

THE MINERAL INDUSTRY OF

ZAMBIA

By George J. Coakley

Zambia is a landlocked country in southern African with an area of 753,000 square kilometers, 9.5 million people, and a per-capita gross domestic product (GDP) based on purchasing power parity of \$950.¹ Overall, mining and quarrying contributed to 5.9% of real GDP in 1996, the latest year for which data were available, and to about 10% of total employment. Copper and cobalt production by the state-owned Zambian Consolidated Copper Company Limited (ZCCM) continued to be the major component of the minerals sector of the Zambian economy accounting for between 70% and 80% of total export earnings.² Zambia ranked as the world's largest producer of cobalt, 11th in copper, and as one of the top producers of gem-quality emeralds in 1997. Gemstones, mostly emeralds, also recorded significant earnings, but probably an even larger amount bypassed official channels. The so-called Copperbelt area of north-central Zambia and adjacent southeast Congo (Kinshasa) contain one of the greatest concentrations of high grade copper-cobalt resources in the world. Besides copper and cobalt, Zambia produced a wide variety of metallic and industrial commodities, along with coal (*See table 1*).

Despite the economy's dependence on copper and cobalt revenues, the Government's past practice of diverting mineral earnings for various social or other economic purposes while neglecting the need for reinvestment in the industry has led to a progressive decline in copper production and revenue. Efforts to privatize ZCCM were only partially successful in 1997, with the lack of new outside investment contributing to a further deterioration of its productivity. By the end of 1997, ZCCM loses of about \$25 million per month were creating a serious foreign exchange liquidity problem in the country (Mining Annual Review, 1998). Efforts by Zambia to secure additional support from the international financial and development institutions to make payments on more than \$7 billion in foreign debt were being tied to the completion of the ZCCM privatization.

Government Legislation and Policies

Legislation

The Investment Act of 1993 established the Zambia Investment Center as a one-stop support facility for investors and offers incentives to investors in the mining sector. In December 1994, the Government had announced that it would no longer participate in exploration or become a shareholder in a mining company and would limit its functions to regulatory or promotional activities.

¹ Where necessary, values have been converted from Zambian Kwacha (K) to U.S. dollars at the rate of K1,695=US\$1.00 for 1997 and K1,282=US\$1.00 for 1996.

² Statistical and other technical data on ZCCM for 1997 used in this chapter have been taken from the ZCCM 1998 Annual Report, which covers the fiscal year April 1, 1997 to March 31, 1998.

Subsequently, the December 1995 Mining Policy officially put in place a privatization program to encourage private development and diversification of the mining sector and to promote small-scale mining, development of gemstone mining and liberalization of gemstone marketing facilities, exploitation of industrial and energy minerals and development of ferrous minerals, reduction of ecological damage arising from mining, and local value-added processing of Zambia's mineral raw materials.

The Government continued to promote actively the private sector and to seek foreign investment, particularly in minerals. The purpose of the Mines and Minerals Act of 1995, passed by Parliament as 1995 Act No. 31 on September 13, 1995, is to attract risk capital, technology, and entrepreneurial efforts to the mining sector. The law covers all mineral commodities and treats large-scale, small-scale, and gemstone operations separately as to mineral rights (prospecting and mining authorizations). Export of radioactive minerals, such as monazite, is illegal without special Ministerial approval. It also gives the Government leeway in negotiating individualized contracts with investors. Among other provisions were secure title to mining rights with provision to assign; the right to market products; international arbitration; exemption from import duties and sales taxes on material, at least for an initial period of exploration and development; and royalty charges of 3% for large-scale mining license holders on the "net back value" of minerals free-on-board, less transport and smelting and refining costs.

Parliament's Environmental Protection and Pollution Control Act (No. 12) of 1990 formed the basis for a Ministry of Environment and Natural Resources and also an Environmental Council of Zambia. The act formally came into full force in February 1992 and gave the Ministry overall responsibility for protecting the environment. In March 1997, the Mines and Minerals (Environmental) Regulations were passed to implement environmental protection provisions of the Mines and Minerals Act of 1995. The 1997 environmental legislation established an environmental protection fund and regulations for environmental impact assessments, mine dumps, air and water quality and emission standards, storage, handling and processing of hazardous waste, and mines inspection.

Privatization

Since gaining independence in 1964, the Government has dominated the structure of the minerals industry for more than 30 years, but that is changing as privatization progresses. The Privatisation Act No. 21 of 1992 established the Zambia Privatisation Agency (ZPA) as an autonomous Government agency. Its functions are to plan, implement, and control the privatisation of state-owned enterprises in Zambia, in cooperation with the Government, by selling them off to companies that have the required capital and technology to run them. Details on ZPA

mission and operations are available through its website, accessible at URL <http://www.zpa.org.zm>. Efforts to privatize most of the more-than-200 Government-controlled companies, which were initiated in 1994, began to materialize in the mining sector in 1997. In late 1996, the Government issued an invitation to prequalify document, for the sale of majority interests in certain Government mining and electricity distribution assets by international tender. This included the sale of ZCCM, the country's major single enterprise. ZCCM had been formed in 1982 with the merger of Nchanga Consolidated Copper Mines Ltd. and Roan Consolidated Copper Mines Ltd., making it at the time the world's second largest copper company after Corporación Nacional del Cobre de Chile. The Anglo American Corp. subsidiary, Zambian Copper Investments also held a 27.3% minority interest in ZCCM.

In February 1997, the ZPA prequalified a total of 38 companies for the sale, including Australia's BHP Minerals International Exploration Inc. (BHP) and Western Mining Corp.; Canada-based Falconbridge Ltd., Indochina Goldfields Ltd., Noranda Inc., and Teck Corp.; China's China National Nonferrous Metals Industry Corp. (CNNC); the South African-based companies Gencor Ltd., Avmin Ltd., and Iscor Ltd.; and Phelps Dodge Corp. and Cyprus Amax Minerals Co. of the United States.

During 1997, as detailed below, five of the nine ZCCM privatization packages were sold, while negotiations were ongoing with the remainder.

- **Privatization Package A.**—In late 1997, the Kafue Consortium, comprised of Avmin, Phelps Dodge, Noranda, and Commonwealth Development Corp. won the rights to Privatization Package A—the Nchanga and the Nkana Divisions (excluding the Chambishi and the Kansanshi Mines) and their respective social assets. This package includes five underground mines and one open-pit mine, associated concentrator facilities, a tailings leach plant, a copper smelter and refinery, an acid plant, and a cobalt plant. These divisions represent about one-half of ZCCM's production capacity and were a key to completing the privatization of ZCCM. At yearend the companies continued their due diligence on the acquisition and negotiations with the ZPA on the final terms of the agreement. Discussions revolved around an offer by the Kafue Consortium for a several-hundred-million-dollar buy-in and a commitment to invest an additional \$1 billion to expand operations, including \$250 million in debt assumption and social development. Faced with declining copper prices and Zambian Government demands for a high up-front cash buy-in level, during the first quarter of 1998, negotiations collapsed, and both Phelps Dodge and Noranda withdrew from the consortium (Metal Bulletin, 1997b).
- **Privatization Package B.**—Binani Group, the Indian zinc producer, purchased the Luanshya Division (excluding the Ndola precious metals plant) and its associated social assets for \$35 million— and committed to spend an additional \$69 million in capital improvements. The Luanshya Division includes the underground copper mines at Baluba and Luanshya, and associated concentrator facilities, the closed Luanshya smelter and the Ndola Copper Refinery. The copper mines will operate as the newly incorporated Roan

Antelope Mining Corporation of Zambia. The Zambian Government retained a 15% carried interest.

- **Privatization Package C.**—Negotiations were also ongoing for the sale of the Mufulira underground mine and concentrator, which produced approximately 48,000 metric tons (t) of copper in concentrate in 1997-98.
- **Privatization Package D.**—in November 1997, the Canadian investment company, Ivanhoe Capital Corp. acquired an 85% interest in the Chambishi copper mine (nonoperational) which had a resource base of 136 million metric tons (Mt) at 2.4% copper and an existing production shaft to the 900-meter (m) level, accessing about one-third of the resource (*See table 3*). In January 1998, Ivanhoe Capital withdrew its bid as a result of financing difficulties (Gooding, 1998) and discussions were reopened with new bidders including CNNC.
- **Privatization Package E.**—Cyprus Amax purchased the Kansanshi copper mine for phased payments of \$28 million—and committed to spend \$20 million on exploration and feasibility studies. The Zambian Government retained a 20% carried interest. The Kansanshi Mine was closed at yearend, but Cyprus Amax will continue to explore for additional reserves through 1998.
- **Privatization Package F.**—no bids were received on the Nampundwe pyrite mine.
- **Privatization Package G.**—The Chambishi cobalt plant, which has a nominal capacity of 2,400 metric tons per year (t/yr), and its associated acid plant were included in the failed Kafue Consortium negotiations and then subsequently sold to Avmin in April 1998 for \$50 million and a commitment to make \$80 million in capital improvements.
- **Privatization Package H.**—The Ndola precious metals plant, which produces gold, silver, and selenium from copper refinery slimes, was being offered for sale to First Quantum Minerals Ltd. of Canada.
- **Privatization Package J.**—ZCCM's Power Division was purchased for \$50 million by the British companies, Midlands Power International and National Grid Co. Plc. and five Power Division management staff and renamed the Copperbelt Energy Corporation (CEC). The Zambian Government retained a 20% interest. The CEC will continue to purchase electricity from the state-owned Zambia Electricity Supply Co. and sell it to Copperbelt mining operations and other customers. In 1995-96, ZCCM's own power consumption was approximately 5,000 gigawatt-hours with a peak demand of 500 megawatts (MW). The Power Division distributed two-thirds of Zambia's electricity.

In other privatization actions:

- **Chibiluma Copper Mines.**—The Metorex Consortium [Crew Group of Canada (29.75%); and its South African subsidiary companies, Maranda Mines Ltd. (25.5%) and Metorex (PTY) Ltd. (12.75%); and Genbel Securities (17%), a South African

investment bank], acquired the Chibuluma South copper mine and deposit for \$17.5 million and committed to invest \$34 million on a new shaft and concentrator for the undeveloped Chibuluma South deposit within 5 years. The Zambian Government retained a 15% carried interest in Chibuluma.

- **Konkola Deep Mining Project.**—A consortium comprising of the Anglo American (40%), Falconbridge (30%), and Gencor (30%), signed a memorandum of understanding with the Government on February 11, 1997, to conduct a feasibility study to develop the Konkola Deep Mining Project. The agreement was contingent on completion of due diligence on the existing operations and on the final sale of the Nchanga and the Nkana Divisions. By year-end, however, Gencor had withdrawn from the consortium and was followed by Falconbridge in March 1998, leaving the future of the project uncertain. Plans had called for a \$700 million to \$800 million investment to develop Konkola Deep's proven reserves of 344 Mt grading 3.8% copper at a rate of 180,000 t/yr of copper (Zambia Investment Center, The privatization of Zambia Consolidated Copper Mines, accessed December 3, 1997 at URL http://www.gozambia.com/invest/fr/p_zccm.html, superceded by <http://www.zic.org.zm>).
- **Konkola North Copper Deposit.**—In March 1997, Avmin signed an agreement with ZCCM and the Government to obtain the mining rights to the Konkola North area. Korea Zinc will have a 30% equity interest in the project, and ZCCM, 15% to 20%. Avmin committed to spend about \$13 million completing a 50,000-m exploration drilling program and a mine prefeasibility study within 2 years. If positive, then Avmin will commit \$12 million to Phase II for another 24 months to complete exploration drilling and a final feasibility study (Avmin, 1997; Zambia Privatization Agency, February 1997, Sale and purchase agreement signed on ZCCM's Konkola North mining prospect, press release accessed April 1, 1997 at URL <http://www.zamnet.zm/zamnet/zambus/zpa/konkola.htm>).
- **Maamba Collieries Ltd.**—An 80% interest in the state-owned Maamba Collieries Ltd. was sold to Benicon Limited of South Africa in November 1997. Benicon assumed \$16 million in net liabilities from the Government and promised to invest an additional \$4.5 million in capital expenditures and refurbishment of the Maamba coal mine that was flooded during heavy rains in early 1997. Benicon's main activity was as a contract coal miner for Anglo American in South Africa (Chilombo Mwondela, November 27, 1997, Government retains 20% shares in Maamba Collieries, The Post, no. 861, November 27, accessed December 3, 1997 at URL <http://www.zamnet.zm/zamnet/post.arch.29743/news/story8.html>).

Production

In 1997, production ZCCM copper mines was 352,900 t, an increase of 5.6% from that of 1996; this was however, only at a rate equal to 43% of the 1969 peak production of 825,000 t. Estimated cobalt mine production declined by 13% and refined cobalt by 5% from that of 1996, still low by historical standards.

Production of byproduct gold, selenium, and silver from ZCCM copper refinery slimes were all down from that of 1996, but overall gold production was up resulting from the startup of the new Dunrobin gold mine. In addition to ZCCM copper and cobalt production, Zambia is a major world supplier of emerald and amethyst and additionally produces gemstone quality aquamarine, garnet, and tourmaline. Most gemstone mining is done by small-scale artisanal miners, and production and export levels are poorly documented. Cement production increased by 10% while coal production dropped sharply following the flooding of the Maamba coal mine. Petroleum refinery products output probably were lower, based on reports of operating difficulties, but numerical information was not available for estimating any decline.

Trade

The major mineral exports by value were copper and cobalt. Some observers, however, believed gemstones were very significant in export value for some time, possibly second to copper, despite the absence of official records. The Government indicated that the value of legally and illegally exported gemstones may be as much as \$250 million per year. For the fiscal year ending March 31, 1998, ZCCM reported sales, chiefly as exports, of \$704 million of copper and \$182 million of cobalt, down from \$921 million and \$202 million, respectively, in fiscal year 1996-97. The revenue decline was attributed primarily to the sharp drop in world commodity prices. ZCCM product sales of \$964 million were distributed among the European Community (20.6%); Japan (15.6%); Saudi Arabia (10%); Thailand (8.1%); and India (7.9%). The difference between export and sales values may be small owing to domestic sales and to metals bought by ZCCM to meet customer contracts. Approximately 58% of bulk copper exports in 1997 were railed from Zambia to the Tanzanian port of Dar es Salaam; 15% via the Mozambican port of Beira; and 24% to 25% through the South African ports of East London and Durban.

The principal import was petroleum, including crude and refined products. The Arabian Gulf States were the principal sources of oil imports, and South Africa was a major source, at least partly because of transshipments from overseas sources. Fertilizer components were the second largest mineral import, particularly phosphorus and potassium. Mining equipment was the largest import from the United States.

Commodity Review

Metals

Cobalt.—Although cobalt mine grades held constant for the year, reduced availability of concentrates particularly to the Chambishi Cobalt Plant, led to an overall 5% decline in refined cobalt output. The Chambishi Cobalt Plant produced 2,208 t of refined cobalt compared with 2,328 t in 1996, and the Nkana Cobalt Plant produced 2,178 t of refined cobalt compared with 2,238 t in 1996. At Chambishi ZCCM reported to high lead levels in the refined cobalt caused by high manganese levels in imported quicklime. Geochemically, manganese is known to be a scavenger of other metals near its environment, apparently, in this instance, lead.

In August 1996, Qasim Mining Enterprises Ltd., owned 60% by Colossal Resources Corp. of Vancouver, Canada, started up its

slag retreatment project designed to reprocess 8.6 Mt of cobalt slag grading 0.70% to 0.81% cobalt and 1.15% copper from ZCCM's Nkana slag dump. The processing center at Kabwe had two 15-t electric arc furnaces, and two induction furnaces with associated granulation units. Qasim produced a water-granulated and milled cobalt-copper-iron mixed-alloy powder product containing 10% to 12% cobalt. The company expected to process from 4,000 to 6,000 metric tons per month of slag during the first year of operation, resulting in 50 t per month of recovered cobalt. As of mid-1997, production was reported to be 3 to 4 metric tons per day (t/d) of 12% to 15% cobalt alloy, with second half production forecast at 20 t/d averaging 2.5 to 3 t of contained cobalt. Details of full-year operations were not reported by the company.

Caledonia Mining Corporation of Toronto, Canada, updated the tonnage and grade estimates on its Nama cobalt-copper oxide project to a total indicated and inferred resource of 953.4 Mt at 0.029% cobalt equivalent (Caledonia Mining Corporation, 1997). The company was undertaking further studies to determine the economics of developing the project to produce several thousand tons per year of cobalt from an open-pit mine, and by using a leach-solvent extraction-electrowinning (SX-EW) process and to examine the potential extension of the deposit into the Democratic Republic of the Congo (Congo-Kinshasa).

Copper.—Pending completion of its privatization program, ZCCM continued to operate one of the largest copper mining complexes in the world through five divisions, listed by decreasing production capacity, Nchanga, Mufalira, Nkana, Luanshya, and Konkola. The Nchanga Division operates one underground and one cobalt-rich open pit copper mine, the Nchanga mill, and a tailings leach plant. For the fiscal year ending March 31, 1998, Nchanga mined 7.32 Mt of copper ore grading 2.34% copper and 833,266 t of cobalt feed grading 1.19% copper and 0.51% cobalt. Concentrate production of 212,801 t was up 32% from that of 1996-97 with a copper recovery rate of 41.37%. Copper in concentrates produced was 70,583 t. The Nchanga leach plant treated 12.5 Mt of material grading 1.12% copper yielding 61,061 t of new copper cathode.

The Mufalira Division operated one major underground mine, a mill, smelter, and refinery. Following the privatization of the Luanshya Division on October 15, 1997, the Ndola Precious Metals Plant was transferred to the Mufalira Division. In 1997-98 Mufalira mined 2.34 Mt of copper ore grading 2.14%. The 17% drop in ore hoisted during the year was attributed to seismic problems and spare part supply problems on the jumbo drills. Concentrate production of 100,948 t, with a copper recovery rate of 96.42%, was down 22% from that of 1996-97. Smelter production was down by 20%, to 102,097 t and refined copper cathode production declined by 14% to 128,363 t.

The Nkana Division mined ore from four underground zones, Central Shaft, Chibiluma, that was sold to Metorex in October 1997, Mindola, and South Ore Body, and operated a mill, a smelter, a refinery, and two cobalt recovery plants and two sulphuric acid plants at Chambishi and Nkana. In 1997-98, the Nkana Division mined 2.69 Mt of copper sulfide ore grading 1.51% copper and 0.10% cobalt; 40% of production coming from the Mindola Shaft. Production of 121,943 t of copper concentrates with a copper recovery rate of 95.6% and 99,467 t of cobalt concentrates with a cobalt recovery rate of 62.49% was down by 11% and 22% respectively, from that of 1996-97. At the Nkana

smelter, which encountered high maintenance problems during the year, the output of 99,783 t was down by 19% from that of 1996-97.

The Luanshya Division operated the Luanshya and the cobalt-rich Baluba underground mines, two mills, a smelter that was reopened in January 1997, and the Ndola precious metals refinery. The copper refinery at Ndola remained closed in 1997-98. Between April 1, 1997 and the sale of the Luanshya Division to the Binani Group on October 1, 1997, ZCCM reported the following production levels: the Luanshya Division mined 603,000 t of ore grading 1.54% copper at the Luanshya Mine, 721,000 t of ore grading 1.82% copper and 0.14% cobalt from the Baluba Mine, and 204,590 t of ore grading 1.91% copper from the Baluba East Mine; mill production included 48,124 t of copper concentrates with a copper recovery rate of 90.34% at the Luanshya mill and 31,177 t of copper concentrates with a copper recovery rate of 93.09% and 36,111 t of cobalt concentrates with a cobalt recovery rate of 6.67% from the Baluba mill; and the Luanshya smelter produced 18,447 t of blister copper.

ZCCM's Konkola Division operated a mill and the Konkola underground mine. Konkola, one of the wettest mines in the world, pumped out 287,000 cubic meters of water per day and was a major input to the local water supply. In 1997-98, Konkola mined 1.94 Mt of copper ore grading 2.90% copper compared with 2.12 Mt grading 2.66% copper in 1996-97. Copper concentrate production of 119,616 t, with a copper recovery rate of 88.22%, remained roughly level with 1996-97.

First Quantum Minerals completed construction of the \$30 million Bwana Mkubwa Copper Project (BMCP) ahead of schedule in December 1997. BMCP, 100% owned by First Quantum, is located 5 kilometers (km) from the regional mining center of Ndola. The leach-SX-EW treatment plant was designed to recover and treat copper from the No. 4 Tailings Dam at the old Bwana Mkubwa Mine. By March 1998 the plant is expected to be at full production, producing 10,000 t/yr of cathode copper and 110,000 t/yr of sulfuric acid, of which 70,000 t will be available for local sales. The plant was designed to provide processing capacity for any additional ore proven up within the mining license and the Koloko Hills prospecting license acquired in 1997. The mine site was first worked for copper around A.D. 700 and more recently from 1930 to 1931 and 1971 to 1984. Drill testing of only the No. 4 oxide tailings dump defined a reserve of 8.4 Mt grading 0.73% copper. In addition, ZCCM reported 230,000 t grading 2.54% copper in the west wall of the pit. In a 1990 report Watts, Griffiths and McOuat (WGM) identified 900,000 t grading 2.85% copper in the pit floor and an additional resource of 3 Mt grading 1.4% copper in the immediate vicinity of the pit (First Quantum Minerals Ltd., June 25, 1998, The Bwana Mkubwa copper mine: accessed November 9, 1998, at URL http://www.first-quantum.com/property_mining_bwana.html).

Cyprus Amax., which acquired an 80% interest in the Kanshansi copper mine and deposit from ZCCM in 1997, committed to spend \$5 million during 1997 and 1998 to evaluate the resource potential of the deposit beyond the 24 Mt of 3% copper previously identified by ZCCM. Depending on the results of the first phase, Cyprus Amax will make an additional payment of \$10 million to ZCCM and commit \$15 million to further drilling and a feasibility study. Upon determination that a mining project is feasible, a final payment of an additional \$15 million will be made to ZCCM. Proximity of Kanshansi to the Congo-Kinshasa border and the

civil war there remained a concern of the company. Cyprus Amax closed the high cost Kansanshi Mine in January 1998, to concentrate capital resources on the regional exploration of the Kansanshi area resource base.

In May 1997, Caledonia also signed a joint venture agreement with Cyprus Amax allowing the latter to earn a 75% interest in Caledonia's Kadola copper prospect. During 1996 exploration, Caledonia had outlined an inferred mineral resource of 74 Mt grading 0.95% copper at the Kadola West prospect (Caledonia Mining Corporation, 1996).

Gold.—Reunion Mining PLC of the United Kingdom poured the first gold at its Dunrobin gold mine, located 120 km west of Lusaka, in August 1997. It is the first privately owned mine to be developed in Zambia in 30 years. Production will be at the rate of 50 kilograms per month or 600 kilograms per year. Proven and probable reserves amount to 1.2 Mt grading 2.1 grams per ton in a semiconsolidated quartz-hematite gossan material overlying the old mine. Reserves were sufficient for 3 years of production. After heap leaching gold, will be recovered by standard carbon columns, elution, electrowinning, and smelting to produce doré bars suitable for export to a refinery in Zimbabwe (Reunion Mining PLC, 1997). The project was financed with a \$4.5 million gold loan provided by N.M. Rothschild & Sons Limited, repayable in equal installments at 6, 12, 18, and 24 months after first production.

Iron and Steel.—A joint venture between Art Engineering of Zambia and United Steel Co. of Kenya announced plans to start trial production of a 20,000-t/yr steel rerolling mill at Ndola. Ziscosteel in Zimbabwe was identified as the likely source of billet for the plant. The joint venture also planned to build a ferrous scrap melting shop to process from 700 to 1,000 tons per month of ferrous scrap currently exported to South Africa for processing (Metal Bulletin, 1997a).

Other Metal Exploration.—In addition to the previously described activity a number of companies had active exploration programs underway in Zambia in 1997. These included American Mineral Fields Inc. of the United States, which was exploring for an extension into Zambia of the Kipushi copper-zinc mine in Congo (Kinshasa) through its 100% owned subsidiary, ZamGold Ltd.; Billiton Plc. of the United Kingdom, which was exploring for carbonate-hosted lead-zinc mineralization in the Kabwe area and for copper-gold targets in the Kafue Flats, the Kasempa, and the Mumbwa areas; Casmyn Corp. of the United States which was active on the Luswishi copper property; the Zambezi Joint Venture, comprised of Anglo American Prospecting Services (Pty.) Ltd. (70%) and Equinox Resources N.L. of Australia (30%), was conducting field and aeromagnetic studies on nine copper-gold prospecting licences within the Copperbelt; First Quantum, which was working on the Karibarembi copper-gold, the Nchombo gold-bismuth, and the Lutembwe gold properties; and Tan Range Exploration Corp. of Canada which was conducting further geochemical sampling and diamond drilling on a highly altered shear zone on its Chetina gold property, north of Lusaka.

Industrial Minerals

Cement.—Chilanga Cement maintained plants at Lusaka and

Ndola on the Copperbelt having capacities rated at 200,000 and 290,000 t/yr, respectively. Chilanga also had the capacity to produce 441,000 t/yr of clinker. In 1997, 384,000 t of cement was produced, an increase of 10% from that of 1996. Total cement sales of 389,000 t were valued at \$26.3 million. Chilanga sold more than 10% of its annual production to ZCCM and maintained strong export markets to Malawi and other neighboring countries. Between 1995 and 1997, Chilanga cement exports increased from 24% to 38% of total cement sales, partly in response to reduced consumption at ZCCM. Chilanga was exploring for additional limestone reserves in anticipation of increasing capacity in the future to respond to an expected increased cement consumption by the newly privatized copper sector (Pangaea/EMI Securities Limited, April 1998, Chilanga Cement PLC, accessed September 4, 1998 at URL <http://www.pangaeapartners.com/chilanga.htm>).

Gemstones.—The Ministry of Mines and Mineral Development continued its program to develop production of gemstones other than diamonds found in many parts of the country. Training and other assistance were being provided to small local mine operators. The Ministry believed the sector should also be attractive to foreign investment in mining, processing, and marketing. Emeralds, mostly produced about 200 km north of Lusaka (Ndola rural area), were estimated to compose about 80% of total gemstone production in value. However, amethyst output, mostly from a location about 300 km south-southwest of Lusaka (Kalomo area), was the largest by volume. Additionally, aquamarine and tourmaline, mostly from a location about 600 km northeast of Lusaka (Lundazi area), as well as garnet, agate, and other gemstones at a number of locations were produced. Of the 30 to 40 registered gemstone operations in the country, two were large, mechanized mines that were joint ventures with the Government. From 200 to several thousand small unregistered mining operations were estimated to be operational. [A description of the Zambian gemstone industry and resources is available on the Internet at URL <http://www.africa-insites.com/zambia/info/General/gemstones.htm>].

During 1997, BHP signed an agreement with Caledonia to fund 100% of the Mulongo Plains diamond project through the completion of a feasibility study to earn a 75% interest in the project. BHP exercised this option following completion of a reconnaissance regional stream and sediment sampling program in 1997. Under the terms of the agreement BHP will cover up to \$75 million of Caledonia's share of any future construction costs (Caledonia Mining Corporation, 1998, Mulongo Plains—Diamond properties—activity report, 1997 annual report, accessed December 12, 1998 at URL http://www.caledoniamining.com/html/activity_report.htm).

Vantage Enterprises Corp. of Canada was awarded a gemstone license to develop a new tourmaline mine at Kalunga Wbeba in the Eastern Province. The Kalunga Wbeba deposit contains gem-quality pink, green, colorless, and watermelon tourmaline. Production of rough tourmaline will be sent to a Vantage subsidiary in India for cutting and polishing. Within Zambia, the company also operated the Krystal amethyst mine, a Lusaka gemstone processing and grading facility, the Berylex emerald exploration project. The Krystal Mine produced around 380 tons of amethyst rough in 1997 (Vantage Enterprises Corp., July 2, 1997, Krystal Mine, accessed June 4, 1998 at URL <http://www.vantage-gems.com>).

Zarus Drilling, a 50-50 joint venture between Mwanamuto Investments of Zambia and two Russian companies, Ural Gold and Platinum Co. and Volgageologia, was also exploring for emeralds.

Lime.—Ndola Lime Company Ltd., a fully owned subsidiary of ZCCM and the country's only producer of quicklime, crushed limestone, hydrated (slaked) lime and agricultural lime was a candidate for privatization. Its largest domestic clients were ZCCM, Zambia Sugar, and water treatment plants. It also sells to the construction, manufacturing and agriculture sectors and exports approximately 3% of its production to Burundi, Congo (Kinshasa), Malawi, Namibia, South Africa, Tanzania, and Zimbabwe. The company, which is located in Ndola, has been operating since 1960 and it has limestone reserves of at least 18 Mt, of which 4 Mt are proven and 14 Mt are probable; there are an additional 60 to 90 Mt of resources. Production of quicklime is about 200,000 t/yr, although rated capacity is more than 300,000 t/yr. Production is tied to ZCCM's level of copper production. In 1995, Ndola Lime's mining licence was renewed for 25 years. The processing plant consisted of crushing and screening equipment installed in 1993. Limestone was burned in a rotary kiln installed in 1973 and an annular shaft kiln installed in 1986. The lime hydration plant dated to 1961. The combined rated capacity of the kilns is 1,000 t/d of limestone (Zambia Investment Centre, 1998, Privatization—Ndola Lime Company Ltd. Accessed January 5, 1999 at URL <http://www.africa-insites.com/zambia/business/investments/privatization.htm>).

Mineral Fuels

In January, heavy flooding caused major damage to the Maamba Collieries leading to its closure. ZCCM coal needs were then imported from the Wankie Colliery in Zimbabwe. The new owner of Maamba, Benicon, was committed to rehabilitating the operation, which is located 350 km south of Lusaka in the Kanzie and Izuma basins. Estimates of remaining coal reserves at Maamba as of January 1996 were 78.2 Mt of which 60.2 Mt were proven and 18 Mt probable. The two open pit mines have the capacity to produce between 600,000 and 800,000 t/yr of coal (Zambia Privatisation Agency, 1996, Mine capacity and reserves—Maamba Collieries Limited, accessed December 4, 1997, at URL <http://www.zamnet.zm/zambus/zpa/mcladv.htm>).

Reserves

Resources of those minerals in production generally were extensive, including separate, unexploited deposits in various areas, and occurrences of other potentially valuable minerals were widespread geographically. ZCCM has provided a comprehensive listing of its copper and cobalt reserves and resources in its 1997 annual report (*See Tables 2 and 3*). Gold ore resources were being studied by several groups but were yet to be fully defined with the exception of the previously discussed Dunrobin deposit. Many occurrences were located throughout the country, some around and to the east of Lusaka. Lead-zinc reserves at former operations were limited, but additional resources were known at several locations. Remaining resources projected at the closed Kabwe Mine were reported to be 59 Mt at 3.5% zinc and 1.5% lead, mostly of low-grade disseminated ores. Nickel resources at the Munali sulfide deposit were put at 10.4 Mt at 1.1% nickel with

minor copper, gold, silver, and platinum-group-metal content. The Kalumbila deposit had resources estimated to be 8 Mt at 0.55% nickel. Neither deposit was fully defined, and extensions were to be explored. Additional resources have been projected at other sites. A large variety of other metallic minerals deposits also were known, but needed further exploration. Most work in the past apparently was on iron, molybdenum, and tin-tantalum. Of the many industrial mineral resources that were being exploited or studied by commercial groups, gemstones were of the most value, but others included clays for brick and tile and for refractories; fluorspar; granite-syenite dimension stone, gypsum; limestone for cement and lime manufacture; magnetite; marble; phyllite, probably for cement manufacture; silica, mostly for glassmaking; and talc. Only low grade phosphate resources were known, one of which was a carbonatite in the northeast. Petroleum resources remained conjectural; no known activity has taken place since some surveys along the Zambesi River east from Victoria Falls to Mozambique were completed in 1990.

Infrastructure

As a landlocked country, Zambia was dependent on truck and rail transport to sustain most of its economy. The truck road and railway networks within the country and externally were reasonably adequate for access to ocean and lake ports for international trade. Major highways generally paralleled the rail lines. About 20% of the main roads were paved, and about 20% were gravel or stabilized earth. The principal rail routes were northeast to and from the port of Dar es Salaam, nearly 2,000 km from Ndola in the Copperbelt, mostly on the Tanzania Zambia Railways Authority (Tazara) line; and south through Zimbabwe to and from South African ports, more than 2,500 km from Ndola, using the Zambia Railways Ltd. line in Zambia. The roughly 2,000-km rail link southeast to the port of Beira, through Zimbabwe, became generally available after a long hiatus owing to civil war in the port country. The more-than-2,200-km rail link north into Congo (Kinshasa) and west to the port of Benguela (Lobito), Angola, has remained unavailable during the 18-year civil war in Angola. A crude oil pipeline ran from Dar es Salaam about 1,700 km southeast to a refinery in Ndola. It was owned and operated by Tazama Pipelines Ltd., a joint venture of the Zambian and the Tanzanian Governments.

The sources of electric power capacity were hydroelectric (70%), oil (20%), and coal plants (10%). Although nearly self sufficient in hydroelectric power, the facilities have suffered from deferred maintenance. With help from the World Bank and other western donors in 1997, Zambia announced a \$200 million project to rehabilitate all the power stations in the country. The project will include power stations at Kafue Gorge, Kariba Dam, Kariba North Bank, Victoria Falls, and transmission and distribution systems in Kitwe, Lusaka, and Ndola. The Government was also seeking foreign investment to own, build, and operate a new-600 MW Lower Kafue Gorge hydroelectric plant to tap the remaining power potential from the Kafue Gorge for future domestic and export market needs. The energy source for mobile equipment continued to be imported petroleum, mostly refined products, although a significant amount of imported crude petroleum was refined in the state-owned facility at Ndola. The household energy source was wood, which continued to be the country's largest single source of energy.

Outlook

The future revitalization of the minerals industry of Zambia, especially of the copper sector, rests on the successful completion of its current privatization plan. Government efforts to put in place a favorable investment climate for new mining projects began to pay off in 1997, with most of the Privatization Packages offered for sale being taken up by foreign investors. The country, however, faced several internal and external hurdles to development, including high transportation costs, the threat that high HIV/AIDS rates in the region posed on maintaining a skilled labor force, depressed world commodity prices, and the renewal of civil wars in neighboring Angola and Congo-Kinshasa, adding to the political risk of financing new projects (UNAIDS, December 1998 report by Joint United Nations Program on HIV/AIDS, accessed December 20, 1998 at URL <http://www.who.int/emc-hiv>). Stabilization of all or some of these factors will be needed for the country to benefit fully from the expected infusion of new foreign investment and technology. Copper-cobalt output in the short term was likely to continue its decline owing to restructuring and operating problems, but improved efficiency and new foreign investment should bring a turnaround. The gemstone sector also has the potential to generate a larger value-added industry in Zambia. A renewed exploration interest in diamond and zinc resources was also evident.

References Cited

- Avmin Limited, 1997, Annual report of Avmin for 1997, Avmin Limited, 67 p.
- Caledonia Mining Corporation, 1996, Caledonia announces initial tonnage and grade for its Kadola West copper oxide deposit in Zambia: Mississauga, Ont., Canada, Caledonia Mining Corporation press release, December 6, 1 p.
- 1997, Caledonia announces a 953 million tonne resource for its Nama project, and future development plans: Mississauga, Ont., Canada, Caledonia Mining Corporation press release, March 6, 2 p.
- Gooding, Kenneth, 1998, Ivanhoe bid for Zambian mine withdrawn: [London], Financial Times, January 16, p. 22.
- Metal Bulletin, 1997a, Zambia gets its first steel mill: [London] Metal Bulletin, no. 8168, May 29, p. 21.
- 1997b, Kafue partnership wavers: [London] Metal Bulletin, no. 8210, September 11, p. 5.
- Mining Annual Review, 1998, Zambia: [London] Mining Journal, p. 173.
- Reunion Mining PLC, 1997, Dunrobin Gold Mine starts production: [London] Reunion Mining PLC press release, August 19, 1 p.
- Zambian Consolidated Copper Company Limited, 1998, Annual report of

Major Sources of Information

- Zambia Investment Centre
5th Floor, Ndeke House
Haile Selassie Avenue
P.O. Box 34580
Lusaka, Zambia
Telephone: 260-1-252130 or 252133
Fax: 260-1-252150
Website: <http://www.zic.org.zm>
- Zambian Privatization Agency
Privatisation House, Nasser Road
P.O. Box 30819
Lusaka, ZAMBIA
Telephone: 260-1-223858, 227735, 227791, 223859, or 238303
Fax: 260-1-227250
E-mail: zpa@zamnet.zm
Website: <http://www.zpa.org.zm>
- Ministry of Mines and Minerals Development
Permanent Secretary
P.O. Box 31969
Lusaka, Zambia
Telephone: 260-1-254107
Fax: 260-1-251224
- Director, Mines Development Department
P.O. Box 31969
Lusaka, Zambia
Telephone: 260-1-251719
Fax: 260-1-252916
- Director, Geological Survey Department
P.O. Box 50135
Lusaka, Zambia
Telephone: 260-1-251570
Fax: 260-1-251973

Major Publication

- Investment Opportunities in the Mineral Sector of Zambia,
Ministry of Mines and Mineral Development, Lusaka, Zambia.

TABLE 1
ZAMBIA: PRODUCTION OF MINERAL COMMODITIES 1/

(Metric tons unless otherwise specified)

Commodity	1993	1994	1995	1996	1997
METALS					
Beryllium: beryl kilograms	178	857	1,000 e/	1,000 e/	800 e/
Cobalt: 2/					
Mine output, Co content	4,840	3,600	5,908	6,959 r/	6,043
Metal, Co content	4,211	2,639 r/	2,934 r/	4,611 r/	4,386
Copper: 2/ 3/					
Mine output, Cu content:					
By concentration or cementation	344,200	289,800	254,000 r/	276,000 r/	288,900
Leaching (electrowon)	84,100	83,400	62,000 r/	58,000 r/	64,000
Total	428,200	373,200	316,000 r/	334,000 r/	352,900
Metal:					
Smelter, primary:					
Electrowon (low grade)	62,400	25,342	65,400 r/	73,900 r/	70,400 e/
Other	305,100	241,036	234,500 r/	250,300 r/	245,300
Total	367,600	266,378	299,900 r/	324,100 r/	315,800
Refinery, primary:					
Electrowon	48,800	67,255	62,000 r/	58,000 r/	66,600
Other	363,200	284,784	266,000 r/	276,000 r/	271,800
Total	412,100	352,039	328,000 r/	334,000 r/	338,400
Gold: 2/ kilograms	235	124 r/	91	119	290 e/
Lead: 2/					
Mine output, Pb content	7,027	--	--	--	--
Metal, refined	2,000	--	--	--	--
Selenium, refined, gross weight 2/ kilograms	26,700	21,115	18,550	20,016 r/	15,161
Silver: 2/ do.	18,000	10,002	8,676	9,410 r/	6,684
Zinc: 2/					
Mine output, Zn content of ore milled	16,704	--	--	--	--
Metal, refined, primary	3,450	--	--	--	--
INDUSTRIAL MINERALS					
Cement, hydraulic e/	310,000	280,000 4/	312,000 4/ r/	348,000 4/ r/	384,000 4/
Clays:					
Brick e/	3,000	3,000	3,000	3,000	3,000
Building, not further specified e/	2,000	27,000 4/	30,000	30,000	30,000
China and ball e/	200	200	200	200	200
Gemstones: e/					
Amethyst kilograms	398,000 4/	366,000 4/	350,000	350,000	380,000
Aquamarine do.	74 4/	21 4/	200	200	200
Emerald do.	138 4/	160 4/	180	180	180
Gypsum e/	14,000	11,200	11,000	11,000	11,000
Lime, calcined e/ thousand tons	206 4/	195 4/	200	200	200
Limestone (cement and lime) e/ do.	770	710	800	800	800
Magnetite, gross weight e/	1,250 4/	1,070 4/	1,000	1,000	1,000
Nitrogen: N content of ammonia e/	5,000	3,000	3,000	3,000	3,000
Sand and gravel, construction e/ thousand tons	500	117 4/	200	200	200
Stone, construction:					
Limestone, crushed aggregate e/ do.	632 4/	668 4/	700	700	700
Other e/ do.	700	700	700	700	700
Sulfur: 2/					
Pyrite concentrate:					
Gross weight	80,800	55,572	69,228	78,971 r/	69,059
S content (42%) e/	33,400	22,062 4/	28,314 4/	33,200 r/	29,005 e/
Sulfuric acid: 5/					
Gross weight	218,175 r/	224,838 r/	218,252 r/	206,572 r/	178,482
S content (32.6%)	71,125 r/	73,300 r/	71,150	67,340 r/	58,185 e/
Total, S content	104,525 r/	95,362 r/	99,464 r/	100,540 r/	87,190 e/
Talc e/	62 4/	76 5/	80	80	80
MINERAL FUELS AND RELATED MATERIALS					
Coal, bituminous e/ thousand tons	301 4/	163 5/	141	100	10
Petroleum, refinery products e/ 2/ thousand 42-gallon barrels	5,300	5,300	5,000	5,000	5,000

e/ Estimated. r/ Revised.

1/ Table includes data available through December 15, 1998.

2/ Data are for year beginning April 1 of year stated.

3/ Terms are used as defined by the International Copper Study Group.

4/ Reported figure.

5/ From Nkana and Chambishi acid recovery plants.

TABLE 3
ZAMBIA: ZAMBIA CONSOLIDATED COPPER MINES LIMITED'S
MINERAL RESOURCES BY MINE, AS OF MARCH 31, 1997

(Million metric tons)

Mine, by type of development	Gross weight	Copper percent TCu	Cobalt percent
Nchanga:			
Underground	41	3.0	--
Open pits	53	3.2	--
Unclassified (OP or U/G)	39	2.6	--
Refractory ore (CRO)	180	1.2	--
Tailings dumps (TD 2, 3, 4)	104	0.8	--
Total	417	1.5	--
Konkola:			
Kirila Bombwe	297	3.8	0.07
Konkola	30	2.5	--
Saddle Lode / Konkola North	50	2.6	0.09
Fitwaola	3	3.5	--
Konkola South	5	2.0	--
Total	385	3.5	XX
Mufulira:			
Orebody extensions	41	3.1	--
Oxide mineralization--Mufulira East	4	2.6	--
Mufulira West	17	1.5	--
Total	62	2.6	--
Nkana:			
Extensions	118	2.4	0.12
Oxide caps	11	3.1	--
Nkana slag dump	20	1.1	0.15
Total	149	2.3	XX
Chibuluma:			
Chibuluma--West	2	2.5	0.12
Chibuluma--South	9	3.9	--
Total	11	3.6	XX
Chambishi:			
Chambishi--Main	45	2.6	--
Chambishi--West	46	2.2	--
Chambishi--Southeast	45	2.4	--
Total	136	2.4	--
Luanshya:			
Extensions	24	2.4	--
Mashiba	4	2.5	--
Oxide mineralization	8	2.6	--
Slag dump	9	0.7	0.40
Total	45	2.1	XX
Baluba:			
Extensions	2	2.1	0.15
Oxide mineralization	23	2.3	--
Total	26 1/	2.3	XX
Grand total	1,231 1/	2.4 2/	XX

XX Not applicable.

1/ May not add to totals shown because of independent rounding.

2/ Weighted average.

Notes--Mineral resources are defined as those materials which have been examined in sufficient detail to establish their mode of occurrence, size, and essential qualities and include reclamation material already mined or treated, for which there is a reasonable expectation of future exploration. Before such mineral resources can be transferred to the ore reserve category, investigation into the feasibility of economic exploration must be and additional investments incurred. ZCCM's resources are quoted as in situ grades and tonnages and are not factored for dilution and/or mineralization left in the ground due to unfortunate shapes, attitudes, or as pillars.

Source: Zambia Consolidated Copper Mines Limited, 1997 company annual report, p. 58.

