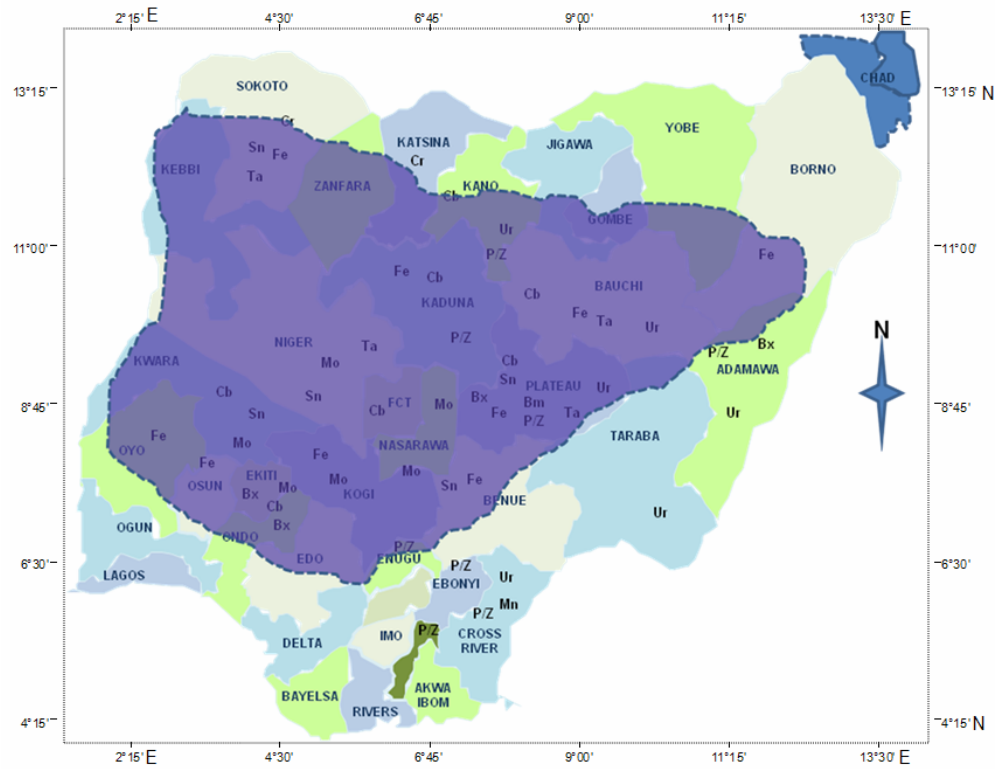

Figure-6. Suggested area for detailed investigation of Iron Ore deposits.

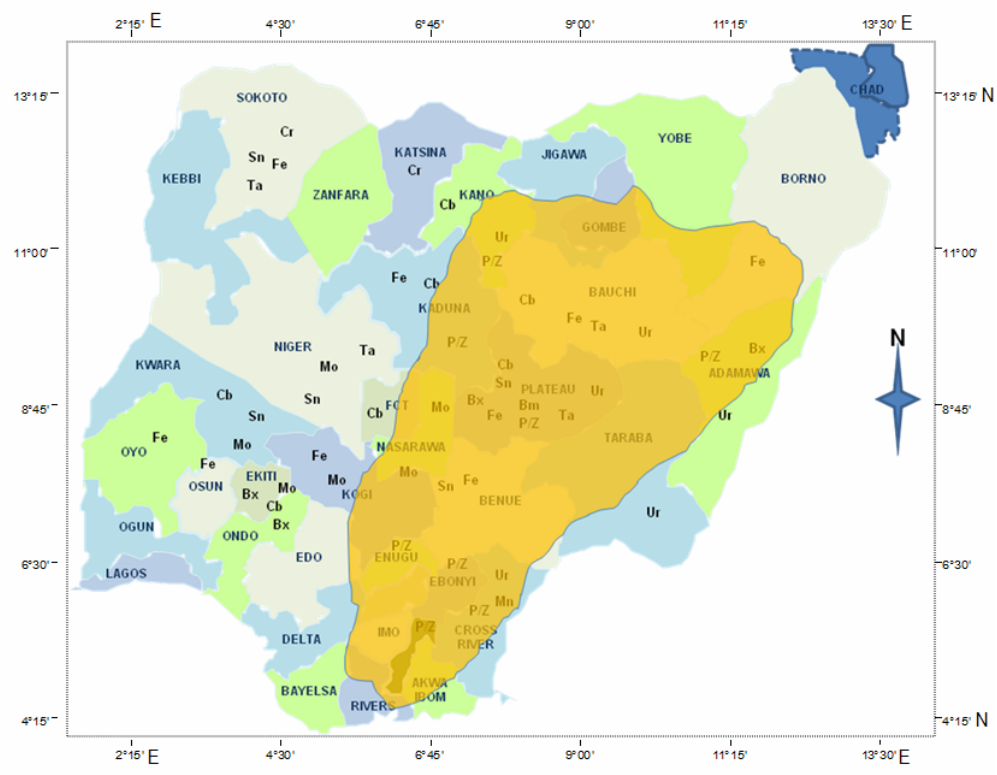

Figure-7. Suggested area for detailed investigation of lead-Zinc Ore deposits.

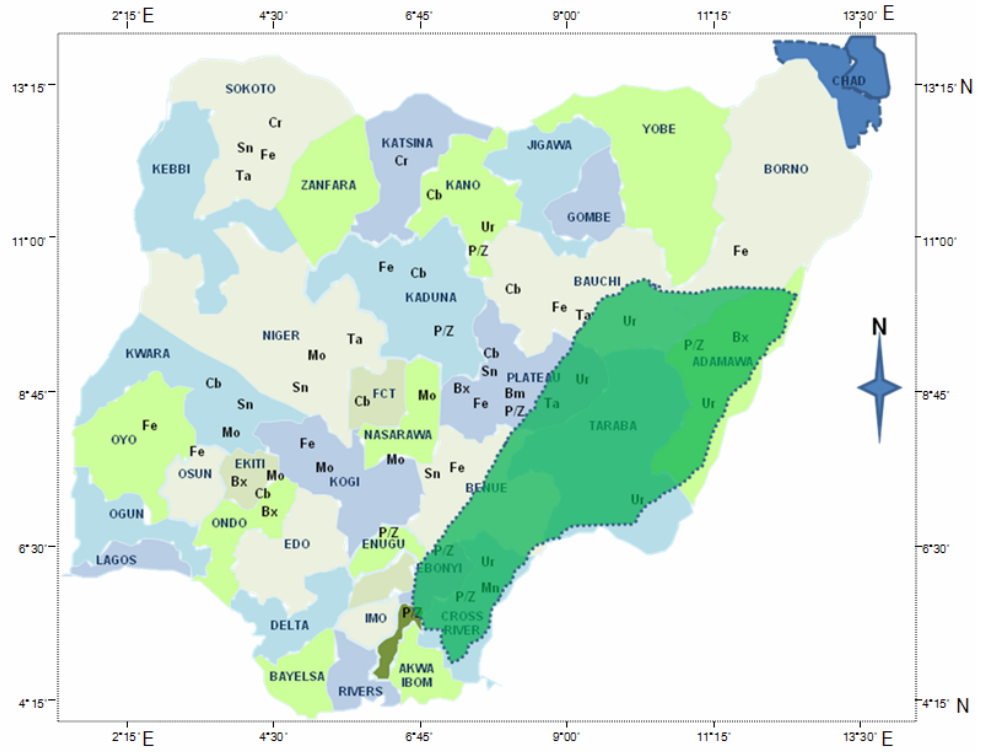

Figure-8. Suggested area for detailed investigation of Uranium Ore deposits.

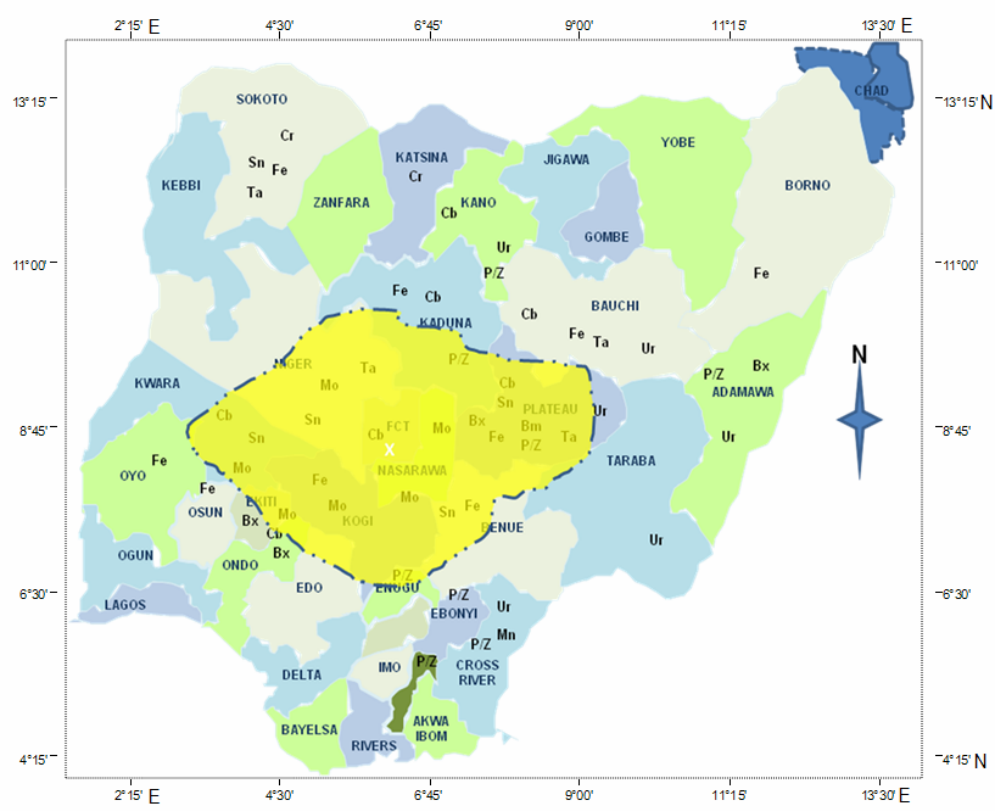

Figure-9. Suggested area for detailed investigation of Molybdinite Ore deposits.

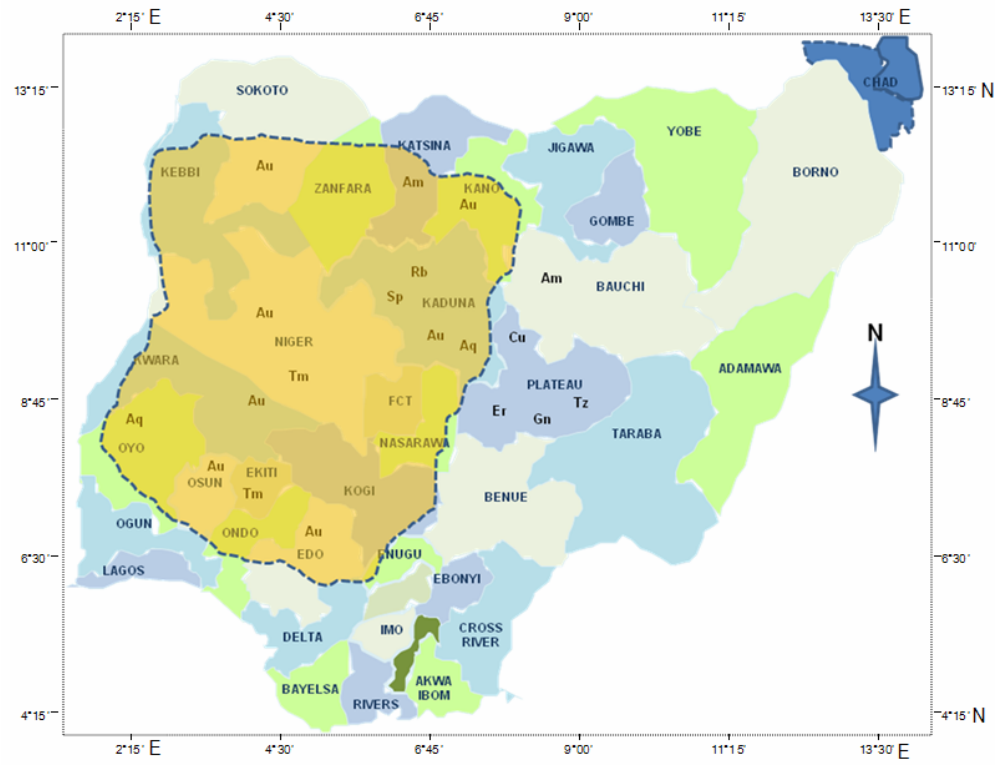

Figure-10. Suggested area for detailed investigation of gold deposits.

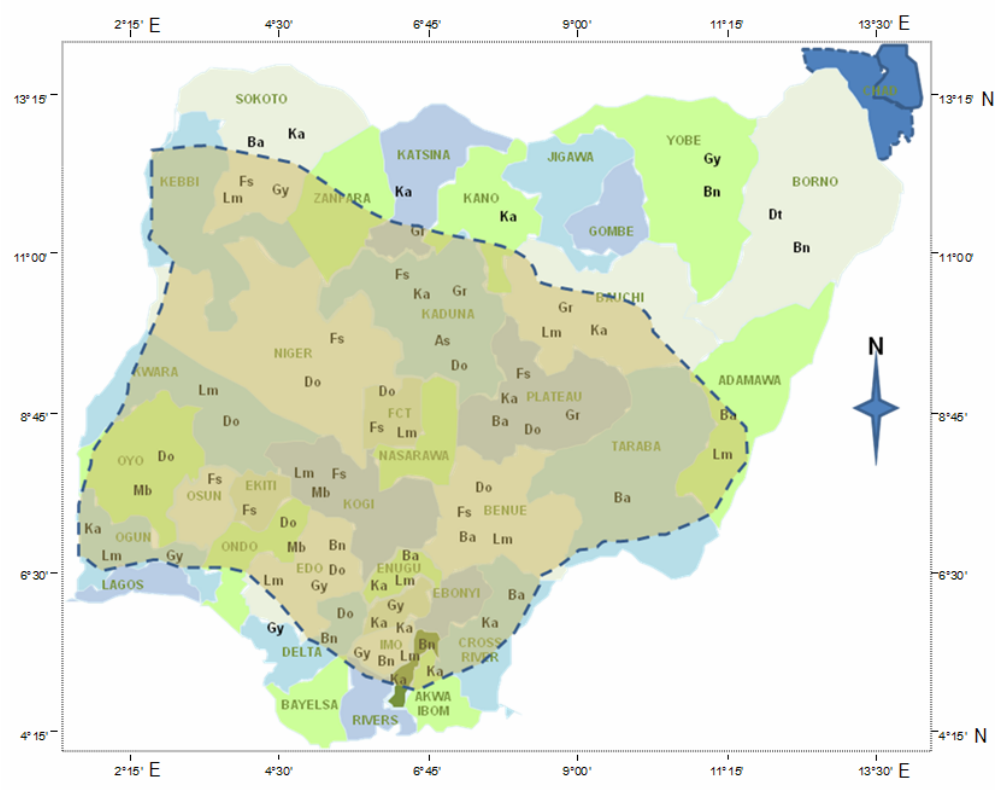

Figure-11. Suggested area for detailed investigation of limestone deposits.

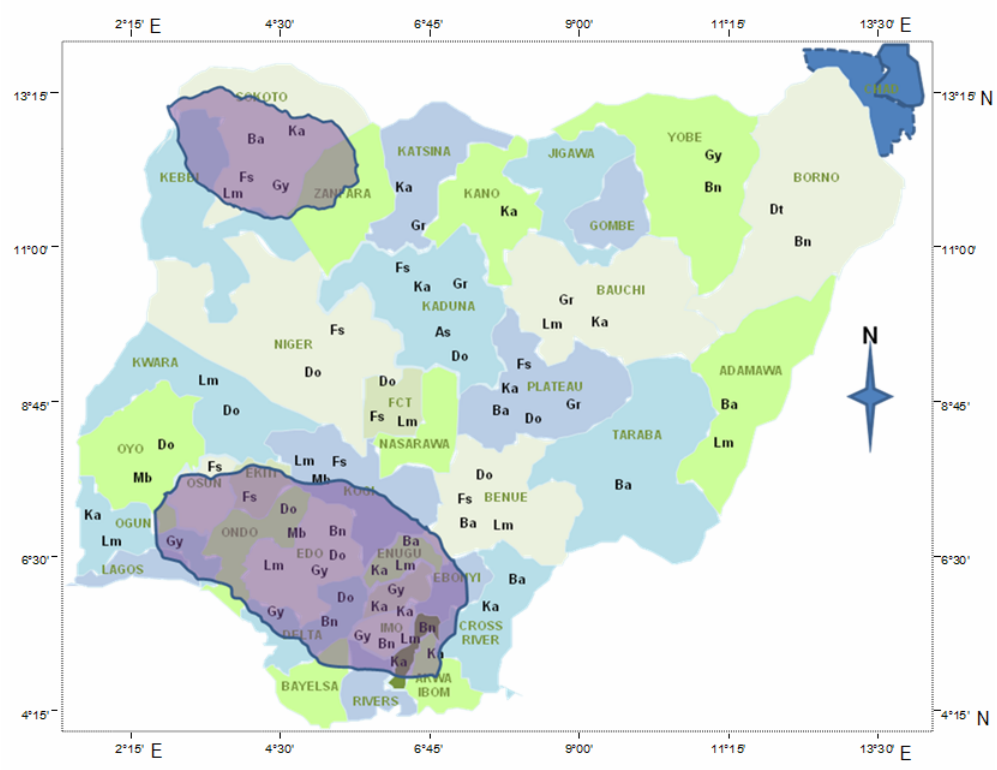

Figure-12. Suggested area for detailed investigation of gypsum deposits.

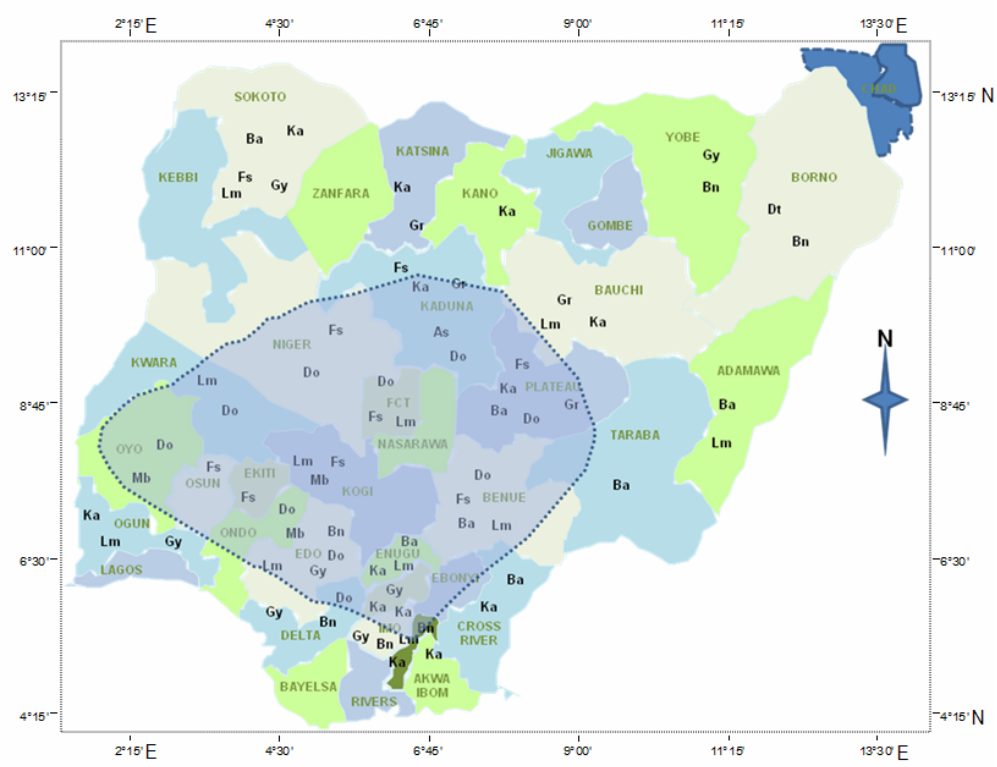

Figure-13. Suggested area for detailed investigation of dolomite deposits.

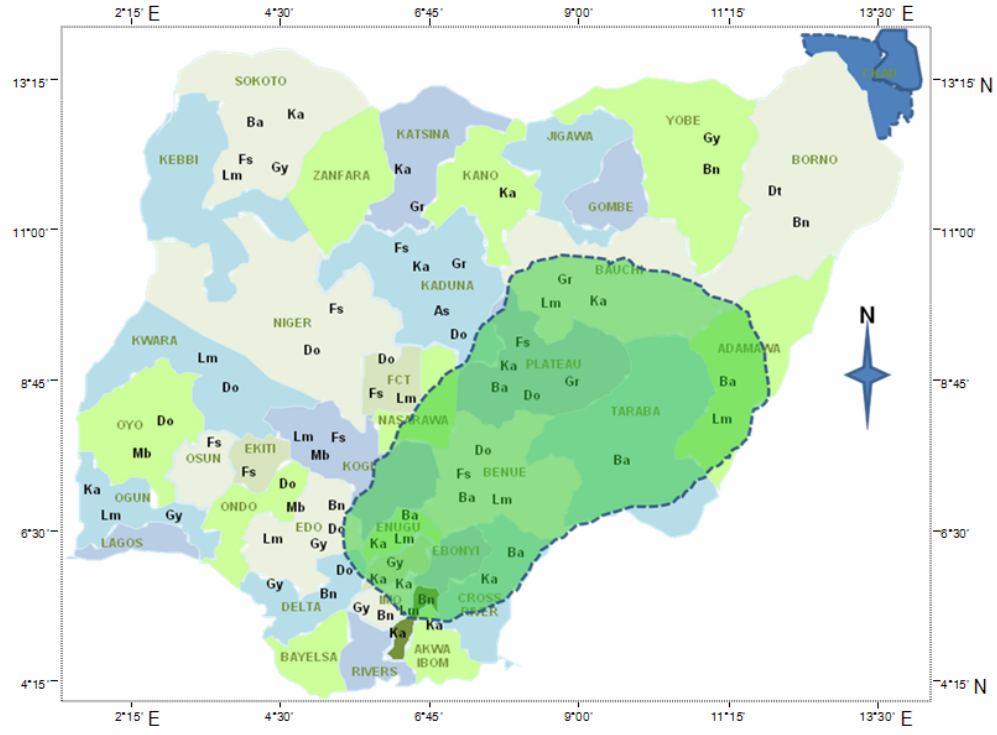

Figure-14. Suggested area for detailed investigation of barites deposits.

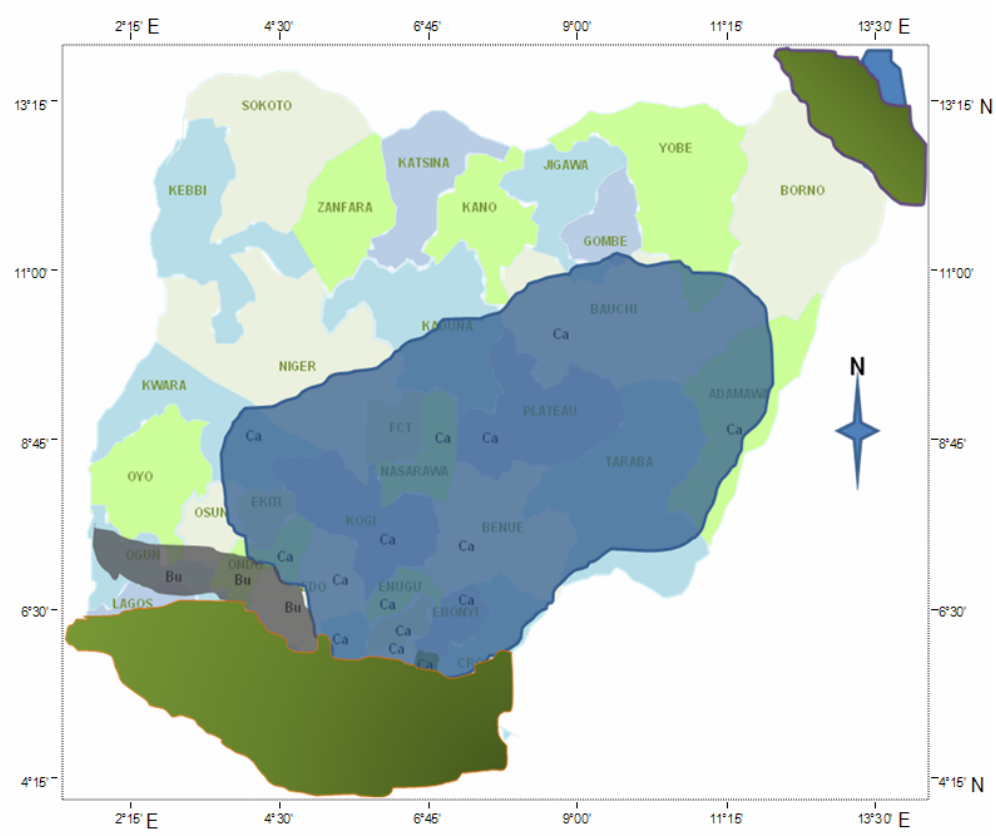

Figure-15. Suggested area for detailed investigation of fuel minerals deposits.

CONCLUSIONS

This pattern of occurrence suggests that detailed investigations could be limited to the suggested areas of influence marked around the existing occurrences and if investigations reveal the presence of these minerals beyond the marked area, this could be extend based on further information from field results. The lack of detailed knowledge about the compositions of the existing minerals is another important reason to carry out a detailed exploration of the known minerals in Nigeria.

RECOMMENDATIONS

It is our opinion that detailed investigation of all identified minerals in Nigeria should commence without delay in order to have a reliable database of their mineralogical components and reserves. To achieve this, we suggest that:

1. The geological survey be fully equipped with:
   a) qualified personnel including all professionals in the minerals industry;
   b) modern equipment to enhance its performance; and
   c) well organized and manned training centers.
2. Foreign private specialist firms in mineral exploration and engineering should be engaged as consultants to undertake the initial technical training of the Nigerian master trainers.

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