

THE MINERAL INDUSTRY OF

GHANA

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In 1999, Ghana, which is a 238,540-square-kilometer country in West Africa, had a population of around 19.5 million and a per-capita gross domestic product (GDP) of about \$420.¹ In 1999, the GDP grew at an estimated rate of 5.5% and was led, in order of value, by gold, cocoa, and timber production (U.S. Department of State, 2000, Ghana—Appendix A, Country Commercial Guide, accessed September 20, 2000, at URL http://www.state.gov/www/about_state/business/com_guides/2000/africa/ghana_CCG2000.pdf). The decline in world commodity market prices for cocoa and gold from 1997 and 1998 levels and the subsequent drop in foreign exchange export earnings, however, were beginning to affect the economy by yearend.

Formerly known as the Gold Coast, Ghana has a long tradition of gold mining with an estimated 2,488 metric tons (t) (80 million ounces) of gold produced between the first documentation of gold mining in 1493 and 1999 (Kesse, 1985, p. 183-186; Ghana Chamber of Mines, 1998, p. 41-42). 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. Gold production in 1999 increased by 49% to more than 81.5 t (2.62 million ounces) compared with that of 1997. The increase in gold production is attributed to the opening of four new gold mines at Bibiani, Damang, Tarkwa, and Wassa since early 1998.

Government Policies and Programs

Legislation that affects mining and mineral exploration in Ghana includes the Minerals and Mining Law, 1986 (PNDCL 153), as amended by the Minerals and Mining (Amendment) Act, 1994 (Act 475); the Additional Profits Tax Law, 1985 (PNDCL 122); the Minerals Commission Law, 1986 (PNDCL 154); and the Minerals (Royalties) Regulations, 1987 (LI 1349). PNDCL 153, the 1986 mining law had been instrumental in attracting \$4 billion in foreign investment to the Ghanaian mining industry, through the end of 1999. Act 475, 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 Petroleum (Exploration and Production) Law, 1984 (PNDCL 84), sets out the policy framework and describes the role of institutional participants, namely the Ministry of Mines and Energy, which regulates the industry. Ghana National Petroleum Corporation (GNPC), which is empowered to undertake petroleum exploration and

¹Where necessary, currency values have converted from Ghanaian cedis (C) to U.S. dollars at the rate of C2,647=US\$1.00 for 1999 and C2,314=US\$1.00 for 1998.

production on behalf of the Government, is authorized to enter joint ventures and production-sharing agreements with commercial organizations; GNPC was established under the GNPC Law of 1983 (PNDCL 64). The 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 Ministry of Mines and Energy oversees all aspects of the Ghanaian mineral economy and is the grantor of mineral and energy exploration and mining leases. Within the Ministry, the Minerals Commission has responsibility for administering the Mining Act, 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, 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, which is 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.

Environmental Issues

Mining and the associated growth of communities has led to locally severe deforestation, erosion, and water pollution. Exploration and mining lease applications that encroach on designated Forest Reserves are subject to close review. Where sulfide gold ores have been roasted, the air has been polluted by sulfur and arsenic gas emissions. The roasting of gold ore, however, is being phased out in 2000 in favor of bio-oxidation leaching (BIOX), which yields more environmentally benign waste products. Mercury is widely used to amalgamate gold by artisanal miners in Ghana. Artisanal usage in particular has led to mercury contamination of rivers. The Government has an active program to promote the use of mercury retorts by small-scale miners, but educating the miners to appreciate the economic advantages of using them remains a problem. 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. Ghana's Environmental Protection Agency, which was established in 1994, is now operational and is working with the industry on addressing some of these problems.

Production

As shown in table 1, changes in production levels of Ghana's major mineral commodities over 1998 were mixed in 1999. In addition to the expansion in gold production, aluminum, cement, and manganese outputs increased by 86%, 15%, and 1%, respectively, from those of 1998. Bauxite and diamond production levels each decreased by 20% from those of 1998. The restoration of enough power supply to allow the beleaguered Volta Aluminum Co. Ltd. (Valco) to operate two more potlines contributed to the increase in 1999; Valco was Ghana's sole producer of aluminum. Reported sales of artisanal gold production to the PMMC and other licensed buyers increased by 23% in 1999 compared with those of 1998. An unknown quantity of artisanal gold production was, however, undocumented owing to theft, internal consumption for traditional gold jewelry and ceremonial artifacts, or alleged smuggling into neighboring countries. Data were lacking for this commerce, and estimates of its magnitude are not included in table 1. Cement and steel were the main mineral commodities produced chiefly for local consumption.

Trade

Virtually all Ghana's primary mineral production was exported, as was much of its secondary, or value-added, mineral output. In 1999, the value of all primary mineral commodity exports was estimated to be around \$894 million, or about 48% of total exports of \$1.88 billion. Ghana's main processed mineral commodity export was aluminum, which was toll refined by Valco from imported alumina. On the basis of the average price of aluminum of \$0.655 per pound in 1999, aluminum production of 104,000 t was valued at about \$150.2 million. According to the Ghana Minerals Commission (2000), the total value of raw mineral exports was \$744.2 million in 1999. Gold sales were valued at \$710.8 million; manganese ore, \$16.7 million; diamond, \$9.4 million; and bauxite ore, \$7.3 million. Gold export earnings remained level despite the 9% increase in production to \$689.5 million compared with \$687.8 million in 1998 and accounted for 36.7% of the total exports of \$1.88 billion in 1999.

Ghana's mineral commodity imports were dominated, in order of value, by petroleum products, alumina, fertilizers, and clinker for cement. The value of these imports was not available, but on the basis of previous years, it was estimated to range between \$300 million to \$400 million. Total imports of all goods in 1999 was approximately \$2.23 billion. Data on imports of mine and mill equipment, explosives, and reagents, such as sodium cyanide for gold leaching, were unavailable, but given the level of gold production and new mine developments, the value probably exceeded \$250 million per year between 1997 and 1999.

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., GNPC, and the state-run Tema

Steel Co.

Efforts to attract foreign investment in recent years have brought in a wide range of companies from Australia, Canada, Ireland, South Africa, the United Kingdom, and the United States that now hold controlling interests in most of the mines in Ghana (table 2). In addition, more than 200 reconnaissance and prospecting licenses were held by foreign companies, the level of active exploration, however, began to drop significantly in 1999, in part, owing to the decrease in exploration risk capital and the weakening gold price. Kaiser Aluminum Corp. of the United States, maintained its longstanding 90% interest in the Valco aluminum smelter, and was the major consumer of hydroelectric power supplied by the state-owned Volta River Authority (VRA).

Commodity Review

Metals

Aluminum and Bauxite.—The Valco smelter at Tema Harbor used prebake technology and toll-processed imported alumina supplied by Kaiser and Reynolds Aluminum Co., which was its minority shareholder, 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. Valco's fluctuating operating level resulted from the amount of power that it was allocated by the VRA under a contract agreement that is valid until 2017. The operating level during the past 5 years has ranged from one to four out of a total of five potlines. During 1999, Valco operated an average of three potlines at a rate of 52% of its 200-metric-ton-per-year (t/yr) capacity but was operating four potlines by yearend. In December 1999, Valco and the VRA reached an agreement that will provide for sufficient power to operate four of Valco's potlines in 2000 and 2001. An increase in the price of power in 2000 will be partially offset that year and in 2001 by the compensation Valco will receive from the VRA for its inability to meet power supply contract obligations in 1998 and 1999 (Kaiser Aluminum Corp., March 3, 2000, Form 10-K for 1999 to U.S. Securities and Exchange Commission, p. 7, 14, 22, accessed October 12, 2000, at URL <http://www.sec.gov/Archives/edgar/data/54291/0000950129-00-001099.txt>).

Ghana Bauxite Co. Ltd. (GBC), which was owned by Alcan Aluminum Ltd. of Canada, operated the country's only bauxite mine at Awaso, which has been in production since 1941. The Awaso bauxite deposits are comprised of five bauxite-capped plateaux; only the Inchiniso plateau was being mined in 1999. The Inchiniso ore horizon is 21 meters (m) thick with an average grade of 52% aluminum trioxide and a range of 48% to 64%. The bauxite is mostly gibbsite, which is an alumina trihydrate that is used for chemical purposes and such other products as abrasives, porcelain, and toothpaste as opposed to its use as a feedstock for the manufacture of aluminum. Overburden averages about 2 m thick. The ore is blasted and crushed and moved downhill on a 2,250-m-long belt conveyor to a washing plant to remove clay and silica impurities. Ore is then shipped by rail in thirty 25-t rail wagons to the port of Takoradi for export. Up to 100,000 t of bauxite can be

stockpiled at Takoradi port facilities. The poorly maintained railroad has been a constraint on exports, and as a result, GBC limited mining to one shift per day in 1999. The mine was supplied with electrical power by the VRA from the National Grid but maintained a 1,200-kilowatt-hour backup power generator. In 1999, GBC operated at about 70% of its 500,000 t/yr of salable bauxite capacity. GBC planned an expansion program to increase export capacity to 1 million metric tons per year (Mt/yr) of bauxite by 2003, which will also require an upgrade of the railroad from the mine to the export harbor at Takoradi (Ghana Bauxite Co. Ltd., 1999; Ghana Chamber of Mines, 2000, p. 29).

Gold.—Faced with declining gold prices and increasing energy costs, several of the small gold alluvial and tailings recovery operations closed during 1999. Of the 12 remaining major gold mines in operation in Ghana in 1999, 5 accounted for a total of 70% of the recorded gold output of the country—the Obuasi Mines (28.4%), the Damang (11.6%), the Teberebie (10.5%), the Bibiani (10.0%), and the Tarkwa (9.8%). A breakdown of gold production, by mine, from 1995 to 1999 is shown in table 3.

In 1999, Ashanti Goldfields Co. Ltd.'s corporate gold production from mines in Ghana, Guinea, and Zimbabwe was 48,569 kilograms (kg), of which approximately 78% came from operations in Ghana. Ashanti had a major financial setback in late 1999 when a sharp \$86 upward reversal in the gold price caused a shift in the value of its gold hedge book from a positive \$290 million to a negative \$570 million. Despite avoiding bankruptcy from the resulting margin calls, the company was forced to sell some of its assets. Intercession by the Government, which was a minority shareholder, helped forestall a takeover and persuaded hedgeholders to accept "an issue of equity warrants over 15% of the company's shares in exchange for 3 years of margin free trading and two subsequent years during which margin limits will be higher than they were in 1999." As part of its long-term debt restructuring, Ashanti had to sell a 50% interest in its major new Geita gold mine development in Tanzania. In April 2000, Ashanti signed a Heads of Agreement with AngloGold Ltd. to sell its 50% interest to AngloGold by September 30, 2000. AngloGold will pay Ashanti \$205 million in cash and will procure or provide \$130 million of the project financing to the Geita project (Ashanti Goldfields Co. Ltd., 2000, p. 5). As part of its belt-tightening budget measures aimed at reducing cash operating cost to \$150 per ounce in 2000 from \$200 per ounce in 1999, Ashanti planned to phase out all surface mining operations, which included the Oxide, the Tailings, and the Pompora Treatment Plants, at the Obuasi Mine by mid-2000. The closures will involve the retrenchment of 2,000 workers, or more than 20% of the Obuasi workforce. By mid-2000, all production of underground sulfide ore will be optimized to produce 17,100 kilograms per year (kg/yr) of gold. At that time, all underground ore will pass through the upgraded Sulfide Treatment Plant (STP), which will use the BIOX process to treat 3 Mt/yr of ore.

With the cessation of surface mining, overall production at Ashanti's Obuasi mining complex, declined by 16% to 23,113 kg compared with that of 1998. The mine exploited quartz and

sulfide ores from a steeply dipping vein and shear zone system in lower Proterozoic greenstones of the Birimian Series. Gold ore grades had averaged about 20 grams per metric ton (g/t) of gold for much of the mine's century-long history but have declined to around 8 g/t in recent years as the ratio of quartz ore to sulfide ore from underground workings has decreased. The Obuasi underground mine delivered 2.35 million metric tons (Mt) of ore to the mill with an average grade of 7.86 g/t compared with 2.24 Mt of ore to the mill with an average grade of 8.57 g/t in 1998. At the Obuasi surface mine operations, 21.5 Mt of waste overburden was stripped, and 3.03 Mt of ore grading 3.03 g/t was mined compared with ore production of 3.22 Mt grading 3.26 g/t in 1998 (Ashanti Goldfields Co. Ltd., 2000, p. 24).

The Obuasi ore was processed at four treatment plants and a heap-leach operation. The Sansu STP was the world's largest BIOX gold treatment facility. The STP treated 2.32 Mt of ore grading 4.97 g/t in 1999 compared with 2.60 t of ore grading 5.29 g/t in 1998. It had a gold recovery rate of 76.9% and contributed 8,891 kg, or 38% of total Obuasi gold production in 1998 (Ashanti Goldfields Co. Ltd., 2000, p. 24).

Ashanti's Pompora Treatment Plant processed 1.61 Mt of ore with an average grade of 8.31 g/t yielding 11,121 kg of gold at a recovery rate of 83%. At the Oxide Treatment Plant, 1.34 Mt of material were processed grading 1.77 g/t yielding 1,752 kg of gold at a recovery rate of 73.9%. The Tailings Treatment Plant processed 1.76 Mt of ore grading 2.31 g/t yielding 1,347 kg of gold at a recovery rate of 33.1% in 1999 (Ashanti Goldfields Co. Ltd., 2000, p. 24).

At Bibiani, which was one of Ashanti's three other Ghanaian mines, the mine and carbon-in-leach (CIL) plant produced 8,146 kg of gold by yearend from the treatment of 3 Mt of ore, grading 3.65 g/t in its first full year of operation (Ashanti Goldfields Co. Ltd., 2000, p. 24).

Ashanti's Iduapriem Mine was nearing depletion by yearend 1999; in May 2000, however, Ashanti announced its intention to buy the Teberebie Mine, which is adjacent to the south of Iduapriem and owned by Pioneer Goldfields Ltd. of the United States, for \$18.8 million. The acquisition of the Teberebie Mine will provide Ashanti with additional ore reserves that contain at least 49,800 kg, and will extend the Iduapriem mine's life by approximately 8 years at a production rate of more than 4,665 kg/yr of gold. Ashanti, in turn, signed an agreement to sell Teberebie's North pit, gyratory crusher and heap-leach pads to Gold Fields (Ghana) Ltd., which was the owner of the Tarkwa Mine, which is adjacent to the north of Teberebie (Ashanti Goldfields Co. Ltd., May 12, 2000), Ashanti Goldfields Co. Ltd. announces acquisition of Pioneer Goldfields Ltd., accessed June 1, 2000, at URL <http://www.ashantigold.com/12may2000.htm>). The sulfide reserves, which were no longer economically treatable at Teberebie's heap-leach operation will be trucked to the Iduapriem CIL plant for treatment. After operating at a loss for 3 years, Pioneer decided to discontinue operations at Teberebie during the second quarter of 1999 and ended mining by yearend (Pioneer Goldfields Ltd., March 22, 2000, Pioneer Goldfields Ltd., Form 10-K, U.S. Securities and Exchange Commission, accessed August 11, 2000, at URL <http://www.sec.gov/Archives/edgar/data/733060/0000950135-00-001553.txt>).

At Ashanti's Ayanfuri Mine, 1.29 Mt of heap-leach ore grading 1.33 g/t was mined compared with 1.48 Mt grading 1.47 g/t in 1998; an increase in the gold recovery rate from 70% to 85.3% accounted for the increased gold production. In February 1999, Ashanti bought the surface rights to the nearby Kubi Concession from Nevsun Resources Ltd. and an option on underground rights exercisable within 4 years to acquire additional feed for Ayanfuri. Ashanti will mine the Kubi ore under a royalty arrangement with Nevsun and truck the ore to the Ayanfuri heap-leach facility for recovery. Nevsun had announced a November 18, 1998, resource estimate for the Kubi property that showed a total indicated resource of 15,085 kg and an additional inferred resource of 8,770 kg of contained gold (Nevsun Resources Ltd., February 18, 1999, Agreement—Kubi property mine development with Ashanti Goldfields Co. Ltd., press release, accessed January 20, 2000, at URL <http://www.nevsun.com/news/nsu99-02.html>). After 2000, operations at Ayanfuri were dependent on the success of ongoing exploration in the area.

On January 25, 2000, Ashanti purchased Birim Goldfields Inc. of Canada's Dunkwa-Mampon property and its 21,770-kg gold resource for \$1.5 million and future royalties. Approximately 30% of the gold resource at Mampon is extractable by open pit. Mampon is along the Ashanti structural trend and south of Obuasi. The Dunkwa property had been previously held by Battle Mountain Gold Co. of the United States (Birim Goldfields Inc., 2000, p. 5).

At the end of 1999, Ashanti reported measured and indicated resources of 80.8 Mt at an average grade of 8.1 g/t that contained 659,400 kg of gold at Obuasi, of which 58.5 Mt of underground resources at a grade of 10.1 g/t of gold will be the focus of future production. Measured and indicated gold resources at other mines included 28 Mt at a grade of 1.5 g/t at Iduapriem, 16 Mt at a grade of 2.3 g/t at Bibiani, and 2.3 Mt at a grade of 1.7 g/t at Ayanfuri. Contained within these resources, Ashanti reported proven and probable ore reserves as of December 31, 1999, based on a gold price of \$300 per troy ounce, of 49.7 Mt at a grade of 7.3 g/t that contains more than 363,900 kg of gold at Obuasi, 15.2 Mt at a grade of 2.5 g/t at Bibiani, 8.2 Mt at a grade of 1.1 g/t at Iduapriem, and 0.9 Mt at a grade of 1.6 g/t at Ayanfuri (Ashanti Goldfields Co. Ltd., 2000, p. 26). Ashanti also maintained active exploration programs in Botswana, Burkina Faso, Democratic Republic of the Congo, Ghana, Guinea, Mali, Senegal, and Tanzania, although exploration in 2000 will be limited to areas adjacent to existing mines and mineralized exploration targets previously identified.

In its first full calendar year of operations in 1999, Gold Fields (Ghana) Ltd.'s major new Tarkwa surface mine, processed 6.30 Mt of ore that yielded 6,806 kg of gold. The \$125 million Tarkwa open pit, heap-leach project will produce 7,775 kg/yr of gold by 2000; the company planned to double production to 15,550 kg/yr of gold. The underground mining at Tarkwa, which has produced gold from the quartz pebble "Banket" conglomerate of the upper Tarkwaian Group since 1878, ceased operations in October 1999. The company reported the following reserves and resources at Tarkwa as of June 30, 1999, based on a gold price of \$285 per troy ounce and a cut-off of 0.5 g/t. In-situ, near surface resources at Tarkwa are

located in nine deposits that contain 291.6 Mt of ore at an average grade of 1.40 g/t for a total resource of 447,780 kg of contained gold. The Akontasi Ridge and the Pepe open pit, which were the two largest deposits, contain resources of 84.4 Mt at a grade of 1.3 g/t and 67.8 Mt at a grade of 1.5 g/t, respectively. The other deposits are, in order of descending gold content, Akontasi East, Kottraverchy Ridge, Mantraim, Akontasi Underground, Pepe West Underlap, Kottraverchy North, and the Pepe N&S pits (Ghana Chamber of Mines, 2000, p. 30).

Gold Fields Ltd. reported that its Tarkwa operations treated 8.02 Mt of ore at a grade of 1.1 g/t that yielded 9,195 kg of gold, chiefly from the Akontasi East Reef. With the acquisition of Teberebie facilities in 2000, Gold Fields was expected to increase production to more than 11,820 kg/yr of gold by increasing ore tonnage throughput from the Phase II level of 650,000 metric tons per month (t/mo) to 900,000 t/mo. Heap leaching of Teberebie ore was expected to begin in September or October 2000. An initial prefeasibility study on installing a phase III, CIL plant at Tarkwa by 2002 was favorable, and work on a full feasibility study will begin in the second half of 2000. The CIL plant will allow Gold Fields to treat unweathered ore up to 180 m below the surface after the top 18 to 20 m of weathered and heap-leachable ore is mined. As of June 30, 2000, Gold Fields reported that total mineral resources at Tarkwa were 285.8 Mt grading 1.5 g/t; this included measured resources of 255.7 Mt grading 1.5, indicated resources of 28.4 Mt at a grade of 1.9 g/t, and inferred resources of 1.7 Mt grading 1.6 g/t. Included within the total mineral resource were 133.7 Mt of proved reserves at a grade of 1.4 g/t and 9.2 Mt of probable reserves at a grade of 1.2 g/t (Gold Fields Ltd., Commentary—Managing Directors Report—Operational highlights, Gold Fields Ltd. 2000 annual report, accessed October 12, 2000 at URL http://www.goldfields.co.za/annual_report/2000/commentary.htm). Mine life expectations project 6 years of heap leaching from 2000 to 2005 to recover 93,300 kg of gold and another 6 years of CIL processing to recover at least an additional 217,700 kg of gold.

Abosso Goldfields Ltd., which was owned by Ranger Minerals Ltd. of Australia, operated the Damang gold mine and CIL plant, which are located 30 kilometers (km) northeast of Tarkwa. Production shown in table 2 for Damang is for calendar year 1999. For Ranger Minerals' financial year ending June 30, 2000, however, Abosso had mined 3.94 Mt of run-of-mine ore at a grade of 3.05 g/t gold and 1.89 Mt of low-and medium-grade ore, averaging 1.21 g/t gold. An additional 7.7 Mt of waste was removed. The mill treated 4.12 Mt of ore at a grade of 2.81 g/t to yield 10,805 kg of gold based on a 93% recovery rate (Ranger Minerals Ltd., 2000, Financials—Quarterly reports—Quarterly report ending 31 June 2000, accessed September 11, 2000, via URL <http://www.ranger.com.au>). The Damang ore occurs in Tarkwaian quartz pebble conglomerates and is overprinted with fracture-controlled, mineralized hydrothermal quartz veining, which gives localized high-grade zones from 3 to 9 g/t. Mineral resources were revised as of December 31, 1999, by using a cut-off grade of 1.0 g/t gold. Mineral resources were reported to be 18.3 Mt measured at a grade of 2.23 g/t, 23.9 Mt indicated at a grade of 1.83 g/t; and 15.5 Mt inferred at a grade of 2.05 g/t, for

a total resource of 57.6 Mt at an average grade of 2.02 g/t, that contained more than 116,000 kg of gold. The company generated new in-situ mineral reserve estimates from its resource model by using a cut-off grade of 1.1 g/t gold for hard primary ore, 0.5 g/t for soft oxide ore, and a realized life of mine average gold price of \$330 per troy ounce. The model estimated proved reserves to be 19.6 Mt with an average grade of 2.18 g/t and probable reserves to be 8.4 Mt with an average grade of 1.86 g/t (Ranger Minerals Ltd., 2000, Financials—Quarterly reports—Quarterly report ending 31 March 2000, accessed September 11, 2000, via URL <http://www.ranger.com.au>). Studies were continuing to optimize reserves, pit engineering and ultimate mine life beyond current projections of 4 years for mining and an additional 7 years for leaching.

Resolute Amansie Ltd., which was owned by Resolute Ltd. of Australia, operated the Obotan gold mine and CIL plant, which were located near Manso-Nkran, 47 km west of Obuasi. The Obotan project included the Adubiaso Hill and the Nkran Hill surface deposits. The gold mineralization occurs within sheared and folded Birimian metagreywackes and phyllites associated with tonalite dikes, quartz veins, and the presence of bleaching, chloritic, ankeritic and arsenopyrite alteration. With the depletion of near-surface oxide ore at Adubiaso Hill, Resolute was installing a new secondary/tertiary crusher to treat harder primary ore that could be encountered by mid-2000. Ore was milled to 80% passing 108 millimeters and fed to the CIL plant. The CIL plant has the capacity to process 2.2 Mt/yr of ore at a 93% gold recovery rate through seven 1,300-cubic-meter CIL agitation tanks and a 5-t gold recovery circuit. Resolute reported that total resources as of June 30, 1999 were 34.5 Mt at a grade of 2.22 g/t gold, which included reserves of 6.1 Mt at a grade of 2.46 g/t (Resolute Limited, 2000, Obotan gold project—Ghana—Gold mines, May 3, 2000, via URL <http://resolute-ltd.com.au>). Production was expected to exceed the design capacity of 3,730 kg/yr of gold. In light of the low gold price, the company was continuing to evaluate optimum minable reserve levels, which included the evaluation of possible underground mining of reserves below the Nkran Hill open pit. Nkran Hill reserves were revised as of March 30, 2000, to 2.3 Mt of ore at a grade of 2.3 g/t of gold. In March 2000, Resolute acquired a 90% interest in Ghana Mining Investments Pty. Ltd., which held a 90% interest in the Obenemasi Gold Mines Ltd. Konongo gold project [Resolute Ltd., April 27, 2000, Obotan, Ghana (Resolute Ltd.—90%)—Report on activities for the quarter to 31 March 2000, accessed May 3, 2000, via URL <http://www.resolute-ltd.com.au>).

Satellite Goldfields Ltd., which was owned by Glencar Mining plc of Ireland through its Wassa Holdings Ltd. subsidiary, operated the Wassa gold open pit and heap-leach project, which was located about 35 km northeast of Tarkwa. The Wassa deposit is located along the major regional Wassa shear zone on the contact between the Lower Birimian metasediments and the Upper Birimian volcanics. The main Wassa pit occurs within a broad recumbent southwest-plunging synclinal structure that folds a sequence of phyllitic quartz sericite metasediments, intrusive diorites, and a suite of felsic volcanic rocks. Vein and stockwork mineralization occurs in the felsic and phyllitic lithologies. Remaining proven and

probable ore reserves as of December 31, 1999, were 15.1 Mt at a grade of 1.52 g/t. Measured and indicated resources were estimated to be 32 Mt at a grade of 1.34 g/t of gold. The ore body at Wassa remained open laterally and at depth and exploration drilling was ongoing to increase the resource base to extend the current (1999) 6-year life of the mine. Since opening in late 1998, 3.58 Mt of run-of-mine ore grading 1.78 g/t has been sent to the heap leach dumps, set up in three lifts of 8 m height each. The ore is crushed, agglomerated with cement, stacked, and leached on a recovery cycle that was projected to run 90 to 120 days but turned out to be much longer. Gold was recovered from leach solutions in an on-site absorption-desorption recovery plant. Poor recovery of gold from the heap leach, however, limited gold production to 2,709 kg in 1999. Recovery was less than 50% compared with the forecast level of 89%. The lower-than-planned cash flow required a renegotiation of the debt repayment schedule. During early 2000, a new leach pad was being designed to allow improved solution control and management that, in turn, should contribute to better recoveries and increased production. The company expected gold production to be between 3,200 and 3,400 kg in 2000. Glencar Mining plc and Moydow Limited, which was its joint-venture partner, were exploring the Asheba and the Kanyankaw concessions south of Tarkwa (Glencar Mining plc, 2000, p. 1- 8).

Bogosu Gold Ltd. (BGL) operated the Bogosu mine and CIL plant which were located between Prestea and Dunkwa. On September 30, 1999, BGL was acquired by Golden Star Resources Ltd. of Canada and Anvil Mining NL of Australia from a consortium of banks led by the International Finance Corporation by assuming \$34 million of BGL debt. The Bogosu deposit is located along the southwest-northeast Ashanti structural trend within a highly sheared graphite- and arsenopyrite-bearing fault, which is locally referred to as the “Crush Zone.” The shear zone separates barren footwall Birimian metavolcanics from mineralized hanging wall Birimian metagreywackes and phyllites. Golden Star reported proven and probable ore reserves as of December 31, 1999, using a \$290 per troy ounce gold price, to be 3.23 Mt at a grade of 2.2 g/t gold. Reserves are contained in the Southern, Central, and Northern Pits and in stockpiles. Oxide ore accounted for 60% of the reserves, and transitional ore, for 40%. In addition, BGL reported additional mineral resources, using a \$325 per troy ounce gold price, of 2.34 Mt of measured resources grading 1.9 g/t, 12.5 Mt of indicated resources at a grade of 3.1 g/t, and 1.05 Mt of inferred resources at a grade of 2.4 g/t gold. Resources were distributed among oxide (6%), transitional (16%), and sulfide (78%) ores. Exploration continued to focus on expanding oxide reserves and sulfide resources. During 1999, BGL milled 2.16 Mt of ore at a grade of 2.31 g/t that yielded 4,058 kg of gold at a 81.4% recovery rate. About 80% of production came from the Northern (Dumasi-Chujah) Pits. For 2000, BGL planned to mill 5,748 metric tons per day of ore with an average head grade of 2.45 g/t gold and with a budgeted gold recovery of 69% (Golden Star Resources Ltd., 2000, p. 3-6, 27-32). Subject to higher gold prices, BGL was evaluating the feasibility of adding a new ball mill, flotation circuit, and BIOX plant to treat 1.4 Mt/yr of refractory sulfides at an 85% gold recovery rate, which would add 6 to 8 years to the life of

the mine. In 1999, the CIL plant had the capacity to treat 2.1 Mt/yr of oxide ore or 2 Mt/yr of transitional ores, which require more milling and a longer leach residence time. Gold recovery rates in the transitional ores can drop to between 45% and 55%. BGL obtained its power from an onsite VRA power substation but also maintained a 6.4-megawatt (MW) backup diesel power generator. BGL was also negotiating with Barnato Exploration Ltd. and Western Areas Ltd. of South Africa to purchase the adjacent Barnex Prestea Ltd. property. Exploration by Barnex around Prestea in 1997-98 had identified a near-surface resource of 145,000 kg of gold (African Mining Bulletin, 1998).

In 1999, Bonte Gold Mines Ltd., which was owned by Akrokeri-Ashanti Gold Mines, Inc. of Canada, treated 1.52 million cubic meters of material that yielded 1,498 kg of gold from the small alluvial mining operation on the Esaase concession. Mining operations and processing equipment were moved from Esaase to the Jeni River. The increase in processing capacity from 160 to 300 cubic meters per hour in 1999 should increase annual production for 2000 to around 2,100 kg of gold (Akrokeri-Ashanti Gold Mines, Inc., 2000, Akrokeri-Ashanti Gold Mines, Inc., accessed October 22, 2000, at URL <http://www.aagm.com/homepage.htm>).

More than 200 exploration licences for gold were held by companies from Australia, Canada, Europe, Ghana, South Africa, and the United States in 1998, with a few exceptions, however, most were inactive by 1999. Advanced-stage exploration projects included Normandy Ghana Gold Ltd.'s Yamfo-Sefwi project, which was owned by Normandy Mining Ltd. of Australia. The project (formerly known as the Gold Fields Centenary gold mining project) is located in the Yamfo-Sefwi greenstone belt in west-central Ghana near Sunyani and Kenyasi, about 60 km east of the border with Côte d'Ivoire. During several transactions in 1999, Normandy acquired a 90% interest in the project through the restructuring of assets of the LaSource Joint Venture between Normandy Mining and the Bureau de Recherches Géologiques Minières of France and by the purchase of Gold Fields equity interest in the Centenary project. Normandy Mining reported mineral resources to be 42.2 Mt of measured resources at a grade of 2.3 g/t, 16.8 Mt of indicated resources at a grade of 2.2 g/t, and 16.7 Mt of inferred resources at a grade of 2.0 g/t gold. In addition, Normandy had a 42.3% joint venture interest in Moydow International's adjacent Ntoroso property, where inferred resources were reported to be 14 Mt at a grade of 2.6 g/t gold. The two deposits have a combined gold content of 205,600 kg (6.61 million troy ounces). The completed feasibility study on the Yamfo-Sefwi project estimated that capital costs of \$152 million would be required to develop 15 pits at Bosumkese, Kenyase, Subenso, and Yamfo and a treatment plant with an initial capacity of 3.5 Mt/yr, which would process oxide (40%) and sulfide (60%) ore. The plant flowsheet incorporated primary crushing, semi-autogenous grinding, and ball milling followed by a CIL circuit. A feasibility study to incorporate Moydow's Ntoroso deposit, which was based on toll processing of Ntoroso ore at the Yamfo-Sefwi treatment plant and an increase in plant capacity to 5 Mt/yr of ore, was expected to be completed by mid-2001 (Normandy Mining Ltd., 2000, p. 15-17).

Chirano Gold Mining Ltd., which was owned by Red Back

Mining NL of Australia (95%), continued exploration drilling at its Chirano property, which is located adjacent to the Ghana Bauxite Mine at Awaso. Mineral resources were reported to be 13.46 Mt at a grade of 2.4 g/t in seven prospects along 4 km of the Chirano Shear Zone, at Akota extension, Akota North, Obra Paboase, Sariehu, Suraw, and Tano. Obra, which was the largest of these, contained 7.8 Mt at a grade of 2.0 g/t. A prefeasibility study that looked at a 1.5 to 2.0 Mt/yr processing facility was scheduled for completion in August 2000 (Red Back Mining NL, 2000). In addition to its work on the Aboronye and the Mampon zones of its Dunkwa license, Birim Goldfields was exploring its Bui area licenses in joint venture with Dominion Mining Ltd. of Australia, and St. Jude Resources Ltd. of Canada continued drilling of the Adoikrom, the Dabrokrom, the Father Brown, and the Seikrom mineralized zones of its Hwini-Butre Concession.

Other exploration programs included Shiega Resources Corp. of Canada (formerly Alpine Exploration Corp.), which acquired Union Mining Ltd. of Ireland's Karemenga and Shiega gold prospects near Bolgatanga in northern Ghana and was working the Nkroful mining lease, which is 80 km west of Takoradi, in joint venture with Ashanti and the adjacent Ebi/Teleku Bokazo license in joint venture with SEMAFO, Inc., of Canada. SEMAFO had reported drill-indicated resources at Teleku Bokazo of 1.7 Mt of oxide ore at a grade of 2.6 g/t and 1.1 Mt of sulfide ore at a grade of 3.1 g/t (Shiega Resources Corp., July 6, 1998, Shiega Resources Corp.—Extension of Nkroful agreement with SAMAX Gold and participation in new agreement with SEMAFO, accessed July 7, 1998, at URL <http://biz.yahoo.com/prnews/980706/shiega-agr-1.html>). Kenor ASA of Norway was pursuing four gold geochemical anomalies on the Wa license in northern Ghana and Shield Equities Ltd. of Australia had identified gold resources of 11,570 kg and 5,600 kg at its Manso Nkwanta and Ashanti Reconnaissance projects, respectively (Leo Shield Exploration NL, 1999, West African Gold exploration, accessed October 24, at URL <http://leoshield.com.au>). Resolute Ltd. was joint-venturing with BHP World Minerals Ltd. of Australia on 16 concessions in Ghana and 4 adjacent countries. Carlin Resources Corp. and EXP Resources Ltd. of Canada were jointly exploring the Chichiwere property, which is 40 km northeast of the Bibiani Mine, and the Canadian joint venture of African Selection Mining Corp. and Golden Eagle Mining Ltd. was drilling on the Grupe license in northern Ghana.

Manganese.—Ghana Manganese Company Limited's Nsuta-Wassaw open pit mine near Tarkwa, which was privatized in 1995, was the only producer of manganese ore in Ghana. The manganese ore is found associated with metatuffs and metaturbidites within the Upper Birimian greenstone belt. Most of the manganese oxide ores, which have been mined since 1916, have been depleted. Production during 1999 was in transitional ore referred to as "Carbox" and in manganese carbonate ore. Total mine production of manganese ore was 541,412 wet metric tons of run-of-mine ore with 638,937 dry metric tons exported. Dried ore is moved 63 km by railroad or 95 km by truck to the export harbor at Takoradi. Mined manganese carbonate ore had a typical composition of 30% manganese, 12% silica, 1% iron, and 0.065% phosphorus, with

a 1.5% to 2% moisture content (Tex Report, 2000). Ore zones are narrow (from 10 to 12 m wide) and require smaller scale, selective mining. GMC's management has been reevaluating the mineral reserves and reinvesting in mine and plant equipment upgrades, which have included the building of a new slimes dam. With help from a European Union "Sysmin" loan, GMC expected that the railroad export line should be upgraded by 2002. The new investments will allow GMC to produce around 600,000 t/yr of manganese carbonate ore for another 10 to 15 years. During 2000, GMC will be removing overburden from Hill D North, which is one of seven minable areas, and expected to reach ore by yearend. Except for a few hundred metric 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 exported for sinter feed to silicomanganese plants in China, Finland, Norway, Saudi Arabia, Ukraine, the United States, and Venezuela.

Industrial Minerals

Cement.—Ghana Cement Works Ltd. (Ghacem) operated the country's only two cement plants at the port cities of Takoradi and Tema. Each plant had the capacity to produce 1.2 Mt/yr of cement from imported clinker, gypsum, and limestone. During 1999, Heidelberg Zement AG of Germany acquired a 94.5% interest in Ghacem from Scancem International AG of Norway (60%) and the Government. The company operated essentially as a monopoly but faced some competition from imported cement from Togo in 1999 and early 2000. During 1999, the Takoradi plant produced around 1,860,000 t of cement and the Tema plant, around 750,000 t of cement. Up to a third of the Takoradi plant output was sold to the mining sector, for construction and for use as a binder in gold heap-leach dumps.

Diamond.—In 1999, the Minerals Commission reported a total production of 684,033 carats of diamond. The majority of diamonds were recovered by artisanal miners from alluvial and raised terrace gravel workings in the Birim Valley. On the basis of sales to PMMC, artisanal output was reported to be 442,967 carats with an average sales value of \$18 per carat. Production from Ghana Consolidated Diamonds Ltd.'s Akwatia diamond mine was 205,025 carats with an average sales value of \$19.80 per carat. Akwatia is located about half way between Accra and Kumasi and was the only formal operating diamond mine in Ghana. Diamond production from galamsey miners was sold to the PMMC, Miramex, and other licensed buying agents. Galamsey is the local term for artisanal and small-scale gold and diamond miners and derives from the pidgin English expression, "Gather them, and let me sell them." The Ministry of Mines estimated that as many as 60,000 artisanal workers were involved with small scale gold and diamond mining, primarily from alluvial operations (Ghana Minerals Commission, 2000).

Other Industrial Minerals.—Carmeuse Lime Products (Ghana) Ltd., which was owned by Carmeuse SA of Belgium, operated out of Sekondi and produced limestone and lime, along with seashells, which were supplied to Ashanti Goldfields for use in its BIOX gold-treatment plant at Obuasi. The Ministry of

Mines estimated that from 20,000 to 30,000 people were involved in the small-scale production of industrial minerals, which included kaolin, limestone, salt, and sand and gravel.

Mineral Fuels

Ghana's estimated 16.5 million barrels of recoverable oil reserves are located in the following sedimentary basins—Accra/Keta, Cape Three Points, Saltpond, Tano, and Voltaian. Exploration offshore Ghana began in the 1970's, and discoveries were made in waters off western Ghana (South Tano, 1978) and central Ghana (Saltpond, 1977). Phillips Petroleum Co. of the United States, which discovered the South Tano field, made a second find with the North Tano field in 1980. Although significant gas reserves were found in the Tano fields, Phillips deemed the finds commercially unviable and relinquished them in 1982. The GNPC subsequently assumed operations of the Saltpond and the Tano fields. In 1999, GNPC produced an estimated 6,000 barrels per day (bbl/d) of crude oil from the Saltpond field. In March 2000, Dana Petroleum plc and the GNPC announced the discovery of oil in the offshore Western Tano Contract Area with a flow rate of up to 1,000 bbl/d (U.S. Energy Information Administration, June 2000, Ghana—Country analysis briefs, accessed October 12, 2000, at URL <http://www.eia.doe.gov/emeu/cabs/ghana.html>).

Natural gas was first discovered in the Cape Three Points Basin in 1974. Tano gas reserves were estimated to be sufficient to power a 100- to 140-MW powerplant for a period of 15 to 20 years. The Tano Fields Development and Power Project (TFDPP), which was established to help meet the country's growing demand for power, is separated into two distinct sections—offshore field development and onshore power generation. The TFDPP's offshore portion will consist of the drilling of eight oil and gas wells on the Tano fields, installation of platforms and process facilities, construction of pipelines and hydrocarbon-gathering systems, and construction of an onshore production facility. The GNPC also planned to maximize oil production of the TFDPP by using horizontal drilling technology. Total cost of the TFDPP was estimated to be from \$450 million to \$500 million. Gas from reserves located in the Cape Three Points Basin or from Côte d'Ivoire's adjacent CI-01 Block would be used to meet any additional gas demand created by a possible expansion of the TFDPP's generation facilities.

In the planning stages since 1995, the West African Gas Pipeline (WAGP) would help relieve Ghana's chronic energy shortages by bringing in Nigerian natural gas that otherwise would be flared. In August 1999, Ghana signed an agreement with the Nigerian National Petroleum Corporation (NNPC) that committed it to buy about 85% of the total gas to be supplied by Nigeria under the WAGP project. Chevron Corp. of the United States became the official operator of the consortium in 1999. Chevron and Shell Exploration and Production Co. will supply initial deliveries of gas from their Escravos gas facilities beginning in 2002. The 998-km WAGP will run offshore, with spurs running onshore to Cotonou in Benin, Lome in Togo, and Effasu, Takoradi, and Tema, in Ghana. The \$400 million WAGP was expected to deliver an initial 3.4 million cubic meters per day (Mm³/d) of gas with the capacity to increase to

5.1 Mm³/d. Initial use of the gas would be to generate electricity, but plans to develop industries to use the gas were still being developed. Ghana estimated that it will save between 15,000 and 20,000 bbl/d of crude oil by taking gas from Nigeria to run its powerplants. In 1999, the WAGP consortium consisted of Chevron, Shell, Nigerian Gas Corporation, the GNPC, Société Beninoise de Gaz, and Société Togolaise de Gaz (Chevron Corp. August 16, 1999, Chevron named project manager for West African gas pipeline project, accessed October 12, 2000, via URL <http://www.chevron.com/newsvs/frame.html>).

Ghana's petroleum refining facilities consist of the 45,000-bbl/d Tema oil refinery (TOR) outside of Accra. TOR was operated by the Tema Oil Refinery Company, which was a subsidiary of the GNPC. TOR primarily processed imported Bonny Light/Brass River crudes from Nigeria and produced a variety of refined products for domestic consumption and export. In 1997, TOR's refining capacity was expanded from 25,000 bbl/d to 45,000 bbl/d. In February 1999, the GNPC signed a \$185 million contract with the Republic of Korea's Samsung Group to build a residual fluid cracking tower at the TOR. The project was scheduled to be completed in 2002 and will help boost the TOR's production of gasoline and distillates. The GNPC also planned to conduct a feasibility study on the construction of a cogeneration plant at TOR. The project, which may be developed as an independent powerplant, will be fueled by gas, which, as of 1999, was being flared at the facility. The size of the plant will be determined by the study, and any excess power generated would be sold to the national grid (U.S. Energy Information Administration, June 2000, Ghana—Refining and downstream oil activities—Country analysis briefs, accessed October 12, 2000, at URL <http://www.eia.doe.gov/emeu/cabs/ghana.html>).

In February 1999, the Government announced plans for a new power system development policy to eliminate the power outages that plagued the economy in 1998. The plan called for Government involvement in joint-venture projects and in expediting licensing of private sector power projects. In 1999, construction began on the joint venture project with the VRA to add 330 MW to the Takoradi thermal power complex, which will be completed between 2000 and 2001. The GNPC also commissioned construction of a 125-MW power barge facility and associated transmission lines financed by the Japanese Government. Other power-generation projects included a joint venture that involved the Electricity Corporation of Ghana in restoring 80 MW of generation capacity and upgrading the distribution network within the Tema industrial estate before yearend 2000 and the 220-MW independent thermal power project being sponsored by the mining companies to assure themselves of long-term reliable power supply, particularly for the bauxite, gold, limestone, and manganese industries.

Reserves

Alcan reported GBC bauxite reserves as of December 31, 1999, to be 6.5 Mt (Alcan Aluminum Ltd, March 29, 2000, Form 10-K, accessed October 12, 2000, at URL <http://www.corporatewindow.com/fl/al/al10k99.html#2>). Before acquired by Alcan, earlier work by the Government at

Awaso suggested the potential for bringing additional known resources of bauxite into the reserve category in the future. As reported by the former director of the Geological Survey Department, the country also 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 that totaled 278 Mt at a grade range of 48.9% to 51% alumina and 2.8% to 4.4% silica. The Kibi area bauxite resource totaled 120 Mt at a grade range of from 40.8% to 45.7% alumina and 1.8% to 3.9% silica (Kesse, 1985, p. 138).

Ghana had the second largest known gold resource in Africa outside of South Africa. Available information on reserves and resources of gold at individual mines have been discussed in the gold commodity section of this report. These published data from the existing mines and drilling at other exploration projects indicated a total defined Ghanaian resource for yearend 1999 of more than 2,050 t of contained gold, of which approximately 498 t of gold were in the minable reserve category; Ashanti Goldfields' Obuasi Mine had about 33% of this resource inventory. Ghana's total gold resources are undoubtedly larger than those reported, because of the known extent of gold-bearing Birimian and Tarkwaian host rocks, which have produced nearly 2,500 t of gold to date (1999); the extent of gold mineralization reported by other ongoing grassroots exploration drilling projects; and the widespread artisanal production of gold.

The only large established manganese ore reserves in Ghana were at the Nsuta-Wassaw Mine, although several other deposits are known. As of the end of 1998, Ghana Manganese reported minable reserves at Nsuta to be 209,000 t of manganese oxide and more than 9.7 Mt of manganese carbonate ore (Ghana Chamber of Mines, 1999, p. 31). By yearend 1999, however, the manganese oxide resources were essentially mined out. In 1964, the Ghana Geological Survey (GGS) had evaluated additional resources of manganese carbonate ore below the oxide deposits; reserves of high-grade carbonate ore were estimated to be 16.9 Mt at a grade of 31.2% manganese, 11.4% silica, and 0.06% phosphorus, and those of low-grade carbonate ore to be 11 Mt at a grade of 20.3% manganese, 21.4% silica, and 0.07% phosphorus (Kesse, 1985, p. 312).

Ghana's diamond resources are based on reserves at the Akwatia Mine and the widespread artisanal production of diamonds. The Akwatia Mine's reserves are located in river or raised terrace gravels along the Birim River. According to Ghana Consolidated Diamonds Ltd., ore reserves as of December 1998 included 119,000 cubic meters of terrace gravels and 12.1 million cubic meters of Lower Birim Valley and Middle Birim Valley gravels. In 1993, the average grade of Akwatia gravels had been reported to be about 1.19 carats per cubic meter (Ghana Chamber of Mines, 1994, 1999). Unlike the richer diamond fields in Guinea and Sierra Leone, very few large gem-quality stones are found at Akwatia. The departure of two potential major international mining company investors [one of which was De Beers Consolidated Mines Ltd. (South Africa)] in the early 1990's from Akwatia, however, put the economics of the deposits in question.

The U.S. Energy Information Administration estimated Ghana's recoverable oil reserves to be 16.5 million barrels and

natural gas reserves to be 2.38 billion cubic meters (Gm³) (840 billion cubic feet). This gas is primarily found in the Tano fields. Ghana's total gas resources, which include assessments of undiscovered resource potential, have been estimated to be from 44 to 59 Gm³ (U.S. Energy Information Administration, June 2000, Ghana—Oil and natural gas sections, Country Analysis Briefs, accessed October 12, 2000, at URL <http://www.eia.doe.gov/emeu/cabs/ghana.html>).

Infrastructure

The mining industry relied on a network of 953 km of railways; 39,000 km of roads, 30% of which are paved; and two main harbors at Takoradi and Tema to support mine logistics and product export. Most of the infrastructure was concentrated in the southern and southwestern parts of the country. Much of the country's road network remained in poor condition and was, therefore, unsuitable for transport of bulk mineral commodities. With the help of international aid and mining company loans repayable in services, several projects were underway to rehabilitate the western railroad track and equipment infrastructure to improve support for the export of manganese and bauxite ores through Takoradi and to provide logistical support to the major gold-producing areas. Tema, which is a shallow dredged harbor near Accra, handled the needs of the Valco aluminum smelter. Both ports handled imports of clinker for cement.

Essentially all Ghana's electrical generating capacity of approximately 7,000 gigawatt hours was from hydroelectric power. Because hydroelectric power is subject to the impact of periodic droughts in the region, power disruptions and rationing were common. This added to lost production and to higher costs for substitute thermal power for the minerals sector. Approximately 35% of the hydroelectric power capacity was consumed by the aluminum smelter at Tema, and an additional 10%, by the mining sector. Electricity exports from the VRA to neighboring countries has been seriously limited since 1994, and Ghana has begun to import electricity from Côte d'Ivoire.

Outlook

Despite a favorable political and investment climate, the prospects for continued development of the key mining sector of the Ghanaian economy were threatened by continued weak commodity prices, particularly for gold in 1999 and early 2000. Weak gold and cocoa prices have reduced the foreign exchange generation capacity of the country, and the resulting currency inflation was expected to begin slowing the economy in 2000. Losses suffered by Ashanti Goldfields from gold hedging margin calls in 1999 has slowed the company's aggressive expansion of operations seen during the 1990's. On the basis of a review of gold company closure, expansion, and new investment plans, gold production appears to have peaked in 1999 at 81 t. Gold production is expected to decline to 75 t in 2000 and 2001. Development of the new Yamfo-Sefwi gold deposit could see national production return to the 79- to 81-t range between 2002 and 2004 but taper off again as the known and economic gold resources at the Bogosu, the Damang, and the Obaton Mines become depleted. A 15% to 25% increase in

the world gold price, however, could stimulate new exploration, access to lower grade ores, and extend the life of these mines. 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. Although new gas fueled powerplant developments will help mitigate this problem, the long-term solution rests with implementation of the West Africa Gas Pipeline.

References Cited

- African Mining Bulletin, 1998, Ghana—Prestea underground closed, but surface deposits to be mined: African Mining Bulletin, no. 87, December 11, E-mail edition, unpaginated.
- Ashanti Goldfields Co. Ltd., 2000, Annual Ashanti Goldfields Co. Ltd. report, 1999: Accra, Ghana, Ashanti Goldfields Co. Ltd, March, 63 p.
- Birim Goldfields Inc., 2000, Annual Birim Goldfields Inc. report for fiscal year ending March 31, 2000, Montreal, Canada, Birim Goldfields Inc., April, 21 p.
- Ghana Bauxite Co. Ltd., May 1999, A profile of Ghana Bauxite Company Ltd.: Awaso, Ghana, Ghana Bauxite Co. Ltd., 14 p.
- Ghana Chamber of Mines, 1994, Annual Chamber of Mines report, 1994: Accra, Ghana, Ghana Chamber of Mines, 50 p.
- 1998, Annual Chamber of Mines report, 1997: Accra, Ghana, Ghana Chamber of Mines, 49 p.
- 1999, Annual Chamber of Mines report, 1998: Accra, Ghana, Ghana Chamber of Mines, 55 p.
- 2000, Annual Chamber of Mines report, 1999: Accra, Ghana, Ghana Chamber of Mines, 54 p.
- Ghana Minerals Commission, 2000, Statistics on Ghana's mineral exports (1997-99): Accra, Ghana Minerals Commission, 1 p.
- Glencar Mining Plc., 2000, Annual Glencar report, 1999: Glencar Mining Plc., Dublin, Ireland, June, 465 p.
- Golden Star Resources Ltd., 2000, Annual Golden Star Resources Ltd report, 1999, Golden Star Resources Ltd., Denver, U.S., March, 104 p.
- Kesse, G.O., 1985, The mineral and rock resources of Ghana: Rotterdam, A.A. Balkema, 610 p.
- Normandy Mining Ltd., 2000, Annual Normandy Mining Ltd. shareholder report, 2000: Normandy Mining Ltd., Adelaide, Australia, August, 88 p.
- Red Back Mining NL, February 7, 2000, Resource estimation Chirano gold project Ghana—Letter to Australian Stock Exchange: Red Back Mining NL, 2 p.
- Tex Report, 2000, Ghanaian Mn-ore production in 1999 increased considerably: TEX Report, June 22, p. 4.

Other Sources of Information

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Other Publication

Barning, Kwasi, ed., 1997, Industrial Mineral Resources of
Ghana: Ghana Minerals Commission, 94 p.

TABLE 1
GHANA: PRODUCTION OF MINERAL COMMODITIES 1/

(Thousand metric tons unless otherwise specified)

Commodity 2/	1995	1996	1997	1998	1999 e/
Aluminum:					
Bauxite, gross weight	513	473	504	442	353 3/
Metal, smelter, primary	135	137	152	56	104 3/
Arsenic, trioxide 4/	4,409	5,443	4,577	5,000 e/	7,000
Cement, hydraulic e/ 5/	1,300	1,500	1,700	1,630 r/ 3/	1,870 3/
Diamond:					
Gem e/	506	572	664	649	520
Industrial e/	126	143	166	160	128
Total 6/	632	715	830	809	648 3/
Gold 7/	53,087	49,211	54,662	72,541	81,594 3/
Manganese:					
Ore, processed	217	448	437	537	541 3/
Mn content e/	85	152	149	172	173
Petroleum:					
Crude	--	2,600	2,600	2,190	2,190
Refinery products: e/					
Liquefied petroleum gas	400	365 3/	350	625	625
Gasoline	1,900	3,285 3/	3,300	5,850	5,850
Jet fuel	400	365 3/	350	625	625
Kerosene	2,000	1,095 3/	1,100	1,950	1,950
Distillate fuel oil	1,500	2,555 3/	2,500	4,450	4,450
Residual fuel oil	2,200	730 3/	700	1,250	1,250
Other including refinery fuel and losses e/	400	730 3/	700	1,250	1,250
Total	8,800	9,490 3/	9,000	16,000	16,000
Salt e/	145 r/	150 r/	150 r/	170 r/	170
Silver, content of exported dore e/	2,660	2,460 r/	2,730 r/	3,630	3,950
Steel, secondary, rebar e/	25	25	75 r/	75 r/	75

e/ Estimated. r/ Revised. -- Zero.

1/ Table includes data available through November 2000.

2/ In addition to the commodities listed, a variety of crude construction materials (clays, sand and gravel, and stone) are produced, as is limestone and lime, which is used for processing of some gold ore, and salt. 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 Ashanti Goldfields (AGC) for 1995-97. Bogosu gold ore roaster closed in 1996. AGC's Obuasi roaster to close in June 2000.

5/ All from imported clinker.

6/ Production includes that of Akwatia Mine as follow, in thousand carats: 1995--294; 1996--271; 1997--300 (estimated); 1998--252; and 1999--205. Remainder are artisanal sales to the Precious Minerals Marketing Corp. Estimates of unreported artisanal production not included.

7/ Does not include estimate of smuggled or undocumented production.

TABLE 2
GHANA: STRUCTURE OF THE MINERAL INDUSTRY IN 1999

Commodity		Major operating companies and major equity owners	Location of main facilities	Annual capacity
Aluminum	thousand metric tons	Volta Aluminum Co. Ltd. (Valco) (Kaiser Aluminum & Chemical Corp., 90%; Reynolds Aluminum Co., 10%)	Aluminum smelter at Tema	200.
Bauxite	do.	Ghana Bauxite Co. Ltd. (Alcan Aluminum Ltd., 80%; Government, 20%).	Bauxite mine at Awaso	500. 1/
Cement	do.	Ghana Cement Works Ltd. (Heidelberg Zement AG of Germany, 94.5%)	Clinker grinding plant at: Takoradi Tema	1,900. 1,200.
Diamond	thousand carats	Ghana Consolidated Diamonds Ltd. (Government, 100%)	Placer mine at Akwatia	360.
Gold	kilograms	Ashanti Goldfields Co. Ltd. [Depositary Nominee, Inc. (Ashanti), 36.1%; Lonmin, plc. (United Kingdom, 31.5%; Government, 19%; others, 13.4%]	Obuasi underground mine (surface mines phasing out by mid-2000)	28,000.
Do.	do.	do.	Iduapriem Mine	5,000.
Do.	do.	do.	Bibiani Mine	5,000.
Do.	do.	do.	Ayanfuri Mine	1,800.
Do.	do.	Ashanti Goldfields total capacity in Ghana	do.	39,800.
Do.	do.	Abosso Goldfields Ltd. [Ranger Minerals Ltd. (Australia), 90%; Government, 10%]	Damang Mine near Tarkwa (1998 start-up)	9,000.
Do.	do.	Barnex (Prestea) Limited, [Barnato Exploration Ltd (South Africa), 90%; Government, 10%]. Sold to employees in 1999	Prestea underground mine closed September 1998	1,100.
Do.	do.	Bogosu Gold Ltd. (Golden Star Resources (Canada), 70%; Anvil Mining NL (Australia), 20%; Government, 10%)	Open pit mine at Bogosu	3,100.
Do.	do.	Bonte Gold Mining Ltd. (Akrokeri-Ashanti Gold Mines, Inc., of Canada, 85%; Government, 10%; Buosiako Co. Ltd. of Ghana, 5%)	Placer mine at Esaase, about 40 kilometers southwest of Kumasi	1,100.
Do.	do.	Dunkwa Continental Goldfields Ltd.	Offin River dredging operation, along along border of Ashanti and central regions	175.
Do.	do.	Gold Fields Ghana Ltd. (Gold Fields of South Africa Ltd., 70%; Golden Knight Resources Inc. of Canada, 17.5%; Government, 10%; Social Security and National Insurance Trust, 2.5%)	Tarkwa underground mine, closing end of 1999	1,500.
Do.	do.	do.	Tarkwa open pit start-up in 1998 (full capacity at end 1999)	3,110. (7,776).
Do.	do.	Midras Mining Limited	Asikam alluvial operation	250.
Do.	do.	Prestea Sankofa Gold Ltd.	Prestea tailings retreatment operation	650.
Do.	do.	Resolute Amansie Ltd. [Resolute Ltd. (Australia), 90%; Government, 10%]	Obotan Mine 40 kilometers northwest of Obuasi	3,920 to 4,666 in future.
Do.	do.	Satellite Goldfields Ltd. [Wassa Holdings Ltd., 90% (of which Glencar Mining plc of Ireland holds 66%); Government, 10%]	Wassa Mine (January 1999 start-up) 30 kilometers northeast of Tarkwa	3,730.
Do.	do.	Teberebie Goldfields Ltd. (Pioneer Group Inc. of the United States, 90%; Government, 10%)	Teberebie open pit mine near Tarkwa	8,000. e/
Limestone and lime		Carmeuse Lime Products (Ghana) Ltd. (Carmeuse SA of Belgium)	Sekondi	NA.
Manganese ore	thousand metric tons	Ghana Manganese Company Limited (Government, minority interest)	Open pit mine at Nsuta-Wassaw in western region	650 (processed ore).
Steel	do.	Ferro Fabrik	Steel mill at Tema (secondary)	20 (rod, rebar, and wire).
Do.	do.	Tema Steel Co., subsidiary of Ghana Industrial Holdings Co. (Government, 100%)	do.	25 (rebar).
Do.	do.	Wahome Steel Ltd. (private Taiwanese investors, 95%; Ghanaian investor, 5%)	do.	30 (rod, rebar, and wire).
Petroleum, crude	thousand barrels	Ghana National Petroleum Corp. (Government, 100%)	Saltpond Field	2,190.
Petroleum products	do.	Tema Oil Refinery (Government, 100%)	Refinery at Tema	16,500 (crude input).

NA Not available. e/ Estimated.

1/ To double capacity to 1 million metric tons by 2001.

TABLE 3
GHANA: GOLD PRODUCTION BY COMPANY AND MINE

(Kilograms)

Company	Mine	1995	1996	1997	1998	1999
Abosso Goldfields Ltd. (Ranger Minerals)	Damang, open pit	--	--	--	8,421	9,446
Ashanti Goldfields Co. Ltd.	Ayanfuri, open pit 1/	1,744	1,717	1,807	1,440	1,381
Do.	Bibiani	--	--	--	4,719	8,146
Do.	Iduapriem, open pit 2/	3,866	3,669	4,560	4,828	4,976
Do.	Asikam, alluvial (Midras Mining Ltd.) 3/	--	--	--	233	34
Do.	Obuasi, open pit and underground	29,138	26,761	26,687	27,537	23,113
AGC Total		34,748	32,147	33,054	39,224	37,650
Barnex (Prestea) Ltd.	Prestea, underground 4/	840	1,062	1,011	600	--
Bogosu Gold Ltd. 5/	Bogosu, open pit	3,349	3,327	3,464	3,813	4,164
Bonte Gold Mines Ltd.	Esaase and Jeni River, placer	567	668	879	1,093	1,498
Dunkwa Continental Goldfields Ltd.	Dunkwa, placer 6/	104	173	118	37	1
Gold Fields (Ghana) Ltd.	Tarkwa, underground 7/	1,382	1,476	1,672	1,670	1,269
Do.	Tarkwa, open pit, 1998 startup	--	--	--	2,522	6,806
Obenemasi Gold Mines Ltd.	Konongo/Obenemasi, open pit	690	588	176	--	--
Precious Minerals Marketing Corp. 8/	Artisanal workings	3,898	2,913	3,331	1,873	4,069
Prestea Gold Resources Ltd.	Prestea Mine	--	--	--	--	894
Prestea Sankofa Gold	Prestea Sankofa, tailings 9/	184	540	626	467	357
Resolute Amansie Ltd.	Obotan, open pit	--	--	2,151	5,411	4,173
Satellite Goldfields Ltd. (Glencar Mining plc.)	Wassa, open pit, 1999 startup	--	--	--	--	2,709
Teberebie Goldfields Ltd.	Teberebie, open pit	7,325	6,317	8,180	7,877	8,558
Total		53,087	49,211	54,662	72,541	81,594

-- Zero

1/ Acquired in purchase of Cluff Resources in 1996; 1,659 kilograms attributed to Ashanti in 1996.

2/ Acquired in merger with Golden Shamrock in 1996; 590 kilograms attributed to Ashanti in 1996.

3/ Sold by Ashanti Goldfields in 1999

4/ Acquired by Barnex (Prestea) Ltd. (JCI Ltd. of South Africa) from State Gold Mining Corp. (SGMC) in 1996.

5/ Acquired by Golden Star Resources Ltd. (United States), 70%, and Anvil Mining NL (Australia), 30%, in 1999.

6/ Acquired from SGMC in 1995.

7/ Acquired by Gold Fields Ltd. of South Africa from SGMC in 1993.

8/ Includes 8 to 110 kilograms per year byproduct gold from Ghana Consolidated Diamonds Ltd.'s Akwatia Mine. Includes gold purchases from small-scale miners by Miramex and other licensed buying authorities.

9/ Acquired by Ashanti Goldfields in purchase of SAMAX, Inc., in 1998; sold in 1999. Included in Ashanti Goldfields total for 1998.

Sources: Ghana Minerals Commission and Ghana Chamber of Mines