

# THE MINERAL INDUSTRY OF

# GHANA

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Ghana is a West African country with an area of 238,540 square kilometers, 17.5 million people, and a per-capita gross domestic product of about \$1,400.<sup>1</sup> Its economic growth rate was 5%, led by gold, timber, and cocoa production. Ghana was the second-largest gold producer in Africa, after South Africa. It also was the third-largest African producer of aluminum metal and manganese ore and a significant producer of bauxite and diamond. Surpassing the historical role of cocoa as the leading export, gold has been Ghana's single most valuable export since 1992. In 1996, officially reported output of newly mined gold was 49 metric tons (t) with a market value of about \$615 million.

## Government Policies and Programs

Restoration of the mining industry continued to be a keystone of the ongoing general Economic Recovery Program (ERP), launched in 1983 and structured in consultation with the World Bank. A significant early component of this program was the adoption of the mining code, the Minerals and Mining Law 1986 (PNDCL 153). In addition to this mining legislation, the ERP sought to improve the general economy through a combination of improved investment laws, a relaxation of foreign exchange restrictions, and the privatization of the large state-owned industrial sector, including several mines. By 1996, the Government had successfully privatized all the former holdings of the State Gold Mining Corp. (SGMC).

Legislation affecting mining and mineral exploration in Ghana includes the Additional Profits Tax Law, 1985 (PNDCL 122); the Minerals Commission Law, 1986 (PNDCL 154); and the Minerals (Royalties) Regulations, 1987 (LI 1349). The Petroleum (Exploration and Production) Law, 1984 (PNDCL 84), controls petroleum-related activities. Regulation of artisanal gold mining is set forth in the Small-Scale Gold Mining Law, 1989 (PNDCL 218). The Precious Minerals Marketing Corporation Law, 1989 (PNDCL 219), set up the Precious Minerals Marketing Corp. (PMMC) to promote the development of small-scale gold and diamond mining in Ghana and to purchase the output of such mining, either directly or through licensed buyers. The Minerals and Mining (Amendment) Act of 1994 reduced the 45% general mining corporate tax rate to 35%, the same as that imposed on other industries.

The Ministry of Lands and Natural Resources oversees all

aspects of the Ghanaian mineral economy and is the grantor of mineral exploration and mining leases. Within the Ministry, the Minerals Commission has responsibility for recommending mineral policy, promoting mineral development, advising the Government on mineral matters, and serving as a liaison between industry and the Government. The Ghana Geological Survey Department conducts geologic studies; the Lands Commission maintains records of exploration licenses and mining leases; and the Mines Department has authority in mine safety matters. All mine accidents and other safety problems also must be reported to the Ghana Chamber of Mines, the private association of operating mining companies. The Chamber also provides information on Ghana's mining laws to the public and negotiates with the mine labor unions on behalf of its member companies. The Ministry of Fuel and Power formulates Ghanaian energy policy and issues licenses for onshore and offshore petroleum and natural gas exploration.

Mining and the associated growth of communities has led to locally severe deforestation, erosion, and water pollution. Where sulfide gold ores have been roasted, there has been air pollution from sulfur and arsenic oxide emissions. Arsenic recovery circuits have been added to two of the three gold-processing plants in the country. Mercury is widely used to amalgamate gold by artisanal miners in Ghana. Artisanal usage in particular has led to mercury contamination of rivers. All new mining operations are required to conduct and submit environmental impact studies and to plan their operations to minimize environmental damage. Similarly, rehabilitation of existing mines now includes environmental planning. The Environmental Protection Agency was established in 1994, and draft guideline environmental regulations were issued. A portion of mining royalties are now directed to an environmental remediation fund, particularly to address problems in the artisanal sector.

## Production

As shown in table 1, production levels of Ghana's major mineral commodities were mixed in 1996. Aluminum, diamond, and manganese production levels increased 1%, 13%, and 450%, respectively, from those of 1995. The jump in manganese production was a result of the renovation of the Nsuta Mine under the management of Elkem International of Norway (Elkem). Output of bauxite declined by 10% and gold, by 8%. The decline in gold is not, however, reflective of the long term upward trend in gold production that is expected to continue as several new mines come into production in the next

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<sup>1</sup>Where necessary, values for 1996 have been converted from Ghanaian cedis © to U.S. dollars at the rate of C1,740=US\$1.00.

1 to 3 years. Reported sales of artisanal gold production to the PMMC declined by 25% in 1996 over those of 1995. An unknown quantity of artisanal gold production is, however, undocumented owing to theft, internal consumption for jewelry and traditional gold ceremonial artifacts, or alleged smuggling into Cote d'Ivoire or Togo where the French West African franc is more convertible. Data were lacking for this commerce and estimates of its magnitude are not included in table 1. Power supply problems continued to beleaguer the Volta Aluminum Company Ltd.'s (VALCO) aluminum smelter, and metal production continued at about two-thirds of capacity in 1996. Cement was the main mineral commodity produced chiefly for local consumption.

## Trade

Virtually all Ghana's primary mineral production is exported, as is much of its secondary, or value-added, mineral output. In 1995, the value of all primary mineral commodity exports was \$682 million, or about 45% of total exports. Gold exports, valued at \$651.1 million, accounted for 95% of all mineral commodity exports in 1995. Available data for 1996 showed a similar pattern with gold, accounting for \$612.4 million out of total exports of all goods of \$1.51 billion. Because the true value of Ghana's diamond and gold exports was unknown owing to alleged smuggling, estimates of this commerce varied widely. A complicating factor was that the flow of diamonds and gold was informally reported in and out of the country. Ghana, in particular, appeared to be an entrepot for smuggled diamonds produced elsewhere in Africa; it would be a likely destination for artisanal diamond from Liberia and Sierra Leone, whose economies have been disrupted by civil wars in recent years. Although most official Ghanaian diamond exports were to Belgium and/or India, U.S. customs data have, in recent years, included imports of stones directly from Ghana in the range of 200,000 to 950,000 carats per year, worth \$40 million to \$126 million. The overall and average per-carat values of these stones are too high for the bulk of them to be Ghanaian production. Ghana's main processed mineral commodity export was aluminum, which is toll-refined in Ghana from imported alumina. On the basis of the average price of aluminum in 1996 of \$0.70 per pound, aluminum exports were worth about \$211 million, of which an estimated \$73 million was the Ghanaian value-added component. Bauxite exports dropped 130,000 t to 400,000 t in 1996, due a train derailment that limited shipments.

Ghana's mineral commodity imports were dominated by petroleum products, alumina, fertilizers, and clinker for cement. Imports of these are estimated to have totaled about \$350 million in 1994. Import data for 1995 and 1996 were not available, but are estimated to be at about the same level as those of 1994. Data on imports of mine and mill equipment, explosives, and reagents, such as sodium cyanide, were unavailable, but given the level of gold production and new mine developments, the value probably exceeds \$200 million per year.

## Structure of the Mineral Industry

Through privatization programs, the Government has greatly reduced its once-dominant stake in the cement and gold industries but has maintained a controlling interest in Ghana Consolidated Diamonds Ltd., Ghana Bauxite Co. Ltd. (GBC), Ghana National Manganese Corporation (GNMC), and the state-run Steelworks Co. Negotiations to privatize some of these companies were underway. With the turnover of control of the Prestea Gold Mine to Barnato Exploration Ltd., an arm of the South African company, JCI Ltd., in 1996, the privatization of the assets of the SGMC was completed. Late in 1995, the Government signed an agreement with Elkem to assist the state-owned GNMC with operation of the Nsuta manganese mine. It was not clear, however, as to whether Elkem acquired an equity position under the agreement (Mining Journal, 1996). The Government had taken over control of the mine in 1973 from a subsidiary of Union Carbide of the United States.

Efforts to attract foreign investment in recent years have brought in a wide range of companies from Australia, Canada, the Netherlands, South Africa, the United Kingdom, and the United States that now hold controlling interests in most of the current gold mines in Ghana. In addition, more than 100 exploration licenses were being actively explored for gold during the year. The American company, Kaiser Aluminum Corp. (Kaiser), maintains a longstanding 90% interest in the VALCO aluminum smelter.

## Commodity Review

### Metals

**Aluminum and Bauxite.**—The VALCO smelter, Ghana's sole producer of aluminum, continued to be affected by drought-induced power disruptions and rationing and operated at only 68% of capacity. The smelter at Tema Harbor uses prebake technology and toll-processes alumina supplied by Kaiser and its minority shareholder, Reynolds Aluminum Co., into primary aluminum. Long-term tolling contracts provide for proportionate payments by the participants in amounts intended to pay not less than all VALCO's operating and financing costs. The company's share of the primary aluminum is sold to third parties. Power for the VALCO smelter is supplied under an agreement that expires in 2017. The agreement indexes two-thirds of the price of the contract quantity of power to the market price of primary aluminum. The agreement also provides for a review and adjustment of the base power rate and the price index every 5 years. The most recent review was completed in April 1994 for the 1994-98 period. The Volta River Authority has allocated to VALCO sufficient electric power to operate at 80% of its annual rated capacity through December 31, 1997 (Kaiser Aluminum Corp., 1997).

Ghana's only bauxite mine, operated by GBC at Awaso, produces chemical-grade bauxite ore primarily for export to Europe. Bauxite storage and shiploading facilities at Takoradi have been expanded in recent years and have contributed to a near doubling of mine production between 1993 and 1995,

although production dropped by 10% in 1996. The company hopes to increase mine production to 1 million metric tons per year (Mt/yr) by 2000. The Government planned on selling 35% of its 55% holding in the mine by mid-1997. Alcan Chemicals Europe is the most likely company to buy the government shares and to increase its holdings in GBC to 80% (Mining Journal, 1997).

**Gold.**—Overall production of gold decreased by 8% from that of 1995, chiefly from drops in output from Ashanti Goldfields Company Ltd.'s (AGC) operations at Obuasi and at Teberebie Goldfields Ltd. (See table 2.) AGC emerged as a major force in African mining in 1996 by listing on the New York, Toronto, Zimbabwe, and Australian stock exchanges and by investing \$518 million, or \$38 per measured and indicated resource ounce acquired, to acquire four companies with significant gold properties in Ghana, Burkina Faso, Guinea, and Zimbabwe. The acquisitions included Cluff Resources plc. (United Kingdom), International Gold Resources Corp. (Canada), Ghana-Libyan Arab Mining Co. (Glamco) Ltd., Golden Shamrock Mines Ltd. (Australia), and the Republic of Ghana's minority interests in the Anyanfuri, Bibiani, and Iduapriem gold mines. AGC's corporate gold production for 1996 was 31,993 kilograms (kg), of which 93% came from operations in Ghana, including partial-year contributions from the Anyanfuri and Iduapriem Mines.

Of the 11 formal gold mines in operation in Ghana in 1996, 4 accounted for a total of 81% of the recorded gold output of the country. These four mines were: the Obuasi mine (54.2%), the Teberebie (13%), the Iduapriem (7.4%), and the Bogosu (6.7%). A breakdown of gold production, by mine, for 1992-1996 is shown in table 2.

One of the richest gold mines in the world, the Ashanti mining complex at Obuasi, experienced a drop in production of 8% in 1996 to 26,671 kg. The mine exploits quartz and sulfide ores from a steeply dipping vein and shear zone system in lower Proterozoic greenstones of the Birimian Series. Gold ore grades have averaged about 20 grams per metric ton (g/t) of gold for much of the mine's century-long history but have declined in recent years as the ratio of quartz to sulfide underground ore has decreased and as large quantities of lower grade surface ores and tailings have begun to be mined. Beginning in 1996 and adjusted for 1995, AGC began reporting on a calendar year basis ending December 31, a change from the old fiscal year ending September 30. The Obuasi underground mine delivered 1.78 million metric tons (Mt) of ore to the mill with an average grade of 8.13 g/t compared with 1.55 Mt of ore to the mill with an average grade of 8.66 g/t in calendar year 1995. At the Obuasi open-pit operations, 59.2 Mt of overburden was stripped, and 5.76 Mt of ore grading 3.1 g/t was mined in 1996 compared with ore production of 6.01 Mt grading 3.33 g/t in 1995. In 1996, AGC spent \$161 million upgrading production facilities at Obuasi, primarily in underground shaft and ore haulage development. AGC has abandoned goals of producing 31,100 kilograms per year (kg/yr) of gold from Obuasi and will stabilize future production at a more optimum operating level of 26,440 kg/yr.

The Obuasi ore was processed at four treatment plants and a heap-leach operation. The Sansu sulfide treatment plant (STP) is the world's largest bio-oxidation (BIOX) gold treatment facility. BIOX is an environmentally benign, low-cost method of treating sulfide gold ores, especially those of too low a grade to justify the cost of roasting or other oxidizing processes. The process can handle arsenopyritic (high-arsenic) ores. The STP treated 2.67 Mt of ore grading 5 g/t in 1996 compared with 2.57 t grading 4.7 g/t gold in 1995. It had a gold recovery rate of 76.6% and contributed 10,234 kg, or 38% of total Obuasi gold production in 1996.

Ashanti's upgraded Pompora treatment plant processed 1.39 Mt of ore with an average grade of 8.02 g/t yielding 9,046 kg of gold. At the oxide treatment plant, 2.55 Mt of material were processed grading 2.72 g/t yielding 4,828 kg of gold with a recovery rate of 84.8%. The tailings treatment plant processed 1.8 Mt of ore grading 3.27 g/t yielding 2,119 kg of gold at a recovery rate of 36.1% in 1996. A small heap-leach plant processed 0.9 Mt of ore grading 0.93 g/t yielding 533 kg at a recovery rate of 62.1%.

At the end of 1996, Ashanti reported proven and probable reserves of 71.2 Mt at a grade of 7.9 g/t containing 560,000 kg of gold at Obuasi, 37.2 Mt grading 1.3 g/t at Iduapriem, 17.2 Mt at a grade of 2.7 g/t at Bibiani, and 3.1 Mt grading 1.3 g/t at Anyanfuri. In addition, Ashanti reported measured and indicated resources of 89.8 Mt at a grade of 7.5 g/t containing 672,000 kg of gold at Obuasi, 54.0 Mt grading 1.3 g/t at Iduapriem, 21.8 Mt at a grade of 2.6 g/t at Bibiani, and 3.1 Mt grading 1.6 g/t at Anyanfuri (Ashanti Goldfields Co. Ltd., 1997).

During 1996, AGC merged with Golden Shamrock acquiring its 70% interest in Ghanaian Australian Goldfields, which operated the Iduapriem open pit gold mine. Total gold output for calendar 1996 decreased 5% from that of 1995 to 3,669 kg attributable to an expected drop in head grades. A new 2.4 Mt/yr heap leach project and carbon-in-leach (CIL) upgrade were commissioned in late 1996, increasing treatment capacity to 5 million metric tons per year (Mt/yr) and gold output to around 5,000 kg/yr.

During AGC's first year of ownership, the Anyanfuri Mine produced 1,717 kg of gold from heap-leaching operations, despite heavy rains during the middle of the year. About 300 kg of gold were produced by trucking higher grade Anyanfuri ore to Obuasi for treatment in the oxide plant CIL circuit. Exploration efforts outlined enough additional resources to extend the life of the mine 1 year beyond its early 1999 planned closure.

At its newly acquired Bibiani gold project, AGC completed additional drilling and a second and final feasibility study during 1996 and announced plans to proceed with development. The \$83 million Bibiani project will be developed as an open-pit mining operation producing 2 Mt/yr of ore for treatment in a conventional crushing, milling, CIL circuit.

Teberbie Goldfields Ltd. (TGL), owned by the Pioneer Group, Inc., of the United States, operates the Teberbie Mine, near Tarkwa, and exploits the Tarkwaian System banded conglomerate, which is similar to the Witswatersrand gold environments of South Africa. The TGL open-pit, heap-leach

operation, Ghana's second most productive gold mining company, extracts ore from the Teberebie/Awunaben and the Mantraim pits. Teberebie gold output decreased by 14% to 6,317 kg. The decline was attributed to dilution from heavy rains that reduced recovery from 78% to 69%. Ore processing also declined to 6.54 Mt grading 1.26 g/t in 1996 from the 7.07 Mt grading 1.28 g/t processed in 1995. In addition, operating costs were impacted by equipment downtime and a shortage of skilled labor. In March 1996, TGL received the necessary environmental permit from the Environmental Protection Agency to proceed with the Phase III expansion. The company was expending \$57 million to expand ore processing capacity to 12 Mt/yr by adding a third gyratory crusher, by modifying the existing West plant, an absorption desorption refinery, and by adding a new South plant, which is expected to have its first gold pour by April 1998. TGL reported that a shift in mine method from selective mining to bulk mining might reduce existing proven and probable minable reserves of 283,000 kg of contained gold (Pioneer Group, 1997).

The Bogosu Mine, acquired by Gencor Ltd. of South Africa in 1994 through its purchase of Billiton International Metals B.V. of the Netherlands, is an open-pit operation exploiting very limited depleting oxide ores remaining from an earlier open-pit operation (the Marlu Mine). Billiton Bogosu Gold Ltd.'s processing facilities for sulfide ores, consisted of flotation, roaster, and CIL circuits. Production, primarily from oxide ores was 3,327 kg in 1996. Oxide reserves are sufficient for only one more year of production. In its 1996 Annual Report, however, Gencor stated that substantial, but metallurgically complex, sulfide ores exist on the property, which are technically amenable to mining and treatment by flotation, BIOX, and cyanidation. The remaining sulfide reserves were given as 11.76 Mt of indicated ore grading 3.32 g/t, and inferred reserves, as 813,000 t grading 2.7 g/t. (Gencor Ltd, 1996).

The Tarkwa Mine was the first active gold mine to be privatized in Ghana. Gold Fields of South Africa Ltd. (Gold Fields) acquired a 70% majority control in mid-1993 from the SGMCo, with the Teck Corp. (Canada) subsidiary, Golden Knight Resources Inc., holding an additional 17.5%. Gold Fields (Ghana) Ltd. produced 1,476 kg of gold from the old underground workings in 1996. The parent companies announced the results of further exploration drilling in 1996 that increased the measured resource in the Tarkwa area from 233,000 kg of gold to 404,346 kg (Golden Knight Resources Inc., 1996; Gold Fields of South Africa Ltd., 1996). The ore is distributed in 324.2 Mt at an average grade of 1.37% gold in five areas in the southern end of the concession. After successful completion of a feasibility study Gold Fields, announced plans to undertake development of the \$125 million Tarkwa open-pit, heap-leaching project. This first phase project will exploit 142 Mt grading 1.27 g/t gold at a 2.25 stripping ratio. Mining would be at the rate of 7.3 Mt/yr to produce 7,150 kg/yr of gold at full capacity. Initial startup capacity of 3,110 kg of gold is expected to be in operation by 1998. The project will involve the relocation of 20,000 Ghanaian villagers now resident above portions of the ore body. Additional exploration has identified nearby mineralization that may also be minable as

a shallow underground mine (Randol International, 1996a).

On behalf of its subsidiary, Barnato Exploration Ltd. (Barnex), JCI Ltd. of South Africa signed an agreement with the SGMCo to take over management control of the Prestea gold mine. Under its first year of operation by Barnex, production from the old Prestea underground workings increased by 26% to 1,062 kg of gold. The company reported that significant gold resources have been identified in the Prestea area during a reconnaissance drilling program and will be the target of further exploration in 1997 (JCI Ltd., 1996). Barnex was also actively exploring for gold elsewhere in Ghana on its own behalf and in joint ventures with the Canadian junior company, Patrician Gold Mines Ltd., and with a local company, Atlantis Mining Co.

Prestea Sankofa Gold Ltd., a joint venture of SAMAX Gold Inc. of the United Kingdom (50.4%), Ghana National Petroleum Co. (39.6%), and the Government (10%), was granted an 8-year lease in early 1994 to recover gold from the old Prestea Mine tailings and dumps. Prestea Sankofa commissioned a new 320,000-ton-per-year CIL plant in May 1995. This first phase investment cost \$7.5 million and was designed to produce up to 680 kg/yr from an initial total of 1.8 Mt of old Prestea calcines, tailings, and mine waste for at least 7 years. Gold production in 1996 was 540 kg from 260,000 t of material remined grading 3.85 g/t. The gold recovery rate was 56.3%. SAMAX reported minable reserves of 1.84 Mt containing 3,575 kg of recoverable gold and further measured resources of 1.41 Mt containing 987 kg of recoverable gold (SAMAX Gold Inc., 1997).

Obenemasi Gold Mines Ltd, a subsidiary of Ghana Gold Mines Ltd. of Australia operated the historic Konongo/Obenemasi gold concession, located 50 kilometers (km) east of Kumasi. The company installed a 300,000-metric-ton-per-year mobile carbon-in-pulp plant in 1995 to treat the remaining oxide ores. Gold production in 1996 was 588 kg. A second phase will look at developing 1 Mt of proven minable sulfide ore reserves at a grade of 5.2 g/t below the Obenemasi open pits. Obenemasi is located within the Tarkwaian system banket conglomerate.

Bonte Gold Mines Ltd. (Bonte) increased output by 18%, to 668 kg of gold, from the small alluvial mining operation on the Esaase concession, which it is mining at a rate of 3,000 cubic meters per day. Bonte is owned (85%) by Akrokeri-Ashanti Gold Mines Inc. (Canada). Exploration on the company's adjacent Jena property outlined 2,940 kg of proven and probable reserves of contained gold and 2,700 kg of possible resources (Akrokeri-Ashanti Gold Mines Inc., 1997).

More than 100 companies, including a majority from Australia, Canada, Europe, Ghana, South Africa, and the United States, were actively exploring for gold in 1996. In addition to Ashanti's Bibiani project a number of advanced gold projects were underway.

Work was underway by Abosso Goldfields Ltd., a 90% owned subsidiary of the Australian company Ranger Minerals NL (Ranger), to open a mine on the Damang quartz vein stockwork deposit, an extension of the old Abosso underground mine adjacent to the Tarkwa Mine. The old Abosso Mine produced nearly 7,800 kg of gold before closing in 1956. As of October 1996, gold resources were estimated, allowing for

dilution, at 94,244 kg of contained gold in 22.9 Mt of ore grading 3.1 g/t (Ranger Minerals NL, 1998). On the basis of a bankable feasibility study completed in February 1996, Ranger is proceeding with development of the new Damang Mine which it plans to have operational by the end of 1997. The \$120 million project will mine at a rate of 3 Mt/yr and using a crushing, CIL process to produce from 8,400 to 9,000 kg/yr of gold (Randol International, 1996b).

During 1996, Resolute Samantha Limited of Australia merged with Associated Goldfields NL of Australia acquiring a 82.5% interest in the Obotan gold project; an additional 10% was held by the Ghana Government, and 7.5%, by Obotan Minerals Co. Ltd. The Obotan project, located 40 km northwest of Obuasi, includes the Nkran Hill and Adubiaso Hill surface deposits. Total resources are 21.9 Mt at a grade of 1.95 g/t of gold, including reserves of 10.15 Mt grading 2.12 g/t. A decision was made to proceed with development, with the first gold pour scheduled for June 1997. The \$30 million project will include two open pits, a gold-treatment plant with a single stage crushing circuit and semiautogenous grinding mill, seven CIL tanks, and a 5-t gold circuit. The deeply weathered ore is free milling with gold recoveries expected in excess of 93%. Mining and plant throughput will be at a rate of from 1.4 to 2 Mt/yr of ore based on mining reserves of 28,000 kg of gold. Annual production is planned to be 126,000 kg of gold. (Resolute Limited, 1997).

Glencar Explorations Plc. of Ireland, which owned 63% of Wassa Holdings Limited, reported promising exploration results from drilling at the Wassa project in its 1996 annual report. Wassa Holdings Limited holds 90% of the Ghana registered operating company, Satellite Goldfields Ltd., with the Government of Ghana holding the remaining 10%. The Wassa property is located about 35 km northeast of Tarkwa in Lower Birimian greenstones, felsic volcanics and a distinctive ironstone formation. Vein and stockwork mineralization occurs in both the felsic and phylittic lithologies. Movable reserves were estimated to be 14.7 Mt at a grade of 1.8 g/t of gold. In August 1996, the total probable movable reserve on the property was estimated to be 26,440 kg at a cut-off grade of 0.8 g/t; the ore body is still open on several sides. The American engineering firm, Pincock, Allen, & Holt, is expected to complete the feasibility study on the project by mid-1997. The study is based on producing 3,420 kg/yr of gold for 7 years from an open-pit, heap-leaching operation. Glencar also held exploration rights to the Kanyankaw property, on which drilling was being conducted by Cyprus Amax Minerals Co. of the United States under an Earn-In Agreement (Glencar Explorations Plc., 1997).

Gencor also reported that initial geologic drilling at the Yamfo project in northern Ghana resulted in resource estimates of 40,000 kg of gold, which would be exploited as an open pit (Gencor Ltd., 1996).

**Manganese.**—Ghana Manganese Corporation's Nsuta Mine has been the only significant producer of manganese ore in Ghana. The mine produces manganese oxide and carbonate ores, as well as a transitional ore referred to as "Carbox." Total

production of manganese ore in 1996 was 789,449 t of run-of-mine ore equivalent to 411,000 t of contained manganese. Except for a few hundred tons of battery-grade oxide ore sold to local battery companies and very small amounts sold to gold-processing plants, the mine's ore sales were exports. Exports of manganese were reported to be 266,440 t, in 1996. The Nsuta Mine's total production and export capacities have been constrained by limited rail capacity to Takoradi Harbor. The railroad is also shared with the Awaso bauxite mine.

### **Industrial Minerals**

**Diamond.**—Ghana Consolidated Diamonds' Akwatia diamond mine was the only operating mine in Ghana in 1996. The Ghana Minerals Commission reported output at 271,494 carats, down by 8% from 1995. Apart from Akwatia, diamond production in Ghana during the year was from widespread artisanal workings. The true level of artisanal output was unknown because of undocumented sales and exports. In 1996, the PMMC reported purchases of 443,243 carats from artisanal and galamsey miners, an increase of 31% from those of 1995.

Several Canadian companies continued with diamond exploration in the general Akwatia area. Most work targeted placer deposits, but one company was also evaluating newly discovered metakimberlites on its concession.

**Limestone.**—Limestone Products (Ghana) Ltd. was formed in 1994 to supply limestone and lime to the gold mining industry and for water treatment. The company's limestone-crushing and lime-processing facilities, near Takoradi, also provide storage for imported lime and limestone. The company was examining local deposits of sea shells along with a nearby limestone deposit as feed sources. The prime customer for the company was its joint venture owner, AGC, which required quicklime, hydrated lime, limestone, and shells for its BIOX gold recovery circuit. In 1995, AGC reduced its participation from 51% to 50% with the remaining 50% held by Carneuse S.A. of Belgium. Carneuse, one of the world's leading companies in the lime products industry, was also planning to pursue other domestic and regional markets.

### **Reserves**

GBC claimed that it had access to bauxite reserves at Awaso sufficient to support a mine life of 100 years, while reporting proven reserves at the end of 1994 of 29.5 Mt (Ghana Chamber of Mines, 1994). Mining plans in 1994 called for output to be expanded to 500,000 metric tons per year (t/yr) and eventually to be doubled to 1 Mt/yr. As reported by the former director of the Geological Survey Department, the country has significant bauxite reserves outside the Awaso area, namely about 60 km west of Kumasi, and those near Kibi. These have been extensively drill sampled. The deposits near Kumasi have an inventory totaling 278 Mt at a grade range of 48.9% to 51% alumina and 2.8% to 4.4% silica. The Kibi area bauxite resource totals 120 Mt ranging in grade from 40.8% to 45.7% alumina and 1.8% to 3.9% silica (Kesse, 1985).

Ghana has large gold resources, although summation of them is complicated by the different reserve reporting methods used by various companies. Published data from the existing mines and for certain advanced projects indicate a total defined Ghanaian resource for year-end 1995 in the range of 1,300 to 1,500 t of contained gold; the Obuasi Mine had about 45% of this inventory. Available information on reserves and resources of gold at individual mines are discussed in the gold commodity section of this report. Ghana's total gold resources, which are undoubtedly larger than those reported, are based on the known extent of host rocks, the widespread artisanal production of gold, and the existence of a number of closed old mines, many of which shut down without having depleted their gold resources and which are just beginning to be reevaluated using current geologic models and considering current processing technology.

The only large established manganese ore reserves in Ghana are at the Nsuta Mine, although several other deposits are known. As of the end of 1994, minable reserves were 222,600 t of manganese oxide and 4,326,300 t of manganese carbonate ore (Ghana Chamber of Mines, 1994).

Ghana's large diamond resources are based on reserves at the Akwatia Mine and the widespread artisanal production of diamond. The Akwatia Mine's reserves are virtually all in river or raised terrace gravels along the Birim River. According to the company, proven reserves in these gravels amounted to about 19.7 million cubic meters grading about 1.19 carats per cubic meter (Ghana Chamber of Mines, 1994). Unlike the richer diamond fields in Sierra Leone and Guinea, very few large, gem-quality stones are found at Akwatia. The departure of two potential major international mining company investors, including De Beers Consolidated Mines Ltd. (South Africa), in the early 1990's from Akwatia, however, puts the economics of the deposits in question. Kimberlites now have been found in the area, but the diamond resources are still being evaluated.

Recent exploration has been able to define Ghana's oil and gas resources better. In the petroleum sector 1 onshore and 5 offshore basins with commercially viable oilfields have been discovered but are still awaiting development. Natural gas reserves have been estimated at 24 billion cubic meters, chiefly in the Tano offshore gasfield (Mbendi Information Services, 1996). With a \$316 million financing support from the U.S. Eximbank plans are underway to develop the Tano gasfield and to build pipelines to a barge mounted 130,000-kilowatt powerplant to be installed near the village of Effasu (Oil & Gas Journal, 1996).

## Infrastructure

Ghana's road infrastructure is concentrated in the southern and southwestern parts of the country. Apart from some of the roads between the main cities, much of the country's road network remained in poor condition, unsuitable for transport of bulk mineral commodities. Ghana's railroad infrastructure remained in poor condition except for rehabilitated sections of the western line. This line is the export route for the country's manganese ore and bauxite and provides logistical support to the major gold-producing area.

Ghana's major ports are Takoradi and Tema. All the country's manganese ore and bauxite shipments are through Takoradi. Tema, a shallow, dredged harbor, handles the needs of the VALCO aluminum smelter. Both ports handle imports of clinker for cement. In 1996, the Government announced plans to invest \$240 million to renovate both ports as part of a policy to promote Ghana as a gateway to the West African region.

Ghana's electrical generating capacity remained at about 1,185 megawatts (MW), of which 1,072 MW was from hydropower. Hydroelectric power is subject to the impact of periodic droughts in the region, and power disruptions and rationing were common. Electricity exports from the Volta River Authority to neighboring countries were terminated in 1994.

## Outlook

Fostered by a favorable political and investment climate, the prospects for continued development of the mining sector of the Ghanaian economy looked promising. Gold should continue to lead growth in the minerals sector and in the overall economy, having overtaken cocoa as the leading export. The aggressive expansion of operations by Ashanti, the post privatization revitalization of the SGMCO holdings and the potential for ongoing exploration to add one to three new mines per year should see annual gold production approach 2 million ounces (62,200 kg) in the near future. The introduction of internationally accepted environmental standards by the Government may, however, slow the rate of exploration and development. Owing to periodic droughts, domestic energy supply, especially hydroelectric power, has been a problem, particularly for the aluminum industry and the expanding needs of the gold industry. The proposed new gas fueled power plant at Effasu should help mitigate this problem.

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### **Other Sources of Information**

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TABLE 1  
GHANA: PRODUCTION OF MINERAL COMMODITIES 1/

(Thousand metric tons unless otherwise specified)

Commodity 2/	1992	1993	1994	1995	1996 e/
<b>Aluminum:</b>					
Bauxite, gross weight	399	365	452	697	631 3/
Metal, smelter, primary	180	175	141	135	137 3/
Arsenic, trioxide 4/	500 r/ e/	902 r/	3,897 r/	4,409 r/	5,443 3/
Cement, hydraulic 5/	1,020	1,200	1,350	1,300 e/	1,300
<b>Diamond:</b>					
Gem e/	525	473	592	506	572
Industrial e/	131	118	148	126	143
Total 6/	656	591	740	632	715 3/
Gold 7/	29,824 r/	38,911 r/	43,478 r/	53,087 r/	49,211 3/
<b>Manganese:</b>					
Ore, processed	353	295 e/	265	217	789 3/
Mn content e/	133	115	101	91	411
<b>Petroleum, refinery products:</b>					
Liquefied petroleum gas	197	40	365	400 e/	400
Gasoline	1,800	325	1,825	1,900 e/	1,900
Jet fuel	384	100	365	400 e/	400
Kerosene	798	200	1,095	2,000 e/	2,000
Distillate fuel oil	1,580	400 e/	1,460	1,500 e/	1,500
Residual fuel oil	1,900	475	2,190	2,200 e/	2,200
Other including refinery fuel and losses e/	801	210	365	400	400
Total	7,460 e/	1,750 8/	7,665	8,800 e/	8,800
Salt e/	50	50	50	50	50
Silver, content of gold ore e/	1,550	1,960	2,230	2,660	2,450
Steel, crude e/	25	25	25	25	25

e/ Estimated. r/ Revised.

1/ Table includes data available through Mar. 13, 1998.

2/ In addition to the commodities listed, a variety of crude construction materials (clays, sand and gravel, and stone) are produced, as is limestone for processing of some gold ore. Output of these commodities is not reported and information is inadequate to make reliable estimates of output levels.

3/ Reported figure.

4/ Reported data from AGC. Bogosu roaster may also produce arsenic.

5/ All from imported clinker.

6/ Production, in thousand carats, includes that of Akwatia Mine (1992--214; 1993--214; 1994--356; 1995--294; and 1996--271), and PMMC purchases of artisanal production (1992--480; 1993--376; 1994--406; 1995--337; and 1996--443). Estimates of unreported artisanal production not included.

7/ Does not include estimate of smuggled production.

8/ Refinery was reported closed for maintenance for much of the year.

TABLE 2  
GHANA: GOLD PRODUCTION BY COMPANY AND MINE

(Kilograms)

Company	Mine	1992	1993	1994	1995	1996
Ashanti Goldfields Co. Ltd.	Ayanfuri, open pit 1/	--	--	139	1,744	1,717
Do.	Iduapriem, open pit 2/	--	3,835	3,689	3,866	3,669
Do.	Obuasi Complex, open pit and underground	21,390	23,831 r/	26,548	29,138	26,761
Barnex (Prestea) Ltd.	Prestea, underground 3/	525	654	612	840	1,062
Billiton Bogosu Gold Ltd.	Bogosu, open pit	2,428	2,784	3,402	3,349	3,327
Bonte Gold Mines Ltd.	Esaase, placer	--	227	508	567	668
Dunkwa Continental Goldfields Ltd.	Dunkwa, placer 4/	145	122	97	104	173
Gold Fields (Ghana) Ltd.	Tarkwa, underground 5/	827	1,221 r/	1,224	1,382	1,476
Obenemasi Gold Mines Ltd.	Konongo/Obenemasi, open pit 6/	46	--	--	690	588
Precious Minerals Marketing Corp.	Artisanal workings 7/	538	1,107 r/	1,772	3,898	2,913
Prestea Sankofa Gold Ltd.	Prestea, tailings 8/	--	--	--	184	540
Teberebie Goldfields Ltd.	Teberebie, open pit	3,925 r/	5,129	5,487 r/	7,325	6,317
Total		29,824 r/	38,911 r/	43,478 r/	53,087 r/	49,211

r/ Revised.

1/ Acquired in purchase of Cluff Resources in 1996.

2/ Acquired in merger with Golden Shamrock in 1996.

3/ Acquired from SGMC in 1996.

4/ Acquired from SGMC in 1995.

5/ Acquired from SGMC in 1993.

6/ Owned/operated by Southern Cross Mining Co. in 1991-92.

7/ Includes 8 to 110 kilograms per year byproduct gold from Ghana Consolidated Diamonds Ltd.'s Akwatia Mine.

8/ Acquired from SGMC in 1994.

Source: Ghana Minerals Commission