GEOLOGIE EN MIJNBOUW VOLUME 51 (3), p. 251–263 1972

# ZAMBIA'S MINERAL INDUSTRY AND ITS POSITION AMONGST WORLD'S MAJOR COPPER PRODUCERS[1])

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## ABSTRACT

Tonnages and values of the chief minerals at present mined in Zambia are included in a survey which also touches on other mineral resources, e.g. nickel.

Zambia's position amongst other major copper producers is described in terms of production, average grades mined, ore reserves and costs.

Estimates of copper production for the next few years are given and some events affecting the copper industry in the past decade considered, especially as they relate to the position of the developing vis à vis the developed countries.

The extent to which copper dominates Zambia's economy is noted and its contribution to the Gross Domestic Product, to exports, Government revenues and employment is compared with that of its sister industries in the CIPEC countries (namely Chile, Peru and Zaire).

The corporate structure of Zambia's copper mining industry is described and the terms of the agreement by which the Government of Zambia acquired a 51 per cent interest in the industry in 1970 are set out. Important implications of recent mining legislation including the Mineral Tax Act 1970 and the Income Tax (Amendment) Act, 1970, are also considered.


## INTRODUCTION

Zambia, with an area of 752,600 km$^2$, is 21 times the size of the Netherlands and 1.4 times the size of France. It has a population of around four million. The larger part of the country is occupied by plateaus at altitudes between 650 and 1200 m, and over 1200 m. These elevations, in combination with Zambia's position between latitudes 8° and 18°S, contribute to its excellent (and sunny) climate.

In its Copperbelt, Zambia contains one of the richest metallogenic provinces of the world. However, the country is also well endowed with a number of other minerals although copper dominates the economy.

For the fascinating history of Zambia's prospecting and mining activities, which were intimately interlinked with the history of the old British South Africa Company, reference is made respectively to

| | tonnes | Approx. value in Kwachas |
|---|---|---|
| Copper | 686,076 | 650,362,350 |
| Zinc | 53,456 | 10,304,300 |
| Lead | 27,207 | 5,159,700 |
| Cobalt | 2,052 | 4,525,450 |
| Coal | 632,976 | 1,246,000 |
| Amethyst | 34,356 kg | 391,200 |
| Silver | 1,530,358 ozs | 1,837,100 |

TABLE 1

Tonnage (metric) and value of main minerals produced in Zambia during 1970. Source: The Mines Department of the Ministry of Mines and Mining Development, Zambia. 84.5% of the copper tonnage is refined, the equivalent figures for the other CIPEC countries are: Chile 64.2%, Zaire 46.6% and Peru 15.4% (World Metal Statistics). A figure of K 2 per tonne of coal is used as arbitray value.[3]) ("Tonnes" refers to metric quantities).

[1]) Occasional Paper No. 51, Geological Survey, Zambia. Published with the permission of the Permanent Secretary of Mines and Mining Development.

[2]) Geological Survey of Zambia (United Nations-Opas).

[3]) 1 Kwacha = $ 1.40.

Drysdall and Slinn in Bostock and Harvey (1972), and to Ter Brugge n (this issue).

## MAIN MINERALS PRODUCED, WITH SHORT GEOLOGICAL NOTES (see table 1)

### *Copper*

During 1970 Zambia was vying with Chile for the position of third largest copper producer after the U.S.A. and the U.S.S.R. but in 1971 Chile undisputedly established herself in this position. In this issue various articles describe the Copperbelt geology in detail. Largely due to the work of Garlick *cum suis* the syngenetic sedimentary genesis of the Copperbelt type of deposits appears now to be generally accepted although Jolly (this issue) points out that diagenetic, metamorphic and possibly other processes had a modifying, or perhaps even a controlling influence. As to the primary source of copper in the sediments, an interesting new view is expressed by Voet and Freeman in this issue who contend that, at least for the Footwall orebodies at Nchanga, the copper was derived from nearby lodes in the basement. In this connection it is interesting to refer briefly to other types of Basement copper mineralization which have not been described in this issue.

In the Mkushi copper deposits, now being exploited in an open pit operation, disseminated copper mineralisation occurs in small lensoid bodies of granite, porphyry, aplite and pegmatite which intrude biotite gneiss. The type of mineralisation, composition of the host rocks and character of alteration products of these deposits show many similarities to porphyry-type copper occurrences (Legg, 1972).

Copper occurs also in basic meta-volcanics, for example at "Greenhills' close to Kabwe, where amygdaloidal andesites were preliminarily drilled in the early 1960s by the Rio Tinto organization (Sharpe, 1963). Assays average some 0.9% Cu in near surface sulphides. Another interesting feature is that these meta-volcanics occur in a belt extending over 160 km, if not more, to the east. Anomalous copper concentrations were also recorded by Chartered Exploration some 85 km east of Greenhills, an area situated on the eastern edge of a 45,000 km$^2$ block west of Lusaka and Kabwe which is being investigated by a joint United Nations-Geological Survey of Zambia Prospecting Programme. It is provisionally planned to undertake additional diamond drilling at Greenhills in the framework of this programme.

Two other types of mineralisation occur – as replacement deposits in, for example, Kalengwa (Van Eden and Binda, this issue) and as veins at the small Hippo mine 80 km northwest of Mumbwa (Cikin, 1968).

The recording of an important copper discovery made by RST some years ago should not be omitted, i.e. the Lumwana deposit (Van Eden and Binda, this issue) some 240 km west of the Copperbelt. Prain (1969) reported "possibly 200 million tons of material with an average copper content of just under 0.9%. However, from an economic viewpoint the stripping ratio is high for a deposit of this nature in a remote undeveloped part of the country". Systematic drilling since this announcement has undoubtedly added to this tonnage.

### *Zinc, lead, silver.*

Zinc, lead and a small part of Zambia's silver (184,990 ozs in 1970) are produced at NCCM's Broken Hill Division at Kabwe. The ore occurs as pipelike bodies in a massive featureless dolomite as is described in detail by Kortman (this issue). The mine's grade is the highest in the world, the average mill grade during 1970 being 11.0% Pb and 29.1%Zn, but the complexity of its ores has made it simultaneously the mineralogist's paradise and the metallurgist's nightmare. For the metallurgy of the plant see Barlin, this issue. The major part of Zambia's silver production is from anode slimes and sludges from the copper refineries at Ndola, Mufulira and Rokana. (From these slimes copper, gold and selenium are also extracted).

### *Cobalt.*

Cobalt is a by-product of the copper industry and is at present being extracted from Rokana and Chibuluma ores. By 1973 important production will also come from the Baluba mine. The average mill grades during 1970 were 0.11% Co at Rokana and 0.21% Co at Chibuluma.

*Coal.*

Coal occurs in the Karroo system (D r y s d a l l et al., this issue) Maamba Collieries Ltd., the successor to the National Coal Board of Zambia, is a wholly owned subsidiary of Mindeco Ltd. and is operating an open pit and coal washing plant at Maamba, 65 km south of Choma in the Southern Province. The annual capacity of the plant is slightly in excess of one million tonnes of washed coal, but production is limited to local demand as little export potential exists. The Maamba coal seam was discovered by the Geological Survey Department in 1965.

*Amethyst*

The bulk of the production comes from "Northern Minerals" (Zambia) Ltd. which is owned by Lonrho interests (55%), the Horden Brothers (25%) and Crystals S.A., a Liechtenstein based company (20%). The mine is the largest producer of any semi-precious stone in the world (currently producing 50% of world's amethysts) and it is also the world's largest known amethyst deposit. On a smaller scale the Precious Minerals Company of Zambia Ltd., a subsidiary of Continental Ore (Zambia) Ltd. have now also gone into mining and marketing of amethyst (see also D r y s d a l l et al., this issue).

*Nickel*

Zamanglo Exploration Ltd., the Zambian exploration arm of Anglo American Corp. (Central Africa) Ltd. has made an encouraging nickel sulphide find which is systematically being drilled. The deposit is at Munali, some 60 km south of Lusaka and occurs in gabbros and peridotites. Geochemical nickel anomalies to the northwest, also associated with basic rocks, are being investigated by the joint United Nations-Geological Survey Prospecting Programme. It is worth noting that gabbroic rocks and amphibolites also occur in a number of other areas, particularly in the Eastern Province of Zambia.

*Iron*

Iron "ore" occurrences are common and widely distributed throughout Zambia. Only a limited amount of work has been done on the great majority of the deposits but several have reached the state of preliminary drilling (S t o h l, 1972). One, Sanje, was investigated in considerable detail by Geozavod under contract to the Geological Survey Department. Various feasibility studies have been conducted concerning the possible erection of a steel plant. A recent tabulation of deposits would indicate that there is a minimum of 1000 million tonnes of material grading between 50 and 60% Fe. This figure can be increased several times over if lower grade material is included. Transportation facilities in the country and the distance to seaports are such that production of iron ore for export seems unlikely (M. W o a k e s, Mindeco, pers. comm., 1972).

However, of these iron deposits the *iron-skarn* type is worthy of separate mention because of the presence in small amounts of several additional minerals (copper, cobalt, nickel, molybdenum, tungsten and tin). Considerable tonnages of this type occur in the aforementioned UNDP-Geological Survey Prospecting area and probably beyond. The following maximum assays have been reported by the Geological Survey laboratories: Cu 1.5%, Ni 0.2%, Mo 0.01%, W 0.08%, Sn 0.13%. The extraction of these

| | Production | Grade | Reserves |
|---|---|---|---|
| U.S.A. | 1,560.0 | 0.79 | 77.5 |
| U.S.S.R. | 925.0 | ? | 34.9 |
| Chile | 685.6 | 1.53 | 53.8 |
| Zambia | 684.1[1]) | 3.38 | 27.2 |
| Canada | 613.4 | 1.04 | 20.8 |
| Zaire | 386.0 | 4.2[2]) | 18.1 |
| Peru | 212.1 | 1.14[3]) | 22.3 |

TABLE 2

World copper statistics. Production: Primary copper production in 1970 (thousand tonnes); Grade: average grade in situ of ore mined in 1970 (percentages); Reserves: estimated commercial reserves (copper content in million tonnes).

Sources: World Metal Statistics, Sampson, formerly RST Group, via P r a i n (pers. comm., 1971), La Générale des Carrières et Mines, Zaire (pers. comm., 1971), Mining Annual Rev. (June 1971), Bulletin U.S. Bureau of Mines no. 650 1970 Edition, Mineral Resources Division, Department of Energy, Mines and Resources of Canada via Robinson, Geol. Surv. Canada, (pers. comm., 1971).

[1]) According to the Mines Department of Zambia this figure should read 686.

[2]) Cu-Co.

[3]) Toquepala mill-grade (Toquepala mine represents 69% of Peru's production).

metals still poses serious metallurgical problems (M. C a p, Geol. Survey Zambia, pers. comm. 1971), but as the tonnages are large and the deposits easily mineable (occurring as hills and ridges) it is possible that with improved metallurgy these iron skarns, or certain parts of them, may eventually become of economic importance (M. K u t h a n, U.N., pers. comm., 1972).

## ZAMBIA'S POSITION AMONGST WORLD'S MAJOR COPPER PRODUCERS

### *Production, average grades of ore mined, and ore reserves*

It should be stressed that the estimates of commercial copper reserves in table 2 give only a rough idea and can be quite misleading. What may be termed "commercial" depends on so many factors including companies' drilling policies, taxation, economic and political measures which can change overnight that ore reserve figures are in fact a "moving picture".

Although this article deals exclusively with copper derived from primary production the very important role of *secondary scrap*, which amounts to some 40% of total copper supplies, should be kept in mind.

| Country | Number of Mines included | | cents/lb. | |
|---|---|---|---|---|
| U.S.A. | 25 | | 28.9 | |
| Zambia | 8 | | 29.0 | |
| Chile | 8 | | 24.3 | |
| Canada | 18 | (30) | 32.9 | (24.8) |
| Zaire | 1 | | 32.5 | est. |
| Peru | 2 | | 22.4 | |
| Philippines | 6 | | 23.5 | |
| Australia | 4 | | 30.2 | |
| S. Africa | 3 | | 23.3 | |
| Elsewhere | 7 | (8) | 43.8 | (36.7) |
| Non-Soviet World | 82 | (95) | 28.5 | (27.9) |

TABLE 3
Cost of production by country. Costs are calculated on electro basis, delivered buyers, including depreciation and interest charges, after deduction of any by-product credit. Zambian royalty and exporttax and Congolese export tax are excluded from the calculations (Sampson via P r a i n, pers. comm., 1971). Zambian royalty and export tax amounted to 18 c/lb (P r a i n, 1970).

### *Costs of production*

In table 3 the ordinary figures exclude mines producing copper as a by-product, whilst those in brackets include them. The total tonnage represents 78.4% of non-Soviet Bloc mine production (81.9% including co-product mines). The average cost was 28.54 cents per lb on ordinary mines, 14.07 cents per lb. on co-product mines, and 27.93 cents per lb. on both combined. No costs are known for Japan, which produced roughly the same tonnage as each of the Philippines, Australia and South Africa, but we have reason to believe that Japan is a high-cost producer.

According to Mindeco's 1971 annual report Zambia's costs during the period 1970-June 1971 were 31.9 c/lb (K 503/tonne c.i.f.), up from 29 c in 1969. In the U.S.A. and Chile, however, costs have been rising considerably more. According to research carried out by Dean Witter and Co., New York (M i n i n g J n l. Oct. 22'71) costs per pound, presumably during the first part of 1971, varied from 32.8 cents to 49.5 cents amongst the major U.S. producers. The cost picture will become even worse because of the high cost of controlling air and water and restoration of mined-out land. Recent studies carried out in the U.S.A. (M i n i n g J n l July 9'71) indicate that costs of pollution control alone could add between three and six cents per pound and possibly even more! The Mining Journal of Nov. 19 1971 reports that the cost of copper production in Chile had risen to 40 c/lb, the main reasons for this immense increase being the steep rise in wages and the fact that production has not increased at the rate expected. These factors are generally attributed to management and labour difficulties experienced since the new Government was formed in November 1970 (see also table 5).

### *Period 1960-1970*

During the period 1960-1969 the biggest increase in copper production, both in absolute and percentage terms, was from the developed countries. Mine production in developed countries increased 42%, in developing countries 25% In absolute terms the greatest increase was in North America. It is interesting to note that the total tonnage of ore mined outside the Soviet Bloc rose from 184 million tonnes in 1952 to 516 million tonnes in 1970

(Sampson, 1971; via Prain, pers. comm.). Because of the increased open pit mining of very low grade copper deposits, (often associated with important amounts of by-products such as gold, silver and molybdenum), the copper industry of today is handling greater tonnages of material than the iron industry (Prain, 1970). Articles in this issue describe some of the technical developments in mining and metallurgy which make it possible to mine lower grades. A striking example is the Brenda mine in British Columbia, Canada, with ore reserves reportedly averaging 0.183% copper and 0.0049% molybdenum (Mining World, July 1969).

This decade has seen an increasing degree of Government interest in copper mines and in 1971 the percentage of non-Soviet Bloc primary production in which Governments held a minority, majority, or total interest was 38%, representing 2.2 million tonnes of capacity – 1.9 million tonnes of this being in developing countries. In this percentage figure, total government ownership amounts to 24% of annual capacity. These tonnages will increase as new mines or extensions of existing mines come into production.

The most important of these government interests relate to Chile, Zaire (formerly Congo-Kinshasa) and Zambia. *Zaire* fully nationalised the mines of Union Minière du Haut Katanga in 1967, but the company acquired a favourable management contract for the continued operation of the mines. In 1969 the agreement was extended for another 25 years and the compensation issue was settled at the same time. In *Chile* partial nationalization (differing from mine to mine) occurred in 1969, followed by total nationalization in 1971 of the largest mines which were formerly owned by Anaconda and Kennecott (Braden Copper Company). *Zambia* acquired a 51% interest in its copper mines on January 1st 1970, and this event is discussed in a later chapter. Peru has not nationalized its mines but it has taken strong measures to control the development of its mineral industries, such as for example its new mining code of June 1971 (Mineral Trade Notes, Oct. 1971).

The tendency on the part of developing countries to nationalize basic industries will induce caution on the part of potential investors and an internationally agreed investment code appears to be necessary.

Developments in Zaire, Chile, Zambia and Peru are to a large extent linked with the foundation in 1967 of CIPEC (Conseil Intergouvernemental des Pays Exportateurs de Cuivre) of which these countries are the sole members to date. The Cipec countries represent some 38% of non-Soviet Bloc mine copper capacity and 67% of non-Soviet Bloc primary copper exports (after Prain, 1971). (Note: This figure of 38% should not be confused with the same percentage figure previously given as applying to government interest in non-Soviet Bloc capacity).

The objectives of Cipec are briefly, (a) to coordinate measures designed to foster real earnings from copper exports, (b) to harmonise the decisions and policies of the member countries on problems related to copper, (c) to obtain better information and appropriate advice on the production and marketing of copper for member countries, and (d) in general to increase resources for the economic and social development of producer countries, bearing in mind the interests of consumers. Last year it was reaffirmed that one of Cipec's main objectives is to assure greater price stability on the international copper market (Gueronik, 1971; Mulaisho, 1971a). In order to increase its leverage in this respect there has been talk of Cipec opening its door to other copper exporting countries. So far Cipec's role has been confined to consultation and statistics. Prain (1970) is, however, of the opinion that potentially the emergence of Cipec as a consultative, though not executive body, is a factor of significance for the future.

It is pertinent to add a few words about mining capacity in the copper industry. Actual production lags behind mine capacity because of delays such as labour disputes, natural disasters, shortage of supplies, etc. For many years production on a world-wide basis has averaged 93% of capacity (which is a very favourable rate as compared with other metal industries). Average production rates obviously differ from country to country. Thus during the 1960-1970 period the lowest average operating rate was in the U.S.A. with 87.7% followed by Chile with 91.6%. The highest rate appears to have been achieved by Zaire at 96.6% followed by Zambia, Peru and Canada. "This record has come as a surprise to many people who have considered that the developing countries have been marked by unstable labour conditions, whereas these figures demonstrate the opposite; and I believe this may be true of industries other than copper" (Prain, 1970).

*The next few years*

Estimated total non-Soviet Bloc mining capacity in 1975 is 7,698,000 tonnes of which the CIPEC countries will contribute 2,754,000 tonnes or 35.8% (P r a i n, 1970) compared with 38% in 1970. The biggest increases in tonnage are scheduled to take place in the U.S.A. and Canada, as was also the case during the past decade, but the highest percentage increases will come from Oceania (Bougainville, West Irian, Sabah) and Middle East (Iran). Zambia's scheduled capacity for 1975 is 900,000 tonnes, although it is likely that the programme will be slightly delayed. It would appear that Zambia will soon have to yield its fourth place (after Chile) to Canada (P r a i n, 1971). On the consumption side it is significant that China's consumption seems to be rising rapidly.

## COPPER IN ZAMBIA: COMPARISONS WITH OTHER CIPEC COUNTRIES

The absolutely dominant position of copper in Zambia's economy is evident from line A, table 4. In reality Zambia's dependence on copper is even greater, a fact which becomes obvious if the *indirect* contributions to the economy are also calculated (lines B & C). A number of industries in Zambia depend completely, or partly, on the copper industry and *to the extent* that the locally produced inputs *have no alternative market* (nationally or internationally) their direct contribution to the GDP etc. may be counted as an indirect contribution by the copper industry.

P. B o t t e l i e r, I.B.R.D., (personal communication), who served as senior economist in the Ministry of Finance and later in various Ministries that dealt with mining, made an estimate of the size of such indirect contributions at the end of 1968. He chose 1965 as year of reference as this was the last year for which figures of the other CIPEC countries were then available. (As far as the author is aware, no such calculations have been made at a more recent date but, as no fundamental changes have occurred in Zambia's economy, Bottelier's figures are still relevant and revealing). Some of the more important locally produced inputs which Bottelier used for this calculations are: coal from the Maamba mine, mine timber, electricity, transport, plant and vehicle repair, rental services. He also took into account a second type of indirect contribution, i.e. the effect of the *disposal of income* generated by the copper industry, to wit wages, salaries, depreciation, dividends, taxes, royalties (which still existed at that time) and re-invested profits. His figures are summarized in table 4.

| | G.D.P. | Exports | Govt. Revenue | Employment |
|---|---|---|---|---|
| | % | % | % | % |
| A | 40 | 93 | 68 | 15 |
| B | 50 | 93 | 76 | 32 |
| C | 69 | 93 | 85 | 57 |

TABLE 4
Influence of copper industry on Zambian Economy in 1965. Line A: direct contribution, Line B: direct contribution ('A') + indirect contribution from locally produced inputs with no alternative market. Line C: 'B' + indirect contribution effected by disposal of income generated by the copper industry, after B o t t e l i e r, Intern. Bank for Reconstruction and Development (pers. comm. 1968).

Line 'C' represents the sum total of *direct* and estimated *indirect* contributions of the copper industry to Zambia's economy. The table makes it abundantly clear that Zambia is an extreme case of a developing country whose economy is dependent on a single commodity which moreover, has a highly volatile price (the monthly average London Metal Exchange price for copper in March 1970 was £ 729; it dropped below £ 437 by the end of the year and briefly below £ 400 at the end of 1971).

From table 5, it can be seen that of the four Cipec countries Zambia's dependence on copper is by far the greatest. The figures (especially for 1969) also reflects the major price movements.

Since Independence one of the main policies of the Zambian Government has been to reduce this total dependence on copper.

During the First National Development Plan (1966-1971) very high rates of growth were achieved in all the non-mining sectors except agriculture. However, what has been accomplished is in the form of import substitution rather than growth of alter-

| | G.D.P. % | | | | Exports % | | | | Revenue % | | | | Employment[1]) % | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | '68 | '69 | '70 | '71 | '68 | '69 | '70 | '71 | '68 | '69 | '70 | '71 | '68 | '69 | '70 | '71 |
| [3]) Zambia | 42 | 54 | 42 | 25 | 96 | 97 | 97 | | 60 | 59 | 52 | 37 | 14 | 14 | 14 | |
| [4]) Zaire | 24.6 | 26.1 | | | 61.1 | 67.4 | | | 38.4 | 41.6 | | [2]) | 4 | 4 | | |
| [5]) Chile | | | 10 | 11 | | | | 64 | | | 14 | 4 | | | 3 | 3 |
| Peru | | 3.5 | 3.4 | 3.0 | | 30.1 | 23.8 | 21.5 | | 10.9 | 13.3 | 7.3 | | | | |

TABLE 5

Percentile contribution of copper industry to the economies of CIPEC countries. [1]) Percentage of wage employment. [2]) Sharp decline after formation of new government due to sharp increases in labour costs and disappointing production.
Sources: [3]) Mindeco Mining Yearbook of Zambia 1970 (the 1971 figures for Zambia are for N.D.P.; Bank of Zambia). The big drop in 1971 was caused by the Mufulira Mine disaster in September 1970 and the low copper price. [4]) Conjuncture Economique 1968, no. 9, June 1969, published by Ministère d'Economie Nationale, Industrie et Tourisme, Rapport Annuel 1969-1970, Banque Nationale du Congo. [5]) (B o t t e l i e r, pers. comm. 1972). The GDP figures for Chile and Peru include coppers "value added". Peru's GDP figures are estimated. Provisional 1971 production figures for the CIPEC countries are (in thousand tonnes): Chile 707,5; Zambia 651.4; Zaire 408.0; Peru 192.6. Source: World Metal Statistics April 1972.

native exports. In fact, other exports have actually diminished in relative importance and have shown no real sign of growth (H a r v e y, 1972), as is clearly demonstrated in the above table.

The Second National Development Plan (1972-1976) puts special stress on development of agriculture, which has a vast potential, and of the rural areas. However, even if considerable success in this sector could be achieved, Zambia's almost complete dependence on copper will remain for a very long time to come, and as H a r v e y (1972) points out it is not possible to foresee the time when alternative exports will be significant.

The problem of diversifying the economy derives in part from the high salaries and wages paid on the mines. "The very prosperity created by copper has enabled the modern sector to give a very high standard of living to the few; and the ability of the economy to import has enabled it to neglect agriculture on which most people still depend". It is to be hoped that the low copper price (at the time of writing) and the devaluation of the Kwacha in line with the U.S. dollar will give a strong impetus to the planned development in agriculture and in the rural areas. The hard economic fact with which Zambia is faced, however, is that the increasing export earnings which are essential for the further expansion of the economy, can, in the short term, only come from copper, whether in the form of rising prices or rising output. Diversification, therefore, recedes even further into the future (H a r v e y, 1972).

*Some cost factors*

The main reason for Zambia's relatively high cost price compared with some other countries – in spite of the very high grade of its ore – is its landlocked position. Distances from the Copperbelt to its main shipping points on the Atlantic and Indian Oceans range from 1600 to 2300 kms. This situation was considerably aggravated by the Unilateral Declaration of Independence (UDI) by Rhodesia in November, 1965. Prior to this virtually all Zambian traffic used the Rhodesia Railways system, but after UDI Zambia made a strong effort to use alternative trade routes, particularly the road northward through Tanzania to the harbour of Dar Es Salaam, but also the railway through the Congo to Lobito (Angola). However, the route through Rhodesia to Beira and Lourenco Marques in Mozambique remained important, mainly because the alternative routes could not handle the required traffic. The use of alternative export routes with higher port charges at Dar Es Salaam, increases in the time taken to transport the copper, aggravated by congestions at various ports and increased *fuel* costs (also largely due to UDI), accounted for a 9% increase in the cost of sales[1]) of Zambian copper (delivered buyer) over the period 1964/65 to 1968/69 (B o s t o c k, 1972). In addition, the rising landed cost of imports in general has also played a

[1]) The "cost of sales" is the sum of all costs of production and distribution incurred by the industry.

significant role. It is expected that the new Tan-Zam railway which will link Zambia with Dar Es Salaam will improve the transport situation substantially, given adequate facilities at Dar Es Salaam. The railway, which will be 1740 kilometers long, is being constructed and financed by China at an originally estimated cost of $ 393 million and is scheduled to be commissioned in 1975. Extra carrying capacity will also become available as Zambia becomes increasingly self sufficient with regard to coal, fertilizers, cables and explosives.

Another adverse factor for Zambia (and Zaire) as compared with North America, Peru and Chile is the very low production in terms of tonnes per manshift (L o w e l l, 1970). This is partly due to geological conditions which often enables mining in the latter countries to be carried out in larger units and with less labour intensive methods, e.g. open pits and block caving. In addition, Zambia's open pit mines have a much higher overburden to ore ratio than the large porphyry type copper deposits of the Americas, which offsets to a large extent the advantage of Zambia's higher ore grades.

In 1969 Chile's large scale mining industry (as opposed to the medium and small mining industry) then produced 547 thousand tonnes of copper with a labour force of around 17,000, which included approximately 1% expatriate technical staff (d e V l e t t e r, 1969). Zambia produced in that year 720 thousand tonnes with 43,500 local employees and 4,727 expatriate employees (M i n d e c o, 1971). In Zambia, therefore, expatriate personnel amounted (and still does) to approximately 10% of the total number of employees, which in any case is two and a half times Chile's labour force. *Zaire* produced 364 thousand tonnes with a work force of 22,348, plus 2,068 technical, managerial and professional staff members. In mid-1970 there were about 600 native Zairians in the latter category, "but an extensive training programme is opening new opportunities to Zairans at the most highly skilled level." (1971).

In analysing these figures it should be borne in mind that Chile has seven long established universities, some of them with large science and engineering departments, and as a result there are numerous Chilean engineers. The situation in Peru is comparable (d e V l e t t e r, 1967). Zambia is a late starter in this field having opened a small science and engineering department in a new university only in early 1969. However, as we have seen in a previous section Zambia's competitive position regarding production costs considerably improved in relation to some other important producers. It should also be mentioned that most of NCCM's increased production will come from low-grade sources, in particular by the leaching of low-grade stockpiled concentrates and tailings as described by B o s s e in this issue.

Cost saving and increased efficiency should result from M i n d e c o' s proposed rationalisation programme. Before the takeover the copper industry was operated by the two large companies on properties virtually adjacent to each other, and with this possibility of rationalisation in mind Mindeco has been directing a significant part of its effort towards a better use of resources available to the industry as a whole (M u l a i s h o, 1971-b).

## CORPORATE STRUCTURE OF ZAMBIA'S COPPER MINING INDUSTRY AND TERMS OF GOVERNMENT'S ACQUISITION OF 51%

At the time of Independence all copper was produced by the two Zambian holding companies, Anglo American Corporation (Central Africa) Ltd. or AAC for short, and Roan Selection Trust Ltd. (RST). In view of Zambia's complete dependence on copper, the Government was naturally anxious to obtain a degree of control over the industry, and an agreement was reached whereby the Government acquired 51% of the shares of these companies on January 1st, 1970.

The Government created a new state company called MINDECO Ltd. (for Mining Development Corporation) to hold its shares in these (and future) mining companies. Mindeco is in turn wholly owned by ZIMCO Ltd., the Zambian Industrial and Mining Corporation, which also owns INDECO Ltd., a holding company for industrial and trading assets. Mindeco has an authorized share capital of K 300,000,000 ( 420,000,000) of which K 209,905,800 has been issued as fully paid. It works within the framework of the Ministry of Mines and Mining Development.

The mines and processing plants of the Anglo-American Group were amalgamated into Nchanga Consolidated Copper Mines Ltd. (NCCM), in which

the Anglo-American Corporation Group holds, through Zambia Copper Investments Ltd. (ZCI), a 49% interest. NCCM consists of the Centralised Services Division, Chingola Division (formerly Nchanga), Rokana Division (formerly Rhokana Corporation and Rhokana Refineries), Konkola Division (formerly Bancroft) – which will include the Kansanshi Mine that is to be reopened – and the Broken Hill Division, formerly the Zambia Broken Hill Development Company, which was acquired as from January 1st, 1971.

The Mines and processing plants of the RST Group were amalgamated into Roan Consolidated Mines Ltd. (RCM), in which RST Ltd. holds, through RST International Corp., 20%, ZCI 12.25% and the general public 16.75%. (RST Ltd. is now a wholly owned subsidiary of American Metals Climax). RCM consists of the Central Services, Mufulira, Luanshya, Chibuluma and Ndola Copper Refinery Divisions. The Chibuluma Division includes Chibuluma, Chambishi and Kalengwa mines.

Payment is based on book values of assets. Zimco will pay Kwacha 125.8 million (U.S. $ 178.7 million) for Mindeco's share in NCCM and Kwacha 84 million (U.S. $ 117.8 million) for its 51% share of RCM (Harvey and Bostock, 1972). Payment for the NCM shares is covered by 6% Zimco loan stock to be paid off over twelve years; payment of the RCM shares is covered by Zimco bonds to be paid off over eight years. These payments are free of Zambian tax and exchange control regulations, and guaranteed as to payment of capital and interest in U.S. dollars by the Government of Zambia. If two-thirds of the dividend to Mindeco from either company comes to more than the annual compensation payment, then the difference must be applied to additional redemptions (Acceleration of payment clause).

Management contracts have been given to the former controlling companies for a minimum of 10 years. The fee is 3/4% of turnover, and 2% of profits after mineral tax but before income tax. These companies also have exclusive sales contracts, the fee for which is 3/4% of sales; exclusive contracts for overseas purchases valid for 5 years, expatriate recruiting contracts. In all these contracts there is an obligation to give staff seconded from RCM and NCCM training and experience at the mining companies' expense.

The vital feature of the agreements is that all essential decisions, especially decisions on investment and financing of investment, must be approved by separate majorities of the "A" Directors (Government) and the "B" Directors (representing the 49% minority interest) and that the companies must be so run as to "optimise production and profit". Bostock and Harvey (1971) point out that the agreement is such that it cannot be said that Government has gained "control" of the mines, since the "B" Directors must approve all expansion plans, and, furthermore, they have no obligation to do so unless the project is commercially viable. The Zambian Government has agreed to join the International Centre for the Settlement of Investment Disputes (ICSID) which is affiliated to the World Bank.

For information on frozen Zambian law during the time that the Zimco bonds are outstanding, non-mining assets which have not been taken over but have been allowed to be externalised – to Bermuda in the case of Anglo American and to the U.S.A. in the case of RST-and other detailed information reference is made to Bostock and Harvey (1972).

The terms of the take-over have been acclaimed as very reasonable by both parties and also in the world press (see for example, Metal Bulletin, May 25, 1971). Bostock and Harvey (1972) point out, however, that an important weakness is the lack of a *deceleration* provision as opposed to the acceleration provision for compensation payments. These authors mention several possibilities which were open to the Government to reduce the burden of the compensation provisions which could become impossibly onerous if the copper price fell sufficiently, or if a further mining disaster occurred. One possibility would have been to make the takeover price "vary, over the period of compensation, with the price of copper and thus the real value of the assets taken over".

Bostock and Harvey (1972) consider that another weak point in the agreement is that no specific mention is made of Zambianisation. The authors note, however, that the companies already had large training programmes before the takeover and that the economic incentive to Zambianise was certainly there, even before Independence. It is pointed out that Zambianisation to a great extent depends on the supply of suitably educated manpower and that Government itself is the main supplier of basic education, and it also determines to a

considerable extent the proportion of different skills produced. So far, priority has been given to producing secondary school teachers, who were over 90% expatriate in 1970. Zambianisation is one of Government's basic policies, but it has also been categorically declared at various times that it will not be implemented so fast that it would affect efficiency.

In conclusion it should be said that the transition from the original structure of private companies to the present organization has been very smooth and marked by excellent mutual understanding and co-operation. Mulaisho (1971-a) stated: "The formula for partnership between Government and the private sector, which has operated so successfully in the last year, will continue to be the inspiration for yet greater co-operation with existing partners and partners to come".

## SMALL AND MEDIUM MINES IN ZAMBIA

In contrast to Chile and Peru (Sutulov, 1969; de Vletter, 1967, 1969), which have a long history of development in this sector, Zambia is a newcomer to this field at least in base metals. In the two Latin American countries the Governments concerned have always made a strong effort to promote the development of small and medium mines by technical and financial support including special tax treatment.

In Zambia there is at the moment only one small (Hippo Mine) and one medium mine (Mkushi Copper Mine) actually producing copper. The latter, operated by the Italian Company Miniera di Fragne Chiliamberto, started production in May 1971 and is now producing at the rate of 6,500 tonnes of copper (in concentrates) per year. Its concentrates are treated at the Rokana smelter of NCCM.

Small tin mining has been carried out since 1935 with an average annual production of 6-7 tons of concentrate; which production is now increasing; amethyst mining started in 1960.

Mindeco's policy is to effect a rapid expansion in the small mining sector, with the support of the technical facilities and personnel of the Geological Survey Department in addition to their own staff. Mindeco is operating a small emerald mine (Kafubu Emeralds Ltd.) near Kalulushi, while studies are well advanced to revive the Lochinvar gypsum project. Small scale co-operative tin production in the Southern Province is carried out under Mindeco guidance. Investigations are being carried out into the possible exploitation of phosphate, graphite, tantalite, manganese and various clays with industrial applications (Mulaisho, 1971-b). One of Zambia's main drawbacks in this sector as compared with its Latin Cipec partners is again the lack of skilled manpower.

## NEW LEGISLATION AND DEVELOPMENTS

### *The Mines and Minerals Act, 1969*

(For details, and discussions on the Mines and Minerals Act reference is made to Drysdall and Langevad from which much of the following notes have been obtained).

The new Mines and Minerals Act, which became law on the 1st January, 1970, is designed to encourage systematic exploitation of the country's mineral sources on an expanding scale (Drysdall and Langevad, 1970; de Vletter, 1970). All mineral rights were vested in the State, and the Government administers and controls the issue and exercise of prospecting, exploration and mining licenses (jointly called "mining rights"). It has the option to take up 51% of the equity in any future mine by paying its share of the prospecting and exploration costs. Government will also put up additional capital for mine development on the same terms as the other shareholders. Provisions have also been made to ensure the conservation and best use of the Republic's mineral wealth.

*Special Grant areas*, covering the whole of the sub-outcrop of the "Mine-Series" in the Copperbelt area, had been granted by the old British South Africa Company "in perpetuity". These Special Grant areas were too large for the two Zambian holding companies to develop, at the rate the Government considered desirable. As a result of discussions between Government and the two Zambian holding companies the latter agreed to surrender those areas on which no prospecting had been carried out since Independence (1964) or which had been given a low priority in the prospecting programme. In the case of existing mines, it was agreed that the Special Grants

would be replaced by mining licenses, valid in the first instance for 25 years but renewable where ore reserves permit, while other Special Grants would be replaced by Prospecting or Exploration Licences.

The larger part of the *Exclusive Prospecting Areas*, which almost completely tied up the most promising parts of the country, were surrendered by the then existing mining and exploration companies. However, the areas retained by the companies of the RST and AAC groups are still large enough (approximately 12½% of their original holdings) for them to utilise the full capacity of their exploration organisations.

One of the main considerations in drafting the new Act was to enforce on holders of the various types of licence an acceptable level of activity. This has been achieved by: a) a limitation of the period of time for which any particular right is valid, b) minimum expenditure obligations and c) penalties if the holder fails to conform to an approved programme (see also Drysdall and Langevad op. cit.). However, it should be stated that the minimum expenditure obligations have been kept at a very reasonable level, and that the Act is quite flexible giving reasonable opportunity for amendments in programmes in the light of new data and circumstances.

The following is a brief description of the three different types of mining rights:

I *Prospecting Licence* – valid for a maximum period of 4 years; no limit of area; annual minimum expenditure obligation Kwacha 25/square mile.

II *Exploration Licence* – valid for a maximum period of 3 years with a right of renewal for a further two years, or, under exceptional circumstances, more. The maximum area is 10 square miles, but if it can be demonstrated that a more extensive orebody may exist, the applicant may apply for more than one adjacent area. Minimum expenditure obligations per square mile: 1st year K 2,000, 2nd year K 4,000, 3rd year K 6,000; for renewal periods K 10,000.

III *Mining Licence* – valid for a maximum period of 25 years with the right of renewal for a similar maximum period, provided that the holder can show that ore reserves remain and submits a satisfactory programme for their exploitation. The holder of a prospecting or exploration licence has the right to obtain one or more mining licences.

The responsibility for the overall administration of the new Act rests with the Minister responsible for Mines and the Chief Mining Engineer. (For readers of Geologie en Mijnbouw more information is contained in d e V l e t t e r, 1970).

*Taxation*

An entirely new system of mining taxation came into effect on 1st April, 1970. The most important change is that all mineral royalties, and in the case of copper, the export tax as well, which were "ad valorem" taxes, have been abolished and replaced by a Mineral Tax charged entirely on *profitability*. The mineral tax on copper is 51 per cent and on lead and zinc 20 per cent. Company tax at a uniform rate of 45 per cent is payable on the balance. The liability for both forms of tax is assessed on the same basis.

Another important change concerns the capital allowances deductable for both mineral and income tax purposes. Any mine will be allowed to write off all capital expenditure in the year in which it is incurred. Accumulated losses and unredeemed balances may be carried forward without limitation. Prospecting and exploration expenditures will be fully allowable in the same year. New mines will pay no tax until the original capitalisation and subsequent expenditures have been recovered. In the case of the existing mines the balance of unredeemed capital expenditure outstanding on 1st April, 1970, will be written off in equal instalments over 20 years or over the life of the mine whichever is shorter.

The main purpose of the new system of capital allowances is to improve the discounted cash flow of return on new investments and thus promote development in the mining sector. Finally, the Mineral Tax Act, 1970, provides for the remission of part or all of the mineral tax paid by new mines where it can be shown that the average after-tax return on equity over a period of three years (starting from the year in which tax is first payable) is less than 12 per cent. Refunds thus obtained are not liable to income tax. The implication of this refund provision in the case of new copper mines is that there is in fact a sliding scale in the overall rate of taxation ranging from a minimum of 22.05 per cent, when all mineral tax is refunded, to a maximum of 73.05 per cent, when no mineral tax is refunded.

Under the provisions of the Mineral Tax Act, 1970, the Minister responsible for Finance has the

power to exempt any mining company from the payment of mineral tax but it may be anticipated that this power will only be exercised in the case of certain very small mines. (After Bottelier, in Drysdall and Langevad, 1970). For comments on the new Tax system reference is made to Harvey and Gordon in Bostock and Harvey (1972).

*New Developments*

One of the main objectives of the agreements with the former Zambian mining companies and the new mining legislation was to broaden the basis of mining interests in the country. Indeed a considerable measure of interest by newcomers is apparent. By the end of 1971, 16 prospecting licences (total area 78,100 $km^2$) and 4 exploration licences (total area 43.3 $km^2$) had been granted to new companies. These new companies are: SOMIREN, a subsidiary of Italy's state-owned oil corporation Ente Nazionale Idrocarburi (ENI) who were granted a prospecting licence (around 52,000 $km^2$) for radioactive minerals. SIDCO, a Yugoslav company, SUICO a subsidiary of the Japanese Mitsui Mining and Smelting Company Limited and Continental Ore, GEOMIN, a Roumanian state-owned company, and METALIMEX, a Czech state-owned company.

In addition to the extensive prospecting activities of the old and new companies, the Geological Survey is conducting a joint large scale prospecting programme with a United Nations Development Programme team as mentioned previously.

In order to supplement its regional mapping programme the Geological Survey Department is increasingly utilising geochemical and geophysical (airborne and ground) techniques. The Department is well endowed with personnel and modern equipment. Its professional establishment has been fluctuating between 33 and 39 in the last few years and its budget for 1971 totalled $ 1.5 million (Drysdall, 1971).

For new developments in the field of mining reference is made to Ter Brugge n' s article in this issue.

## ACKNOWLEDGEMENTS

I would like to express my very sincere thanks to Sir Ronald Prain, Chairman of RST International Metals Ltd. and Mr. P. Bottelier, Economist with the International Bank for Reconstruction and Development for the very interesting data that they kindly made available. Also gratefully acknowledged is the very valuable assistance received from Dr. R.A. Drysdall, Director of the Geological Survey Department of Zambia, Miss M. Kershaw and Mr. C.A. Legg, both also of the Geological Survey, and Mr. A. Warwick Ching, Economist with the Ministry of Mines and Mining Development for their critical reviews and suggestions. Finally I should like to thank warmly all those who made the effort to answer my letters of helped me otherwise.

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