



Cuprum Zambia

Zambia boasts large, high-grade copper resources in a stable environment. **John Chadwick** reports from the region he worked as a mining engineer (many years ago)

Zambia boasts a stable, multi-party democracy with English language and law and a modern mining act. Copper is the backbone of Zambian economy and there is a strong mining culture in the country, that was the world's largest copper producer in the 1970s, when I worked there.

The table (source Brook Hunt and Konkola Copper Mines – KCM) shows KCM's integrated Konkola/Nchanga operation to be the country's top producer. While true, it is likely that First Quantum Minerals' (FQM) Sentinel will be in production by 2015 and making a significant contribution to the country's output (see Great Mines article, this issue).

According to a central bank statement, copper output is expected rise to 900,000 t in 2011 from 819,159 tonnes last year as mines boost output. Central bank spokesman Kanguya Mayondi also told Reuters Zambia's 2010 cobalt output at 8,782 t was 49% higher than the 5,879 t produced in 2009, due to the resumption of output at two major mines.

The Republic of Zambia (population over 12 million) is a landlocked country covering

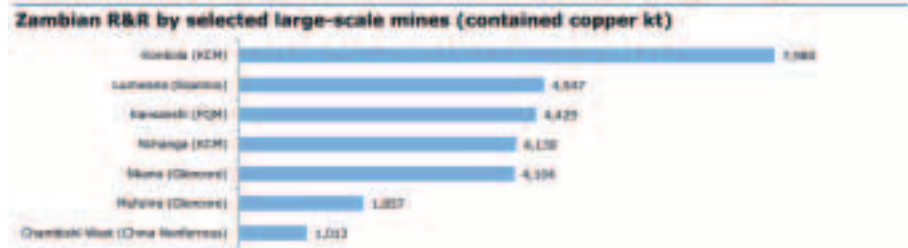
752,600 km². It shares its Copperbelt with Katanga province in the DRC across the border to the north. The Copperbelt is Zambia's industrial base. The Zambian part of the Copperbelt accounts for some 46% of the production and reserves of the Central African Copperbelt, the largest and highest grade sediment-hosted stratiform copper province known on Earth.

Copper accounts for 80% of Zambia's foreign exchange earnings and has, since 2003, been the main driver of an annual

economic growth rate of 5%. This dependence on the production and export of a single product, copper, has caused its problems in the development of the country. However, the future for copper looks strong, and the country should achieve the targeted 1 Mt/y output forecast for 2012.

Vedanta is to float off its Zambian copper arm – Konkola Copper Mines (KCM) - valuing it at £4.5 billion (\$7.3 billion) in a London IPO very soon. Vedanta itself is London listed with its major mining interests in India and Africa.

Producer	Controlling Interest	FYE-December ¹			Integrated
		2011	2010	2009	
Konkola/Nchanga	Vedanta Resources 79.4% / ZCCM 20.6%	163	296	346	✓
Kansanshi	FQM 80% / ZCCM 20%	234	236	238	
Lufuwa	Equinox 100%	145	165	150	
Muchinga/Neame	Ngweni 100%	114	119	112	✓
Others		148	142	178	
Zambia Total		625	1,001	1,062	
Africa Total		1,379	1,333	1,366	
ICM % Zambia Total		25%	31%	40%	
ICM % Africa Total		13%	16%	21%	
ICM's Position in Zambia (by Production)		42	41	41	



Forecast integrated production profile ('000 t/y) of Zambia's copper mines¹. Equinox is now part of Barrick Gold and KCM is launching an IPO



KCM winder at the Konkola Deep project

As the graphic shows, KCM is currently the biggest producer and has a stated aim to become one of the world's top ten copper miners in its own right. Its Zambian properties are comprised of four mines, one at Konkola, two at Nchanga and one at Nampundwe, a tailings leach plant at Nchanga and a smelter at Nkana. Production of copper cathode was 507,000 t in fiscal 2010. Production increases, together with higher copper market prices, enabled revenues to reach \$3.8 billion in 2010.

Konkola is currently undertaking key projects to extend the life of mine and increase copper production. Most important among these is the Konkola Deep Mining Project (KDMP). This project (*IM*, February 2007, pp17-19) is aimed at expanding production from 2 Mt/y of ore to 7.5 Mt/y by accessing the rich orebody that lies beneath what the current operations have been exploiting. This involves the sinking of a new mine shaft to the depth of approximately 1,500 m, the deepest new shaft sinking project in Africa, which has been completed. In addition, the project involves the deepening of an existing shaft, sinking of three new ventilation shafts, one dewatering shaft and the construction of a new pump chamber. Pumping and power infrastructure is in place.

Alongside the KDMP, a modern concentrator is being built to handle the additional ore that will be produced.

In May, Vedanta reports its results for the 2010-11 financial year, in which it achieved record production. Mined metal production

Mopani Copper Mines' facilities are primarily in Kitwe and Mufulira

higher with its own integrated operations producing 133,000 t of copper, up 6% on the previous year, at a cost of \$1.97/lb, while ore production from the open pits increased by 96%. There was increased stripping with a new Life-of-Mine (LOM) plan. Contained copper in the ore stockpile increased from 11,000 t to 34,000 t awaiting processing de-bottlenecking. Custom smelting operations produced 84,000 t, up 79%. Continued exploration success has added some 10 Mt to reserves and resources.

The Glencore influence

Glencore owns 73.1% of Mopani Copper Mines (MCM), with the remainder owned by First Quantum (16.9%) and Zambia Consolidated Copper Mines (ZCCM) Investment Holdings (10%). First Quantum's activities in the country are examined in the Great Mines article in this issue.

MCM is a partially integrated mining and processing operation, producing copper and

cobalt metal. It expects to produce some 236,000 t copper in 2011, of which approximately 111,000 t (47%) will come from MCM's mines. Custom concentrates are received from other mines, including Katanga, Mutanda, and tolled third-party sources.

Since Glencore also owns 74.4% of Katanga across the border in the Kolwezi region of the DRC, MCM is a central facility for Glencore processing in the region. Katanga has a 75% stake in Kamoto Copper Co (KCC). Substantial high-grade resources indicate a potential mine life for KCC in excess of 25 years and a potential to produce 310,000 t/y of copper and 8,000 t/y of cobalt and 22,000 t/y of cobalt contained in cobalt hydroxide by 2015. Katanga's main mining operations are KOV, Komoto Underground, T-17, and Mashamba – both open-pit and underground mines, extracting both sulphide and oxide ores.

KCC also owns the Kamoto Concentrator (KTC) concentrator and the Lulu refinery, which enables the production of refined copper and cobalt metal on-site. KTC is currently being refurbished to a capacity of 150,000 t of copper metal and 8,000 t of cobalt, due to be completed by the second quarter of 2011. KCC is planning to convert the existing unused electro-refinery to a 200,000 t/y EW facility along with the installation of a 200,000 t/y SX plant, which, combined with Lulu, should enable KCC to exceed 300,000 t of copper capacity by 2015.

Back in Zambia, MCM is also expected to produce about 2,200 t of cobalt metal in 2011. It can process oxide and sulphide copper-cobalt concentrates produced by Katanga and Mutanda, and produces sulphuric acid, which is used in the leaching operations at Katanga and Mutanda.

MCM's Nkana complex, centred in Kitwe, consists of four underground mines, four open pit mines, a sulphide copper-cobalt concentrator, an oxide copper agitation leach-





Konkola North

SX plant, and a cobalt plant including a copper SX plant and an EW tank house. Nkana's mines contain copper-cobalt ore and have a mining capacity of approximately 3.9 Mt/y of ore.

Mopani has started the construction of a new shaft at Nkana in order to mine an untapped ore resource containing about 115 Mt of copper ore which should help increase ore production at Nkana by 4 Mt by 2018 and extend the life of Nkana mining operations to at least 25 years.

The oxide ore produced from the open pits is processed in the agitation-leach plant, while the Nkana concentrator processes the sulphide ore mined in Nkana's underground and open pit mines and has a capacity of 12,000 t/d. The copper concentrates produced at Nkana are transported by road to Mufulira for smelting and refining.

Xstrata Technology (XT) commissioned a new ISASMELT™ plant at Mufulira during 2006. It was designed initially to smelt 650,000 t/y of concentrate with the potential to expand to 850,000 t in the future. The Mopani ISASMELT plant replaced an existing electric smelting furnace. It comprises a new feed preparation system, electric settling furnace, waste heat boiler, electrostatic precipitator, gas cleaning plant, oxygen plant and acid plant. There were also improvements made to the converter aisle and anode plants.

It took only 28 months from signing of the engineering and licence agreement to achieve the first feed on in the furnace in September 2006. In addition to the engineering design of the plant and supply of key equipment such as the waste heat boiler, XT designed and supplied a plant wide process control system for the project based on a Yokogawa CS3000 platform. This control system allows the acid plant, oxygen plant and ISASMELT plant to be controlled from one central control room.

Cobalt concentrates from MCM's Nkana

mine, Katanga and Mutanda, are processed directly at the Nkana cobalt plant. The current production capacity is 2,800 t/y of cobalt metal, which should increase to 3,500 t/y by 2020. Mopani also has a copper SX facility, which recovers the copper contained in the cobalt concentrate.

Mopani is set to expand copper production by approximately 40,000 t/y by 2013, with plans to double its cobalt production to ~2,200 t in the same period. Glencore has a 100% offtake agreement for both copper and cobalt over the life of the mines.

Mutanda is a newly developed high-grade copper and cobalt producer, in the DRC's Katanga Province. Glencore holds a 50% interest in Samref Congo, which in turn holds an 80% interest in Mutanda, which is being developed to produce 110,000 t/y of copper and 23,000 t/y of cobalt contained in cobalt hydroxide as of 2012.

The new players

Barrick Gold is moving into Zambia, by buying Equinox. Equinox acquired the Lumwana project in 1999 and following nearly 10 years of feasibility, financing and construction, commissioned the mine, plant and infrastructure in December 2008. Situated 220 km west of the Copperbelt, Lumwana is now a major open-pit copper mine that positioned Equinox as one of the world's top 20 copper producing companies.

At initial design capacity, Lumwana is processing about 20 Mt/y of ore. The ore, which is predominantly sulphide, is treated through a large, yet conventional plant, producing a copper concentrate for sale to local and international offtakers.

Growth opportunities include phased expansions of the mine and plant to increase process throughput rates to 24 Mt/y and potentially 35-45 Mt/y, maximising the benefit of the large scale Lumwana copper resource.

Equinox recently filed an updated NI 43-101 compliant Technical Report for Lumwana, which supports in particular Equinox's February 2, 2011 disclosure on the proposed expansion of Lumwana to a processing throughput rate of 45 Mt/y as subsequently updated. That expansion is the subject of a feasibility study that is currently underway. The mine is a world leader in the application of trolley assist trucks.

The mine operates 32 Hitachi EH4500 diesel-electric hybrid trucks, each with a capacity of 240 t. These achieve an operating cost saving of some 30% through their use of electricity from hydroelectric sources. They also provide reduced cycle times due to increased speed up ramps. The seven-strong loading fleet of Hitachi excavators and face shovels are all 518 t machines with 27 m³ buckets – three diesel and four electric units. A significant rise in the cost of electricity for the mines is expected.

The revised report also contains an exploration target developed based on 2010 drilling results, which had previously been disclosed by Equinox on February 2, 2011. Equinox used this exploration target for pit optimisation studies at a long term copper price of \$2.50/lb which indicates that a mineral inventory of 1,000 to 1,500 Mt at 0.6% Cu could be realised when further drilling is completed.

In 2008, Equinox completed a uranium feasibility study investigating the onsite treatment of discrete, high grade uranium mineralisation contained within the Lumwana mine copper pit shells. This confirmed the potential viability of onsite uranium treatment,

MCM's incremental sales contribution from 20% increase in copper and 50% increase in cobalt production

	2008	2009	2010	2011e	2012e	2013e
Copper production ('000 t)	165.4	184.7	197.4	236.0	210.5	242.0
Cobalt production ('000 t)	1.5	1.3	1.1	2.2	2.2	2.1
Revenues (\$ million)	865	594	863	1,195	956	1,136
EBITDA (\$ million)	94	118	218	567	399	494
Capex (\$ million)	-137	-58	-130	-183	-178	-151

Source: company data, RBC Capital Markets estimates

Mineral resources summary as at 30 June 2010

Mineral project	Ownership	Mineral Resource category	Mineral Resources Mt	Total copper %	Contained copper Mt
Konkola North Copper Project					
South Limb ¹		Measured	0.7	2.70	0.02
		Indicated	23.9	2.13	0.51
		Total	24.6	2.15	0.53
East Limb ²		Measured	4.0	2.64	0.11
		Indicated	16.6	2.58	0.43
		Total	20.6	2.59	0.54
Fold Axis ²		Measured	0.4	2.10	0.01
		Indicated	11.8	2.70	0.32
		Total	12.2	2.68	0.33
Total		Measured	5.1	2.60	0.23
		Indicated	57.4	2.42	1.30
South Limb ²		Inferred	13.8	2.22	0.31
East Limb ²		Inferred	0.4	2.00	0.01
Fold Axis ²		Inferred	9.7	2.25	0.22
Area "A" ²		Inferred	219.5	2.64	5.79

¹ ZCCM IF has a buy-in right for up to 20% (5% of which is free-carried interest).
² The mineralised zones were modeled on a 1% total copper cut-off, and were signed off by an independent Competent Person.

producing about 2 Mlb/y of uranium over a six to seven year period. Should it be successful in negotiating viable uranium offtake agreements, the company estimated plant construction to take some 18 to 24 months.

Lumwana's Measured and Indicated resources are 358 Mt @ 0.76% Cu, with 564 Mt @ 0.63% Cu Inferred.

In one of Zambia's biggest underground developments for decades, Murray & Roberts Cementation secured the development phase contract at Konkola North for the East Decline system and ramps to access the orebody. The Konkola North copper project is a 50:50 joint venture between African Rainbow Minerals (ARM) and Vale, situated near the town of Chililabombwe, adjacent to the border with the DRC and north of the Konkola mine.

The scope of Cementation's work comprises some 2,100 m of conveyor belt ramp development, 4,000 m of access ramp development and 12,900 m of footwall and ore drives. In addition, raise drilling will be done for a total of about 550 m to accommodate service ways, air ways, dams and silos. These raise drilled holes will be at varying diameters.

Previously, the Konkola North orebody was developed between 1953 and 1959 by others, following which the mine was exploited for a period of some two years. Thereafter it was closed due to the poor economic climate at the time.

Konkola North is a continuous orebody and consists of two distinct, the South and East, Limbs. The orebody strikes generally in a northeast to southwest direction and dips between 15° and 77° in a southerly direction. The mineralisation associated with the tabular orebody occurs along an extensive strike length, with a true thickness range of 3 to 15

m in the currently planned areas and up to 18.6 m in the high grade, deeper regions.

Access to the East Limb will be via the new East Declines which will be sunk from surface to the 75 and 100 m levels. On the 100 m level footwall drives will be developed on strike for the top access of the three ramp systems to access the orebody down to 250 m level in phase one of the project. A set of three conveyor declines with transfer silos will be developed during this phase.

In the final configuration, ore and waste handling from underground will be by means of permanent conveyors and the East Limb material will report to either the concentrator on surface or waste stockpiles.

Development started in February 2011 from the portal access, and is being executed using mechanised mining equipment consisting of twin boom drill jumbos, bolter rigs for support, LHDs, 40 t mine trucks, emulsion explosive chargers and purpose fit utility vehicles.

Total mine capital expenditure, in July 2010 terms, on the Konkola North development was estimated at \$380 million. Construction commenced in August 2010 with commissioning of the concentrator plant

expected 27 months later and the mine is planned to reach full production in 2015.

The expected life of mine of Konkola North is 28 years. A further three-year exploration programme to evaluate area "A", which has potential to double the output to 100,000 t/y of copper in concentrate is in progress. Initially, the South and East Limb mines will be developed, after which the deeper, higher grade and wider reef areas will be mined. The Vale/ARM joint venture has completed 86,000 m of exploration drilling and defined 300 Mt at an average grade of 2.57% total Cu.

The South/East Limb mine's throughput design is 2.5 Mt/y of ore at an average mill head grade of 2.3% Cu, yielding 45,000 t of contained copper in concentrate to be toll smelted in Zambia.

Longer term, there is Mukuba Resources and its Northcore project - licensed for copper and cobalt – which encompasses approximately 2,274 km² of geologically prospective ground in the Domes Region of the Zambian Copperbelt. Over 95% of known Zambian copper reserves occur in rocks of the Lower Roan Group, Mukuba says, or in the adjacent basement complex. The Northcore area contains roughly 2,000 km² of the Lower Roan Group.

Mukuba also controls the Nyimba Project near the town of Nyimba, some 300 km east of Lusaka. Historic exploration records indicate there are five defined areas of mineralisation within the 500 km² license area. These polymetallic deposits host zinc, with copper, lead, molybdenum, silver, and gold, and were systematically explored and partially drilled by Minex (Mindeco) - a Zambian government department - in the late 1970s and early 1980s. The Nyimba project rights were acquired by Rio Tinto in 1994. Exploration on the property ceased in 1997 when Rio Tinto, along with most other mining companies, withdrew from Zambia. **IM**

Detailed country information is available on www.zambiamining.co.zm

KONKOLA NORTH COPPER PROJECT GEOLOGICAL CROSS SECTION

