

Nigeria

Total population (July 2000 estimate): 123,338,000

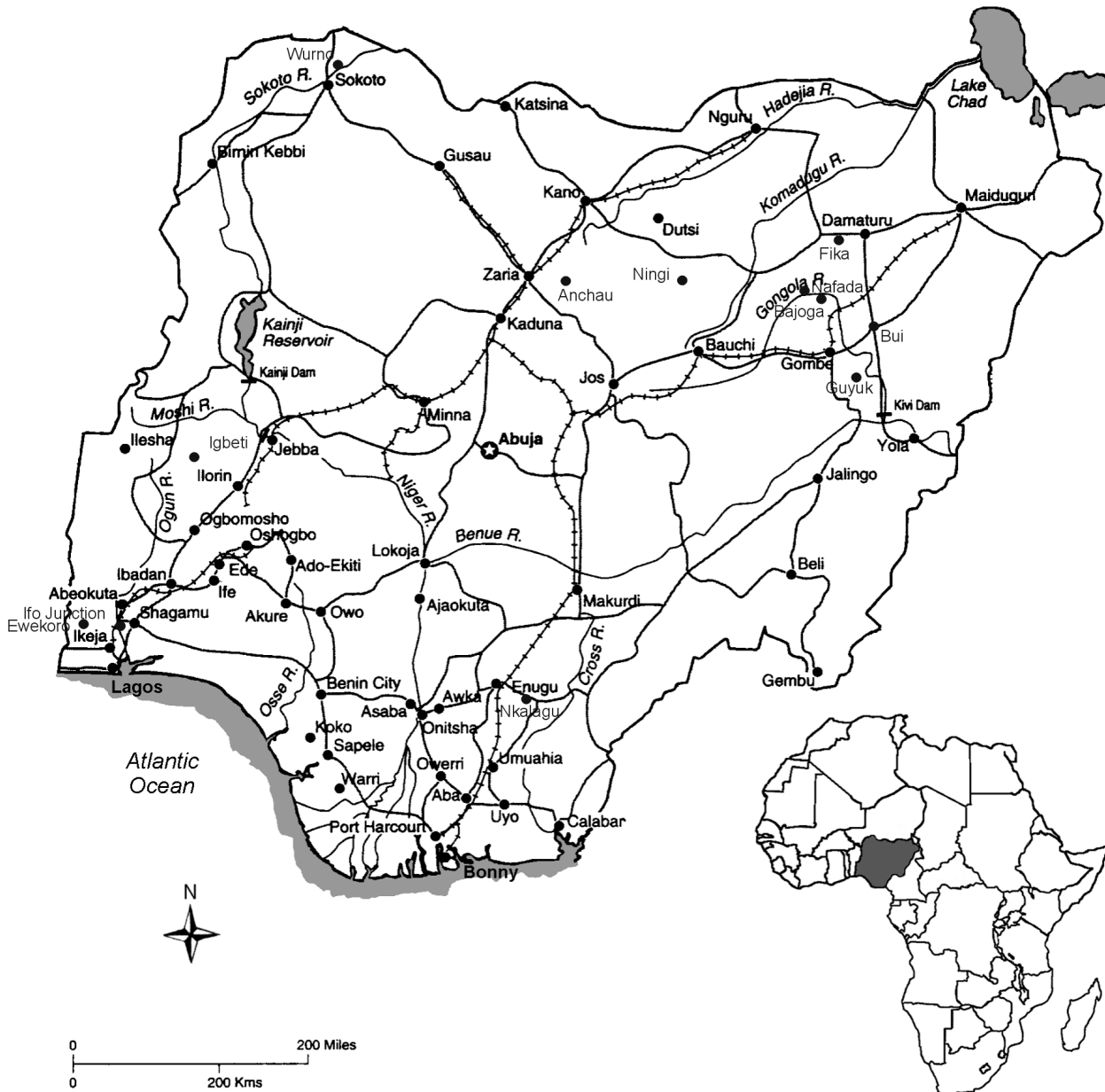
Area: 923,768 km²

Annual population growth rate (2000): 2.67%

Life expectancy at birth (1998): 50.1 years

People not expected to survive to age 40 (1998): 33.3% of total population

GDP per capita (1998): US \$795



Nigeria is the most populated country in sub-Saharan Africa. Geographically, it can be divided into four main landscape units: the low-lying swampy areas in the south and southeast, the inland tropical forest, the open woodland and grass savanna beyond the tropical forest, and the open grassland in the north of the country.

Nigeria's economy is largely based on its oil resources. Although Nigeria is a country rich in natural resources, more than 40% of its population exists at the absolute poverty threshold of less than US \$1 per day. The agricultural sector is expected to play an increasing role in the economy of the country. In 1999, agriculture accounted for 39% of the GDP and employed more than 50% of the population, mainly in subsistence farming and in estate farming. The main food crops are cassava, sorghum, maize, millet, rice and taro. Main export crops and agricultural products include palm oil, rubber, groundnuts and cocoa. One of the major soil related constraints of sustainable crop production on the acid soils of large parts of Nigeria is phosphorus deficiency (Adediran *et al.* 1998).

Nigeria is the largest oil producer in sub-Saharan Africa. In 1998, the oil reserves were estimated at 22.5 billion barrels. Also, the natural gas reserves are large with proven reserves of 124 trillion cubic feet (TCF). However, due to a lack of gas utilization infrastructure, Nigeria flares (burns off at the well) 75% of the gas it produces.

The sale of oil accounts for about 35% of Nigeria's GDP and more than 90% of its export revenues. Other potential mineral raw materials include gold, coal, aluminum, tantalum and tin. The Raw Materials Research and Development Council (RMRDC) advertises a list of non-metallic minerals with extensive reserves including asbestos, barite, bauxite, clay, kaolin, fireclay, diatomite, dolomite, feldspar, fluor spar, gypsum, ilmenite, kyanite, limestone, phosphate, salt, soda-ash and talc (Ministry of Solid Minerals Development 2000).

The RMRDC installed a 15,000 tonne per year pilot plant for the mining and processing of, among other things, phosphate rock at Katsina in the north of the country (Synge 1996).

Geological outline

Precambrian rocks of the 'Basement Complex,' including gneisses, amphibolites, marbles and the 'Older Granites' underlie large parts of Nigeria. Post-tectonic tin-tungsten-bearing 'Younger Granites' of late Paleozoic to Mesozoic age exhibit ring structures. The southwest-northeast striking Benue Trough is part of a down-faulted 'failed arm' of a triple junction that formed when Africa and South America separated in the Cretaceous. The Benue Trough is largely covered by Cretaceous continental and marine sediments (Figure 2.13). Transgressive marine Upper Cretaceous as well as Tertiary sediments are found in the northwestern Sokoto State near the Niger-Benin border as well as in the south of the country. Post-Eocene sediments cover large parts of northeast Nigeria, as well as the Niger Delta. Volcanic rocks including basaltic lava flows, trachytic plugs, central volcanoes and small basaltic cinder cones occur in the Jos Plateau and the Benue Trough, for instance in the Biu area.

AGROMINERALS

Phosphates

Lower Eocene sedimentary phosphates have been known from southern Nigeria since 1921 (Russ 1924, quoted in McClellan and Notholt 1986). Phosphatic sediments occur between the Ifo Junction and Ososum in southwestern Nigeria, approximately 43 km and 48 km north of Lagos (McClellan and Notholt 1986).

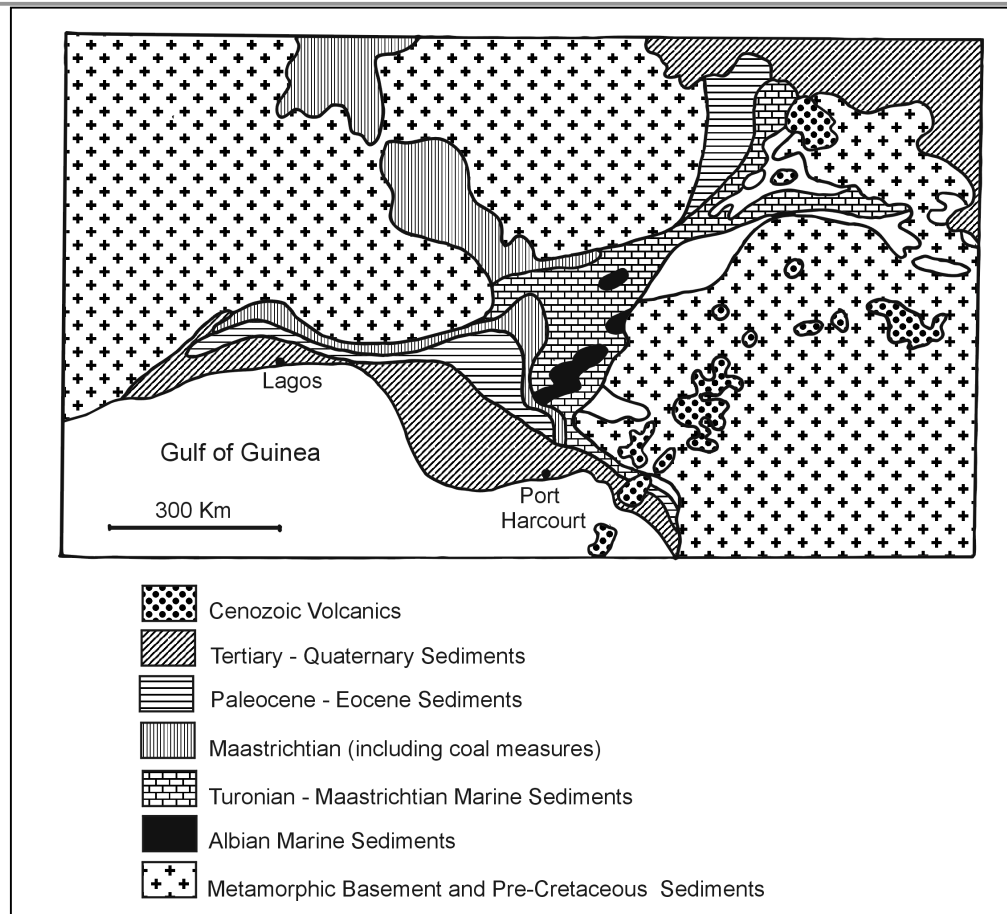


Figure 2.13: The geology of the Benue trough (after Wright *et al.* 1985).

In the southwestern part of the country, phosphate resources occur in the Eocene Ilaro Formation and are presently being mined at Ifo Junction in Orgun State. The resource estimate of this phosphate deposit is 40 million tonnes, but the reserve estimates need updating and confirmation (Ministry of Solid Minerals Development 2000). Other authors, for instance McClellan and Notholt (1986) estimate the PR reserves at this location as slightly over 1 million tonnes only. The Eocene sedimentary succession in the coastal zone of Nigeria is geologically similar to the succession with the economic Togo phosphates. Unfortunately, the phosphate-bearing sedimentary layer reaches only a thickness of 1.3 m and the overburden can reach up to 15 m (McClellan and Notholt 1986).

A phosphate deposit of greater significance is located in northwestern Nigeria in a Paleocene sedimentary sequence in Sokoto State. The Dange Formation (of Paleocene age) is mainly known for its wealth of vertebrate remains including crocodiles. The Dange sediments contain gypsiferous shales and phosphate nodules (Kogbe 1972, 1976). The overlying Paleocene Kalambaina and Gamba Formations are dominated by limestones and laminated ('paper') shales. A horizon with phosphatic pellets within the Gamba Formation (Kogbe 1976) is probably equivalent to the phosphate-containing marine sequence in neighbouring Niger and Mali (Wright *et al.* 1985; Hanon 1990). In southwestern Niger, in the striking continuation of the Sokoto phosphates, the phosphates occur mainly in the 'Formation de Garadaoua,' which is stratigraphically equivalent to Paleocene to Eocene sediments of northern Nigeria (Hanon 1990).

Mineralogical data of the Sokoto phosphate rock (Sokoto PR) indicate a francolitic composition with a unit-cell a -value of 9.353 \AA and a molar PO_4/CO_3 ratio of 11.5 (Mokunye 1995). The neutral ammonium citrate-soluble P_2O_5 is relatively high (3.1 to 3.7 % P_2O_5), as compared to 1.7 % for the Togo PR (Adediran *et al.* 1998).

The reserve estimate of the Sokoto phosphate deposit is 5 million tonnes (Ministry of Solid Minerals Development 2000). The Raw Materials Research and Development Council (RMRDC) has set up pilot plants for the mining and processing of phosphate rock in Sokoto State (Ministry of Solid Minerals Development 2000; Aribisala and Adegbesan 1994; Synge 1996). Mining is currently ongoing.

Agronomic Testing of Sokoto Phosphate Rock

Sokoto PR was used in several agronomic studies on a variety of soils in Nigeria (Adediran and Sobulo 1998; Adediran *et al.* 1998; Akande *et al.* 1998). Results indicate that this indigenous PR is largely suitable for direct application on acid soils under humid climatic conditions. Trials using partially acidulated Sokoto PR gave clearly higher relative agronomic effectiveness than Sokoto PR applied directly (Adediran and Sobulo 1998).

Other agrominerals

Limestone/dolomite

A substantial number of large limestone and dolomite occurrences have been reported by Bell (1963), Ola (1977) and Gwosdz (1996). The resources are grouped into Precambrian limestones, marbles and dolomites, Cretaceous and Tertiary limestones, as well as concretionary calcretes, known in northern Nigeria as 'jigilin' (Ola 1977). Most surveys for limestone, marble, or calcrete have been carried out for the purpose of finding raw material for the building industry, mainly for cement purposes (with low Mg content), for ornamental stone, or as flux in the iron and steel industries of Nigeria. Some of these resources have also been tested for road stabilization purposes (Ola 1977). No systematic surveys have been undertaken to study the limestone and/or dolomite resources for their use as agricultural liming material.

Precambrian marbles and dolomitic marbles occur predominantly in gneiss sequences. Dolomitic marbles of the area near Igbeti in western Nigeria have been regarded as suitable for agricultural purposes and a grinding plant was constructed in 1980 (Gwosdz 1996). However, no data on the agricultural performance of these dolomitic liming materials are available. Another Precambrian marble occurrence is reported from Ilorin. Extensive low Mg-marbles to the west of Lokoja were investigated for their suitability for the cement and steel industries. They are currently being worked for use as decorative stone. Additional dolomitic marbles with reserves exceeding 1 million tonnes are located southwest of Lokoja. Other Precambrian marbles, some of them dolomitic, occur southwest of Minna, and in the Anchau and Ningi areas (Gwosdz 1996).

Paleocene limestones in the coastal area close to Lagos include the deposit of Ewekoro with approximately 31 million tonnes, and Shagamu. Both deposits are mined for raw material in the cement industry.

Cretaceous limestones in the coastal basin and the Benue Trough include the limestone beds at:

- Nkalagu, east of Enugu (reserves 110 million tonnes),
- Yander, east of Makurdi (reserves in excess of 70 million tonnes),
- Mfamosin near Calabar,
- Gombe-Ashaka near Gombe.

Limestones are also extracted for cement manufacture in the northwest of the country, at Kalambaina near Sokoto.

Agricultural Lime Testing in Nigeria

Many agricultural experiments have been carried out in Nigeria with liming material. Among them are experiments carried out by Friesen *et al.* (1982) in very acid soils of southeastern Nigeria. In this area with high rainfall and underlain by Pleistocene coastal sediments, they evaluated the lime requirements and residual values of hydrated lime ($\text{Ca}(\text{OH})_2$). The results showed that with very modest rates of lime application (0.5 tonnes per hectare), maize yield could be maintained at near maximum for 2 years. Sustained maize yield for 5 years or more were possible with a lime rate of 2 tonnes per hectare (Friesen *et al.* 1982).

Gypsum

Gypsiferous shales are reported from the upper Cretaceous Dukamaje Formation and the Paleocene Dange Formation in the Sokoto area. The 1.46-million tonne gypsum deposit at Wurno in Sokoto State is currently being mined by small-scale miners to supply the Sokoto cement plant. Other gypsum prospects are reported from Nafada/Bajoga in Gombe State, at Fika in Yobe State, and at Guyuk/Gwalura in Adamawa State (Ministry of Solid Minerals Development 2000).

Volcanic rocks/cinder cones

There are several cinder cones reported from the Jos Plateau and the Biu area.

Agromineral potential

There are two sedimentary phosphate deposits/occurrences in Nigeria, in the south and in the northwest of the country. The phosphate resource base seems to be small, and not economic for large-scale operations, but interesting for small-scale development. Initial results with Sokoto PR as a directly applied phosphorus resource and in modified forms, for example partially acidulated, are encouraging. More work on modification techniques and organic/inorganic interaction should be envisaged.

Equally, the dolomitic limestones in the Precambrian terrain seem to be interesting for small-scale dolomite/limestone production and utilization on acid soils. Low-level lime applications have proven to be effective in sustaining high yield responses of maize and cowpea in the southeastern part of Nigeria. Further systematic investigations using limestone and/or dolomitic limestone should be conducted to study the agronomic effectiveness of these resources on acid soils in various areas of Nigeria.

It is not known whether gypsum resources have been studied with the aim of using them in Nigeria's agriculture, for instance for the fertilization of groundnuts, or to supplement fertilizers with the much-needed sulphur nutrient component, or for remediation of alkaline saline soils.

The potential of using basaltic scoria and other light, consolidated, volcanic, gravel-size materials as a means of rock mulching, as successfully tested in Ethiopia, should be explored, especially in semi-arid areas of Nigeria, in close vicinity to volcanic scoria cones.

References:

- Adediran JA, Oguntoyinbo FI, Omonode R and RA Sobulo 1998. Agronomic evaluation of phosphorus fertilizers developed from Sokoto rock phosphate in Nigeria. *Comm. Soil Sci. and Plant Anal.* 29:2659-2673.
- Adediran JA and RA Sobulo 1998. Evaluation of phosphorus availability from three phosphorus sources in Nigerian soils. *Comm. Soil Sci. and Plant Anal.* 29:2415-2428.
- Akande MO, Aduayi EA, Olayinka A and RA Sobulo 1998. Efficiency of Sokoto Rock Phosphate as a fertilizer source for maize production in southwestern Nigeria. *J. Plant Nutr.* 21:1339-1353.
- Aribisala OA and BA Adegbesan 1994. Exploitation and export prospects of Nigerian industrial minerals. In: Mathers SJ and AJG Notholt (eds.) *Industrial minerals in developing countries. AGID Report Series Geosciences in International Development* 18:107-110.
- Bell JP 1963. A summary of the principal limestone and marble deposits of Nigeria. *Geol. Surv. Nigeria, Rep.* 1192.
- Friesen DK 1991. Fate and efficiency of sulfur fertilizer applied to food crops in West Africa. *Fert. Res.* 29:35-44.
- Friesen DK, Juo ASR and MH Miller 1982. Residual value of lime and leaching of calcium in a kaolinitic Ultisol in the high rainfall tropics. *Soil Sci. Soc. Am. J.* 46:1184-1189.
- Gwosdz 1996. Nigeria. In: Bosse H-R, Gwosdz W, Lorenz W, Markwich, Roth W and F Wolff 1996 (eds.) *Limestone and dolomite resources of Africa. Geol. Jb., D,* 102:326-333.
- Hanon M 1990. Notice explicative sur la carte géologique de L'Ader Doutchi. Ministère des Mines et de l'Energie, Direction des Recherches Géologiques et Minières, Niamey, Niger, 36pp.
- Kogbe CA 1972. Geology of the Upper Cretaceous and lower Tertiary sediments of the Nigerian sector of the Iullemeden Basin (West Africa). *Geol. Rdsch.* 62:197-211.
- Kogbe CA 1976. Outline of the geology of the Iullemeden Basin in North-Western Nigeria. In: Kogbe CA (Ed.) *Geology of Nigeria. Elizabethan Publ. Co. Sulurere (Lagos) Nigeria,* 331-343.
- McClellan GH and AJG Notholt 1986. Phosphate deposits of sub-Saharan Africa. In: Mokwunye AU and PLG Vlek (eds.) *Management of nitrogen and phosphorus fertilizers in sub-Saharan Africa. Martinus Nijhoff, Dordrecht, Netherlands:*173-224.
- Ministry of Solid Minerals Development 2000. An inventory of solid mineral potentials of Nigeria. Prospectus for Investors, 15pp.
- Mokwunye AU 1995. Reactions in soils involving phosphate rocks. In: Gerner H and AU Mokwunye (eds.) *Use of phosphate rock for sustainable agriculture in West Africa. IFDC, Miscellaneous Fert. Studies* 11: 84-92.
- Ola SA 1977. Limestone deposits and small scale production of lime in Nigeria. *Engineering Geol.* 11:127-137.
- Russ W 1924. The phosphate deposits of Abeokuta Province. *Bull. Geol. Surv. Nigeria* 7, 43pp.
- Synge R 1996. Nigeria. *Mining Annual Review 1996, Mining Journal Ltd. London,* p.164.
- Wright JB, Hastings DA, Jones WB and HR Williams 1985. *Geology and mineral resources of West Africa. Allen and Unwin, London, UK,* 187pp.