MP

mineral perspectives

THE MINERAL ECONOMY OF

GUINEA

This report has been prepared by the Bureau of Mines, U.S. Department of the Interior, to provide the latest available data and information on the mineral economy of Guinea.

Comments, revisions, and additional information on the subject are invited.

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THE MINERAL ECONOMY OF GUINEA

By George A. Morgan,[1] David Izon,[2] and Nene Ousmane Sow[3]

ABSTRACT

Guinea is the second largest producer of bauxite in the world and possesses the world's largest known resources of that commodity. Guinea's economy is dominated by bauxite, with minor production of diamonds and gold, which together account for about 90% of the country's foreign exchange earnings. Large resources of high-grade iron ore also exist, but their development remains uncertain owing to lack of infrastructure, cost, and regional difficulties.

Information available to the Bureau of Mines indicates that potential for expansion of output of bauxite is good, given adequate infrastructure and demand. Further downstream processing to alumina and aluminum likewise remain a goal, having the additional dependency of new electric power capacity. Increased output of gold is dependent upon investment funding. A review of mining policy is underway by the Government, which, coupled with a continuation of privatization schemes for Government services, may lead to increased exploration, development, and diversification of the mineral industry.[4]

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[4]All tons in this report are metric tons.

SUMMARY

Mineral production is the principal industrial activity in Guinea. The industry itself is dominated by bauxite owing to the quality and quantity of the resource existing in Guinea. This Mineral Perspective provides the latest information available on the mineral industry of Guinea, including its role in the economy, and the production, capacity, and trade of the minerals produced.

Coverage is also provided for the role Government policies as well as the country's infrastructure play in the mining industry. Also included are comment and analysis on mining, investment and labor laws, as well as energy, railroads, ports, and roads as they relate to the mining industry. Emphasis is on the bauxite sector owing to Guinea's position as the second largest world producer and largest world resource of that commodity. The essential findings of this Mineral Perspective on Guinea are as follows:

1. Bauxite and alumina are the main foreign exchange earners for Guinea, accounting for about 90% of total mineral exports. The availability of large bauxite resources for development, as well as the established presence of three large producers having a total capacity of 16.7 million tons with participation by downstream consumers, indicate that this situation is likely to continue. However, the current surfeit of worldwide supplies of aluminum metal, particularly record stocks owing to sales by the former U.S.S.R., may lead to short-term stagnation of output.

2. Development of placer diamond mining has added diversity to the economy and further development of the industry. The quality of the diamonds produced is very high, but satisfactory recovery has not occurred owing to erratic distribution of the diamonds, which has led to high operating costs. Small-scale independent entrepreneurs, referred to as artisanal miners, are recovering a significant amount of generally higher quality gem diamonds, but their activity is illegal. Improved control of artisanal mining, along with further exploration for diamond, should improve prospects for the sector.

3. Delineation of gold-bearing zones and startup of formal gold production by overseas investors are a continuation of the former gold mining tradition of the country, based on its favorable geological potential. As with diamonds, improved infrastructure, pricing, and access to modern recovery techniques should lead to increased activity in the gold mining sector.

4. Infrastructure development and maintenance remain the most critical aspects for sustained overall economic integration of the country. Interconnecting agricultural areas with population centers through improved transportation should provide for better fuel distribution and sales networks with significant benefits to the mineral industry.

5. Small industrial operations, such as placer mining of gold and diamond, may have their energy requirement satisfied by on-site mobile generators. However, any large project, either expansion of additional bauxite output or processing to alumina or even to aluminum would require much larger hydroelectric power capacity to avoid the importation of liquid fuel. Current total electrical energy capacity for Guinea is inadequate for any sustained industrial enterprise beyond existing facilities.

6. Development of large, high-grade iron resources at Mount Nimba near the border with Liberia remains a goal. Enormous difficulties and costs need to be overcome prior to their development. Among these are settlement of the unrest underway in Liberia; resolution of the transport scheme for both starting the mine and moving the product to market; and financing for the project, as well as marketing of the iron ore produced.

INTRODUCTION

Guinea's principal mineral resource, both in terms of importance to the national economy and in terms of supply to the world market, is bauxite, the primary ore of aluminum metal. However, other mineral resources of significance, such as diamond, gold, and iron ore, also exist. This report on Guinea by the U.S. Bureau of Mines is part of a series of Mineral Perspectives, the purpose of which is to examine and record the mineral industry of selected countries, both as a unique sector of their economies and in the context of indigenous labor, transportation, and energy. Guinea's mineral production and its role in world trade, particularly with regard to the United States, are examined. Figure 1 gives Guinea's principal mines, deposits, and infrastructure.

Gold was the first mineral to be mined in Guinea. The characteristic red tint of the gold found in west Africa caused Guinean "red" gold to be prized over yellow gold, and it was reported in the treasuries of Carthage and Rome. The guinea, an English coin, was composed of 22-karat gold and was so named because the coin's first minting in 1663 was of gold produced in Guinea. It is believed that several hundred tons of gold were mined

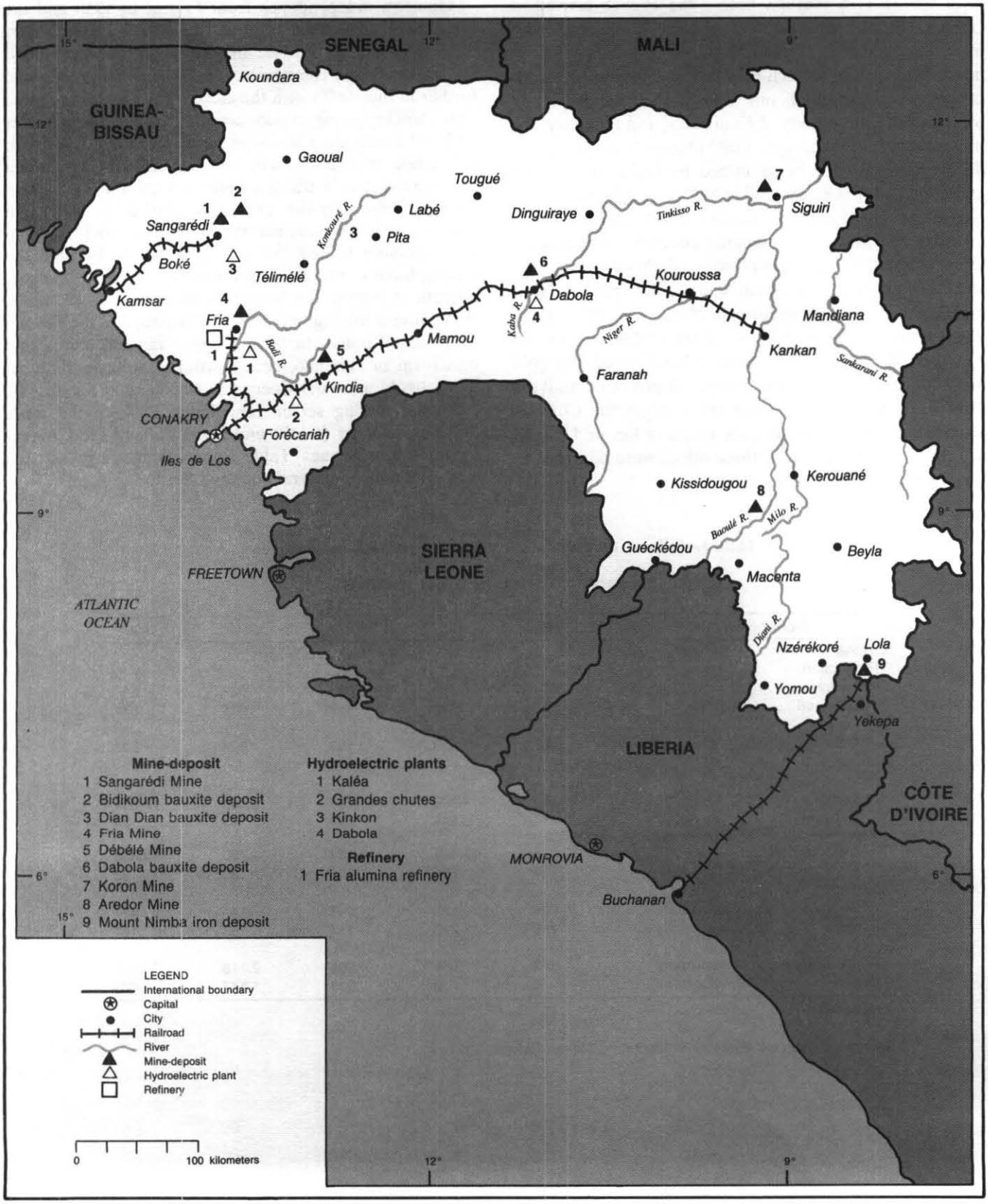

Figure 1.—Guinea's principal mines, deposits, and infrastructure.

prior to the 19th century, before the French arrived in Guinea. In 1900, Guinea became a French colony, and a more systematic accumulation of geologic data led to a minor gold rush by French companies. Two main gold localities were identified; one was in the Niandan-Banie Mountains in the vicinity of Kouroussa, and the other was in Banora near Dinguiraye. Gold placers in the vicinity of Siguiri were already being mined by Guineans (fig. 1). Diamond was first discovered in 1932 near Macenta by geologists working for Consolidated African Selection Trust, a British company. This diamond discovery drew new interest in Guinea's mineral industry. Diamond prospecting and mining permits were granted under the French administration to several private foreign companies. Mining was also allowed in areas which were not covered by a company permit. Despite discoveries of bauxite and iron, gold and diamonds were the major minerals produced until the 1950's. At that time, an iron ore mine in the Conakry district was opened, and bauxite mines at Iles de Los and at Fria commenced. All of these mines were operated by foreign companies.

Guinea's independence from France in 1958 and the subsequent change in political direction by the country were followed by the banning of all gold and diamond mining by foreign companies. The mining sector declined further in the 1960's with the closure of the iron ore mine near Conakry owing to poor economic prospects. The Iles de Los bauxite mine was shut down about 1962 owing to exhaustion of reserves. The Fria bauxite mine assumed a new partnership in which Guinea gained a 47% share in the operation. By the 1970's, the decline in activity in other economic sectors and the increase in world demand for aluminum helped the mining sector to become the driving force in the national economy. Two new bauxite operations began: the Sangarédi Mine near Boké, which is the largest mining operation in Guinea, and the Debélé Mine near Kindia. In 1984, a large diamond mine came on-stream in G'benko, near Kérouané, and, in 1988, an alluvial gold mine was opened in Koron, near Siguiri. By 1990, the mining sector contributed 28% to the gross domestic product (GDP) and about 65% of the Government's total revenue. Table 1 gives Guinea's production and shipment of mineral commodities.

Table 1.—Guinea: Production and shipment of mineral commodities

(Thousand tons unless otherwise specified)

Commodity	1986	1987	1988	1989	1990
Alumina:					
Production:					
Hydrate	571	542	593	627	642
Calcined	556	543	589	619	631
Exports:					
Calcined	567	539	593	624	631
Bauxite:					
Production (wet basis):					
Metallurgical	14,844	16,299	17,729	17,404	17,384
Calcined	117	114	130	143	133
Exports:					
Metallurgical	12,146	13,829	14,524	14,750	13,835
Calcined	122	124	136	136	133
Diamond:					
Production .. thousand carats	204	175	146	147	127
Exports ..... thousand carats	188	210	117	163	147
Gold:					
Production ..... kilograms	0	864	1,996	2,118	e6,341
Exports ..... kilograms	0	0	312	1,177	1,773

eEstimated.

Source: Bureau de Stratègie et Marketing Minier, Guinea, 1991.

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THE MINERAL INDUSTRY

MINERAL PRODUCTION AND TRADE

The major industrial activity in Guinea has been the mineral industry. The industry itself consists of production of only four major mineral commodities: alumina, bauxite, diamond, and gold. However, these four commodities accounted for about 28% of Guinea's GDP of $2.9 billion in 1990 and about 90% of total exports. About 65% of the Government's revenue is from mining. The remainder is from customs, 9.7%; petroleum taxes, 0.8%; company taxes, 3.3%; and all other taxes, 27.7%. Of about $868 million in total imports, $150 million was for food, $118 million for petroleum, $76 million for consumer goods, and the remainder for intermediate products and machinery.

Combined bauxite output by the country's three producers at 17.5 million tons in 1990, wet basis, is second in the world only to Australia. About 2 million tons of the bauxite is processed to alumina for export by one company at Fria. The Government retains a major interest in all three operations, ranging from 49% to 100%. Complete official trade statistics generally are not available for Guinea, and most trade is confidential. However, production of bauxite and alumina from two of these operations is primarily for export to consortium members in Europe, Canada, and the United States, as indicated in data released by the Ministry of Natural Resources and the Environment (see table 1). Output from the third company is shipped to the former U.S.S.R. as payment for goods and for debt service. About 10% is available for sale on the open market. See table 2 for Guinea's value of mineral exports. Also, see figure 2 for Guinea's value of major mineral exports and total exports.

Guinea was the major source of bauxite for the United States in 1986. However, the trade pattern has changed considerably, since U.S. imports have nearly doubled in 5 years to 12.1 million tons, with much of the increase coming from Australia, Brazil, and Jamaica. Total Guinean shipments of bauxite to world markets declined by about 900,000 tons in 1990. Guinea's share of U.S. bauxite imports in 1990 of 3.7 million tons was also considerably below the record of 4.5 million in 1988. Currently, about one-third of the total U.S. import supply of bauxite is from Guinea. Imports of alumina from Guinea by the United States are insignificant. Occasional small shipments of calcined bauxite for use in abrasives have been made to the United States. Most such material has been shipped to Europe. See table 3 for U.S. imports of bauxite from Guinea.

Table 2.—Guinea: Value of mineral exports

(Million U.S. dollars)

Commodity	1986	1987	1988	1989	1990
Alumina	73	87	93	131	166
Bauxite	405	404	361	416	446
Diamond	47	59	46	35	56
Gold	0	0	4	14	74
Total mineral exports	525	550	504	596	742
Total all exports	538	571	635	741	829
Mineral exports as percentage of total exports	98	96	79	80	90

Source: Bureau de Stratègie et Marketing Minier, Guinea, 1991.

Table 3.—United States bauxite imports[1]

(Thousand tons unless otherwise specified)

	1986	1987	1988	1989	1990
Guinea	3,356	4,256	4,526	3,504	3,669
Jamaica	2,119	2,799	2,654	3,330	3,886
Australia	579	1,167	1,612	1,535	1,430
Brazil	100	451	792	1,373	1,812
Other	302	483	360	1,151	1,345
Total U.S. imports	6,456	9,156	9,944	10,893	12,142
Percent of total from Guinea	52	46	46	32	30

[1]Data represent imports for consumption of crude and dried bauxite.

Source: Bureau of the Census.

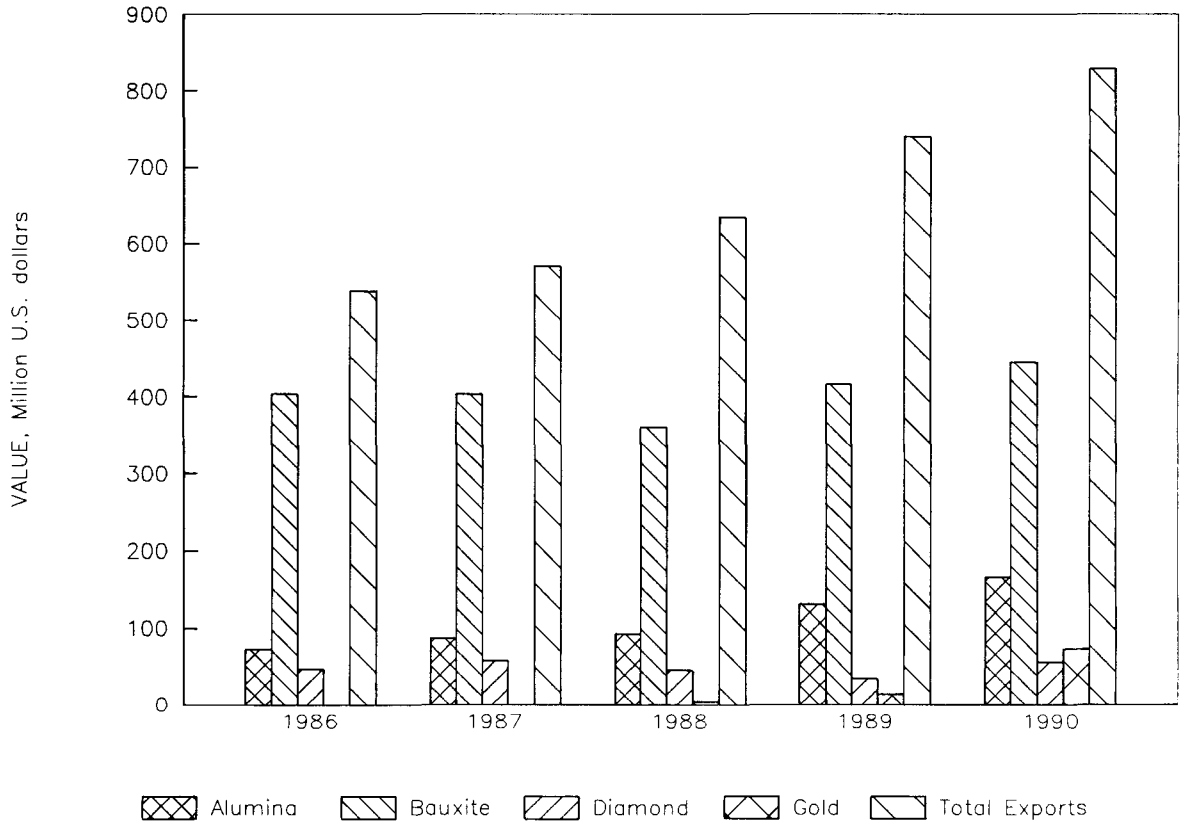

Figure 2.—Guinea: Value of mineral exports.

Market conditions in 1990, in comparison to prior years, have led to lower prices for aluminum. In 1991, additional changes in consumption patterns in Eastern Europe and the former U.S.S.R. have led to further availability of excess stocks of aluminum metal on the open market. Guinea may be expected to face a reduction in revenue from sales of bauxite, as well as possible stagnation of production at current levels owing to generally lower worldwide demand in the short term.

Central to further development and diversification of the mining sector in Guinea are activities relating to diamond and gold. A single formal diamond operation by Aredor-Guinea S.A. currently produces about 130,000 carats per year, although mine capacity is rated at 500,000 carats per year. Unrealized production goals have been primarily a function of difficult and even disappointing ore reserve delineation and diamond recovery. The mine's production from alluvial deposits east-southeast of Kissidougou is estimated to be about 93% gem-quality diamond, with stone size averaging about 0.75 carats. Variations in grade of mined material owing to erratic diamond distribution and fluctuations in stone size have placed strains on the operation. The normal finds of exceptionally large, high-quality stones have not been sufficient to offset these ore-grade and operational problems. Also, mine operations are far removed from efficient centers of supply and communication, adding to the cost of production. However, minable reserves exist at the mine site.

Illegal small-scale (artisanal) production occurs in several areas. Such production remains undocumented, but an estimate of about 55,000 carats from artisans in 1989 is based on sales of Guinean diamonds reported on the Antwerp diamond bourse compared with reported production. Further interest in diamond mining may be expected as exploration continues and the transport sector improves. See figure 3 for U.S. bauxite imports from Guinea.

The country's history of gold production has generally been one of small, artisanal output. Total output from artisanal gold miners is unreported, but has been estimated at 2 tons annually. This does not include gold produced and smuggled out of the country. The Bank of Guinea purchases such artisanal output at a price that is competitive locally. The 1988 startup of the Koron Mine in eastern Guinea near the Mali border represents a change in the normally informal supply of gold from Guinea. The mine is operating at nearly full design capacity of about 2 tons of gold per year. Research on mineralization discovered in the Dinguiraye area is underway for possible commercial development. Both undertakings are positive developments for the future of gold mining in Guinea.

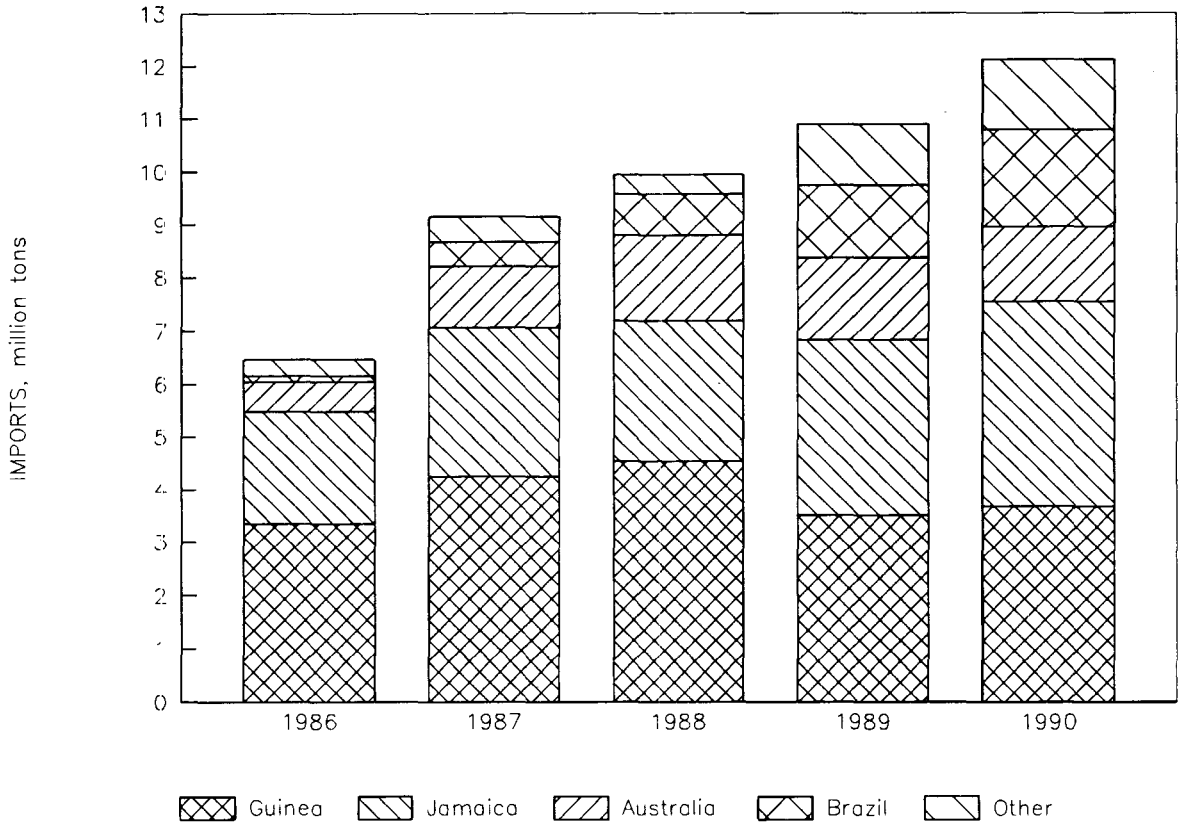

Figure 3.—United States bauxite imports.

Gold is also present in the alluvial diamond mine near Kissidougou, but operation of a pilot recovery plant at the mine did not prove economic. Only a few kilograms of gold were produced. Better accounting and control of both artisanal diamond and gold production would provide a stronger mineral resource base in Guinea and a clearer indication of the relative importance of the mining sector.

ECONOMIC GEOLOGY

Guinea is largely underlain by Precambrian granites and gneisses, dominantly of Archean age. In much of the western one-third of the country, these basement rocks are overlain by Paleozoic clastic sedimentary rocks that have been intruded in many places by Mesozoic diabase and ultramafic sills. Deep and prolonged weathering of the sediments and the mafic intrusives has led to the formation of the extensive bauxite deposits whose development has dominated the Guinean economy. In southeast Guinea, within Archean granite-gneiss terrane, are northeast- to north-trending Archean greenstone belts containing iron formations, including those in the Nimba Mountains in the south near the Liberian border. Numerous gold placer deposits are known in gravels derived from gold-bearing quartz veins and shear zones within the Precambrian rocks, particularly those in the Siguiri area near the Mali border. Diamondiferous kimberlites of Mesozoic age have intruded the Precambrian rocks in southeast Guinea; these have eroded to form placer diamond deposits of mainly high-quality gem diamond. See figure 4 for a generalized geological map of Guinea.

Bauxite

The bauxite deposits of Guinea are blanket-type deposits that characteristically occur at or near the surface of a plateau developed on alumina-silicate-bearing bedrock. These deposits are generally undisturbed flat-lying residual layers of variable thickness and extent. Guinean deposits are the result of prolonged weathering during a long period of stable geologic conditions in the late Tertiary and Pleistocene. Each deposit is also known locally as a plateau. They are grouped into six large regions (see figure 3), each of which include two or more deposits, and are as follows:

1. Boké region—comprising the Sangarédi, Bidikoum, N'Dangara, Dian, Aye-Koyé, Sinthiouriou, Ourorbé, Parawi, Tiangui, Dakalari, and Madina-I deposits.
2. Gaoual region—comprising the Koumbia and Paraou Tombé deposits.

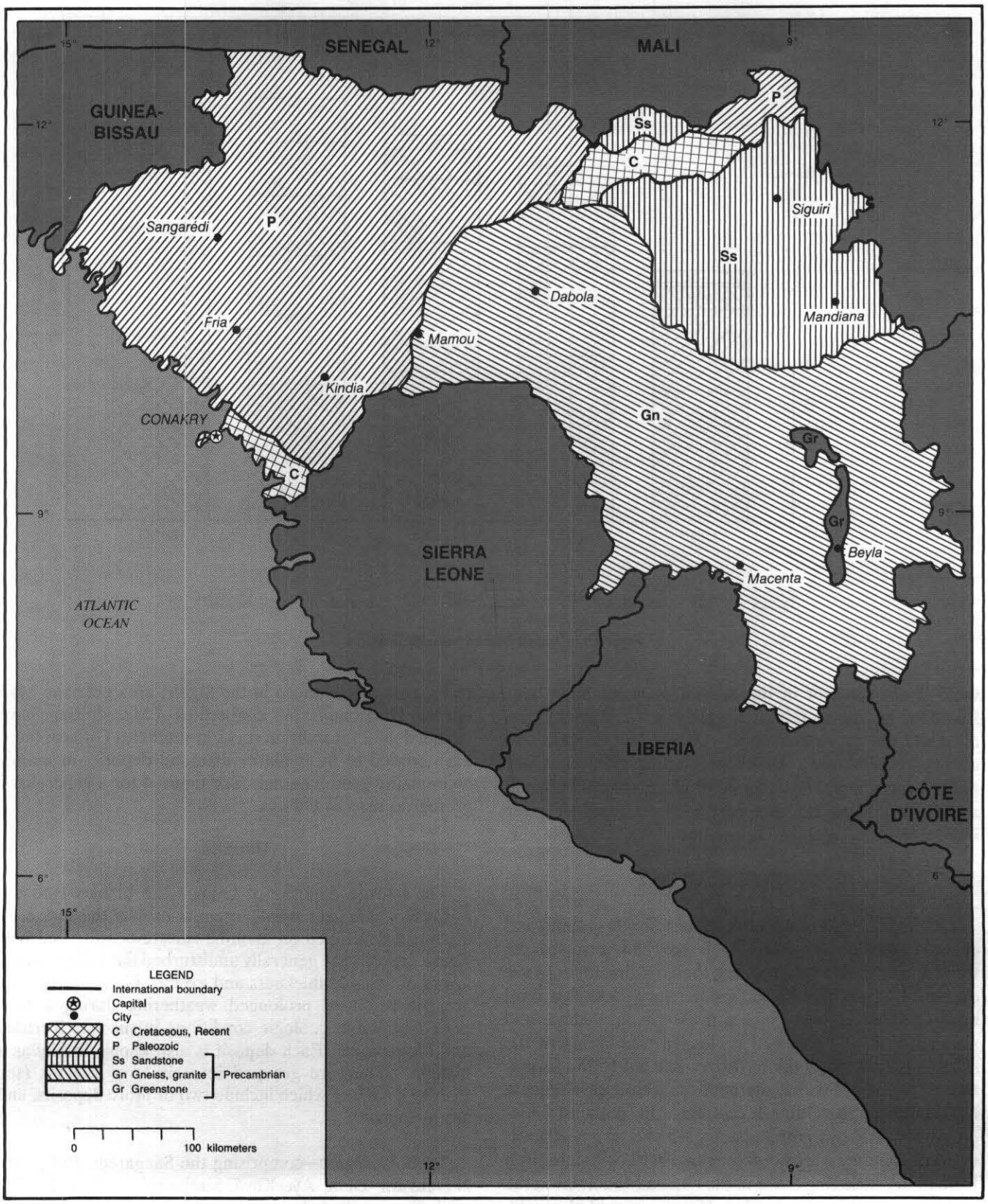

Figure 4.—Generalized geological map of Guinea.

3. Telimélé region—comprising the Fria, Sodioré, Boundou Lengué-Ouande, Sampiri, Manda, and Debélé deposits.

4. Labé region—comprising the Dognel-Sigon, Bantignel, Bougoume, and Bokira deposits.

5. Tougué region—comprising the Pontiolon and Tiankoun Guele deposits.

6. Dabola region—comprising the Tekoulou, Tekoulou Goral, and Leguetera deposits.

See figure 5 for the bauxite regions in Guinea.

A number of bauxite deposits are in various stages of development. Sangarédi, Fria, and Debélé are currently being mined. Some, such as Iles de Los, have been mined out. Others, such as Bidikoum, N'Dangara, Parawi, Dian, Sintiourou, and Sodiore, are under permit for mining. Almost all of them have been the subject of detailed studies. Among the most significant deposits are the following:

1. The Sangarédi and associated deposits rest on a series of horizontally bedded sandstones, siltstones, and shales of Devonian or younger age that are intruded extensively by diabase dikes and sills. Debate continues as to whether the parent rock of the bauxite was a sedimentary rock or its metamorphosed equivalent, a cordierite hornfels, or a basalt flow associated with the diabase intrusives. Primary ore minerals are gibbsite and boehmite. Other minerals include hematite, goethite, quartz, kaolinite, rutile, and anatase.

2. Debélé is a typical blanket-type residual deposit developed on a plateau. The bauxite bed is nearly 10 square kilometers in area and averages 6 to 8 meters thick, although locally its thickness varies from 3 to 12 meters. The parent rock underlying the deposit is a siliceous schist. Major ore minerals are gibbsite and boehmite, and the major gangue minerals include quartz, kaolinite, and hematite.

3. The bedrock in the Fria Mine consists of argillites, siltstones, sandstones, and shales of the Silurian Telimélé Formation. The sedimentary rocks are intruded by a Mesozoic diabase sill. Uplift of the area occurred during the Eocene, and peneplanation and laterization occurred during the Miocene. Bauxite is restricted to the upper horizon of the laterite mantle. Its thickness varies from 6 to 10 meters, averages 8 meters, and underlies about 40 centimeters of overburden. Gibbsite is the only ore mineral in these deposits. Gangue minerals include goethite, hematite, kaolinite, quartz, and ilmenite-anatase.

4. Three large bauxite deposits having similar characteristics have been identified in the vicinity of Dabola. In general, the top layer of these bauxite deposits is several meters thick and consists of large cemented bauxite blocks. An underlying layer is composed of smaller bauxite blocks. The bottom unit of the ore is a fine-grained bauxite with bauxitic gravels. The average thickness of the ore is about 8 meters. The principal ore mineral is gibbsite; boehmite composes only 11% of the total alumina content. Major gangue minerals are goethite, hematite, and quartz.

Gold

Gold placers associated with quartz veins and shear zones have been mined for decades in Guinea. The principal deposit type is a laterite-covered layer of unconsolidated alluvial gravel in the areas of Siguiri, Mandiana, and the Niandan-Banie Mountains. Gold is reported to occur in lower Paleozoic quartzite conglomerates and sandstones in near Forecariah and Koundara.

Gold has also been found in quartz veins in Birimian metavolcanic rocks at several locations in Guinea, including Fatoya and Banora. Precambrian rocks host vein mineralization in the Bassaris Mountains near Bantala southeast of Koundara, near Faranah, and also at Boudano, between Beyla and Nzérékoré. A stratiform gold-bearing veinlike structure, within a green, highly siliceous schist, is found in the Niandan-Banie Mountains near Kouroussa. The 1- to 3-meter-thick deposit grades 10 to 20 grams of gold per ton and may be up to 100 meters deep.

Diamond

During the late Cretaceous throughout much of west Africa, clusters of kimberlite pipes and dikes were intruded into the Precambrian granitic rocks, apparently along shear zones. They appear to be the primary source of most of the diamonds in west Africa. Two types of diamond deposits have been identified in Guinea, primary and alluvial. Primary diamond deposits are in kimberlite pipes, and alluvial diamond deposits are in stream gravels that extend from these kimberlites. The extensive alluvial diamond deposits in Guinea are a direct result of as much as 800 meters of vertical erosion of at least 30 kimberlites. Only deeper portions of the kimberlite intrusions remain. Six kimberlites clustered near Banankoro in the vicinity of Kerouané appear to be the source of Guinea's richest alluvial diamond deposits. The deposits are in the northward-draining Baoule and Bimboko River Valleys. Attempts at profitable mining of the primary deposits have been unsuccessful. The principal economic placer diamond deposits are in alluvial flats and terraces along the Baoule, Milo, and Diani Rivers of southeastern Guinea. The flood-plain of the swampy Baoule River and adjacent terrace deposits were the first to be mined. Gravels in

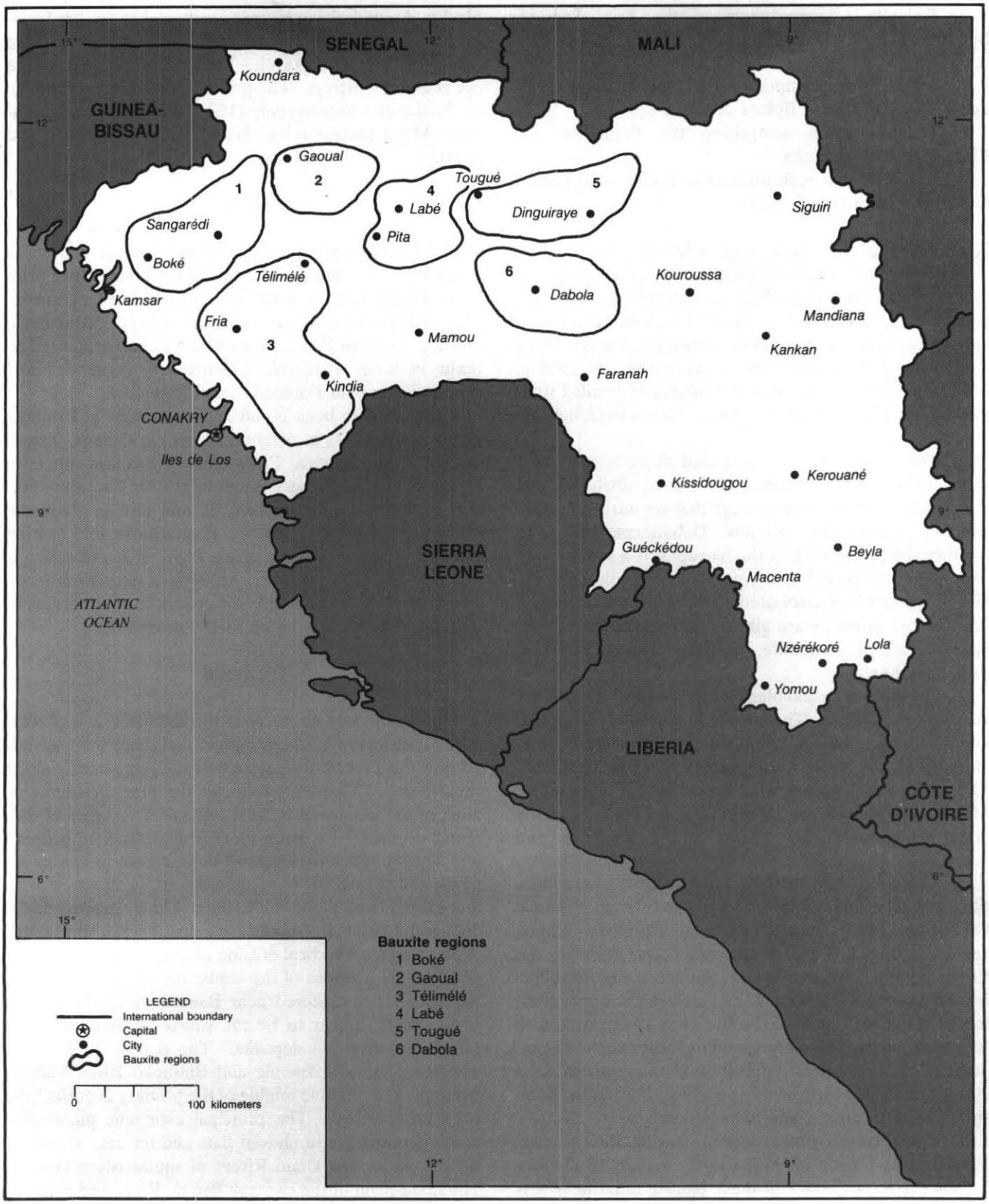

Figure 5.—Bauxite regions in Guinea.

these deposits contain diamonds, coarse pebbles, and subangular fragments of quartz with some granite and other rocks. Other materials in the matrix include quartz sand, silt, and clay. Flood-plain gravel units, usually less than 1 meter thick, are overlain by as much as 7 meters of sandy, clayey alluvium, while terrace gravels are covered by only about 3.5 meters of overburden. The gravels rest on saprolitized granite that has an undulating surface capped locally by residual hard boulders. The source of the gravels was the adjacent higher level terraces. The flood-plain gravels contain about two-thirds of the diamond reserves and provide 80% of current production at the country's single large producer. Diamonds have also been found in the Forecariah and Kindia-Telimélé regions, in the Mongo River basin between Mamou and Faranah, and associated with a fracture zone in the northernmost part of Guinea not far from the kimberlite pipes of western Mali.

Iron

Known iron resources in Guinea include the lateritized deposit near Conakry and Lake Superior or itabirite-type deposits in the Nimba and Simandou ranges near Liberia and in the Yamboieli district in the Forecariah region bordering Sierra Leone. The chromiferous iron ore of the Kaloum peninsula near Conakry is a lateritic weathered type of deposit developed on ultramafic rock. The deposit consists of an 8- to 10-meter-thick laterite crust covering an area of about 175 square kilometers and an underlying powdery, fine-grained laterite. The best known iron deposit in Guinea is the Pierre Richaud or Nimba deposit. Almost all of the Pierre Richaud hematite deposit in the Nimba range is in the core of a syncline having limbs of parent itabirite grading about 50% Fe. The mineralized part of the Pierre Richaud ridge is several kilometers long, but the main deposit is concentrated at the southern end. The deposit measures about 2,700 meters by 500 meters in plan view, and its central portion is at least 400 meters thick. The deposit grades into itabirite to the north. To the south, the mineralized zone grades into the separate Grand Rochers deposit. Numerous zones of soft to medium-hard waste itabirite intercalate the Pierre Richaud deposit, especially near the hanging wall. Intercalated waste is minimal in the central portion and minor near the footwall. The original host rock is a fine-grained, recrystallized, thinly banded itabirite with alternating beds of quartz and iron oxides of magnetite, hematite, and martite. Total iron content varies normally between 30% to 38%. Alumina and phosphorus contents are insignificant.

Two basic ore types are recognized in the Pierre Richaud deposit: blue and brown ores. Blue ore is primarily anhedral hematite, with minor martite and magnetite. Where the blue ore is of a very high grade, in excess of 68% Fe, total granular quartz and alumina plus loss-on-ignition are less than 3%. The phosphorus content is mainly the same as in the itabirite or about 0.033%. Brown ore is anhedral hematite with various amounts of goethite. The quartz content of brown ore is low, less than 2% at the surface, but increases gradually towards the itabirite contact. Loss-on-ignition is more than 2% because of the goethite content as well as the presence of iron silicates as intercalated laminae. The phosphorus content is higher than in the blue ore and may occasionally exceed 0.1%. The transition from high-grade ore into itabirite is locally across a narrow contact zone of siliceous rock that has noticeably visible quartz and an iron content of between 50% and 60%. Capping or crustal ore blankets most of the deposit typically to depths of 1-2 meters. This hard ore is characterized by higher alumina, phosphorus, and loss-on-ignition.

NONFUEL MINERALS

Bauxite and Alumina

Bauxite is the most important mineral resource in Guinea. According to the Government, the country has more than 20 billion tons proven and probable reserves. See table 4 for Guinea's proved and probable reserves of bauxite in the main bauxite regions.

Table 4.—Bauxite: Proved and probable reserves in the main bauxite regions

(Billion tons)

Regions	Reserves[1]	
	40% to 50% Al_2O_3	More than 50% Al_2O_3
Boké	5.33	1.50
Gaoual	7.40	.56
Telimélé	1.30	0
Labé	1.57	0
Tougué	1.81	0
Dabola	.64	0
Total	18.05	2.06

[1]Silica contents average 1.6% to 4.2%.

Source: Direction Nationale de la Geologie, Guinea.

Although the existence of bauxite in Guinea was known in the early 1900's, mining of bauxite started only after World War II. Since the early 1970's, the bauxite industry in Guinea has continued to expand. Guinea is currently the second largest producer after Australia. Alumina production in Guinea is very small, amounting to about 600,000 tons per year. The country has three bauxite producers and one alumina refinery.

Compagnie des Bauxites de Guinée (CBG)

CBG was the largest bauxite producer with 12.4 million tons in 1990, all of which was exported. The CBG operation is a joint venture with the Government of Guinea owning 49% and a consortium of North American and European companies, Halco Mining Inc., owning 51%. Halco consists of Aluminum Co. of America, 27%; ALCAN Aluminium Ltd. (Canada), 27%; Pechiney (France), 10%; Vereinigte Aluminium-Werke A.G. (Federal Republic of Germany), 10%; Commonwealth Aluminium Co. (Australia), 8%; Aluminia S.p.A. (Italy), 6%; Billiton International Metals B.V. (Netherlands), 6%; and Reynolds Metals Co. (United States), 6%. CBG was created in 1963 and started production in 1973 with an initial annual capacity of 9 million tons per year. CBG operates the Sangarédi Mine, which is the country's largest mining facility. The deposit covers an area of 7 square kilometers, is 40 meters thick, and had 250 million tons of proven reserves when mining commenced in 1973. It is also the richest single bauxite deposit in the world, averaging 60% Al_2O_3 and 1% SiO_2.

Sangarédi is 242 kilometers north of Conakry and 86 kilometers northeast of the Boké district on a plateau about 300 meters above sea level. CBG also has access to other deposits such as N'Dangara, Boundou Ouande, and Bidikoum. Bidikoum is scheduled to go into production in 1993. Because of the location and configuration of the ore body, the Sangarédi deposit is mined by open pit and track mining methods. The ore is blasted from 12-meter-high benches, and loaded by 9-cubic-yard-capacity electric shovels into 75-ton railroad cars that run on temporary track parallel to the mine face. A 20-to-25-car train is hauled to the switchyard where a 95- to 100-car train is assembled for the 135-kilometer trip to Kamsar. Kamsar's facilities cover 150 acres and provide for unloading, crushing, drying, calcining, stockpiling, and shipping of bauxite. See figure 6 for exposure of bauxite at the Sangarédi Mine.

Five trains arrive at the Kamsar plant daily, and dump their bauxite into two large hoppers. Bauxite from the hoppers moves along a traveling apron feeder to a 1,000-ton-per-hour hammer mill. The combined 2,000-ton-per-hour output of minus-4-inch material is conveyed to a 700,000-ton-capacity open stockpile. Bauxite from stockpiles or crushers is conveyed to dryers through three 200-ton-capacity transfer hoppers at rates of 450 to 650 tons per hour. The initial moisture content of the bauxite of between 8% and 15% is reduced to 6%. Alongside the dryers, a rotary kiln, 100 meters long and 3 meters in diameter, is used to calcine a separate bauxite feed. The maximum TiO_2 content permitted for bauxite feed for calcining is 3.1%. Dried bauxite is conveyed to a 130,000-ton-capacity covered storage building where it is reclaimed with a 4,250-ton-per-hour rail-mounted bucket wheel. Before loading into 50,000-deadweight-ton ships, quality control sampling of the dried bauxite is done between the plant and the dock. Shipments to members of the Halco Group are based on 5-year contracts, which specify a minimum amount to be delivered over a specified timeframe.

Production of metallurgical-grade bauxite has increased from 5.51 million tons in 1975 to 12.4 million tons in 1990. Shipment in 1990 was 10.9 million tons with a value of $364 million. The company finalized plans in 1989 for bringing the nearby Bidikoum deposit on-stream in 1993. Bidikoum will be worked simultaneously with Sangarédi, which will delay the exhaustion of the latter's high-grade 62% alumina ore. The Bidikoum ore averages about 55% alumina and has a higher iron and titanium content than the ore at Sangarédi.

Office des Bauxites de Kindia (OBK)

The second largest bauxite producer in Guinea is OBK, with output of about 3 million tons per year. OBK is a 100% state-owned enterprise and is a recipient of Soviet technical assistance. The former U.S.S.R. is heavily dependent upon bauxite imports. In November 1969, an agreement was signed between Guinea and the former U.S.S.R. to exploit the Debélé bauxite deposit at Kindia. Debélé is 75 kilometers northwest of Conakry and 550 meters above sea level. The installed capacity of the mine was to be 2.5 million tons of bauxite per year for sale to the U.S.S.R.

The former U.S.S.R. financed and built the mine, railroad, port terminal, and related infrastructure and provides technical assistance in the operation of the mine. The Government continues to repay the loan by delivering bauxite and by making additional shipments under a fixed-price contract to the Nicolayev plant near Odessa in the former U.S.S.R. (the Ukraine as of December 1991) to produce alumina. The alumina is shipped to Tursunzade in Tajiskistan by rail for smelting. Sales amounting to 10% of production are made on the open market whenever possible. Construction of the open pit mine and plant facilities began in 1972, and the first shipment of bauxite was made in late 1975. Debélé bauxite mineralization is gibbsite, a trihydrate of alumina. In the mining process, a thin covering of laterite, soil, and root material is scraped away by an electric shovel to expose the bauxite. Many large boulders produced by blasting need to be drilled for secondary blasting.

Transport from the open pit to a 160-cubic-meter bin at the crusher is by truck. The bauxite is crushed and screened in a two-stage process by hammer and jaw crushers to get a minus-60-millimeter product. There are two identical, parallel crusher lines, each having a capacity of 400 tons per hour. At the crusher, mixing of ore is done

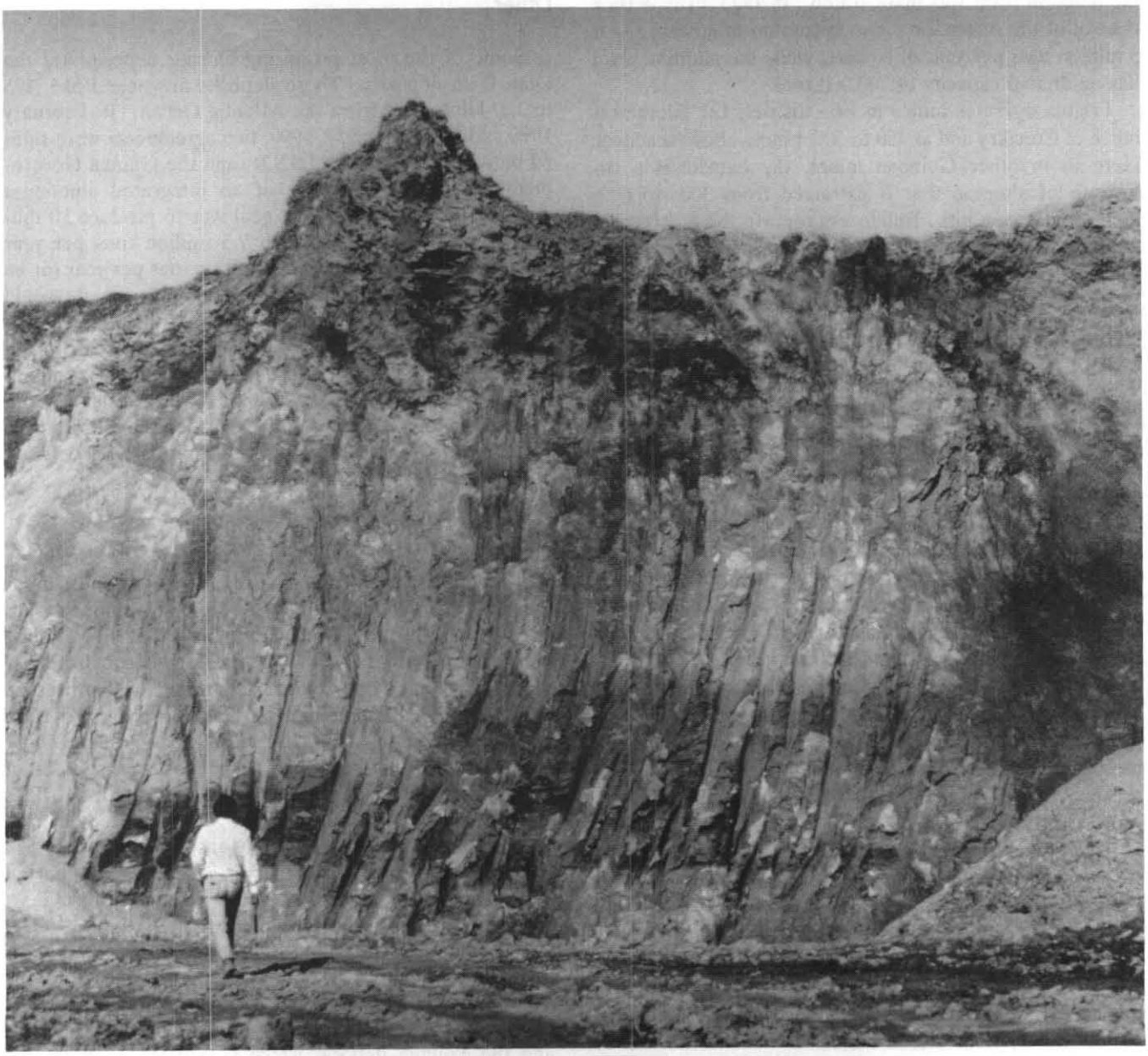

Figure 6.—Exposure of bauxite deposit at the Sangarèdi Mine.

from several pits to maintain required contract quality. Transport of the final bauxite product is to OBK's port facility in Conakry. At the port, the ore is stockpiled or loaded directly into ships by conveyor belts. Each month, 12 ships, each of 20,000-30,000-deadweight-ton capacity, load bauxite for shipment.

From 1975 to 1990, production increased from 2.2 million tons to 3.2 million tons of bauxite. Ninety percent of the OBK's bauxite production was sold to the former U.S.S.R. as wet ore. Of these sales, 56% is for debt repayment, and 44% is for financing goods imported from that country.

Société d'Economie Mixte Friguia (Friguia)

Friguia produces about 2 million tons per year of bauxite, which is processed on-site to alumina for export. Friguia is a joint venture between the Government and FRIALCO Holding Co., each holding 49% and 51%, respectively. FRIALCO is a consortium of North American and European companies consisting of Noranda Minerals, Inc. (Canada), 30%; Pechiney (France), 30%; British ALCAN Aluminium (Canada), 20%; and Norsk Hydro Aluminium (Norway), 20%. Construction at the site was begun in 1957 by a private company, and, in April 1969,

the alumina plant was inaugurated. In 1973, Friguia took control of the operation. The maximum mine capacity is 3 million tons per year of bauxite, while the alumina plant has an annual capacity of 700,000 tons.

Friguia operates mines in Fria district, 121 kilometers north of Conakry and at 250 to 500 meters above sea level. Here as in other Guinean mines, the bauxite is a trihydrate of alumina that is extracted from 300- to 600-meter-wide open pits. Bulldozers remove the overburden 2 years in advance to allow natural rain leaching of the silica from the deposit. Sampling of the bauxite is done systematically on blocks 25 meters square. Blasting is done with a nitrate-fuel oil mixture. Broken rock from the 8- to 10-meter-high face is loaded by front-end loader trucks and transported to the alumina plant, which is within 10 kilometers of the open pits. The plant comprises two alumina production units, each of which includes a complete range of production facilities extending from bauxite crushing to the hydrated alumina calcination stage. Ore is crushed to minus 0.4 centimeters by a rotary crusher followed by a secondary hammer crusher. Standard Bayer digestion technology is used except for a patented Pechiney extraction process for separating fine alumina from solution. There is also preheating of alumina before the calcination stage that saves fuel. An oil-fired powerplant produces steam and electricity for alumina manufacture and the company's housing estate. A plant purifies Konkoure River water for industrial and domestic use. Alumina is stored in a 6,000-ton-capacity silo for subsequent shipment on a 145-kilometer, 1-meter gauge railway to Conakry.

The alumina wharves at Conakry cover an area of 90,000 square meters that was entirely reclaimed from the sea with 650,000 cubic meters of fill. Ships up to 24,000 deadweight tons can berth at two stations, 150 and 200 meters long, respectively. Alumina-bearing railcars are automatically unloaded into a hopper from which alumina is conveyed to three 17,000-ton-capacity silos and one 20,000-ton-capacity silo. Alumina is then transferred by two gantries moving along the length of the wharf to the ships. In 1970, loading capacity was increased from 480,000 tons per year to 700,000 tons per year. Full capacity was nearly reached in 1980. However, from that time, the product was changed from "European" quality, a heavily calcined, floury product, to "American" quality, a sandier product. This resulted in a capacity decrease to 620,000 tons per year. Currently, the alumina plant's capacity is 700,000 tons per year, but, because of the depressed market, only 542,100 tons was produced in 1987, the lowest output recorded by the company. Bauxite production in 1990 was 2,183,000 tons. In 1989, alumina production began to increase again and, in 1990, was 642,100 tons for hydrate and 631,200 for calcined alumina.

Other

Some of the most promising bauxite deposits are the Dian Dian deposits. These deposits are near Boké, 125 to 150 kilometers from the Atlantic Ocean. In February 1990 and on October 17, 1990, two agreements were signed between the former U.S.S.R. and the Guinea Government for the development of an integrated aluminum complex in Dian Dian. The goal was to produce 10 million tons of bauxite, of which 7.5 million tons per year would be for shipment and 2.5 million tons per year for an alumina plant to be built. The alumina refinery would have a capacity of 800,000 to 1 million tons of sandy alumina. The agreement also included the construction of an aluminum smelter of 150,000 tons per year. A detailed study is underway aimed at increasing reserves from 225 million to 500 million tons. Work on the initial stages of the study were nearing completion in early 1991.

Reserves

According to the Direction Nationale de Geologie, proved and probable reserves of bauxite are about 20 billion tons. These include about 18 billion tons of ore grading 40% to 50% Al_2O_3 and 2 billion tons of ore grading more than 50% Al_2O_3. These data include bauxite deposits which may be economically mined and processed domestically to alumina for export. CBG's proven reserves at Bidikoum were about 20 million tons grading about 55% alumina. There are large additional resources of lower grade material in the Bidikoum area. OBK's reserves at the Debélé deposit are reported by the company to be about 28 million tons grading about 45% to 46% alumina. Friguia's reserves, all classes, as reported by the company, exceeded 200 million tons grading at least 40% alumina. Other explored bauxite deposits in Guinea include the Aye-Koye deposit 30 kilometers northwest of Sangarédi, which has resources of about 195 million tons grading about 50% alumina; the Dabola deposit with a resource of about 450 million tons grading 42% alumina; and the Tougué deposit, which is believed to contain a resource in excess of 1 billion tons grading about 41% alumina. The Dabola deposit is near the Conakry-Kankan railroad, but this line is not in condition to handle ore shipments.

Diamond

Output by Aredor-Guinea S.A., the country's only large producer is noted for its high proportion of gem-quality diamond, 93%, and its occasional very large stones of extraordinary quality and value. Diamond was first found in Guinea in 1932 in the Makona River near Macenta. Production began in 1934, with about 66% of output being

of industrial quality. In 1959, more stones of gem quality were found in new alluvial fields, and output rose to 643,000 carats. Three foreign companies mined diamond in Guinea between 1936 and 1960. Artisanal diamond mining was legalized in 1956, and production between 1956 and 1959 was estimated at 515,000 carats in areas where companies held no concessions. However, a group of private Guineans formed Beyla-Kissidougou-Macenta (Pty.) Ltd. (BEKIMA) and produced 1,285,000 carats from 1956 to 1960. In 1961, after Guinea's Independence, diamond mining by foreign companies was banned. Between 1961 and 1973, L'Enterprise Guinéenne d'Exploitation de Diamant produced 214,314 carats, and, from 1980 to 1986, the Service National d'Exploitation de Diamant produced 104,620 carats. There are no records of any production from 1974 to 1979. In 1984, all diamond production by private individuals was banned also. Production is now by a single company, Société Mixte Aredor-Guinée S.A. (Aredor-Guinea S.A.).

Aredor-Guinea S.A.

Aredor is an acronym for Association Pour la Recherche et l'Exploitation du Diamants et de l'Or. Its interests are intertwined with a number of individuals or companies involved in diamond development. In 1978, Simonius, Vischer, and Co. (SV), a Swiss commodity trading firm, and Industrial Diamond Co. Ltd. (IDC), a privately owned company of traders of rough diamonds, agreed with the Government to explore for diamonds. The lease area was over a potential diamondiferous region of 27,000 square kilometers in southwestern Guinea near the Sierra Leone border. Bridge Oil Co. of Australia later joined SV, IDC, and several banks to form Aredor Holdings Ltd. as part of a 50-50 joint venture with the Government that was called Aredor-Guinea S.A. Aredor Holdings Ltd.'s current ownership is Bridge Oil Ltd. 79.2%; Bankers Trust Australia Ltd. (United Kingdom), 3.52%; Industrial Diamond Co. Ltd. (Holdings, United Kingdom), 6%; and the International Finance Corp., 11.28%. Bridge Oil's subsidiary, Bridge Oil Services (Australia), was to provide management and technical assistance.

Aredor-Guinea is mining the Gbenko alluvial deposits on the Baoule River, about 100 kilometers southeast of Kissidougou, 750 meters above sea level. The designed capacity of the Aredor Mine is 500,000 carats. The mining method used at Aredor is conventional strip mining. In this method, a sump is excavated at the downhill end of the area to be mined to initiate drainage. Dewatering pumps are installed to discharge water into the most appropriate downstream watercourse. Mining is done with a 7-cubic-yard tracked dragline in discrete 18-meter by 12-meter sections at a rate of six sections per 24-hour period. Overburden is stripped, and gravel is moved to a 200-cubic-meter pile near the dragline to allow drainage before loading onto trucks for transport to the plant. Mined material for processing averages 5 centimeters of overburden, 60 centimeters of gravel, and 15 centimeters of decomposed bedrock. This material is moved to the central recovery plant on the left bank of the Baoule River where it is washed and sieved at a rate of 35 tons per hour, nearly 100% of design capacity. Large boulders are removed by grizzlies, and the material passed is fed to washers and screened to produce a plus 2- minus 25-millimeter diamondiferous fraction for heavy-media separation and a plus 25- minus 60-millimeter fraction that passes directly to the final recovery building for separation of large diamonds. The finer fraction is mixed with a heavy medium of water, ferrosilicon, and magnetite to form a slurry with a specific gravity of 2.55, which is passed through a cyclone where heavy and light minerals are separated. The heavy-media separation plant receives 1,200 tons per day of primary feed from the two washing plants and produces about 6 cubic meters per day of concentrate. Washing of the heavy fraction removes the heavy medium at a rate of 60 tons per hour. The heavy medium is reclaimed while the heavy gravel is screened and conveyed to the final recovery building where the diamonds are extracted from the gravel. Consumption of the heavy medium is at a rate of 1,514 liters per ton.

At the final stage of mechanical diamond recovery, diamondiferous concentrate is fed into Sortex X-ray separators where it is passed by gravity through an X-ray beam. Fluorescence by the irradiated diamonds activates a rapid-response jet of compressed air that blows the diamonds with some waste into a separate collecting hopper. The nonfluorescent material drops into a waste bin. Final sorting is done by handpicking. Additional sorting is accomplished on grease tables.

Annual mine production at Aredor mine increased from 47,168 carats in 1984 to 147,000 carats in 1989, but declined to 127,200 carats in 1990. Large, 60- to 200-carat diamonds have been found also on occasion and have been valued at several million dollars. Sales in 1989 averaged $282 per carat. If stones exceeding 100 carats mass were included, the average sales price would be $345 per carat. Despite the quality of these stones and the revenue gained, Aredor is a high-cost mining operation, and a loss was declared in 1989 despite the increase in revenue. The extension of mining upstream closer to the kimberite source was due to the winning of two lease extensions. The extension has not helped the company's performance.

Reserves

Diamond deposits are located in the Kerouané, Beyla, Macenta, Guéckédou, and Kissidougou districts. The grade of the placers in these areas ranges from 0.12 to 2 carats per cubic meter. Total diamond reserves are estimated to be between 25 to 30 million carats, of which gem quality is estimated to be 45% to 60%. Aredor's reserves are about 2.1 million carats.

Gold

Gold has been mined in Guinea for many years from a laterite covered layer of unconsolidated alluvial gravel in the vicinity of Siguiri, Banora, near Mandiana on the Sankarani River, the Niandan-Banie Mountains, and Totaba. Until recently, mining of gold has been done on an artisanal basis by private Guineans on a very small scale. However, 9 tons of gold production was reported in the Boure region alone before French interests arrived in 1900. Between 1900 and 1958, 70 tons of gold were produced by private French companies. After independence in 1958, production from small-scale mining and the quantity of gold smuggled out of the country became unknown factors. In 1986, small-scale artisanal mining of gold was legalized, and private citizens were allowed to buy, own, and sell gold. Sales of gold produced by private Guineans to the Guinean Central Bank rose from 864 kilograms in 1987 to 2,298 kilograms in the first semester of 1990. Perhaps as much as 2 tons of gold are produced annually from artisanal mines. A large-scale gold mining operation commenced in 1988 at Koron.

Auriferè de Guinée (AuG)

AuG is operated by Chevaning Mining and Exploration Co., 51%, and the Government, 49%. Chevaning is a joint venture of Union Miniere S.A. of Belgium, 50.1%, and Pancontinental Mining Ltd. of Australia, 49.9%. AuG is mining gold at Koron, 25 kilometers northeast of Siguiri. The ore is mined from a 2-meter-thick gravel zone extending 12 kilometers and covered by 2 meters of overburden. See figure 7 for heavy-mineral test sample for diamonds at the Aredor Mine. The installed mine capacity is 2 tons of gold per year, with the potential to increase to 3 tons per year using a mobile process plant to reduce ore haulage. Amalgamation is used to recover the gold from the processed gravel. The gold is poured at the mine sites, and the ingots formed contain 95% to 97% Au and weigh 14 to 28 kilograms. The first bullion was poured in July 1988. Output is flown to Conakry, then sold in Europe for further refining. Annual production increased

Figure 7.—Heavy-mineral test sample for diamonds at the Aredor Mine.

from 1,202 kilograms in 1989 to 1,745 kilograms in 1990, valued at $19.5 million. In 1989, AuG experienced a 40% reduction in planned recovery owing to the presence of excess clay in the gravels. During an 8-month period, AuG sought to regain gold recovery and to reduce clay discharge to the Niger River by constructing a water impoundment basin. A flocculation system to reduce clay discharge to the Niger River was planned. The clay problem forced AuG to shift gravel transport from conveyor belts to truck haulage, and, as a consequence, AuG recorded a deficit of $7.2 million for the year owing to the redesigned plant and haulage scheme.

Reserves

Total gold reserves reported by the Government were 140 tons in the following five regions:

1. Siguiri—Mandiana-Dinguiraye-Kouroussa.
2. Nzérékoré (Gama)—Yomou (Kerana).
3. Mamou—Faranah Region along the Kaba and Mongo Rivers.
4. Kindia Region along the Menyenkene and Kibessa Rivers.
5. Labé, Koundara, and Gaoual.

See figure 8 for gold regions in Guinea.

Iron Ore

Guinea's iron ore deposits are potentially among the most important worldwide. The geological resources are more than 9.4 billion tons, with 350 million tons of proven reserves at Nimba in southeast Guinea grading 66.5% iron. From the early 20th century, iron deposits were known in Guinea, but production only began in 1952 by the Compagnie Miniere de Conakry (CMC). CMC operated a mine in Conakry from 1952 to 1966 with an annual production of about 700,000 tons.

Société Miniere de Fer de Guinée (Mifergui)

In 1973, multiple efforts to develop the iron ore deposit at Mount Nimba in southern Guinea began to coalesce by the formation of a partnership consisting of the Government of Guinea, other foreign governments, and private companies. Planned production capacity was 15 million tons annually. However, a number of changes in partnership and modifications to the planned development owing to limited infrastructure have occurred. An agreement signed in December 1989 between the Governments of Guinea and Liberia, the newly created African Mining Consortium Ltd. (AMCL) of Liberia, and BRGM set up the Nimba International Corp. (NIMCO). NIMCO sought external financing for the development costs of Mount Nimba, which were estimated at $200 million. NIMCO's shares were held in three shareholder classes. Mifergui formed class A and provided the mining rights to the deposit. The class B partner was the Liberian Mining Corp. (LIMINCO), owned by the Government of Liberia. LIMINCO had control of Liberia's railroad and port infrastructure. Initially, the class C partners were to be BRGM and AMCL, which were to provide some funds and the operating, shipping, and marketing expertise. BRGM and AMCL were also to bring in new investment partners. Development of the project relied heavily upon the availability and improvement of transport service through Liberia for ore shipment from the Port of Buchanan.

An interim or bridging project in Liberia was necessary to keep the infrastructure in that country from deteriorating further. This was in anticipation of participation in the successful startup of the Mount Nimba iron ore project across the border in Guinea. This bridging project involved the mining of the Yekepa deposit in Liberia for 3 years and the development of the Nimba Mine and infrastructure. The project experienced difficulties owing to the insurgency in Liberia. However, both partners expected to overcome obstacles as soon as stability was restored in Liberia.

Reserves

According to the Ministry of Natural Resources and the Environment, Guinea has about 9.4 billion tons of iron ore resources that are distributed as follows:

1. Kaloum deposits (Conakry district), 6 billion tons.
2. Forécariah region: Yamboieli district, 4.5 million tons, and Forécariah district, 400 million tons.
3. Simandou region, 2 billion tons.
4. Nimba region, 1 billion tons, of which 350 million are proven reserves.

A 1977 feasibility study by Kaiser Engineering of the Pierre Richaud deposit at Mount Nimba originally reported 315 million tons of iron ore reserve grading 66.5% Fe.

Other Nonfuel Minerals

The presence of Archean terrane in the country similar to that found in the Côte d'Ivoire containing nickel sulfides has lead to speculation about the existence of similar mineralization in Guinea. The Guinean Government

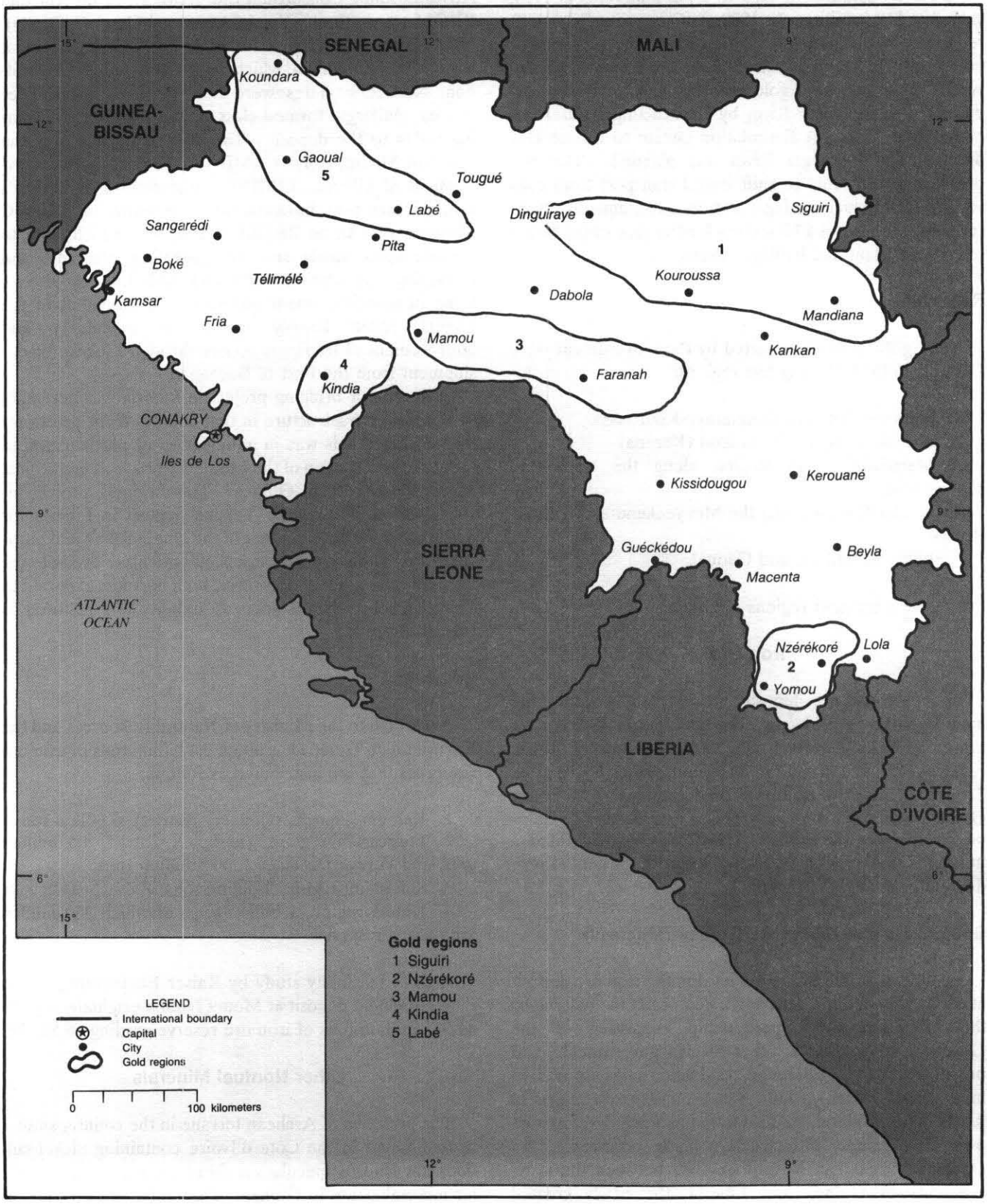

Figure 8.—Gold regions in Guinea.

estimated nickel resources in an ultramafic sequence in the Labé region at 185,000 tons nickel contained in rock grading between 0.7% and 0.9% nickel. Signs of nickel, cobalt, and copper are also known in the Coyah, Dubreka, and Kissidougou regions. Also reported were titanium resources in black sand in the Boké-Boffa regions. Alluvial black sands are being mined for rutile at Sherbro, Sierra Leone.

Uranium exploration has been underway since 1961 in Guinea by several foreign government surveys and private companies. Two anomalous zones were identified by Geosurvey International, which commenced an aerial geophysical and photographic reconnaissance in 1979 for Guinea. These zones were found at Firawa in Kissidougou region and Damara in Kerouané and Beyla regions. In 1982, a company consisting of Guinean, American, Moroccan, and Nigerian shareholders, called Uranium Sud East (Pty.) Ltd., was created. However, this company did not reach the production stage because of falling uranium prices and problems between Guinea and Geosurvey International. Potential uranium deposits are believed by BRGM to be in both the Archean and lower Proterozoic metamorphic rocks and upper Proterozoic metasedimentary rocks of Guinea.

Commercial-quality grey granite is mined at Maferinyah, about 45 kilometers south of Conakry. Output is by Maurice Delens Co. of Belgium and Société d'Application Mecano-Granite of France (Sigmar). Other participants are the Government, 20%, private Guineans, 20%, and the International Finance Corp., 9%. Reserves were reported to be 40 million cubic meters.

Guinea imports cement clinker for production of cement at a single plant near Conakry. The clinker grinding plant is operated by Société d'Economie Mixte Guineo-Arabe. Capacity is 250,000 tons per year.

MINERAL FUELS

There is no production of crude petroleum or natural gas in Guinea. A joint venture between the Government's Société Guinéenne des Hydrocarbures and Union Texas Petroleum Corp. in 1980 to explore for oil and gas was terminated in 1986. No drilling occurred during this period. The only discoveries of hydrocarbons in Guinea were flows of wet gas from Silurian shales in two shallow holes drilled for engineering purposes 100 kilometers north-northeast of Conakry. However, crude petroleum and natural gas reservoirs are known in Guinea-Bissau and Senegal. Geologic data has indicated the potential for offshore reservoirs, but these have yet to be confirmed.

FACTORS IN MINERAL INDUSTRY DEVELOPMENT

MINING LAW

The Mining Law, No. 076/PRG of March 1986 and as amended by Order Nos. 10236-10245, states that the state is the sole owner of the territory over which its sovereignty extends and all natural resources located within it. A permit is required to conduct prospecting activity or to operate a mine. The Ministry of Natural Resources issues prospector permits and operating permits on the recommendation of the National Director of Mines. A concession is awarded according to an ordinance or a decree. A prospecting permit allows prospecting activity for specified substances within authorized boundaries. Such activity is to be completed during a specified minimum work program with a required minimum financial outlay. The area may not exceed 25 square kilometers where geological surveys are available on a scale of at least 1:200,000 or 2,000 square kilometers in other areas. Prospecting permit applications are evaluated on the basis of the technical capabilities of the applicant as well as the commitments made by the applicant regarding work to be accomplished and expenses to be incurred. The permit has a duration of 2 years and is renewable twice. The prospecting permit for a quarry covers an area of 10 hectares and is also valid for 2 years, but is nonrenewable.

An operating permit allows the holder to engage, within a specified area, in all activities related to prospecting for and exploiting deposits of the mineral substances for which the permit was issued. The surface area may not exceed 25 square kilometers. The holder of a prospecting permit may receive an operating permit when he demonstrates the existence of an exploitable deposit within the area defined in the prospecting permit. The operating permit is valid for 10 years and is renewable every 5 years. The operating permit for a quarry is valid for 2 years and is renewable several times.

A concession grants exclusive rights to the holder to engage, within authorized boundaries, in all activities related to prospecting for and exploiting deposits of specified substances. Concessions shall only be granted to a company, as defined by Guinean law, or a group of companies acting together and only in the event of the discovery of a deposit for which exploitation requires substantial input of financing and effort. When a deposit is found, the state has the option to take a share in the company. In previous participation agreements, the Government has taken 49%.

All expenses in the prospecting stage are the responsibility of the holder of the permit. If the Government decides to participate in a mining operation, a mining agreement is drawn up according to the Mining Law and the investment requirements.

TAXATION

The actual tax system in Guinea's mining sector is closely related to the state's participation in mining operations. However, the mining law provides for different types of taxes and duties. Fixed duties are collected at the time of issue, renewal, or changing ownership of a title. An annual land use tax of 5,000 to 15,000 Guinean francs is imposed, depending on the location of the area and its proximity or remoteness to existing infrastructure. The corporate tax is 65% and includes a 30% tax on profits and a 35% tax on dividends. Import taxes are 5.6%. Ad valorem taxes for industrial minerals are 6% of the revenue. Duties and export taxes on minerals are 10% for precious stones and a cumulative rate of 4% for other minerals. A special export tax on minerals also applies according to the type of mineral exported. In addition, each company is required to create a land reclamation fund to be used for site rehabilitation upon termination of operations. A tax exemption is applicable to companies during the research and exploration stage for a period of 2 to 6 years and in the construction stage for a period of 2 to 3 years. Mining policy by the Government of Guinea is currently under review by the Ministry of Natural Resources and Environment, and this review is expected to lead to some changes in the mining law.

INVESTMENT LAW

The Investment Law, Investment Code No. 001/PRG/87 of January 1987, defines the status of foreign enterprises established in Guinea and describes guarantees and benefits offered to the investor who files an application with the National Investment Commission (NIC). A key provision of the law is that participation by the Government is compulsory in certain sectors, including mining.

The law guarantees freedom to all investors to import goods and equipment and to export their production, to set and implement their own operating and employment policies, to choose clients and suppliers and establish prices, and to compete freely with private and parastatal enterprises alike. Freedom of transfer is granted to all persons who have invested capital in Guinea. This freedom applies to capital from abroad, to lawfully earned profits, to the proceeds of the sale of the investment, and to the compensation paid in the event of expropriation or nationalization. Freedom from expropriation is guaranteed, except in cases where the Government cites compelling reasons for the public welfare. There is a provision for fair compensation based on international standards in the event that expropriation is required in the public interest. The rights of ownership of movables and immovables and of the legal exercise of economic activities are guaranteed to all enterprises without discrimination between foreign nationals or between foreign nationals and Guinean citizens. Similarly, equality of tax treatment with Guinean nationals and corporations is guaranteed. The law guarantees equal trademark, copyright, and patent protection and equal access to the courts.

Capital goods may be imported duty free for a project during the development phase of the project and within 2 years from the date of approval by the NIC. Income tax deductions are allowed for 3 years from project startup. These deductions are equivalent to three times the monthly minimum wage times the number of Guineans employed. Further income tax deductions are allowed for years 4 and 5 and are equal to 50% of this amount. During the first 5 years, the project is exempt from apprenticeship and payroll taxes, and the latter are reduced to 50% for the following 3 years.

Special incentives are available for several categories of enterprises. Some are based on location of the enterprise. For example, for projects planned outside Conakry, complete freedom from income taxes is allowed for 5 years from startup, and a 33% reduction in the turnover tax is allowed for 5 years from startup. For small and medium enterprises, exemption from the mandatory minimum flat rate tax is permitted for 10 years. For exporters, exemption from income taxes is permitted for a period of 5 years from startup. This exemption is equivalent to the percentage of net income, which is the percentage difference between export sales and local sales up to a maximum of 60% of net income. For users of local resources, deduction from net income is permitted for 20% of the value of local inputs, labor not included, for a period of 5 years from startup.

Applications for benefits under one of the categories just described must be submitted to the Secretariat of the NIC with a cover letter stating the category applied for and summarizing its content. The application is deemed complete if the applicant receives no comment from the NIC within 30 days. Information required in the application includes the following:

1. A technical description of facilities, equipment, processes, and goods or services to be produced.
2. The availability and cost of local and imported inputs.

3. An estimate of capital costs and working capital requirements with currency breakdown and timing of disbursements.
4. Financial projections for 5 years, including production and sales, fixed and variable production costs, loan amortization schedules, and a complete cash-flow statement.
5. Employment and salary structure, with specific reference to Guinean management personnel and training programs.
6. A statement of actual or intended legal and ownership structure.

In addition to the aforementioned application requirements, NIC-approved enterprises must submit the following information to its Secretariat annually: audited accounts, a list of employees by category and salary, a list of equipment in use and accumulated depreciation, and information showing continued compliance with category eligibility conditions.

LABOR

The formal mining sector employs an estimated 8,500 workers out of a total formal labor force of about 2.6 million. The remainder of the labor force is primarily in agriculture. Nearly 75% of mining industry labor is employed in the production and transport of bauxite and alumina. The remainder are employed in the production of diamonds and gold. Each Guinean miner is estimated to provide support for 11 people. The Government has helped reduce the number of artisanal workers illegally exploiting mining concessions held by the major producing companies. However, full-time artisanal workers throughout Guinea may number 15,000 to 20,000, with most of their production unreported.

Expatriates make up a very small percentage of the mining sector's work force. Expatriate labor at Friguia is about 1% of the total, at CBG about 2.5%, and at Aredor about 5%. Mining companies follow Government policy, which is to replace expatriates wherever possible with trained local labor.

The Labor Code sets forth requirements for employers in the mining sector regarding formal employment. Guidelines are provided for wages, holidays, and work schedules. However, the code is less clear regarding an employer's rights concerning hiring and dismissal policies. The Government retains the right to approve hiring and dismissals of Guinean staff by mining enterprises. Generally, companies have maintained excess labor which they might otherwise dismiss, preventing full operational effectiveness of the enterprise. Employers must also follow overtime pay and vacation and maternity-sick leave guidelines. Considerable technical skills are required for establishing and maintaining mining enterprises, usually in demanding physical environments. Issues that impact negatively upon the availability of qualified technical personnel, including the timing of their appointment, will most likely be a disruptive factor in timely and cost-effective completion of a mining project.

INFRASTRUCTURE

Much of the history of the development of Africa to this day is linked to infrastructure development, specifically transportation, serving the mining industry. This is especially true for Guinea. Excluding three relatively short railroads of varying gauge dedicated to active mining enterprises, transport to the interior is virtually nil, and road density is among the lowest in Africa. State administration in the transport sector is also divided among various agencies. While the Ministry of Transport and Public Works has overall administrative responsibility of the transport sector, the Ministry of Agriculture and Animal Resources has de facto responsibility for the rural tertiary road system. Large hydroelectric energy potential belies the modest existing hydroelectric and thermal power facilities that provide electricity only for current industrial operations. Perhaps the single most important aspect to sustained development in Guinea is the maintenance of existing operational infrastructure, as well as of any planned new road, railroad, or powerplant construction.

Energy

An estimated 85% of total energy consumed in Guinea is derived from wood, either as direct fuel or processed to charcoal. Only about 2% of the population is estimated to have access to electrical energy supplied by the Société Nationale d'Electricité, the state electrical utility. Perhaps another 1% of the population has access to energy produced by the mining industry. Of a total electrical generating capacity of 176 megawatts, 129 megawatts was from thermal plants using imported fuel, and 47 megawatts was from hydroelectric power. Potential hydroelectric capacity for the country is estimated at 6,000 megawatts. With all current hydroelectric capacity accounted for, construction of new process plants, particularly a proposed aluminum smelter, would require additional hydroelectric capacity. A powerplant with about 200 megawatt capacity would be required to supply sufficient power for an aluminum smelter with a capacity of 100,000 tons per year.

With the exception of OBK, which uses some hydroelectric power, operations at all mining facilities were entirely dependent upon imports of refined petroleum products. The mining sector accounts for most of the 129 megawatts of thermal power capacity in Guinea. Friguia has three boilers using bunker C oil to produce steam,

which is passed through several turbo-alternators for electricity generation prior to being used for evaporation and digestion. Total fuel consumption is estimated at 1.4 million barrels per year. Fuel storage capacity at Fria is about 42,000 barrels. Friguia's fuel storage capacity at Conakry is about 480,000 barrels in four 120,000-barrel tanks, located about 2 kilometers from the port. CBG's electricity is from three 3,000-horsepower diesel-powered engines connected to generators. Dryers at CBG use bunker C oil that is fired in separate combustion chambers.

Transportation

The focus of economic activity in Guinea is the mining industry and the transport of the industry's products. The three bauxite-producing companies maintain separate railroads for shipment of bauxite and, in the case of Friguia, alumina to the Ports of Kamsar and Conakry. Haulage distances to ocean ports are relatively short. Return trains bring fuel, equipment, food, and chemicals to the mine sites. Road transport is divided into primary, secondary, and tertiary systems, with some secondary and most tertiary roads concerned almost entirely with agriculture. Being dependent upon seasonal rains, river transport on the Milo and Niger Rivers is very limited.

Ports

Guinea has two ocean ports, Conakry and Kamsar, both of which are dominated by mineral-related traffic. The Port at Conakry is the main facility for commercial cargo and is under the administration of the Port Autonome de Conakry (PAC). A number of Government agencies concerned with port operation have been privatized, leading to substantial diversity and improvement in the quality of services available. Independent freight handlers and customs agents are available. PAC has had measurable success in improving the port's efficiency, with revenues now adequate to cover operating and maintenance costs. In addition, containerization has increased, along with total tonnage through the port. In 1989, the latest year available, total tonnage through the port was 5 million tons, of which about 3.6 million tons was bauxite and alumina. Shipments of calcined alumina from Conakry are about 630,000 tons per year. Friguia's Port facilities include four fuel oil tanks with total capacity of 480,000 barrels and three caustic soda storage tanks with a total capacity of 30,000 tons. Programs to limit silting and increase vessel draft in both the access channel and the Port of Conakry for increased ore handling have been carried out by private international contractors. Silting problems at the port have limited ship capacity to 36,000 deadweight tons; however, this may be increased as dredging programs continue. However, expansion of mineral production and exports would require considerably more berthing and storage capacity at the port.

Kamsar commenced operation in 1975 and was dedicated to handling bauxite shipments from CBG's Sangarédi Mine, which amount to about 11 million tons per year. A single loading berth exists at the bauxite wharf, which is about 1 kilometer offshore Kamsar and has a depth of 13.5 meters. The mobile shiploader at the wharf is rated at about 4,000 tons per hour. Petroleum products are also loaded or discharged at the bauxite wharf. Storage facilities at Kamsar include three 70,000-barrel bunker oil tanks and two 21,000-barrel diesel tanks. Vessels using the wharf sail during flood tides.

Railroads

Four railroad lines exist in Guinea. The longest is a 662-kilometer, 1-meter gauge line operated by the Office National du Chemin de Fer de Guinée and extends from Conakry to Kankan. Completed in 1914 with French assistance for general freight and passenger service, the line is now virtually inoperable, with landslides and washouts cutting the line at several places. Only a short 36-kilometer section in Conakry is serviceable, and it provides solely passenger service. The line originally provided transport of imported cement clinker from the Port of Conakry to a cement plant 25 kilometers east in Sonfonia, but this has been replaced by truck transport. CBG's bauxite mine at Sangarédi is linked with the Port of Kamsar by a 135-kilometer, 1.435-meter gauge railroad. Ore trains are normally composed of about 100 cars, each carrying about 75 tons of bauxite. About 11 million tons per year of bauxite are dried and shipped from Kamsar to overseas destinations. About 20,000 tons per month of bauxite is calcined and shipped from Kamsar for use in abrasives. See figure 9 for bauxite being loaded into railroad cars at the Sangarédi Mine.

Friguia's Mine at Fria is linked to Conakry via a 145-kilometer, 1-meter gauge railroad. All bauxite is processed near the mine to alumina and shipped via railroad on trains averaging about 1,800 tons per train. About 320,000 tons per year of food, equipment, fuel oil, caustic soda, and lime are backhauled to Fria. OBK's bauxite is shipped from the mine at Kindia to Conakry via a 104-kilometer, standard-gauge railroad. About 3 million tons are shipped annually from Kindia. Storage facilities at Conakry are considered just adequate for handling current production. Any significant expansion of production at either OBK or Friguia would require improvements to the existing railroad and port facilities.

Figure 9.—Bauxite loaded into railroad cars at the Sangarèdi Mine.

Roads

The current road situation represents both the worst scenario and the future hope for economic development. At best, the local transport system has short sections of paved primary road, totaling about 1,200 kilometers, connecting the main economic centers. Following the recent termination of Government transport monopolies, these roads became the main freight haulage routes for private trucking firms. At worst, large areas of the country are in virtual isolation, with a large number of bridges and ferries requiring either repair or replacement. These conditions are preventing movement of primarily agricultural products, especially coffee, a main export item, even to local markets. The latter problem, particularly for tertiary roads, is being rectified by the involvement of local private contractors using labor-intensive methods in rural areas. These roads are mainly dirt tracks, maintained locally using correct drainage and maintenance techniques. Secondary roads and some primary roads linking mainly isolated administrative districts are being built or maintained by the Office du Projet Routier (OPR). These are gravel roads using local quarry rock, and OPR's recent successes in this area may lead to its privatization and the contracting or rental of its equipment and expertise. At times, the Government has also requested the major mining companies to undertake selected road or sanitation projects owing to their possession of the necessary skills and equipment.

Private trucking firms have increased since the disbanding of state transport companies and the deregulation of tariffs. These firms generally consist of owner-operators having one or two trucks. Several firms have 10 to 20 vehicles, with the country's overall truck fleet amounting to about 9,000 vehicles. Vehicle imports are about 8,000 per year, many of which are used. The only direct tax on vehicles is an annual vehicle tax. Improved collection of import duties, an expansion of motor fuel supply and distribution networks, and a proposed axle-load tax may help to further improve the road transport sector.

OUTLOOK

The prospect for growth in Guinea's mineral industry is highly dependent upon world demand for aluminum metal because the local industry and the economy are dominated by bauxite production. Despite dampened worldwide demand, Guinea's resources of bauxite are well known, and current mining and processing companies provide a core of expertise that is available for future expansion. Such expansion could involve increasing capacity to produce bauxite above the 17.7 million tons of current production or further processing of the bauxite to alumina and aluminum. This would require capital for improving energy availability as well as transportation. Traditionally, under the 1969 sales agreement with the former U.S.S.R., OBK's bauxite production has been shipped to the Nicolayev plant in the Ukraine. With the breakup of the former U.S.S.R. at yearend 1991, the future of the sales agreement has become uncertain. However, as of early 1992, shipments were being made as normal.

Success by producers of other mineral commodities, such as diamonds and gold, however limited, should provide opportunities for further investment in these sectors. Infrastructure to facilitate startup of new mining enterprises would require improvements in the transportation sector. The difficulty of assessing reserves and even resources of diamonds and gold in placer deposits must be considered when contemplating an investment in these sectors. Investors can be expected to be sensitive to any institutional and fiscal framework that makes success in high-risk ventures, particularly in mining, difficult to achieve.

Overall improvement in the economy, while very dependent upon mineral commodity markets and domestic political and legal developments, will remain equally dependent upon regional stability. A continuation of regional transportation disruption and the cross-border movement of large numbers of refugees resulting from civil strife in neighboring countries will further delay development of iron ore resources on the Guinea-Liberian border.

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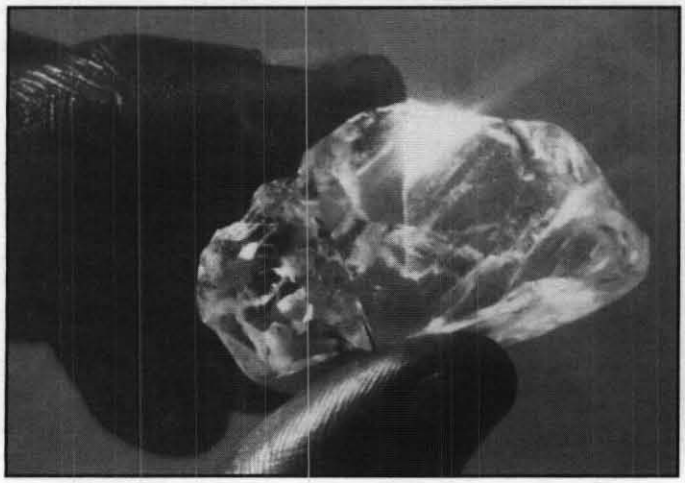
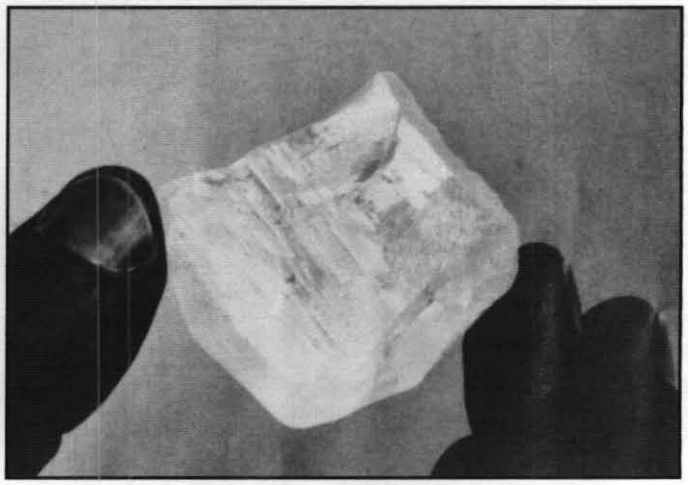
Aredor-Guinea Diamond Mine

Exceptional Stones Discovered

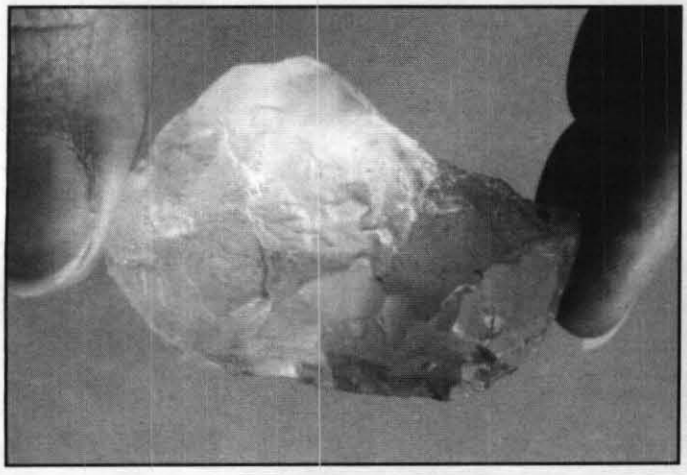
	1986	1987
Size (Carats)	100.20	142.96

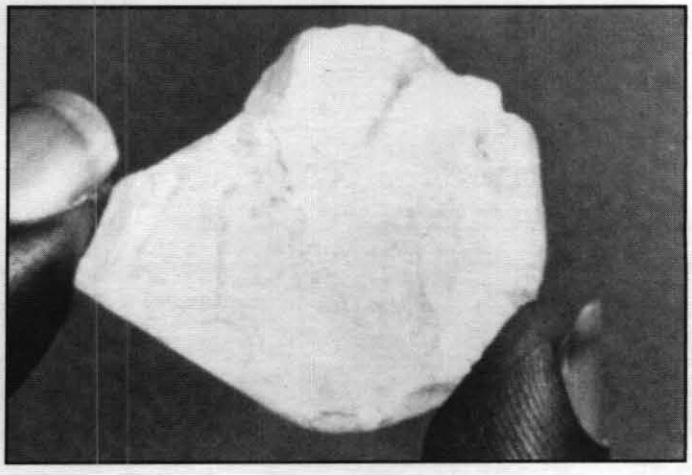




Selling Price (US$)	$1,558,000	$3,654,000
Price Per Carat (US$)	$15,533	$25,559

	1988	1989
Size (Carats)	181.77	255.61





Selling Price (US$)	$8,618,000	$10,036,000
Price Per Carat (US$)	$47,412	$39,262

Photos Courtesy of:
Bridge Oil Limited

As the Nation's principal conservation agency, the Department of the Interior has responsibility for most of our nationally-owned public lands and natural and cultural resources. This includes fostering wise use of our land and water resources, protecting our fish and wildlife, preserving the environmental and cultural values of our national parks and historical places, and providing for the enjoyment of life through outdoor recreation. The Department assesses our energy and mineral resources and works to assure that their development is in the best interests of all our people. The Department also promotes the goals of the Take Pride in America campaign by encouraging stewardship and citizen responsibility for the public lands and promoting citizen participation in their care. The Department also has a major responsibility for American Indian reservation communities and for people who live in Island Territories under U.S. Administration.

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U.S. BUREAU OF MINES