

# THE MINERAL INDUSTRY OF

# GHANA

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Ghana is a West African country with an area of 238,540 square kilometers, a 1998 population of around 19 million, and a per capita gross domestic product of about \$378.<sup>1</sup> Its economic growth rate was 4.6%, led by, in order of value, gold, cocoa, and timber production. The impact of a domestic energy crisis was shown in the drop in the rate of growth of the industrial sector of the economy to 2.5% from 6.4% in 1997. The growth rate of the mining and quarrying subsector also declined to 4.0% from the 5.6% level of 1997 (Ghana Ministry of Finance, 1999, Budget review—GDP growth rises by 4.6 percent, accessed September 30, 1999, at URL <http://www.ghanaweb.com/GhanaHomePage/ghana/news/ECONS/budget1.html>). 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. With contributions from three new mines at Bibiani, Damang, and Tarkwa, gold production increased by 33% to 72.5 metric tons (t).

## Government Policies and Programs

Legislation affecting mining and mineral exploration in Ghana includes the Minerals and Mining Law 1986 (PNDCL 153); the Additional Profits Tax Law, 1985 (PNDCL 122); the Minerals Commission Law, 1986 (PNDCL 154); and the Minerals (Royalties) Regulations, 1987 (LI 1349). The 1986 mining law had been instrumental in attracting more than \$3 billion in foreign investment in Ghanaian mining industry through the end of 1997. 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 Energy and Mines, which regulates the industry, and the Ghana National Petroleum Corporation (GNPC), which is empowered to undertake petroleum exploration and production on behalf of the Government. The GNPC was established under the Ghana National Petroleum Corporation Law of 1983 (PNDCL 64) and is authorized to enter joint ventures and production-sharing agreements with commercial organizations. 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 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.

## Environmental Issues

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 gas emissions. Ashanti Goldfields Co. Ltd. used an arsenic recovery circuit in its gold roasting plant at Obuasi. Mercury was widely used to amalgamate gold by artisanal miners in Ghana. Artisanal usage in particular has led to mercury contamination of rivers. The Environmental Protection Agency was established in 1994. All new mining operations will be required to conduct and submit environmental impact studies and to plan their operations to minimize environmental damage. Similarly, rehabilitation of existing mines will include environmental planning. A portion of mining royalties will be 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 1998. In addition to the expansion in gold production, manganese output increased by

<sup>1</sup>Where necessary, currency values have been converted from Ghanaian cedis (C) to U.S. dollars at the rate of C2,417=US\$1.00 for 1998 and C2,050=US\$1.00 for 1997.

23% over 1997. Aluminum, bauxite, and diamond production levels decreased by 63%, 12%, and 3%, respectively, from those of 1997. Power supply problems continued to beleague the Volta Aluminum Co. Ltd.'s (VALCO) aluminum smelter, which operated at less than 25% of capacity in 1998. Reported sales of artisanal gold production to the PMMC declined by 44% in 1998 over those of 1997. An unknown quantity of artisanal gold production was, 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 was more convertible. 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. According to the Ministry of Finance, gold export earnings increased to \$687.8 million compared with \$646.7 million in 1997, accounting for 37.6% of total exports of \$1.83 billion in 1998 (Ghana Ministry of Finance, 1999, Ghana budget, accessed August 30, 1999, at URL <http://www.finance.gov.gh/budget/index.html>). In 1998, the value of all primary mineral commodity exports was estimated to be around \$793 million, or about 46% of total exports. Ghana's main processed mineral commodity export was aluminum, which was toll refined in Ghana from imported alumina. On the basis of the average price of aluminum of \$0.65 per pound in 1998, aluminum production of 56,000 t was valued at about \$80 million. The Ghana Chamber of Mines reported that the total value of mined product sales, which approximate export sales, by member companies, was \$712.6 million in 1998. Gold sales were valued at \$679.4 million; diamond, at \$15 million; manganese ore, at \$11 million; and bauxite ore, at \$7.2 million (Ghana Chamber of Mines, 1999).

Ghana's mineral commodity imports were dominated by alumina, fertilizers, clinker for cement, and petroleum products. The value of these imports was not available but were estimated, on the basis of previous years, to range between \$300 million to \$400 million per year. 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 exceeded \$250 million per year.

## Structure of the Mineral Industry

Through privatization programs, the Government greatly reduced its once-dominant stake in the cement and gold industries but has maintained a controlling interest in Ghana Consolidated Diamonds Ltd., the GNPC, and the state-run Steelworks Co.

Efforts to attract foreign investment in recent years have brought in a wide range of companies from Australia, Canada, South Africa, the United Kingdom, and the United States that

now hold controlling interests in most of the current mines in Ghana. (See table 2.) In addition, more than 100 exploration licenses were held by foreign companies; however, the level of active exploration began to drop in 1998, in part owing to the decrease in exploration risk capital from Canada. The American company, Kaiser Aluminum Corp., maintained 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 less than 25% of capacity in 1998. The smelter at Tema Harbor used prebake technology and toll-processed imported 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. During most of 1998, the VALCO smelter operated only one of its five potlines compared with 1997 when VALCO operated four potlines. Each of VALCO's potlines produced approximately 40,000 metric tons per year of primary aluminum. VALCO received compensation, in the form of energy credits to be used during the last half of 1998 and during 1999, from the Volta River Authority (VRA) in lieu of the power necessary to run two of the potlines that were curtailed during 1998, although VALCO continued to seek compensation from the VRA with respect to the January 1998 reduction of its power allocation. On the basis of VALCO's proposed 1999 power allocation from the VRA, VALCO announced that it expected to operate three lines during 1999. The decision to operate at that level was also based on consideration of market and other factors (Kaiser Aluminum Corp., 1999, Annual report, Form 10-K, 1998, U.S. Securities and Exchange Commission, accessed October 12, 1999, at URL <http://www.sec.gov/Archives/edgar/data/811596/0000811596-99-000004.txt>).

Ghana Bauxite Co. Ltd. (GBC) operated the country's only bauxite mine at Awaso. In March 1998, Alcan Aluminum Ltd. of Canada increased its equity position in GBC from 45% to 80% and was pursuing an initiative to expand mine capacity (Alcan Aluminum Ltd., 1999, Annual report for 1998, accessed September 28, 1999, at URL <http://www.alcan.com/AnnualRp.nsf/webpages-E/product-review>). In 1998, GBC shipped more than 400,000 t of chemical grade bauxite ore to captive alumina plants—most to the Burntisland plant in Fife, Scotland, and lesser amounts to plants in Jonquiere, Quebec, and Aughinish, Ireland.

**Gold.**—Of the 18 gold mines in operation in Ghana in 1998, 4 accounted for a total of 70% of the recorded gold output of the country. These four mines were the Obuasi (38.0%), the Damang (11.6%), the Teberebie (10.9%), and the Obotan (7.5%). A breakdown of gold production, by mine, for 1994

through 1998 is shown in table 3.

Ashanti's corporate gold production for 1998 from mines in Ghana, Guinea, and Zimbabwe was 48,136 kilograms (kg), of which approximately 81% came from operations in Ghana. AGC also maintained active exploration programs in Botswana, Burkina Faso, Mali, Mozambique, Senegal, Tanzania, and Zambia; the Geita gold project in Tanzania was scheduled for development by 2000.

The Ashanti mining complex at Obuasi, Ghana, one of the richest gold mines in the world, increased overall production by 3% in 1998 to 27,537 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 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 7 g/t in recent years as the ratio of quartz to sulfide ore from underground workings has decreased and as large quantities of lower grade ores from surface workings and tailings have begun to be mined and re-mined. As reported in the Ashanti annual report for the calendar year ending December 31, 1998, the Obuasi underground mine delivered 2.24 million metric tons (Mt) of ore to the mill with an average grade of 8.57 g/t compared with 1.93 Mt of ore with an average grade of 8.48 g/t in 1997. The increase in underground productivity was a result of the mine expansion and mechanization program begun in 1993, which culminated in the commissioning of the Kwesi Renner Shaft in July 1998, providing an additional 1 million metric tons per year (Mt/yr) of hoisting capacity. At the Obuasi surface mine operations, 29.8 Mt of waste overburden was stripped, and 4.32 Mt of ore grading 3.22 g/t was mined compared with ore production of 3.99 Mt grading 3.06 g/t in 1997. Operations at the Sansu pit, one of four surface oxide deposits being mined, ended in November 1998.

The Obuasi ore was processed at four treatment plants and a heap-leach operation. The Sansu sulfide treatment plant (STP) was the world's largest bio-oxidation (BIOX) gold treatment facility. The STP treated 2.60 Mt of ore grading 5.29 g/t in 1998 compared with 2.49 t of the same grade ore in 1997. It had a gold recovery rate of 78.8% and contributed 10,823 kg, or 39% of total Obuasi gold production in 1998.

Ashanti's Pompora treatment plant processed 1.75 Mt of ore with an average grade of 8.65 g/t yielding 12,379 kg of gold at a recovery rate of 81.8%. At the oxide treatment plant, 2.29 Mt of material were processed grading 1.74 g/t yielding 2,706 kg of gold at a recovery rate of 68.2%. The tailings treatment plant processed 1.85 Mt of ore grading 2.61 g/t yielding 1,538 kg of gold at a recovery rate of 31.9% in 1998. A small heap-leach plant stacked 217,000 t of ore grading 0.71 g/t and recovered 73 kg of gold.

At Ashanti's three other Ghanaian mines, the Bibiani mine and carbon-in-leach (CIL) plant, which were commissioned in the first quarter of 1998, were operating near its full annual capacity of 6,840 kg of gold by yearend; the economic reserves at Iduapriem were expected to be depleted by the end of 1999; and at Ayanfuri, heap-leach ore stacking was increased from 1 to 1.3 Mt/yr to compensate for declining ore grades. Operations at Ayanfuri after 2000 will be dependent on the

success of ongoing exploration in the area.

At the end of 1998, Ashanti reported measured and indicated resources of 63.9 Mt at an average grade of 10.2 g/t containing 727,800 kg of gold at Obuasi, of which 41.7 Mt of underground reserves grading 9.2 g/t of gold will be the focus of future production. Measured and indicated gold resources at other mines included 21.7 Mt grading 2.7 g/t at Bibiani, 20.9 Mt grading 1.5 g/t at Iduapriem, and 3.4 Mt grading 1.5 g/t at Ayanfuri. Contained within these resources, Ashanti reported proven and probable ore reserves as of December 31, 1998, on the basis of a gold price of \$300 per ounce, of 55.7 Mt at a grade of 7.6 g/t containing more than 426,000 kg of gold at Obuasi, 16.4 Mt at a grade of 2.7 g/t at Bibiani, 6.2 Mt grading 1.1 g/t at Iduapriem, and 1.8 Mt grading 1.8 g/t at Ayanfuri (Ashanti Goldfields Co. Ltd., 1999). Ashanti acquired the 50.4% equity interest in Prestea Sankofa Gold Ltd. previously held by SAMAX Gold Inc. of the United Kingdom (50.4%) when Ashanti purchased Samax and its Ghanaian and Tanzanian gold properties for \$135 million in late 1998. Other partners in the Prestea Sankofa joint venture were the GNPC (39.6%), and the Government (10%). The joint venture had been granted an 8-year lease in early 1994 to recover gold from the old Prestea Mine tailings and dumps. A 320,000-metric-ton-per-year CIL plant commissioned in May 1995 was to produce up to 680 kilograms per year (kg/yr) from an initial total of 1.8 Mt of old Prestea calcines, tailings, and mine waste for at least 7 years.

Gold Fields (Ghana) Ltd.'s major new Tarkwa surface mine started production in April 1998, milling 3.05 Mt of ore, grading 1.18 g/t, and yielding 2,522 kg of gold during its first year of operation. The \$125 million Tarkwa open pit, heap-leach project, which involved the relocation of more than 20,000 Ghanaian villagers, will produce 7,775 kg/yr of gold by 2000, with plans to double production to 15,550 kg/yr of gold. Gold Fields also produced 1,670 kg of gold from 227,864 t of ore milled grading 1.46 g/t from the old, 1,000-meter deep underground workings in 1998. The company reported reserves and resources at Tarkwa, as of June 30, 1998, using a gold price of \$290 per troy ounce as follows. The underground workings contained a measured and indicated ore resource of 541,927 t grading 6.4 g/t of gold, of which proven and probable ore reserves were 178,801 t grading 13.7 g/t. In situ, near surface resources at Tarkwa are located in seven deposits containing a total of 298 Mt at an average grade of 1.40 g/t for a total resource of 13 million troy ounces (429,542 kg) of contained gold, one of the largest gold deposits outlined in the world in recent years. The mineralization occurs within a quartz pebble "Banket" conglomerate of the upper Tarkwaian Group, similar in characteristics to the Witwatersrand goldfields of South Africa. The two largest deposits, the Akontasi Ridge and the Pepe open pit, contained resources of 87.7 Mt grading 1.2 g/t and 67.8 Mt grading 1.5 g/t, respectively. The other deposits were, in descending gold content, Akontasi East, Kottraverchy, Mantraim, Pepe West Underlap, and Pepe N&S. Movable reserves at the new Tarkwa mine were reported to be 157.2 Mt grading 1.35 g/t (Ghana Chamber of Mines, 1999; Gold Fields Limited, 1998, Gencor/Gold Fields of South Africa merger prelisting statements—3. Geology and resource/reserve estimates,

accessed November 13, 1998, at URL <http://www.goldfields.co.za/prelist/prlst12.htm>).

Abosso Goldfields Ltd., owned by Ranger Minerals Ltd. of Australia, began first production of gold at its new \$135 million Damang gold mine, located 30 kilometers (km) northeast of Tarkwa, in November 1997; plant commissioning continued through December 1997. During its first full year of operations in 1998, 3.99 million cubic meters (Mm<sup>3</sup>) of ore and 6.32 Mm<sup>3</sup> of waste were removed to produce 8,421 kg of gold. The project was based on mineral resources, based on a cutoff grade of 1.0 g/t of gold, as of December 31, 1998, of 15 Mt measured grading 2.22 g/t; 26.3 Mt indicated grading 2.03 g/t; and 18.7 Mt inferred grading 2.06 g/t for a total resource of 60 Mt at an average grade of 2.09 g/t containing more than 4 million troy ounces (125,409 kg) of gold (Ranger Minerals Ltd., 1999, Damang Resource estimate as at 31 December 1998, accessed September 11, 1999, at URL <http://www.ranger.com.au/operations.htm>). Mining at Damang, during an 8-year mine life will be at rate of 4 to 4.5 Mt/yr of ore, with an annual production of more than 10,000 kg of gold, based on an expected recovery of 94% from a standard CIL plant. The CIL plant constructed by Minproc Engineers Ltd. of Australia consisted of a gyratory crusher, a primary high lift semiautogenous (SAG) mill in closed circuit with a pebble mill and a secondary ball mill, gravity concentration, a six-stage CIL leach-adsorption circuit, and an Anglo desorption plant. Capital costs included diversion of five watercourses draining away from the mine into the Bonsa River, a 6.6-km deviation of the Accra-Takoradi railway line, the resettlement and establishment of a new townsite for Damang, and a 25-km-long powerline linked to the national grid. In July, Ranger spent an additional \$7.5 million to install a 17-megawatt (MW) powerplant at Damang to enable it to maintain operations during power shortages on the national grid.

Teberebie Goldfields Ltd. (TGL), owned by the Pioneer Group Inc. of the United States, operated the Teberebie Mine, 6 km south of Tarkwa. The TGL open pit heap-leach operation extracted ore from the Teberebie/Awunaben and the Mantraim pits. Teberebie gold output decreased by 4% to 7,877 kg in 1998. The decline was attributed to reduced heap-leach recoveries from the harder, less weathered ore that was being treated. The harder ore being mined will require a transition from heap leaching to bulk mining and conventional milling and will likely reduce the minable portion of the 183,500 kg of in situ reserves reported previously by the company. The \$57 million Phase III expansion of Teberebie was completed by the end of 1997, expanding ore processing capacity to 12 Mt/yr by adding a new heap-leach operation, a third gyratory crusher, and a new South plant and by adding a second carbon absorption train to the absorption desorption refinery (ADR) plant. The Pioneer Group announced its plans to offer TGL for sale in 1999 (Pioneer Group Inc., 1999, Annual Pioneer Group Inc. report and form 10-K—1998; U.S. Securities and Exchange Commission, accessed October 12, 1999, at URL <http://www.sec.gov/Archives/edgar/data/733060/0000950135-99-001704.txt>).

Resolute Amansie Ltd. poured the first gold at its \$32 million Obotan gold project in May 1997. The project included 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. In its first full year of operation, Obotan produced 5,411 kg of gold from 2.28 Mt of ore processed. For the quarter ending December 31, 1998, head grades at Obotan averaged 2.32 g/t with a 92.2% recovery. Recovery rates were dropping as mining at the Nkran Hill open pit moved into harder ore with a higher sulfide content (Resolute Ltd., 1999, Report on activities for the quarter ending 31 December 1998, accessed May 10, 1999, at URL <http://resolute-ltd.com.au/sc14-qreport/pdfs/December%20Quarterly%201998.htm>). The Obotan project, 40 km northwest of Obuasi, included the Nkran Hill and the Adubiaso Hill surface deposits. Production was expected to average 4,665 kg/yr of gold during its 10-year mine life. Mine development was based on total resources of 21.9 Mt at a grade of 1.95 g/t of gold, including reserves of 10.15 Mt grading 2.12 g/t (Resolute Limited, 1997, Annual Resolute Limited report, 1996, accessed February 3, 1998, at URL <http://resolute-ltd.com.au>). In 1998, Resolute reported 900,000 troy ounces (28,000 kg) of contained gold reserves and an additional 1.3 million troy ounces (40,400 kg) of gold resources with exploration activities focused on identifying additional nearby oxide reserves and on defining the potential for future high-grade underground mining (Resolute Ltd., 1998, Obotan gold project—Ghana, accessed July 7, 1998, at URL <http://resolute-ltd.com.au/sc10-gold/html/10obotan.html>).

Satellite Goldfields Ltd., controlled by Glencar Explorations Plc. of Ireland, completed development of its \$42.5 million Wassa project, about 35 km northeast of Tarkwa, during 1998 with the first gold pour taking place on January 23, 1999. Development costs included the purchase of five 1,250-kilovolt-ampere generator sets, which will insulate the mine from national power shortages. The 3-Mt/yr open pit and heap-leach operation was expected to produce at a rate of 4,043 kg/yr. More than 390,000 t of run-of-mine ore had been mined, and 232,000 t, grading 1.64% gold, had been stacked during 1998 in anticipation of startup. The ore was crushed, agglomerated with cement, stacked, and leached on a 90-day recovery cycle. Gold was recovered from leach solutions in an on-site ADR plant. The Wassa deposit is within Lower Birimian greenstones, felsic volcanics, and a distinctive ironstone formation. Vein and stockwork mineralization occurs in the felsic and phyllitic lithologies. Mining is based on a reserve of 23 Mt at a grade of 1.4 g/t gold with an ongoing exploration program around the mine designed to expand the known reserves. The minable reserves at Wassa represented about 50% of the known resource base. Glencar, with its joint-venture partner, Moydow Limited, was also exploring the Kanyankaw and Asheba concessions south of Tarkwa (Glencar Explorations Plc., 1999).

Bogosu Gold Ltd. operated the Bogosu mine in the Western Region, processing 2.03 Mt of ore yielding 3,813 kg of gold in 1998. While the company was working on an oxide reserve base, it had on-site processing facilities for sulfide ores, consisting of flotation, roaster, and CIL circuits. The company reported proven and probable oxide ore reserves, as of March 31, 1999, of 1.96 Mt of ore grading 2.6 g/t gold. These ore reserves were contained within measured and indicated mineral

resources, which included 2.87 Mt of oxidized material grading 2.3 g/t gold, 3.2 Mt of transitional mineralization grading 2.8 g/t, and 10.3 Mt of sulfide material grading 3.3 g/t gold (Ghana Chamber of Mines, 1999). Work done by the previous owner Billiton plc. (formerly Gencor Limited of South Africa) indicated that the metallurgically complex sulfide ores on the property were technically amenable to mining and treatment by flotation, BIOX, and cyanidation (Gencor Limited, 1996).

Barnato Exploration Ltd. (Barnex), a subsidiary of JCI Ltd. of South Africa, ceased mining the Prestea underground workings in August 1998 after 70 years of operation. Former employees announced their intentions to buy the underground mine and to operate it under the umbrella of Prestea Gold Resources Ltd. (Mining Journal, 1998b). The 3.8 billion cedis (\$1.6 million) used to acquire the underground mine represented the severance awards payable to the 1,712-person workforce by Barnex (Ghana Daily Graphic, 1998, Ex-Barnex workers set to acquire company, accessed December 7, 1998, at URL <http://graphic.com.gh/dgraphic/news/ex5.htm>).

Exploration by Barnex around Prestea identified a near-surface resource of 4.68 million troy ounces (145,656 kg) of gold. Prestea Gold was conducting a feasibility study on developing an open pit mining operation on the property (African Mining Bulletin, 1998).

Bonte Gold Mines Ltd., owned by Akrokeri-Ashanti Gold Mines Inc. of Canada, treated 1.06 Mm<sup>3</sup> of material yielding 1,093 kg of gold in 1998 from the small alluvial mining operation on the Esaase concession. Remaining ore reserves, as of December 1998, were reported to be 5,392 kg of contained gold (Ghana Chamber of Mines, 1999). Akrokeri-Ashanti also acquired an 85% interest in the Goldenrae alluvial mine from the Netherlands Development Finance Co. The company planned on reopening Goldenrae in mid-1999, with production planned at 871 kg/yr of gold from a plant with the capacity to process 150 cubic meters per hour of alluvial material (Mining Journal, 1998a).

Active exploration for gold by companies from Australia, Canada, Europe, Ghana, South Africa, and the United States continued in 1998. Advanced stage exploration projects included the Gold Fields Limited's Centenary gold mining project, where a feasibility study was initiated in 1998 on the basis of a reported 43,545-kg gold reserve estimate (Gold Fields Limited, 1998, Orogen—Centenary Gold Mining Project, accessed November 13, 1998, at <http://www.goldfields.co.za/ops/orogen.htm>); Birim Goldfields Inc. of Canada was exploring the Mampon and Aboronye zones of its Dunkwa license in joint venture with Battle Mountain Gold Co. of the United States and its Bui Area Licenses in joint venture with Dominion Mining Ltd. of Australia; St. Jude Resources Ltd. of Canada continued drilling of the Adoikrom, Dabrokrom, Father Brown, and 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, 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 grading 2.6 g/t and 1.1 Mt of sulfide ore grading 3.1 g/t (Shiega Resources Corp., July 6, 1998, Extension of Nkroful agreement with SAMAX Gold and participation in new agreement with SEMAFO, press release, accessed July 7, 1998, at URL <http://biz.yahoo.com/prnews/980706/shiega-agr-1.html>). Red Back Mining NL of Australia was exploring the Chirano gold property, adjacent to the Bibiani Mine, in joint venture with Reunion Mining plc of the United Kingdom. Kenor ASA of Norway was pursuing four gold geochemical anomalies on the Wa license in northern Ghana; and Leo Shield Exploration NL of Australia had identified gold resources of 11,570 kg and 5,600 kg, respectively, at its Manso Nkwanta and Ashanti Reconnaissance projects (Leo Shield Exploration NL, 1999, West African Gold exploration, accessed October 24, at URL <http://leoshield.com.au>). Resolute Ltd. established a joint venture 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, 40 km northeast of the Bibiani Mine, and the Canadian joint venture of African Selection Mining Corp. and Golden Eagle Mining Ltd. were drilling on the Grupe license in northern Ghana. Nevsun Resources Ltd. of Canada reported a gold resource of 3.63 Mt of primary ore grading 3.63 g/t and 1.64 Mt of oxide ore grading 1.64 g/t at its Kubi property on the basis of exploration through November 1998 (Nevsun Resources, November 18, 1998, Update on the Kubi property—Ghana, press release, accessed November 19, 1998, at URL <http://biz.yahoo.com/bw/981118/nevsun-1.html>).

**Manganese.**—Ghana Manganese Company Limited's Nsuta-Wassaw open pit mine, which was privatized in 1995, was the only significant producer of manganese ore in Ghana. The mine produced manganese oxide and carbonate ores, as well as a transitional ore referred to as "Carbox." Most of the carbonate ores at the Nsuta Mine had been depleted, and exploration aimed at expanding manganese resources on adjacent hills was ongoing. Total production of manganese ore in 1998 was 536,871 wet metric tons of run-of-mine ore with 390,156 dry metric tons exported. 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.

### ***Industrial Minerals***

Ghana Consolidated Diamonds' Akwatia diamond mine was the only operating diamond mine in Ghana in 1998. A total of 252,377 carats were recovered from 375,000 cubic meters of ground mined. Akwatia also produced 24 kg of gold as a byproduct. The Akwatia production in 1998 had a value of \$17.60 per carat of diamond exported. Apart from Akwatia, diamond production in Ghana during the year was from Birim Valley artisanal workings. The true level of artisanal output was unknown because of undocumented sales and exports. In

1998, the PMMC reported purchases of 556,590 carats from artisanal and galamsey miners, with an average value of \$19.08 per carat of diamond.

### **Mineral Fuels**

As of yearend 1998, petroleum and natural gas exploration in Ghana has been summarized by the United States Energy Information Administration (U.S. Energy Information Administration, 1999, Country Analysis Briefs—Ghana, accessed October 12, 1999, at URL <http://www.eia.doe.gov/emeu/cabs/ghana.html>). Ghana's estimated 16.5 million barrels of recoverable oil reserves are located in five sedimentary basins—the Tano, the Saltpond, the Accra/Keta, the Voltaian, and the Cape Three Points. Exploration offshore Ghana began in the 1970's, and discoveries were made in waters off western Ghana (South Tano in 1978) and central Ghana (Saltpond in 1977). Phillips, the discoverer of 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, which is also responsible for the importation of crude and petroleum products, subsequently assumed operations of the Saltpond and Tano fields. In 1998, the GNPC produced an estimated 6,000 barrels per day (bbl/d) of crude oil from the Saltpond Field.

Natural gas was first discovered in the Cape Three Points Basin in 1974. The GNPC has continued exploration and appraisal on the Tano fields and has deemed that the natural gas reserves are suitable for electricity generation. 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) was established to help meet the country's growing demand for power. The TFDPP was separated into two distinct portions—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. GNPC also planned to maximize oil production of the TFDPP by using horizontal drilling technology. Total cost of the TFDPP was estimated to be \$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.

Tentative plans called for Ghana to begin receiving Nigerian gas through the West African Gas Pipeline (WAGP) starting in 2001. In January 1995, the Nigerian Government first announced plans to build the WAGP, which would run from fields where gas was being flared to the neighboring countries of Benin, Togo, and Ghana. Chevron Corp. of the United States, which would supply initial deliveries of gas from its Escravos Gas Project facilities, stated that the 998-km (620-mile) WAGP would be run totally offshore, with spurs running onshore to sites in Nigeria, Benin, Togo, and Ghana. The \$400

million WAGP would have the capacity to transport more than 5 Mm<sup>3</sup> of gas. Initial use of the gas would be to generate electricity, but plans to develop industries to use the gas were being developed. A study commissioned by Chevron indicated that between 10,000 and 20,000 primary sector jobs would be created as the new power supplies stimulated industrial growth. A feasibility study commissioned by the WAGP consortium was completed in February 1999, and construction of the WAGP was projected to begin in late 1999 or early 2000. World Bank studies showed that the countries involved in the WAGP could save approximately \$500 million in primary energy costs within 20 years. In 1998, The WAGP consortium consisted of Chevron, Shell Petroleum Development Co., Nigerian Gas Corporation, GNPC, Societe Beninoise de Gaz, and Societe Togolaise de Gaz. Chevron announced in October 1998 that it had been chosen to supply 1.13 Mm<sup>3</sup> of gas to a 220-MW powerplant, which was under development at Tema, Ghana.

Ghana's 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, a subsidiary of the GNPC. TOR primarily processed imported Bonny Light/Brass River crudes from Nigeria and a variety of refined products for domestic consumption and export. TOR's refining capacity was expanded from 25,000 bbl/d to 45,000 bbl/d in 1997, and the GNPC planned additional refinery upgrades (U.S. Energy Information Administration, 1999, Country analysis briefs—Ghana, accessed October 12, 1999, 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 expediting licensing of private-sector power projects. A major project earmarked for 1999 was the joint venture involving the Volta River Authority adding 330 MW to the Takoradi Thermal Power complex, which will be completed between 2000 and 2001. The second initiative was the GNPC project to fully commission and operate a 125-MW power barge facility and associated transmission lines under construction with funding from the Japanese Government by the end of the year. Two other projects were a joint venture involving the Electricity Corporation of Ghana to restore 80-MW generation capacity and to upgrade the distribution network within the Tema industrial estate before 2000 ends and the 220-MW independent thermal power project being sponsored by the mining companies, particularly in the bauxite, gold, limestone, and manganese industries, to assure themselves of long-term reliable power supply.

### **Reserves**

GBC claimed that it had access to bauxite reserves at Awaso sufficient to support a mine life of 100 years; proven reserves of 29.5 Mt were reported at the end of 1994 (Ghana Chamber of Mines, 1994). 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 totaled 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. Available information on reserves and resources of gold at individual mines are discussed in the gold commodity section of this report. This published data from the existing mines indicated a total defined Ghanaian resource for yearend 1998 of approximately 1,900 t (61 million troy ounces) of contained gold, of which approximately 560 t (18 million troy ounces) of gold were in the minable reserve category; the Obuasi Mine had about 38% of this resource inventory. Ghana's total gold resources are undoubtedly larger than those reported on the basis of the known extent of gold-bearing Birimian and Tarkwaian host rocks, 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 were known. As of the end of 1998, minable reserves totaled 209,000 t of manganese oxide and 9,745,000 of manganese carbonate ore (Ghana Chamber of Mines, 1999).

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, ore reserves as of December 1998 included 119,000 cubic meters of terrace gravels and 12.1 million cubic meters of Lower and Middle Birim Valley gravels. In 1993, the average grade of Akwatia gravels had been reported at about 1.19 carats per cubic meter (Ghana Chamber of Mines, 1994, 1999). 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, put the economics of the deposits in question.

The U.S. Energy Information Administration reported that Ghana's recoverable oil reserves were estimated to be 16.5 million barrels and that natural gas reserves were estimated to be 2.38 billion cubic meters (840 billion cubic feet). This gas is primarily found in the Tano fields. Ghana's total gas resources, including assessments of undiscovered resource potential, were estimated to be from 44 to 59 billion cubic meters (U.S. Energy Information Administration, 1999, Country analysis briefs—Ghana, accessed October 12, 1999, 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 were 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, unsuitable for transport of bulk mineral commodities. In recent years, the western railroad infrastructure has been rehabilitated to support the export of manganese and bauxite ores through Takoradi better and to provide logistical support to the major gold-producing areas. Tema, 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 6 billion kilowatthours was from hydroelectric power. Hydroelectric power was subject to the impact of periodic droughts in the region, and power disruptions and rationing were common. Electricity exports from the VRA to neighboring countries has been seriously limited since 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 former state-owned mines, and the potential for ongoing exploration to add several new mines should see annual gold production approach 96,500 kg (3 million ounces) during the first decade of the third millennium. The introduction of internationally accepted environmental standards by the Government, along with the vagaries of metal commodity price cycles, may 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 developments should help mitigate this problem.

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## **Major Sources of Information**

### **Geological Survey Department**

P.O. Box M 80  
Accra, Ghana  
Telephone: 233-21-228093

### **Minerals Commission**

P.O. Box M 248  
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### **Mines Department**

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## **Internet Reference**

Republic of Ghana Home Page—  
<http://www.ghana.com/republic>



TABLE 1  
GHANA: PRODUCTION OF MINERAL COMMODITIES 1/

(Thousand metric tons unless otherwise specified)

Commodity 2/	1994	1995	1996	1997	1998 3/
<b>Aluminum:</b>					
Bauxite: Gross weight	426	513	473	504 3/	442
Metal, smelter, primary	141	135	137	152 3/	56
Arsenic, trioxide e/ 4/	3,897	4,409	5,443	4,577	5,000 e/
Cement, hydraulic 5/	1,346	1,300 e/	1,500 e/	1,700 e/	2,000 e/
<b>Diamond:</b>					
Gem e/	592	506	572	664	649
Industrial e/	148	126	143	166	160
Total 6/	740	632	715	830	809
Gold 7/	43,478	53,087	49,211	54,662	72,541
<b>Manganese:</b>					
Ore, processed	265	217	448	437	537
Mn content e/	101	82	152	140	172
<b>Petroleum:</b>					
Crude	--	--	2,600	2,600	2,190
<b>Refinery products</b>					
Liquefied petroleum gas	365	400 e/	365 r/	350 r/ e/	350 e/
Gasoline	1,825	1,900 e/	3,285 r/	3,300 r/ e/	3,300 e/
Jet fuel	365	400 e/	365 r/	350 r/ e/	350 e/
Kerosene	1,095	2,000 e/	1,095 r/	1,100 r/ e/	1,100 e/
Distillate fuel oil	1,460	1,500 e/	2,555 r/	2,500 r/ e/	2,500 e/
Residual fuel oil	2,190	2,200 e/	730 r/	700 r/ e/	700 e/
Other including refinery fuel and l	365	400 e/	730 r/	700 r/ e/	700 e/
Total	7,665	8,800 e/	9,490 r/	9,000 r/ e/	9,000 e/
Salt e/	50	50	50	50	50
Silver, content of gold ore e/	2,230	2,660	2,450	3,200	3,600
Steel, crude e/	25	25	25	25	25

e/ Estimated. r/ Revised.

1/ Table includes data available through June 1999.

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 capable of producing arsenic before closing in 1996.

5/ All from imported clinker.

6/ Production, in thousand carats, includes that of Akwatia Mine [1994--356; 1995--294; 1996--271; 1997--300 (estimated), and 1998--252]. Estimates of unreported artisanal production not included.

7/ Does not include estimate of smuggled production.

TABLE 2  
GHANA: STRUCTURE OF THE MINERAL INDUSTRY IN 1998

	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 Metals Corp., 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. (Scancem International ANS, Norway, 59.5%, Government, 40%; other, 0.5%)	Clinker grinding plant at: Takoradi Tema	400. 700.
Diamond	thousand carats	Ghana Consolidated Diamonds Ltd. (Government, 100%)	Placer mine at Akwatia	360.
Gold	kilograms	Ashanti Goldfields Co. Ltd. [Depository Nominee, Inc. (Ashanti), 36.1%; Lonmin, Plc., United Kingdom, 31.5%; Government, 19%; other private, 13.4%]	Obusai mines; surface operations phasing out in 1999-2000 Iduapriem Mine, (closing in 2000) Bibiani Mine Ayanfuri Mine Prestea Sankofa Tailings Asikam alluvial operation	28,000. 5,000. 5,000. 1,800. 650. 250.
Do.	do.	(Ashanti Goldfields, 60% interest in Midras Mining) Ashanti Goldfields total capacity in Ghana	do.	40,700.
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, [Barnto Exploration Ltd., (South Africa), 90%; Government, 10%]	Prestea underground mine	1,100.
Do.	do.	Bogosu Gold Ltd. (Gencor Ltd. holdings sold?); IFC, 9%; Government, 10%)	Open pit mine at Bogosu	3,100.
Do.	do.	Bonte Gold Mining Ltd. (Akrokeri-Ashanti Gold Mines, Inc., Canada, 85%; Government, 10%; Buosiako Co. Ltd., 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 border of Ashanti & 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. Tarkwa open pit start-up in 1998 (Full capacity at end 1999)	1,500. 3,110, (7,776).
Do.	do.	Resolute Amansie Ltd. [Resolute Ltd. (Australia), 90%; Government, 10%]	Obotan Mine 40 km 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 ( Jan. 1999 start-up) 30 km northeast of Tarkwa	3,730.
Do.	do.	Teberebie Goldfields Ltd. (Pioneer Group Inc., United States, 90%; Government, 10%)	Teberebie open pit mine near Tarkwa	8,000. e/
Manganese ore	thousand metric tons	Ghana Manganese Company Limited (Government, minority interest)	Open pit mine at Nsuta-Wassaw in Western Region	550 (processed ore).
Steel	do.	Steelworks Co. subsidiary of Ghana Industrial Holdings Co. (Government, 100%)	Steel mill at Tema	2.5 (rebar).
Do.	do.	Wahome Steel Ltd. (private Taiwanese investors, 95%; Ghanaian investor, 5%)	do.	30 (rod, rebar, and wire).
Petroleum prod	thousand barrels	Tema Oil Refinery (Government, 100%)	Refinery at Tema	10,600 (crude input).

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	1994	1995	1996	1997	1998
Abosso Goldfields Ltd. (Ranger Minerals)	Damang, open pit	--	--	--	--	8,421
Ashanti Goldfields Co. Ltd.	Ayanfuri, open pit 1/	139	1,744	1,717	1,807	1,440
Do.	Bibiani	--	--	--	--	4,719
Do.	Iduapriem, open pit 2/	3,689	3,866	3,669	4,560	4,828
Do.	Asikam, alluvial, (Midras Mining)	--	--	--	--	233
Do.	Obuasi, open pit and underground	26,548	29,138	26,761	26,687	27,537
Do.	Prestea Sankofa, tailings 3/	--	184	540	626	467
Total		30,376	34,748	32,147	33,054	39,224
Barnex (Prestea) Ltd.	Prestea, underground 4/	612	840	1,062	1,011	600
Bogosu Gold Ltd. (Billiton)	Bogosu, open pit	3,402	3,349	3,327	3,464	3,813
Bonte Gold Mines Ltd.	Esaase, placer	508	567	668	879	1,093
Dunkwa Continental Goldfields Ltd.	Dunkwa, placer 5/	97	104	173	118	37
Gold Fields (Ghana) Ltd.	Tarkwa, underground 6/	1,224	1,382	1,476	1,672	1,670
Do.	Tarkwa, open pit, 1998 startup	--	--	--	--	2,522
Obenemasi Gold Mines Ltd.	Konongo/Obenemasi, open pit	--	690	588	176	--
Precious Minerals Marketing Corp.	Artisanal workings 7/	1,772	3,898	2,913	3,331	1,873
Resolute Amansie Ltd.	Obotan, open pit	--	--	--	2151	5,411
Teberebie Goldfields Ltd.	Teberebie, open pit	5,487	7,325	6,317	8,180	7,877
Total		43,478	53,087	49,211	54,662	72,541

1/ Acquired in purchase of Cluff Resources in 1996; 1659 kilograms attributed to Ashanti in 1996.

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

3/ Acquired in purchase of SAMAX Gold Inc. in 1998

4/ Acquired from State Gold Mining Corp. (SGMC) in 1996.

5/ Acquired from SGMC in 1995.

6/ Acquired from SGMC in 1993.

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

Sources: Ghana Minerals Commission and Ghana Chamber of Mines.