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# COUNTRIES PRODUCING NON-FERROUS METALS: CHARACTERISTICS, PROSPECTS AND STRATEGIES **

Prepared by the System of Consultations Division

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## COUNTRIES PRODUCING NON-FERROUS METALS: CHARACTERISTICS, PROSPECTS AND STRATEGIES

### A. INTRODUCTION

Both the structural changes and the changes conditioned by market trends that have been taking place in the world economy since roughly the middle of the 1970s are having a marked though varying effect on the development of the different non-ferrous metals.

Overall production of non-ferrous metals has, generally speaking, undergone a sharp decline in the last few years as a result of the fall in the growth rate of the production of the more traditional non-ferrous metals (copper, aluminium, nickel, zinc, lead and tin). Nevertheless, it can be pointed out that at the present time there is a trend towards relatively faster growth of new metals (titanium, silicon and others) which are being used in the advanced industries such as electronics, nuclear power, space technology and so on. 1/

In the 1970s the trend in the consumption of metals traditionally known as non-ferrous was far below that of the non-ferrous metals associated with the so-called "advanced" sectors. Over that period the world annual consumption of primary aluminium increased by 5.5 per cent, that of refined copper by 2.9 per cent, refined tin by 0.2 per cent, refined nickel by 2.4 per cent, zinc billets by 2.1 per cent, and refined lead by 3.8 per cent.

After 1982 there was an increase in the growth rate of the world economy, a relatively limited rate, however, being observed in the consumption of the more traditional non-ferrous metals owing to structural changes affecting the world economy, more especially the main industries that make use of these metals. Thus we see that over the period 1983-1986 the consumption levels for most of the non-ferrous metals under consideration remained virtually stable and in the case of tin were lower than the levels attained prior to 1983. It should be pointed out, however, that the world consumption of aluminium in 1985 exceeded the levels for the first few years of the 1980s and was slightly higher than the maximum consumption recorded in 1979.

Because of the moderate increase in consumption as well as the large stocks available, producers have generally tended to keep production levels relatively low so as to improve their prices. The adjustments made by the producers to bring their production capacity into line with the consumption and price levels has resulted, firstly, in considerable decreases in production capacity through the shutdown of plants, and, secondly, in the cancellation or postponement of new

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1/ During the 1970s the annual consumption of tantalum in the United States rose by 19.5 per cent, beryllium by 11.9 per cent, zirconium by 8.0 per cent, silicon by 6.9 per cent, titanium by 6.2 per cent, and lithium by 5.2 per cent. Over the same period the annual consumption of tantalum in Japan increased at an annual rate of 13.6 per cent, titanium 12.9 per cent, lithium 11.7 per cent, silicon 10.3 per cent, and zirconium 8.4 per cent. Pierre-Nöel Giraud, "Geopolitics of mineral resources", Economica, Paris (1983), pp. 326 and 327.

projects, as well as a tendency to relocate or set up new production capacities only in countries offering very favourable conditions in terms of the abundance of minerals and cost of energy. Nevertheless, it should be pointed out that in recent time, on account of a certain increase in prices and the scarcity of metal supplies, attempts have been made in North America to persuade a number of aluminium plants to resume operations at some of their inactive plants. 2/

The process of expansion of non-ferrous metal production on a world-wide basis has shown fundamental changes. As far as the developing countries are concerned, the world expansion process for mining production and the processing of non-ferrous minerals took place, roughly up to the middle of the 1970s, chiefly by means of direct investment; later on, the most important method used in this process was that of credit. Another change which can be seen in the world-wide expansion of non-ferrous production is a change in the degree of concentration of the ownership and/or control of certain non-ferrous metals and minerals, as a result of the nationalization undertaken by certain mining developing countries as well as the participation by transnational corporations from outside the non-ferrous metal sector, mainly oil companies. 3/

During the 1960s the developing countries adopted measures aimed at stepping up their control over their raw materials. This led to a nationalization process, first and foremost for copper; there was an increase in the taxes levied on transnational companies and producers' associations were set up or strengthened in order to try to control the trend in prices.

These measures led to a state where the principal transnational companies adopted new strategies by gearing their new investments mainly to developed countries or to developing countries where the risk of nationalization was considered minimal. They also increased their degree of vertical integration and put into practice new methods of exploiting the reserves (open cast mining). Furthermore, in the 1970s the predominance of the United States in the production of non-ferrous metals began to decline on account of these new trends and the important role that Japan and Europe had begun to play in non-ferrous metal production.

During the 1970s, approximately 85 per cent of the mineral prospecting in the world took place in the developed countries. 4/ In certain instances the prospecting was carried out at deposits which had a lower percentage of mineral content than in the developing countries. In order to exploit those relatively low-grade deposits there was need to apply mining techniques involving high capital expenditure that the smaller and medium-sized firms could not afford.

Hence from about the end of the 1960s the larger transnational companies cut down their direct investments in the developing countries. The direct share of private capital in the financing of the mining industry dropped from

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2/ Metal Bulletin, 19 May and 23 June 1987, pp. 7 and 11, respectively.

3/ For more detail see "Development and restructuring of the non-ferrous metal industries", ID/WG.470/6, UNIDO, August 1987.

4/ Most of this prospecting was carried out in Australia, Canada, South Africa and the United States.

90 per cent of the total capital by about 1960 to approximately 33 per cent during the 1970s. 5/ The decrease in direct investment by the transnational companies was replaced by the system of loans.

The decrease in direct participation by the transnational companies in new projects in the developing countries was due to many factors. Over the period between 1973 and 1980, the member States of OECD underwent a decline in industrial production as well as in their fixed investments, 6/ which had an adverse effect on the consumption of non-ferrous metals and on the world-wide expansion of their non-ferrous metal industries. Another reason which further decreased direct investment with credit was that the capital required for new projects was over and above the generation of liquidity and the capacity for indebtedness of the mining- metallurgical firms in existence; this was most obvious in the major projects for developing countries for which considerable investments were needed to develop the basic infrastructure required for that type of project.

The new investment system began to spread starting from the middle of the 1970s, with the emergence of new sources of funds, such as the transnational oil companies, the Governments of oil-producing countries, and the insurance companies of the developed countries with a market economy. 7/ Similarly, the rapid expansion of the Eurodollar market created a climate favourable to an increase in loans. 8/

The process by which the non-ferrous metals have developed in the different countries has varied. The industrialized countries are the ones showing the highest consumption of non-ferrous metals, as well as being the main producers of processed products, though not the principal mining countries. However, between 1972 and 1984 the industrialized countries underwent a relative decline in their share in the world consumption and industrial production of the principal non-ferrous metals. 9/ It is important to note that in those countries the consumption of new metals associated with the advanced sectors has been considerably stepped up, chiefly in the United States and Japan.

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5/ "The nickel industry in the developing countries", United Nations, New York (1980).

6/ Between 1973 and 1980 the increase in the GDP of the OECD countries was 2.6 per cent yearly, while over the period 1963-1973 it was 5.2 per cent. (UNCTAD, "Trade and Development Report" (1982) pp. 53 and 57). The fixed investment by the United States, which had increased by 72.7 per cent during 1966-1973, rose by 38.2 per cent in 1974-1979, and 18.8 per cent between 1980 and 1982.

7/ For more details see Radetzki and Zorn, "Financing Mining Projects", United Nations study, London (1979).

8/ Ibid., p. 58.

9/ For more detail see "Development and Restructuring of the Non-Ferrous Metal Industries" (ID/WG.470/6), UNIDO, System of Consultations Division (August 1987), pp. 70 and 72.

A characteristic of the centrally planned economies is that they have maintained a certain balance between their production and consumption, and have as a result a relatively smaller share in international trade in these metals as compared with the developed countries with a market economy or the developing countries.

Although the developing countries are the principal mineral producers, their relative share in the processing and consumption is limited, mainly because of the logic of development that privileges exports. Nevertheless, between 1972 and 1984 these countries underwent an increase in their share in the consumption and processing of non-ferrous ores. 10/

Among the developing countries producing non-ferrous metals there are differences with regard to the problems facing the sector, the level and type of reserves and also the features of their production structure. Similarly, they differ with regard to the direct and indirect impact of the non-ferrous sector on the economies and development strategies which they adopt. This also applies to the industrialized countries.

To gain an idea of the specific factors arising in the development of the non-ferrous sector in the developing countries as well as in some of the industrialized countries, a set of case studies was made in different regions with a view to acquiring new information for analysing the problems, characteristics and prospects of the non-ferrous metals sector.

The study of specific cases is intended, first, to supplement and enrich the more general investigations which have been made in the non-ferrous sector, first and foremost in the restructuring process, and, second, to ascertain in more concrete form the changes that are occurring and the action that is being taken by different countries within the context of the new situation.

This paper is a brief account of the different case studies carried out. In the region of Asia it was the non-ferrous metal sector in Indonesia, Malaysia, India and Thailand that was studied. In Africa it was Guinea, Zambia and Zimbabwe. In Latin America it was Bolivia, Peru, Chile, Brazil, Venezuela, Colombia and Nicaragua. In Europe it was Hungary, Yugoslavia, Sweden and Portugal. A study was also made of Australia because of the impact that the development of its non-ferrous metal sector is having on the overall sector situation.

Among the countries of Asia mentioned above it can be noted that in Malaysia and Indonesia the production of tin plays a prominant part in the overall production of minerals and metals, while in India the most significant production is that of aluminium, zinc and copper. In Thailand zinc is the most important output, although the production of tin is also significant.

Growth in the output of tin in Malaysia and Indonesia began to decline in 1981, while the production of copper in Malaysia underwent a marked increase of approximately 374 per cent over the period 1981-1985. However, bauxite production in that country fell 30 per cent over the same period. In India, copper production underwent a 112 per cent increase between 1975 and 1984,

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10/ Ibid., pp. 70 and 72.

whereas the output of bauxite remained virtually unchanged. In that country there was also a drop in the degree to which the installed capacity was used to produce aluminium, as a result of limited energy supply. In Thailand, since the collapse of the tin market more than 50 per cent of the mines have been closed down. The number of miners officially employed fell from 46,411 in 1981 to 30,118 in 1985, and it is still decreasing. The production of mined tin concentrates dropped from 42,968 tons in 1981 to 23,022 tons in 1985.

The output of minerals and metals in those countries is managed by the State as well as by the national and international private sector. In Indonesia, approximately 75 per cent of the output of tin is accounted for by the State, and the remaining 25 per cent is produced by foreign companies. In Malaysia foreign capital plays a minimal part in mining production, whereas its share in processing operations is greater. In India, the primary processing of copper is in the hands of the State, while aluminium is produced by four companies, of which the State-owned company accounts for about 28 per cent of the production capacity. Thailand focuses its mining-metallurgical development on the private sector, which is both domestic and foreign. Despite the increase in the domestic private sector during the processing stage, this part of the process is still to a large extent under the control of Billiton/Royal Dutch Shell.

With regard to the impact of the mining-metallurgical sector on the economy of these Asian countries, both in the case of Indonesia, Malaysia and also Thailand, exports from the sector are an essential source for generating foreign currency for the normal operation of their economies. Internal consumption is therefore limited. In India the impact of the sector on the economy is different since production is geared mainly to internal consumption. The output of non-ferrous metals there is one of the main inputs for the process of growth and development of the industrial sector.

The strategies planned by those countries for developing the mining-metallurgical sector have different features. In Malaysia the development strategy for the sector is mainly based on achieving a better balance between the increase in income from the exploitation of mineral resources and their conservation, and also on increasing vertical integration. In Indonesia efforts are being made to reduce the extensive dependence on exports by promoting internal consumption. In Thailand the development of the non-ferrous sector, especially as concerns tin, is focused on export as an essential way of producing foreign currency, although in the long run it is affecting the need to increase production for internal consumption. In India strategy is mainly geared to reducing the imbalance between mining and processing operations.

In Africa, the countries studied have different types of reserves. Guinea has considerable bauxite reserves, while Zambia has mainly copper reserves and Zimbabwe has nickel and copper. Bauxite production in Guinea increased 25 per cent over the period 1976-1984. Copper production in Zambia and Zimbabwe has declined. In Zambia it fell by 22 per cent between 1974 and 1984, and in Zimbabwe the decline was greater, since it fell 56 per cent over the period 1973-1984. As far as nickel production in Zimbabwe is concerned, the figure fell by 38 per cent between 1977 and 1984.

In Guinea production of minerals and metals is carried out by joint ventures in which the State has gone into partnership with transnational corporations, for example the Compagnie des Bauxites de Guinée (CBG), or the Office des Bauxites de Kmdea (OBK), in which the State owns 100 per cent of the capital. This latter company was set up on the basis of an agreement signed in 1969 with the Soviet Union, under which that country undertook to construct the

mine and the railway in exchange for receipt from the Government of Guinea of 50 per cent of the bauxite mined. In Zimbabwe mining-metallurgical output has been throughout its history in the hands of foreign companies, but starting from 1980 State participation has gradually increased.

In Zambia the mines were nationalized in 1970 and reorganized into the Nchanga Consolidated Copper Mines (NCCM) and Roan Consolidated Mines (RCM), in which 51 per cent of the shares were held by the State concern Zambia Mining and Industrial Corporation Limited (ZIMCO). In 1982 the NCCM and RCM were merged to form the Consolidated Copper Mines Limited (ZCCM), 60.3 per cent of which is held by the State.

The impact of the non-ferrous metal sector on the economies of the African countries studied is considerable, although the degree of its influence is different. In Guinea the overall functioning of the economy depends to a large extent on income from bauxite and aluminium exports. In 1984, approximately 93 per cent of the foreign currency receipts stemmed from the export of bauxite and aluminium. In Zambia the mining-metallurgical exports account for about 93 per cent of the country's exports and in Zimbabwe the export of ores and non-ferrous metals has attained 49 per cent of total exports.

The development strategy applied by those countries has basically been to promote exports and thereby acquire the foreign currency that the economy needs for normal operation. Nevertheless, it should be pointed out that since its independence and basically over the period covered by the First Economic Plan (1960-1963), Guinea has sought to promote the development of the non-ferrous metal sector mainly on a domestic basis. At present both Zimbabwe and Zambia are postulating a strategy aimed at attaining higher levels of regional integration.

The countries studied in Latin America have considerable reserves of non-ferrous minerals, mainly copper and bauxite, though also lead, zinc and tin. There are countries among them which mainly have reserves of one single metal or in which the reserves of it are much higher than those of other non-ferrous minerals; this applies principally to Chile (copper), Bolivia (tin) and Venezuela (bauxite). Brazil has important reserves of bauxite which place it third with respect to the world reserves of this mineral, but it also has large reserves of other non-ferrous minerals, for example, copper, nickel and tin. Peru has diversified non-ferrous mineral reserves, with copper standing out among them, although there are significant reserves of zinc and lead. The reserves discovered in Colombia are relatively scarce compared with the potential which it has not yet been possible to quantify. Among the principal non-ferrous minerals possessed by Colombia are nickel, copper and bauxite. In Nicaragua, the main non-ferrous ore deposits are located in the Bonanza region. The reserves calculated for this region were approximately 1.5 and $10^6$ tons, with a 12 per cent zinc content, 60 per cent lead and a notable copper, gold and silver content.

The evolution of mining-metallurgical production in those countries has shown different trends. In Brazil output indicated a considerable growth over the years 1975-1985. We see that over that period the production of aluminium, lead, copper, tin, nickel and zinc in both primary and secondary forms rose by 309 per cent, 30 per cent, 328 per cent, 278 per cent, 477 per cent and 206 per cent, respectively. In Chile, the output of Codelco fine copper rose during the years 1976-1984 by 23 per cent. In Venezuela, the gross output of primary aluminium increased between 1980 and 1985 by roughly 21 per cent. In Colombia, bauxite production underwent considerable growth between 1981 and

1982, and the output of nickel and copper attained likewise a significant growth between 1982 and 1983. In Peru, copper output reached its highest growth rate over the years 1950-1960, increasing by 45.2 per cent, and later showing a lower growth rate up to 1979, but it then decreased by 13 per cent in 1981 in order to recover in 1982. Lead like copper experienced its best growth rate during the 1950s, and later showed a slight uptrend until 1983, after which it decreased by 1.7 per cent in 1984. Production of zinc showed significant growth rates in the 1950s and 1970s, namely 10.3 and 9 per cent, respectively. Later on it increased, but at a slower rate, though without showing a downtrend. Bolivia showed a downtrend in its tin production during the period between 1976 and 1985. Production dropped over this period by 4[illegible] per cent. Between 1983 and 1984, as well as between 1984 and 1985, it showed the greatest rate of decrease, the figures being 21.3 per cent and 19.1 per cent, respectively. In Nicaragua, production is limited to 26 tons of copper alloys per year and 20 tons of aluminium alloys per year. This country had planned to increase the output of non-ferrous metals by 23.9 per cent between 1983 and 1986, approximately.

The forms of ownership within the mining-metallurgical sector in Latin America differ according to the countries studied. In Peru, 1968 saw the beginning of a process of growth in the share of the State and private domestic companies in the output of minerals and metals. Over the period between 1968 and 1975 foreign companies reduced their share in production by roughly 54 per cent, moving from a contribution of 87 per cent in 1968 to 33 per cent in 1975. Since 1952, a year in which the three major mining companies in Bolivia were nationalized, the ownership structure in that country has remained almost unchanged. In Chile, a process by which greater emphasis is placed on the foreign private sector to develop copper production is under way. This trend can be seen clearly from the new projects in which an extensive share of foreign capital is observed. In Brazil, participation by the State and both domestic and foreign private sectors varies as a function of the type of production of non-ferrous metals. For copper the State is responsible for 100 per cent of the production, while for aluminium foreign capital occupies a large share, and also for lead. For zinc, domestic private capital is significant. In Venezuela, the two main companies producing aluminium (CVG and VENALUM) are joint ventures in which the State has a majority share. In Nicaragua, non-ferrous metal production is basically in the hands of small and medium-sized companies in the private sector. In Colombia, State-run companies (Empresa Colombiana de Minas and others) coexist with joint companies (Mineros del Choro and others) in mining activities.

Development of the non-ferrous sector is having a vital impact on the economies of some of the Latin American countries studied. In Bolivia, exports from mining, first and foremost tin, which accounts for 70 per cent of the total mining exports, are making a distinct contribution to the acquisition of foreign currency and growth of the economy. In Bolivia, a fall in the consumption of tin and also the price of it has had an adverse effect on the country's economic recovery. In Chile, too, copper exports are the principal source of foreign exchange. Similarly, it is making some substantial investments in copper mining and metallurgy for the purpose of upgrading the part played by this activity as a basis for national development. In Peru, the mining-metallurgical sector is perceived as a strategic sector for development of the Peruvian economy. The mining-metallurgical sector accounts for more than 40 per cent of the country's total exports. In Brazil, although the weight of the non-ferrous sector is now relatively low in the economy, considerable investment effort is being made and will result in a greater share of this sector in the economy. In Venezuela, aluminium exports are at present of little significance and only represented 1.94 per cent of the total exports in 1984. Conversely, this year the export of

oil and petroleum derivatives accounted for about 93 per cent of the total exports. However, it has to be pointed out that development of the aluminium industry in Venezuela is attaining greater levels of integration with the rest of the economy, since its production for internal consumption is on the increase. In Colombia, participation by the mining sector in the economy is limited. Mining production in that country only accounted for about 1.7 per cent of national output over the years 1975-1981. Exports only attained 10 per cent of the total exports between the years 1980 and 1982. In Nicaragua, the non-ferrous sector is at the moment of little relevance. This country is planning to step up production in the sector in the future by increasing mining operations in the Mina Vesubio areas and by reactivating the production of non-ferrous minerals in Bonanza.

The development strategies put into effect by the Latin American countries show different features although it can be pointed out that the predominant approach is to promote exports. The country most clearly showing an approach geared to sending abroad is Chile, on the basis of the low cost of copper mining compared with the other chief producers. Furthermore, Nicaragua is planning a development style which tends to favour the internal integration of the sector without ignoring export possibilities. Brazil is implementing a number of projects, mainly in the field of aluminium and nickel, that will substantially improve the country's export capacity. Bolivia does not yet have an alternative strategy that might make it possible to free itself from the crisis through which its tin production is passing. In Peru and Venezuela strategies are being promoted that are intended to increase the national aggregate value of exports and to promote internal consumption.

Broadly speaking, the European countries producing non-ferrous metals which have been investigated show smaller reserves and lower quality levels than a large number of developing countries covered by the present study. Some of the non-ferrous producing countries of Europe studied back up their non-ferrous production to a large extent by importing significant amounts of minerals.

Hungary's chief mining product is bauxite. As to industrial production in the true sense, of greatest significance is aluminium, although Hungary also produces copper and copper alloys as well as semi-manufactured products made of lead and zinc. Mining production in Yugoslavia relates mainly to copper, lead, zinc and bauxite. With regard to processing, the products of greatest relevance are alumina and aluminium, although there is also production of the metals copper, lead and zinc. Sweden has zinc, lead, copper, silver and gold deposits which are normally worked. Most of the 20 mines which are being operated in Sweden are small and the mineral content is relatively low-grade. As regards the production of metals, most significant are copper and refined lead. Portugal now depends almost entirely on the import of minerals for its non-ferrous industrial production. The aluminium output for domestic purposes depends on considerable imports of primary products. The same applies to the industrial production of copper and lead, to a lesser extent, to zinc. Zinc billets, which used not to be produced prior to 1980, are being made at Quimigal, though difficulties are now being encountered.

In Hungary, the metallurgical production of aluminium has increased considerably since the Second World War. Production of alumina has increased at successive stages and now stands at approximately 880,000 tons. Regarding semi-manufactured products, production rose from 12,000 tons in 1950 to 180,000 tons in 1985.

In Yugoslavia, alumina production rose 17.3 per cent annually over the period 1976-1983. The production of semi-manufactured products over the same period increased by 5.8 per cent per year. With regard to copper, production started to decline in 1978. From a figure of 151,000 tons for that year it dropped to 124,000 tons in 1983. The output of lead and tin remained virtually stable during that time. In Sweden refined copper production between 1965 and 1985 went up from 50,500 tons in 1965 to 63,200 tons in 1985; the figure for refined lead over this period stayed virtually unchanged, moving from 40,400 tons in 1965 to 43,200 tons in 1985.

In Portugal, the production of semi-finished copper goods dropped between 1982 and 1983 from 22,637 to 21,603 tons. Zinc production at the State-owned company Quimigal underwent a slight increase between 1982 and 1983 and rose from an output of 4,214 to 4,427 tons.

The development of mining-metallurgical activities in the developed countries of Europe under consideration has had and still has a marked impact on the overall economy of the majority of them. In Hungary, it has made a significant contribution to that country's exports. Hence in 1983 it exported 431,000 tons of bauxite, 659,000 tons of alumina, 57,822 tons of aluminium slabs and 48,479 tons of semi-finished goods. In Yugoslavia, the non-ferrous sector played a marked role in the build-up of that country's gross capital between 1976 and 1980. Over that period the mean annual increase in investments was 46.8 per cent. It should be pointed out, however, that in the years 1981-1982 investment in the non-ferrous sector dropped substantially. In 1984 the sector employed 60,148 workers. In Sweden, exports of minerals and metals, mainly semi-manufactured items, account for about 15 per cent of that country's exports. In Portugal, the non-ferrous sector does not at present play any great role in the economy, although major projects have been planned for it - mainly in copper, zinc and tin production - which may increase its role in the country's economy.

With regard to the major lines of development and strategies applied and/or planned by the countries of Europe studied, we can say that in the case of Hungary the production of aluminium was supported to a large extent by international co-operation which provided it with adequate funds, backing for its research and development activities as an important source for the supply of raw materials and sale of its products. In Yugoslavia, the new development strategy planned for non-ferrous metals is geared mainly to overcoming the imbalance between the different non-ferrous production stages. To do so, it is planned to step up the internal production of bauxite and to attempt to make good the deficiencies by means of imports. Similarly, there is need to review the policy of exporting semi-manufactured goods so as to find a solution to the problem of surplus installed capacity. In 1982 Sweden established a number of guidelines for developing the mining-metallurgical sector. They include the need to guarantee a stable supply of minerals for the processing industry and to promote the use of Swedish minerals, while at the same time keeping in mind the problem of the environment. Portugal's development strategy is geared to reducing external dependence in the non-ferrous sector by developing new production capacities. To do so it is implementing a number of projects aimed at stepping up copper production (Somicor project), tin production (Argimela and Somicor projects) as well as zinc and lead production (Aljustrel project). 11/

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11/ This project has also been designed to include copper production.

Australia, as already stated, is one of the world's main producers of non-ferrous metals. It possesses approximately 13 per cent of the world reserves of bauxite, 9.3 per cent of the lead reserves, 6.7 per cent of the zinc reserves and 2.7 per cent of those of copper.

The aggregate value of the aluminium smelting and refining activities in Australia grew at a mean annual rate of 4.7 per cent over the period 1972-1984. Regarding the aggregate value generated by the same activities in the case of copper, the mean annual growth rate was 5.2 per cent for the period 1971-1983.

In the output of non-ferrous metals in Australia foreign capital has an important share, that is to say in ownership and control. The largest share of foreign capital in the non-ferrous sector applies mainly to the production of alumina and aluminium, as well as copper.

The contribution made by the non-ferrous sector to Australia's overall economy is considerable. Together with the agricultural sector, it is the largest source of the country's foreign currency. Similarly, the non-ferrous sector makes a considerable contribution at the employment level. Over the period 1983-1984 47,736 persons were employed by it.

As a whole, the Government of Australia has not engaged in any direct intervention in the development of the non-ferrous sector, apart from fixing customs and excise dues to protect the industry and promoting internal production of non-ferrous metals. Nevertheless, it should be stated that the Government is intervening in decisions on the geographical location of those industries. There is also a tendency to promote greater integration between the non-ferrous industry and the metal-mechanical industry, first and foremost capital goods production.

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# THE NON-FERROUS METALS INDUSTRY IN INDONESIA

## I. INTRODUCTION

After petroleum and natural gas, tin is the second most important product from the mining sector industry in Indonesia. Indonesia's average annual production of tin ranges between 25.000-29.000 tons. More than 90 per cent of the tin production is exported. The balance (± 10 per cent) is consumed domestically. The largest domestic consumer of tin is the tin plate factory which commenced its production in the late 1985. Other consumers are mostly small manufacturers of solder, babbit metal, etc.

Tin mining in Indonesia started in the 18th century. The first mining activities were carried out in the islands known as the tin islands of Indonesia such as Bangka, Belitung and Singkep. The Indonesian Government began taking over all the mining activities in 1953, after the expiry date of mining concessions with the former Dutch mining companies.

A State-owned company was then established to take charge of all mining activities. In 1976, the Government changed the company's mining status to full commercial status forming PT. Tambang Timah, which enabled it to be active in mining as well as in other business activities.

The Government policy on domestic and foreign investment, gave foreign investors the opportunity to invest in mining industries. At present there are three foreign companies active in tin mining - PT. Kobatin and PT. Broken Hill Proprietary Indonesia (PT. BHPI), both of Australia, and PT. Riau Tin Mining (PT. RITIN) of The Netherlands.

Prior to 1973, before the foreign companies started their mining operations, all the tin produced was mined by PT. Tambang Timah. At present, approximately 75 per cent of the total Indonesian tin production, is still produced by that company, whilst the remaining 25 per cent is produced by the above three foreign companies.

The tin deposits in Indonesia lie inside the so-called tin belt that extends from southern China through Burma, Muangthai, and the Malay peninsula to Indonesia's Riau group of islands.

The tin belt in Indonesia stretches from the north to the south, covering the islands of Karimun, Kundur, Singkep, Bangka and Belitung as well as the Bangkinang area on the mainland of Sumatra.

At present most of the mining activities are still concentrated on these tin islands, and mostly on the secondary type of deposits (alluvial or elluvial). Mining of primary deposits is only carried out at the Pemali area near Sungailiat (Bangka island) by PT. Tambang Timah and at the Kelapa Kampit area (Belitung island) by PT. BHPI.

There is only one tin smelting and refining plant in Indonesia, which is owned by PT. Tambang Timah and located at Muntok (Bangka island).

Almost all the tin concentrate coming from the tin mining areas is smelted and refined on site, except the concentrate from PT. BHPI which, because of its chemical characteristics, cannot be smelted at Muntok, but has to be smelted and refined at Datuk Kramat Smelter, Penang, Malaysia and Copper Pass & Sons in England.

## II. TIN RESERVES

On-shore and off-shore tin reserves in Indonesia are estimated at 1,640,000 metric tons of tin content consisting of:

| | | |
|---|---|---|
| reserves measured | - | 740.000 metric tons |
| reserves inferred | - | 400.000 metric tons |
| reserves conditional | - | 200.000 metric tons |
| reserves unknown | - | 300.000 metric tons |

About 60 per cent of the potential reserves are found in Bangka island and its surrounding off-shore area. About 43 per cent of the total potential reserves in Indonesia are all located in off-shore areas.

To support the continuous operation of tin mining, exploration of reserves was stepped up during the last 15 years by PT. Tambang Timah as well as foreign companies.

As can be seen from the following Table 1 on the development of tin reserves, the prospects of tin mining in Indonesia are increasingly directed towards off-shore areas. This is due to the fact that mining of on-shore deposits had been undertaken for centuries, resulting in increased difficulties to find reserves with a relatively high tin content.

In 1966, the ratio of on-shore to off-shore tin reserves was 3,6:1,0 declining to 1,96:1,0 and 1,0:1.08 in 1977 and 1982 respectively.

## III. EVOLUTION OF PRODUCTION, EXPORTS AND DOMESTIC CONSUMPTION

### 1. Tin concentrate production

Before 1973, all tin in Indonesia was produced by the state owned PT. Tambang Timah. The foreign mining companies, such as PT. Koba Tin started production only in 1973, followed by PT. Broken Hill in 1975 and PT. RITIN in 1979.

As shown in Table 1, Indonesian tin concentrate production increased during the period 1974-1981, except in the 1975 to 1976 biennium. The decrease in production in those years was due to the export quota introduced by the International Tin Council on 30 April 1975.

The peak was reached in 1981 with a total production of 35.391 tons of concentrate. Due to the world economic recession and a tighter quota system introduced by the International Tin Council in 1982, Indonesian tin production declined to 33.806 tons in 1982, to 26.553 tons in 1983, and to 23.223 tons in 1984. The tin output amounted to 16.725 tons in the first nine months in 1985.

PT. Broken Hill which started production in 1975, experienced problems of crushing and drying of the ore and the low content of its ore feed at that time. But production stabilized at approximately 500 tons after 1979.

Table 1. Tin Production, Indonesia in tons Sn - 1974 - 1984

| Year | BANGKA | BELITUNG | SINGKEP | BANGKINANG | OTHERS | TOTAL | PT KOBATIN | PT BROKEN HILL | PT RIAU TIN | T O T A L |
|---|---|---|---|---|---|---|---|---|---|---|
| 1974 | 17,658.50 | 5,403.30 | 1,776.00 | 185.20 | | 25,023.00 | 686.45 | | | 25,709.45 |
| 1975 | 17,180.50 | 5,209.00 | 1,801.00 | 200.50 | | 24,391.00 | 867.09 | 79.20 | | 25,337.20 |
| 1976 | 16,046.00 | 4,717.50 | 1,269.00 | 152.00 | | 22,202.50 | 1,021.90 | 210.15 | | 23,434.55 |
| 1977 | 17,721.00 | 4,800.00 | 1,411.40 | 881.50 | | 24,020.56 | 1,609.62 | 296.28 | | 25,926.45 |
| 1978 | 18,213.50 | 4,928.00 | 842.20 | 80.50 | | 24,064.20 | 2,914.00 | 431.73 | | 27,400.93 |
| 1979 | 18,460.00 | 5,390.00 | 1,250.00 | 63.90 | | 25,163.90 | 3,807.63 | 468.62 | 95.30 | 29,535.45 |
| 1980 | 19,501.00 | 5,417.00 | 1,126.00 | 72.00 | | 26,116.40 | 5,262.23 | 504.73 | 644.10 | 32,527.45 |
| 1981 | 19,608.50 | 6,364.50 | 1,135.00 | 70.60 | | 27,178.60 | 6,581.16 | 522.00 | 1,109.80 | 35,391.56 |
| 1982 | 18,446.00 | 6,468.50 | 1,250.00 | 54.10 | | 26,218.60 | 5,471.00 | 647.68 | 1,408.80 | 33,806.08 |
| 1983 | 13,892.50 | 4,513.50 | 1,506.50 | 40.00 | | 19,952.50 | 5,252.95 | 649.08 | 698.40 | 26,552.93 |
| 1984 | 11,333.00 | 4,043.50 | 2,200.00 | 31.00 | | 17,607,50 | 4,215.00 | 473.43 | 927.40 | 23,223.33 |

Source: Indonesian Mining. Year Book, 1980/1984.

PT. RITIN started production only in 1979 with an output of concentrate of 95.3 tons. Production increased to 1.110 tons in 1981 and 1.469 tons in 1982, but fell to 927 tons in 1984.

From 1974 to 1981, production of PT. Kobatin increased from only 867 tons in 1974 to the peak of 6.581 in 1981, but also fell to 5.471 tons in 1982, to 5.253 tons in 1983 and 4.215 tons in 1984. PT. Kobatin started production only in 1973. The increase in output was due to the expansion of the mining area and its activities.

2. Tin metal production

Indonesian tin metal production followed the same pattern as the tin concentrate production.

Peak of production was reached in 1981, but fell sharply to 22.467 tons in 1984. Compared with the production of 32.519 tons in 1981, the decline was approximately 31 per cent.

Table 2 shows the production of tin metal and the rate of increase/decrease per year from the tin smelting and refining unit at Muntok.

Table 2. Tin metal production from Muntok Smelting & refining Unit (in tons) 1974 - 1984

| Year | Production | Rate of increase |
|---|---|---|
| 1974 | 15.066 | - |
| 1975 | 17.825 | 18.3 |
| 1976 | 23.322 | 30.8 |
| 1977 | 24.005 | 2.9 |
| 1978 | 25.830 | 7.6 |
| 1979 | 27.790 | 7.6 |
| 1980 | 30.465 | 9.6 |
| 1981 | 32.519 | 6.7 |
| 1982 | 29.755 | -8.5 |
| 1983 | 28.390 | -4.6 |
| 1984 | 22.467 | -20.8 |

Source: Indonesia, Mineral yearbook, 1984.

The Muntok smelting unit started operation in 1967 using 3 rotary furnaces with an installed capacity of 15.000 tons per year. Three additional stationary furnaces were then installed with a capacity of 18.000 tons/year and commenced production in 1976. Total smelting capacity was then 33.000 tons per year. After 1976 all of the tin concentrate

produced from PT. Tambang Timah, PT. Kobatin and PT. Ritin was smelted in Muntok which increased its tin metal production in the year 1976 by 30.8 per cent as shown in Table 2. In 1982 the smelting capacity was expanded again to 38.000 tons per year, but the tin market situation caused the factory to work at below capacity.

3. Export

Since Indonesia's tin consumption is very small, most of the tin output is exported.

Tin is exported directly to the consumer through PT. Tambang Timah overseas representative.

Before 1976, some of the tin concentrate production was exported and smelted at Penang smelter and/or Arnhem in Holland. Starting in the year 1977, after Muntok smelter increased its capacity, all of the tin exported was in the form of tin metal.

Exports are mainly to the United States of America, The Netherlands, England, Italy, Japan, West Germany, France, and East European countries.

Indonesia's total tin export during 1974-1984 is listed in Table 3.

Table 3. Indonesia's export of tin, 1974-1984

| Year | Tin concentrate (tons Sn) | Value (US$'000) | Tin metal (tons) | Value (US$ million) |
|---|---|---|---|---|
| 1974 | 8.106 | 61.393 | 14.948,4 | 113.190 |
| 1975 | 7.295 | 45.834 | 14.890,7 | 96.565 |
| 1976 | 1.093 | 6.160 | 23.018,4 | 162.894 |
| 1977 | | | 24.914,0 | 250.994 |
| 1978 | | | 25.549,0 | 311.293 |
| 1979 | | | 25.737,0 | 376.078 |
| 1980 | | | 30.885,0 | 499.331 |
| 1981 | | | 31.879,0 | 437.383 |
| 1982 | | | 26.825,0 | 342.507 |
| 1983 | | | 25.332,0 | 313.504 |
| 1984 | | | 21.640,0 | 256.680 |

Source: PT. Tambang Tomah statistical yearbook 1984.

The export figures show a steady increase of export volume from 14,948 tons in 1974 to its peak of 31,829 tons in 1981, with a decline to 26,825 tons in 1982 and drop to 21,640 in 1984.

The decline in the volume of exports is caused by the weakening of the international tin market, as well as by the tighter export quota imposed by the International Tin Council (ITC). The quota system in 1982 allowed Indonesia to export only 22.000 tons a year, that was approximately 60 per cent of the total capacity of Indonesia's tin production of 35.000 tons.

4. Domestic consumption

Indonesia's tin processing industry has not developed as yet. Domestic tin consumption is still very small. Metal tin is mostly absorbed by the small tin alloy metal manufacturers such as solder and babbit metal. Pewter craftsmen consumed about 25 tons annually.

Domestic requirements of tin plate and other articles made from tin are still imported. The first Indonesian tin plate factory was built in 1982 and began trial production in October 1985.

PT. Tambang Timah is the only company supplying tin for domestic market/use. Average annual tin consumption amounted to approximately 400 tons over the past years. Government efforts for promoting the development of export commodities (including tin articles) effected positively tin sales for local consumption in 1984 as shown on Table 4.

Table 4. Domestic tin sales by PT. Tambang Timah
1974-1984

| Year | Sales (tons) | Average price Rp. '000/ton |
|---|---|---|
| 1974 | 334,5 | 2717.0 |
| 1975 | 382,3 | 2520.7 |
| 1976 | 567,0 | 2708.3 |
| 1977 | 445.8 | 3908.9 |
| 1978 | 430.2 | 4961.6 |
| 1979 | 389.9 | 8196.0 |
| 1980 | 335.2 | 10037.2 |
| 1981 | 378.4 | 8470.2 |
| 1982 | 554.7 | 8373.4 |
| 1983 | 364.5 | 10384.8 |
| 1984 | 1495.4 | 11131.1 |

Source: Mineral yearbook, Indonesia 1984.

Indonesia's tin consumption is projected to increase to about 2000 tons a year when the first tin plate factory reaches its full production capacity.

## IV. LEGAL AND INSTITUTIONAL ASPECTS

Foreign investment in Indonesia is governed primarily by the Foreign Investment Law of January 1967 (Law No. 1, 1967), as amended in August 1970 (Law No. 11, 1970) and its ancillary regulation.

The law stipulates that foreign companies may invest and operate in Indonesia either independently or in joint venture with an Indonesian partner and with the approval of the Government for a maximum period of 30 years. Since January 1974, all foreign investments, other than investments in specific areas, have been undertaken through joint ventures with Indonesian partners.

In 1986 some provisions were issued regarding conditions of foreign investment:

a. The licence for a Foreign Investment (PMA) company lasts for thirty years from the date of incorporation of the legal entity.

b. Foreign investment may only be conducted through joint ventures between foreign companies and Indonesian national companies or individual Indonesian citizens with the shares of the Indonesian partners at the time of formation of the joint venture company constituting at least 20 per cent of the authorized capital of the company.

c. for a Foreign Investment (PMA) company which:

1. faces a high risk of business failure,
2. requires large amounts of capital and high technology,
3. is located in a remote area, or
4. produces entirely for export.

the initial share of the national participant may start at 5 per cent and thereafter be increased to 20 per cent within five years after commercial production.

d. The foreign partner must allow the Indonesian partner to increase its shareholding to a majority position (51 per cent or more of the authorized capital of the joint venture company) within ten years of commercial production. In the event that the existing national partner is unable to increase its share ownership, offers may be made to other national partners, and where there are no other interested national partners, offers may be made to banks, to financial institutions, or through the capital market.

If after following the above steps the foregoing provisions still cannot be carried out within the stipulated period, then they can be fulfilled gradually with the assistance and guidance of BKPM. The same provision applies to the additional share capital required to finance expansion programmes.

e. A Foreign investment (PMA) company which increases its capital to expand its investment by constructing additional infrastructures and adding production equipment may obtain an additional license for a maximum of thirty years from the approval or the additional investment by the Government.

f. Foreign Investment (PMA) companies must comply with Government Regulation Number 36 of 1977 concerning the Termination of Foreign Business Activities in the Field of Trade which stipulates that Foreign Investment (PMA) companies are not permitted to engage in trading activities.

g. A Foreign Investment (PMA) company which meets any of the following conditions will be afforded the same treatment as a Domestic Investment (PMDN) company:

i) 75 per cent of its shares are owned by the State and/or by national private parties, or

ii) it has gone public and the percentage of its shares have been sold through the capital market, or

iii) it has gone public and the percentage of its shares owned by the State and/or national private parties which have been sold through the capital market is at least 51 per cent, provided that at least 20 per cent of the total shares are offered through the capital market.

Treatment as a Domestic Investment (PMDN) company does not alter the status of the Foreign Investment (PMA) company.

h. A Foreign Investment (PMA) company may reinvest its profits either in its own company for an expansion programme or in other companies, whether new or already in operation. The same provision applies to new investments from Foreign Investment (PMA) companies using funds other than profits. Any company, all or part of the shares of which are purchased by a Foreign Investment (PMA) company, will automatically have its status changed to a Foreign Investment (PMA) company.

i. A minimum investment of US$1,000,000. is required for a Foreign Investment (PMA) company, except for investments in consulting and engineering services and in certain fields as stipulated by the Department concerned based on special conditions or by BKPM based on specific policies.

j. All fields of investment, whether declared open or closed in the DSP, may be open for Foreign Investment (PMA) and Domestic Investment (PMDN) as well as non-PMA/PMDN investment if the entire production is intended for export. For this purpose, entire production means at least 85 per cent of the production must be sold on the export market.

k. Fields of investment that are only open for Domestic Investment (PMDN) and non-PMA/PMDN Investment (Category II) may be open for Foreign Investment (PMA) if a cooperative(s) is invited to participate with a shareholding of at least 20 per cent at the time of formation of the joint venture company.

l. A joint venture company may undertake an expansion programme in fields of investment that are currently not promoted for Foreign Investment (PMA) but are only open for Domestic Investment (PMDN) and non-PMA/PMDN

investment (Category II), provided that 20 per cent of the shares have been sold publicly on the capital market or a cooperative(s) is invited to participate as shareholder and holds at least 20 per cent at the time the application for the expansion programme is submitted.

m. Investment activities in certain provinces require Security Clearance from the Department of Defence and Security of the Headquarters of the Armed Forces, which can be obtained by or through the Investment Coordinating Board (BKPM).

n. Investment companies must comply with the rules on efforts to prevent environmental pollution as well as efforts to conserve nature and preserve the environment in accordance with Law Number 4 of 1982 concerning Basic Provisions on Management of the Environment.

o. Investment companies may utilize foreign experts who are required to guarantee the success of the venture, provided that such companies offer education and training as well as transfers of knowledge and technology programs so that gradually and within the stipulated time the work performed by such foreign experts may be performed by Indonesian workers. The rules of the utilization of foreign experts in investment companies are issued by the Minister of Manpower taking into account the considerations of the Minister responsible for the development of the field of investment concerned and the Chairman of BKPM.

p. The procedures for applications for approvals of investments in the scope of Foreign Investment (PMA) and Domestic Investment (PMDN) are issued by the Chairman of BKPM. For Foreign Investments (PMA) in the field of general mining pursuant to contracts of work, the procedures are issued by the Minister of Mines and Energy. For fields of investment outside the scope of Foreign Investment (PMA) or Domestic Investment (PMDN), the procedures are issued by the Minister in charge of the development of that particular field of investment.

1. Investment incentives 1986

A. With the enactment of Law Number 7 of 1983 on Income Tax, Law Number 8 of 1983 on Value Added Tax and Luxury Sales Tax, Law Number 12 of 1985 on Tax on Land and Buildings and Law Number 13 of 1985 on Stamp Duties, the fiscal facilities which may be granted in the scope of Foreign Investment (PMA) and Domestic Investment (PMDN) are as follows:

i) Exemptions or reductions in import duties on machinery and equipment and spare parts.

ii) Exemptions or reductions in import duties on raw materials or materials used to assist in production for at most two years.

iii) Deferral of payment of the Value Added Tax (PPN) on the importation of capital goods utilized in the production of goods and in services.

iv) Exemption from duties on the registration of ships registered for the first time in Indonesia.

B. The importation of goods which are already produced domestically in adequate quantities and which have been listed on the List of Capital Goods which are not eligible for import duty facilities (the "negative list") will not enjoy import duty facilities. Companies which export their entire production may still import such goods with import duty exemptions. Goods not listed on the "negative list" may still be imported by Foreign Investment (PMA) and Domestic Investment (PMDN) companies with import duty exemptions.

C. Foreign Investment (PMA) and Domestic Investment (PMDN) companies which purchase capital goods from domestic production may obtain exemptions from import duties on raw materials and/or components which were previously imported to produce such capital goods.

2. Investment on mining

Foreign interest in mining activities was stimulated by the so-called First Generation work contracts in 1967, offering such incentives as reduced tax rates for 10 years, duty free import of equipment and accelerated depreciation of fixed capital assets. Certain requirements also were set for using domestic labor, materials and technology.

Second Generation work contracts in 1972 increased Indonesian participation participation and benefits, including a timetable for replacing all foreign managers and technical personnel by Indonesians.

In April 1977, the first Third Generation work contract was signed. The Third Generation contract provides for greater benefit to Indonesia. Among the new conditions are a 10 per cent export tax on unprocessed minerals and a 60 per cent tax on profits in excess of a return of 15 per cent of investment cost averaged over a three-year period. Incentives provided for mining activities are based on Government Regulation No. 21 od 1976, and Presidential Decree No. 49 of 1981, adjusted to Tax Laws Nos. 7 and 8 of 1983.

For mining investment purposes, minerals are divided into three categories:

a. strategic minerals: oil, tin, nickel, uranium and other radioactive minerals, coal, cobalt, asphalt and others;

b. vital minerals: gold, silver, lead, zinc, copper, bauxite, manganese, iron and others;

c. other: primarily industrial minerals such as limestone, clay, sulphur, gypsum and so on.

The mining of strategic minerals can, in principle, only be done by the State, but arrangements have been worked out to permit private companies, both domestic and foreign, to mine strategic minerals. Foreign investment in mining must be made under either production-sharing contracts or work contracts with the Government.

The principle underlying this system is that the foreign party conducts all stages of the operation, including general prospecting, exploration, refining and processing, transport and marketing of the mineral products as contractor to the Government or State enterprise.

The foreign party, as the operating company, has to be incorporated in Indonesia unless special exemption is granted. It has control and management of all its activities under the agreement and assumes full responsibility for all risks of operation.

In general, the various stages of work to be stipulated in the contract comprise:

* general prospecting for a period of up to 12 months
* exploration 36 months
* evaluation 12 months
* construction 36 months
* operation 360 months

During the general prospecting, exploration and evaluation periods, the company has to relinquish periodically its right to non-prospective parts of its contract area.

As to land retained under the contract, the Government undertakes to resettle indigenous inhabitants, but the company must pay compensation to them.

Furthermore, the company has to keep the Government informed of its activities through submission of quarterly progress reports and annual programmes.

Within one year after termination of the exploration period, the company has to file with the Ministry of Mines and Energy a summary of its geological, mining, ore-dressing and metallurgical investigations together with representative samples, drawings, logs and other data. The Government is entitled to all documents and data supplied by the company, but, at the request of the company, certain data may be treated as strictly confidential.

The company must also submit to the Government its annual work programmes and budget plans, together with the regular reports on progress. Furthermore, it is required to employ Indonesian personnel to the maximum extent and must undertake schooling and training for them.

In addition, the company must endeavour to use Indonesian services, raw materials produced from Indonesian sources and products manufactured in Indonesia. It should also provide a genuine opportunity for Indonesian capital participation as soon as production of the project commences.

Regarding financial aspects, the company will be subject to the payment of rent in respect of the contract areas, royalties in respect of the company's production of mined minerals, corporation tax in respect of annual profits and general sales tax in Indonesia, together with tax upon transfer of ownership of motor vehicles and ships.

Exemption is provided from import and other customs duties in relation to the importation of machinery, equipment, tools and ancillary supplies needed for the operation of the project. Any item imported by

the company for the operation of the project and no longer needed may be re-exported free of all export and other custom duties, or sold in Indonesia after compliance with customs and import laws and regulations.

Furthermore, the law permits transfer of profits, providing taxes and other official obligations have been met. Provision is also made for accelerated depreciation of fixed capital assets.

### 3. The Investment Coordinating Board (BKPM)

For all the approvals, licenses and permits required to establish or expand production facilities to obtain grants and other advantages, the investor deals solely with BKPM (except for forestry and mining projects). Moreover, the processing of applications is undertaken completely by BKPM. The Board administers the Foreign and Domestic Investment Acts and is the central point of investment authority under Presidential Decrees No. 33 of 1981 concerning the status, duties and functions of BKPM, and No. 54 of 1977 concerning the principal rules regarding capital investment procedures.

This has permitted the streamlining of processing procedures and provides a single point of advice and guidance for prospective investors.

The Board has 13 major obligations:

* coordination and planning of sectoral and regional investments and the synchronizing of these plans with a master plan
* formulation of investment policies
* preparation and publication of priority lists
* encouraging the spread of investment activities to the provinces in accordance with development policies
* supervising the implementation of approved investments
* development and processing of priority projects
* encouraging and fostering the completion of investment projects
* establishing effective promotional communication with investors in particular and the business world in general
* evaluation and screening of investment applications
* submission of evaluated foreign investment applications to the President for his approval
* approval of domestic investment applications
* issuing of required permits and the granting of facilities
* provision of general investment services.

The Board also oversees investments in oil related industry, mining and forestry, although it does this for these sectors only after an initial working contract or forestry agreement has been issued by the appropriate ministries.

## V. POLICIES OF DEVELOPMENT

World market demand for tin, and the present market price situation cause most of the tin producing countries to limit their tin production. In 1982, total on-shore and off-shore secondary tin reserves on the tin islands of Indonesia amounts to 754.852 tons Sn. Based on Indonesia's average annual tin production of 30.000 tons, as well as intensified exploration conducted nowadays, secondary tin deposits in Indonesia can be exploited for at least 25 years.

Long-term new exploitation will focus on secondary tin deposits on-shore as well as off-shore. It is most likely that mining of the non-exploited primary tin deposit will only be carried out when the secondary deposits have been exausted.

Estimated investments required for mining and exploitation of primary tin deposit at Pemali area on Bangka island is about US$ 3-4 million. This includes investment for machinery and equipment, piping and installation, staff housing, infrastructure and spare parts.

Considering the fact that 90 per cent of Indonesia's tin production is exported, the depressed international tin market had a negative impact on the tin mining industry in the country. The situation caused Indonesia to decrease its exports and limit its mining operations.

To reduce the heavy dependency on export markets, Indonesia has developed and promoted the local tin consuming industries. Diversification of production and increased production capacity for export may be alternatives to increase the local consumption of tin.

# THE NON-FERROUS METALS INDUSTRY IN MALAYSIA

## I. INTRODUCTION

Malaysia produces a variety of non-ferrous minerals, although few are refined nationally into metals. Many, such as ilmenite, columbite and wolfram are produced as by-products of tin mining which is the predominant mineral of Malaysia.

Although as many as thirty four non-ferrous minerals are common to Malaysia, only twelve are produced in significant amounts:

- Antimony
- barite
- bauxite
- copper
- columbite
- gold
- ilmenite
- monazite
- tin
- wolfram
- zirconium

The mining of most of these is comparatively recent and reflects the expansion of the mining industry from the late 1970s, although tin and alluvial gold have been mined for centuries.

Production of copper (with gold as a by-product) significantly increased, - from 28,600 tonnes in 1981 to 127,871 tonnes in 1985, - with the coming on stream of a new mine in Sabah. Growth of world demand for ilmenites stimulated production from 176,432 tons in 1981 to 315,736 tons in 1985, almost all of which was sold of direct contract to Japan. However, as ilmenite is a by-product of tin, output is now affected by the closure of many tin mines. Bauxite production has also fallen under the impact of world recession and declining demand for its end product aluminium, - from 700,000 tons in 1981 to 491,904 tons in 1985.

Despite the recent problems in the international market, tin remains the most important and the most valuable of Malaysia's non-ferrous minerals. Even though the price of tin fell substantially during the year October 1985/ October 1986, it remains the most valuable of the base metals. Copper, lead, zinc, etc. are traded on the world markets at hundred of pounds (UKP) per ton, tin at thousands of pounds. During the decade 1974-1984 Malaysia tin concentrate production had an annual value of MS$1,000+ million and was a major contributor to the economy.

Thus a study of Malaysia non-ferrous metals is essentially a study of tin mining and its related industries.

## II. EXPLOITED MINES

The mining activity in Malaysia peaked in 1970, with over 1,000 mines producing over 73,000 tons of tin in concentrates. Although both the number of mines and production thereafter declined, the value of Malaysia's tin production rose after 1973. In 1973, with 1,083 mines operating, value was MS$1,013 million. In 1976, with 811 mines operating, value was MS$1,200 million. In 1979, when production of tin metal exceeded world consumption by 17,000 tons, and in 1980, when there was a further surplus of about 24,000 tons, the value of Malaysia's tin production was MS$2,040 and MS$2,111 million respectively.

Mining operations are spread throughout the Malay peninsular, with the largest number of mines in the west coast states of Perak (280 in 1984) and Selangor (76). Even within the federal territory of Kuala Lumpur (Wilayah Persekutuan), the most intensely urbanised part of Malaysia, there were eight mines operating in 1984. Dredging is concentrated in Perak and Selangor. There are twenty-two underground mines, fifteen of which are in the Northern State of Perlis.

Despite the then high prices, the number of mines operating in Malaysia had begun to decline in 1979. This decline accelerated after the imposition of ITC Export Controls in 1983. Between 1979 and the end of 1982, 243 mines closed. A further 176 followed during the next two years. During 1985, when the market collapsed, another 243 mines closed. Closures continued until mid-1986, when only 187 mines were operating.

The bulk of Malaysia's production comes from alluvial deposits. Gravel pumping has remained the most important overall producer, 55 per cent as against approximately 30 per cent from dredging. Gravel pumping also employs 60 per cent of mining labour against dredging's 22 per cent. In terms of operational costs per unit of volume of ground treated, dredging is by far the cheapest method of mining, due to economies of scale. But not all deposits are suitable for dredging. Furthermore, over 80 per cent of gravel pump mining is conducted within areas left behind by dredges. It is argued that only through mining these areas can Malaysia maintain her high level of production. Thus, notwithstanding the higher operational costs, gravel pump mining continues as a highly important sector.

Malaysia's mining costs compare favourably with those of Thailand and Indonesia, the other major alluvial fields. Offshore mining, which Malaysia does not have, is cheaper in these two countries. Thailand's mining costs are further increased by the much higher level of taxation there. The costs of underground mining in Malaysia is high MS$41.51 per kg of tin-in concentrate and compares badly with Australia's equivalent of MS$26.12 per kg. The higher Malaysian tax level makes an important addition here. It is perhaps surprising, in view of their higher costs viz-a-viz other forms of Malaysian mining, that the underground mines have so far survived. Even so, their costs are very much lower than the hard rock underground lode mines of Bolivia and Great Britain.

## 1. Tin mines production

The mines production of Malaysia in the years 1984 and 1985 are shown in table 5.

Table 5. Mines production of Malaysia
1984-1985

| Mine | 1985 | 1984 (tons) |
|---|---|---|
| Austral Amalgamated | 704 | 732 |
| Ayer Hitam | 890 | 1,327 |
| Berjuntai | 2,563 | 2,050 |
| Bidor Malaya | 585 | 696 |
| Kramat Tin | 186 | 161 |
| Southern Kinta | 751 | 821 |
| Southern Malayan | 879 | 989 |
| Sungei Besi | 469 | 557 |
| Syarikat Lombong Sebina | 246 | 287 |
| Timah Dermawan | 753 | 795 |
| Timah Matang | 219 | 318 |
| Tronoh Mines | 435 | 395 |
| MMC Kpg Gajah | 2,334 | 2,250 |

## 2. Labour

### 2.1 Workers

The number of persons employed in the tin mining sector has been declining since the onset of the recession amongst industrial nations and, with it, falling demand for tin. The decline was accelerated by the failure of the price support exercise in 1982 and the subsequent imposition of export controls by the ITC. Following the collapse of October 1985, this decline became very severe indeed, as mines closed completely or larger operations retrenched workers. The number of tin mines in operation in Malaysia had fallen from 868 at the end of 1979 to 187 by July 1986. The total number of workers employed had fallen from 39, 109 at the end of 1979 to 12, 111 by July 1986, a decline of almost 70 per cent (see table 6).

The gravel pump mines are the largest employers, with the highest proportion of Malaysian production, even though individually the mines themselves may be very small. The production costs of gravel pump mines are also higher than the more capital intensive dredge mines. The comparative costs between gravel pump and dredge mines (after tax) was estimated in 1981 as MS$6.43 per cubic metre of ground mined compared to MS$3.38 per cubic metre of ground mined by dredging. It is the gravel pump mines that have experienced the highest number of closures (772 mines working in 1979; 120 in July 1986) and the most severe unemployment (25,055 workers in 1979 to 3,763 in July 1986). The gravel pump mines are almost entirely Chinese-Malaysian owned and operated. The labour force is unskilled (or semi-skilled through experience at water monitor operation). Management at the mines may have clerical skills, but are not qualified either as mine managers nor as mining engineers - the basic simplicity of gravel pumping does not require this.

Table 6. Employment in the tin mining sector in Malaysia 1979-1986

| Period | Total | Dredges | Gravel Pump | Open cast | Under-ground | Retreatment |
|---|---|---|---|---|---|---|
| 1979 | 39,109 | 8,674 | 25,389 | 1,460 | 1,772 | 1,814 |
| 1980 | 39,009 | 8,955 | 24,961 | 1,487 | 1,730 | 1,876 |
| 1981 | 35,198 | 9,741 | 20,356 | 1,953 | 1,680 | 1,468 |
| 1982 | 28,432 | 7,775 | 15,815 | 1,863 | 1,701 | 1,278 |
| 1983 | 25,641 | 6,927 | 13,728 | 2,257 | 1,476 | 1,253 |
| 1984 | 23,623 | 6,576 | 12,586 | 1,771 | 1,490 | 1,200 |
| 1985 | 16,829 | 6,091 | 6,977 | 1,605 | 1,068 | 1,088 |
| 1986 Jan. | 16,119 | 5,929 | 6,309 | 1,523 | 1,276 | 1,082 |
| Feb. | 15,377 | 5,890 | 5,728 | 1,436 | 1,289 | 1,034 |
| March | 14,855 | 5,920 | 5,334 | 1,388 | 1,203 | 1,028 |
| April | 13,955 | 5,808 | 4,836 | 1,168 | 1,161 | 982 |
| May | 12,829 | 5,787 | 3,992 | 1,146 | 976 | 928 |
| June | 12,533 | 5,734 | 3,769 | 1,103 | 972 | 955 |
| July | 12,111 | 5,449 | 3,763 | 991 | 958 | 950 |

Source: Department of Mines, Malaysia.

Dredge mining is not only more cost effective, it also requires a more highly skilled work force at all levels. Dredge mining companies have been reluctant to loose these skills and although there have been retrenchments and the numbers employed have fallen, the decline has not been so severe. This is most clearly shown in the figures for 1984 and 1985. There were 12,586 persons employed in gravel pump mines at the end of 1984. By the end of 1985 this number had halved to 6,977 (almost all the fall occuring after October). By contrast, the numbers working in dredge mining only fell by 485 - from 6575 in 1984 to 6091 in 1985. This differing rate of decline continued with the number of gravel pump workers halving again to 3,992 by end of May 1986 whilst dredge workers fell by 304 in the same period from 6091 to 5787 in May 1986.

Most of the dredge mining operations fall within the MMC (Malaysian Mining Corporation) group, although they also have the large opencast mine at Sungei Besi. Altogether a total of 3986 persons are employed directly in MMC's mining operations, but mining has been cut back considerably over the past three years. Of the 42 dredges within the MMC group, only 22 were operating at 31 December 1986. Of those employed in mining, 100 persons are senior staff - qualified managers, mining engineers, geologists, metallurgists, etc. There are few, if any ex-patriates. The 154 supervisory staff include foremen, dredgemasters and shift bosses. There are 192 clerical workers. Skilled workers (324) include mechanics, welders, electricians, etc. All hold recognised qualifications. Semi-skilled workers fall mainly into the same occupational categories but lack formal qualification and length of job experience. There are 1652 unskilled workers although there is even a degree of on-job skill acquired through working on the dredges.

This employment pattern will be the same, though on a smaller scale for the dredge mining companies outside the MMC group. In addition, however, MMC runs an apprenticeship scheme, with 133 trainees currently. Apprentices from MMC used to attend the government sponsored National Training Centre. The rise in importance of petroleum however has led to all NTC places being re-allocated to that sector. MMC now runs its own in-house training programme for apprentices.

2.2 Wage agreements

Wages in the mining sector are higher on average than in other industries in Malaysia. The arduous and risky work, especially in the gravel pump mines, makes high-wage levels a necessity. Salaries and labour are the second largest cost (after Power) for both gravel pump and dredge mines (see tables 7 and 8). In both types of operations labour has become more cost effective in terms of per kilogramme of tin concentrate produced even though the percentage of total costs taken by wages has risen. Salaries and labour in gravel pump mines cost MS$5.53 per kg tin concentrate in 1981, but MS$4.77 in 1984. The percentage of total costs however rose from 21.7 per cent in 1981 to 27.4 per cent in 1984. In the dredge mines, salaries and labour cost MS$2.80 per kg tin concentrate in 1981 and MS$2.31 in 1984 whilst the proportion of total costs rose from 14.3 per cent in 1981 to 16.6 per cent in 1984.

There are three trade unions for workers in the mining industry. These are the All Malaysia Mining Industry Staff Union (for supervisory and non-senior staff), the Security Guards Union and the Malaysian Mine Workers Union. Union membership is optional. Senior staff do not have a union. Wages are arranged by three yearly Collective Agreements between the relevant union and the Malaysian Mining Employers Association (MMEA). All the larger dredge, opencast and underground mining companies belong to MMEA. The gravel pump mines are almost entirely non-unionised. In addition to agreeing wage levels, the collective agreements also make provision for payment of retrenchment benefits, which may also have helped slow down the retrenchment rate in the dredging sector.

Table 7. Gravel pumping cost of tin production 1981 and 1984 average
(Cost in M$ per kg tin concentrate)

| | Heading | 1981 Cost | 1981 % | 1984 Cost | 1984 % |
|---|---|---|---|---|---|
| 1. | Power | 4.96 | 19.4 | 4.68 | 26.9 |
| 2. | Salaries and labour | 5.53 | 21.7 | 4.77 | 27.4 |
| 3. | Materials | 2.44 | 9.6 | 1.99 | 11.4 |
| 4. | Overheads and other charges | 2.51 | 9.8 | 2.24 | 12.9 |
| 5. | Depreciation | 1.52 | 6.0 | 1.04 | 6.0 |
| 6. | Exploration and development | 0.78 | 3.1 | 0.33 | 1.9 |
| 7. | Realisation | 0.66 | 2.6 | 0.64 | 3.7 |
| 8. | Tributes | 2.27 | 8.9 | 0.98 | 5.6 |
| 9. | Export duty | 4.84 | 19.0 | 0.72 | 4.1 |
| | Total | 25.31 | 100.0 | 17.39 | 100.0 |
| | Equivalent in metal | 33.84 | | 23.05 | |

Source: Department of Mines Malaysia Statistics.

Table 8. Dredging cost of tin production: 1981 and 1984 averages
(Cost in M$ per kg tin concentrate)

| | Heading | 1981 Cost | 1981 % | 1984 Cost | 1984 % |
|---|---|---|---|---|---|
| 1. | Power | 3.55 | 18.1 | 2.97 | 21.4 |
| 2. | Salaries and labour | 2.80 | 14.3 | 2.31 | 16.6 |
| 3. | Materials | 2.91 | 14.8 | 2.21 | 15.9 |
| 4. | Overheads and other charges | 2.37 | 12.1 | 2.50 | 18.0 |
| 5. | Depreciation | 1.17 | 6.0 | 1.45 | 10.4 |
| 6. | Exploration and development | 0.14 | 0.7 | 0.19 | 1.4 |
| 7. | Realisation | 0.62 | 3.2 | 0.64 | 4.6 |
| 8. | Tributes | 1.20 | 6.1 | 0.91 | 6.5 |
| 9. | Export duty | 4.84 | 24.7 | 0.72 | 5.2 |
| | Total | 19.60 | 100.0 | 13.90 | 100.0 |
| | Equivalent in metal | 26.00 | | 18.45 | |

Source: Department of Mines Malaysia Statistics.

## 2.3 Health and safety

The fatality rate for the mining industry - 0.031 per 1000 employed - is extremely low. To a considerable extent this reflects the nature of the mining process in Malaysia where mineral can be extracted without shaft sinking and tunnelling through rock.

The main cause of death is from falls of ground in gravel pump mines. The slope of the pit can rapidly become unstable in malaysia's frequent, heavy rain, or by incorrect use of the water monitor pump which can cause an overhang. In 1984, 14 persons were killed in such mudslips. Dredge mining has a higher risk of accident and injury - due to the nature of the machinery involved, but fatalities are rarer. Seven persons drowned in 1984 in one accident when a dredge turned turtle, but those were the only dredging fatalities. The underground mines (19 operating in 1984) where falls of ground should be a risk, had no fatalities in 1984 at all (see table 9).

The Mines Inspectorate visit mines to check for safe working. The Mines Department also issues a booklet "A guide on Safety in Open Mines" (1981). This is available in Bahasa Malaysia, Chinese and English and is distributed amongst mine management and personnel. In addition, there currently is a joint ASEAN/EEC visiting programme on "Open Mining in Soft Ground" to teach improved techniques.

Both smelters have dust extraction machinery, hard hat discipline, and usage of safety gloves and shoes. Accidents are chiefly burns from splashes of metal. Fatalities are rare.

Table 9. Mining accident fatality by mining methods and causes
1984

| Mining Methods | Fall of rock or ground | Fall of person | Drowning | Explosives | Mechanical digging | Transport | Other | Total | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | Number | Rate per 1,000 |
| Total | 14 | 3 | 10 | - | 1 | 2 | 1 | 31 | 0.031 |
| Dredging | - | - | 7 | - | - | - | - | 7 | 0.007 |
| Gravel pumping | 14 | 2 | 3 | - | 1 | 1 | 1 | 22 | 0.022 |
| Opencasting | - | - | - | - | - | 1 | - | 1 | 0.001 |
| Underground | - | - | - | - | - | - | - | - | - |
| Other | - | 1 | - | - | - | - | - | 1 | 0.001 |

Source: Mines Department.

Note: This table only records accidents classified as mining accidents by law and does not include accidents in connection with machinery or electricity.

## III. PROCESSING OPERATIONS

### 1. The Malaysian tin smelting industry

Malaysia Smelting Corporation and Datuk Keramat Smelting are the first and second largest tin smelters in the world. Both are working under capacity.

The two smelters in Thailand and Indonesia are, theoretically, not in competition with Malaysia. The Thailand Smelting and Refining Company (Thaisarco) is aiming at different ores. The P.T. Timah (Persero) smelter takes all Indonesia production except that of P.T. Preussage (formerly BHP Indonesia). The different mineral characteristics of this ore, as well as the company relationship, results in it coming to Datuk Keramat. Nonetheless, there is excess smelting capacity both in South East Asia and in the world.

Despite the problems raised by the depressed state of the tin market however, both Malaysian smelters seem not too hard pressed. In MSC's case this is due in no small part to its ensured intake (twice that of Datuk Keramat) from MMC. To compensate, Datuk Keramat has adopted a more aggressive marketing strategy and in 1986 was still the largest profit earning company within Amalgamated Metals. Indeed, in 1984, Amalgamated Metals smelting division, consisting of Datuk Keramat and Makeri Smelting of Nigeria were responsible for pre-tax profit of UKP4,925,000, more than ten times the group's profits from its merchanting activities.

World tin production has declined by 20 per cent since the collapse of 1985. The three ASEAN tin producers have announced (January 1987) that they will continue to control production to ensure an orderly disposal of the supply overhang. Other ATPC (Association of Tin Producing Countries) countries are expected to follow suit. Brazil has informally agreed to hold production at the 1986 level. With less ore produced, some rationalisation of world smelting overcapacity should be expected.

Additionally, the Malaysian smelters will suffer should the ITC's creditors win their legal action. The metal currently held will go to redeem the tin warrants held by bankers and brokers, at pre-crash prices that represent a loss of hundreds of millions of pounds.

### 1.1 Datuk Keramat Smelting Sendirian Berhad

The smelter is at Georgetown, Penang Island, Penang. There are also three ore buying offices at Ipoh, Kampar and Kuala Lumpur, each with a small laboratory where assaying can be done.

The company is wholly owned subsidiary of Datuk Keramat Holdings Berhad. This parent company is owned 49 per cent by various Malaysian shareholders and 51 per cent by Amalgamated Metals/Preussag AG. The original company was founded in the 1890s by Lin Chin Ho, a prominent miner, to smelt his own and other ores from the Federated Malay States and from Siam (Thailand). By 1910 however, lack of liquidity to finance his mining projects led to the reformation of the company, largely with British capital, to become the Eastern Smelting Company Ltd. In 1929, during Simon Patino's horizontal amalgamation of the world tin industry, Patino's Consolidated Tin Smelters Ltd. took controlling interest.

Following Malayan Independence, 49 per cent of the shares were sold within the country in 1960. The Amalgamated Metals Company, long associated with Consolidated Tin Smelters, did a "reverse takeover" in 1978. At the same time the Patino family gave control of their holdings to Preussag AG.

The size of non-Malaysian holding exceeds the 30 per cent NEP (National Economic Policy) target. However, smelting is seen by the Malaysian Government as differing from manufacturer in that is an extension of primary industry and has an important strategic function for the Malaysian economy.

Datuk Keramat employs a total of 450 workers, including those in the three branch offices. Of these, 50 are skilled artisans: fitters, furnace bricklayers, etc.; 87 are semi-skilled (through experience, not training): these are furnacemen, furnace operators, etc. 150 workers are unskilled. There are management and clerical staff. Senior staff are highly trained e.g. at the Royal School of Mines, London.

Wage levels are governed by the normal three-year collective agreements. 375 workers are members of the Malaysian Smelting Workers, and other Trade Unions. The Malaysia Industrial Court will be shortly hearing the Smelting Workers Union's claim for a 51 per cent pay increase.

This company is the largest employer of Malay workers in Penang. Only the Managing Director is an expatriate non-Malaysian.

Datuk Keramat operates three oil fired regenerative furnaces. Anthracite is used for reduction. Furnace design has not altered greatly over fifty years. In part this reflects the lack of need for change due to the high cost grade of Malaysian ore. Datuk Keramat has an issued share capital of MS$15 million but a throughput turnover of MS$1,000 million.

However, over the past twenty years, considerable plant alteration has taken place in the refining sector. This has been to take account of the increase in heavy metals impurities, especially iron, arising from greater imports of foreign ore. Datuk Keramat handles concentrates from Australia (almost soley from Rennison Mines), Bolivia, Nigeria and Zaire. The People's Republic of China sends those concentrates that are high in heavy metals and which their own smelters cannot handle.

The refinery consists of a mixer (a high proportion of high-grade tin needs to be added to the more complex ores); kettles for initial melting; a centrifuge that takes molten metal and a final remelting liquator. Arsenic is nor treated and refined separately. The Rennison ore has a high arsenic content and in addition is very finely milled. The old process of roasting and catching is not satisfactory so Datuk Keramat have moved downstream producing separately white arsenic.

The smelter is now producing ingots of differing size and standard to customer requirement, in addition to the standard Straits Refined ingot of 99.85 per cent tin. Specially shaped anodes are produced specifically for the tin-plating requirements of Broken Hill Propriety of Australia. Finally, after all the processing and reprocessing, the final slag, containing less than 1 per cen tin, is sold to Singapore for use in sand-blasting.

There are laboratories at the smelting works. X-ray Flourescence Spectrometry is undertaken to monitor the slag and impurities of ore are measured by electric charge with subsequent percentage breakdown of all metal type content. The company also has a vehicle maintenance department for its vans and lorries and a maintenance department of carpenters, blacksmiths and welders. In addition, use is made of a wide range of specialist foundaries in Penang that have developed consequent to the smelting industry.

The price for Straints Refined is determined through the Kuala Lumpur Tin Market (KLTM), but the different quality ingots are separately determined depending on tin content. 80 per cent of the value of concentrates is paid on delivery and the remainder after sale. Similarly, 80 per cent is advanced for imports on receipt of shipping documents. The larger mines are now sending on a toll basis and then taking back the smelted tin to hold rather than sell due to low state of the market. Both the Malaysian smelters are now holding tin metal from mines who have not paid their tolls. More significantly, both are holding large tin stocks purchased by the ITC prior to the collapse. Datuk Keramat have some 20,000 tons of ITC tin unpaid for, the fate of which awaits the result of litigation by the ITC creditors.

Although the smelters margin is very low, many costs are passed on to purchasers. Since tin is bought 'ex-works', transport and shipping costs are bourne by producers and purchasers. This is neither unique to Malaysia nor new. Indeed, miners and others around the world have been complaining of smelters' costs for centuries (see, for example, Lewis The Stannaries Cambridge 1924).

1.2 Malaysia Smelting Corporation Berhad

The MSC smelter is at Butterworth on the Penang mainland. It handles with high-grade concentrates to produce Straits Tin of 99.85 per cent purity. The company is 42 per cent owned by Malaysia Mining Corporation (MMC) and 58 per cent by the Straits Trading Company of Singapore.

Tin smelting had followed the growth of tin mining in the Malay peninsular during the nineteenth century. The Straits Trading Company was the first European venture, begun as a partnership between Messrs. Sword and Muhlinghaus in 1886 and with the first reverbatory smelter built at Pulau Brani, off Singapore, in 1887. In 1902 the company opened another smelting unit at Butterworth. Its eight furnaces were more efficient than Pulau Brani and between 1908-1915 those were replaced by fifteen large gas-fired furnaces on the Butterworth design. The Butterworth smelter was shut down during the Japanese occupation in World War II. It did not re-open until 1955 when a new plant was built. This had three, later five, regenerative oil-fired furnaces. It is this plant that continues operation today.

Straits Trading closed their Pulau Brani smelter in 1971 and concentrated their activities at Butterworth. In 1982, after previously considering opening its own smelter at Klang, Selangor, MMC acquired its interest in the Butterworth smelter and MSC was formed. The Straits Trading Company is expected to offer 23 per cent of its holdings to Malay nationals over time to meet NEP requirements. MSC takes all concentrates from the MMC group.

MSC employs 480 plus 40 management staff. There are 60 workers in the three ore buying offices at Ipoh, Kampah and Kuala Lumpur. A fourth office, in Perak, was closed in early 1986 and its six workers retrenched.

Wages have been increased by 5 per cent in the Collective Agreement of the past three years. Union membership is optional but 95 per cent of workers are in the Malaysian Smeltin; Workers Union. Management staff are not covered by the collective agreements, but, despite the tin market collapse, increments have still been given and ex-gratia bonuses were made at year end 1986.

Reflecting the joint ownership of the Corporation, the Chairman of the Board is nominated by MMC, the Managing Director by Straits Trading. He is the only ex-patriate. The Deputy Managing Director has come from MMC.

MSC predominantly takes high-grade concentrates. Approximately 20 per cent of these were foreign during 1986. The main source of foreign ore in Australia with lesser amounts from Bolivia, Burma, the People's Republic of China, Nigeria, Rwanda and Zaire. Prior to 1975 and the building of a smelter by P.T. Tambang Timah, Indonesian tin was smelted. The company turned to Australia in the late 1970s to take up capacity shortfall even though the Australian tin content (50 per cent) was low by Butterworth standards. In 1986, 60,000 tonnes of tin metal were produced. This is equal to almost one third of world consumption but nevertheless, the smelter is only working at half capacity.

The smelting process is essentially similar to Datuk Keramat but without the extended refinement of DK's lower grade and complex ores.

Energy costs, of oil and the anthracite used as coke for reduction, are externally determined: oil is now cheaper, coke the largest energy source, costs porportionately more although the same amount is used as in the 1950s.

Transport costs and insurance on ore sent from the branch offices to Butterworth are charged to the miners. MMC bears its entire transport costs to Butterworth, but gets discount on other costs due to large amount. Tin metal is sold ex-works. Tin metal is usually shipped via Singapore. MSC acts as forwarding agents and ship directors. The works are very near the port where MSC has its own wharf. The main materials cost is for furnace bricks. These are imported from germany and are affected by the revaluation of the Deutschesmark against the Ringgit.

Advances of 95 per cent of tin price are given, with the balance following sale on the KLTM. No cash advances are made to MMC who have a tolling arrangement and collect their own metal, so they incur no interest charges. Like Datuk Keramat they hold large stocks of unpaid ITC tin.

## 2. Users of production

### 2.1 Internal

The principle internal use for tin in Malaysia is as a solder, followed by tinplate. Internal consumption, however is very low. In 1984 internal consumption of solder was 726.60 tons and tinplate 406.54 tons, but total internal consumption of all uses only amounted to 1,519.78 tons. Indeed, consumption by tin producing countries overall is very small. Of the seven countries which are members of ATPC per capita consumption is only 0.019 kg, or 6,500 tons in total. Compared to the 0.27 kg per capita consumed in Japan and 0.17 kg in the United States of America this is a paltry.

In December 1982, the Malaysian Government imposed a heavy duty on imported tinplate, which has led to declining imports. Demand for tinplate comes chiefly from the Malaysian can manufacturers, who are increasingly turning to the Malaysian Tinplating Company Perusahaan Sadur Timah Malaysia Sdn. Bhd. (Perstima) in MMC group. For the nine months ended 31st December 1985, Perstima sold some 56,304 tons of tinplate, giving a turnover of MS$97.832 million.

### 2.2 External

The principle world use of tin remains tinplate, although there has been a steady decline in the amount of tin used in the plating process and the recession has led to decline in production. The final users are the tin can manufacturers such as Metal Box, and those involved in tinplating, for example Nippon Steel and other major steel corporations.

Tin metal usage has been declining overall. The growth of alternative forms of packaging, particularly the aluminium can and plastics, have eroded the tinplate market. The invention of the silicon chip has diminished demand for solder. However there is a growing, although not yet significant usage of tin as a chemical. In this form tin is used in paint, as a flame retardent, and as a timber preservative. Research is well advanced in the use of organo-tin as a biodegradeable, pest specific insecticide. This could have important implications for vertical integration of production and manufacture within Malaysia. None of these uses however require the volume of tin as does tinplate.

# IV. ANALYSIS OF MAIN ACTORS

## 1. Government strategy, policies and inceptives

### 1.1 Federal Government

The Government of Malaysia outlines its strategy for the nation in the quinquennial Malaysia Plans. The period of the Fourth Malaysia Plan ended in 1985, and the Fifth Malaysia Plan strategy will apply from 1986-1990.

Within the framework provided by the Plans, the Government is committed to the development of the non-ferrous metals industry through the private sector, as consistant with the policies of the NEP. The mining industry is currently entirely own-funded with neither local nor foreign loans, although a soft loan scheme has been introduced as a result of the tin crisis. Both federal and state governments play an important role in the encouragement of exploration and research.

Under the Third Malaysia Plan a National Mining Code was initiated to standardize all mining enactments pertaining to prospecting, land alienation, issues and renewal of leases and conversion of mining land in the various states. Also, in 1980 a national Minerals Policy was formulated to encourage diversification beyond alluvial tin mining and to ensure orderly exploitation and development of non-hydrocarbon minerals.

The strategy for the mining sector under the Fourth malaysia Plan aimed to strike a balance between increasing revenue from the exploitation of mineral resources and the need to conserve these resources for future development. During this period the tin mining industry - affected by ITC export controls - suffered severe decline and growth came chiefly from petroleum. Thus the Fifth Plan has as its main thrust the encouragement of more intensive prospective for other minerals.

The sector of the Government responsible for the non-ferrous metals industry is the Ministry of Primary Industries. As the name suggests, all primary industries - rubber, palm oil, etc. - come under its aegis.

The two main departments involved with the industry are the Department of Mines and the Geological Survey. Both are extremely long established. The Mines Department was set up in the Federated Malay States by the British in 1894. The Geological Survey even earlier. The Mines Department administers the Mines Enactment and the Rules on Health and Safety in Mines.

1.2 State Government

The individual State governments have powers to make a variety of rules under the mining enactments. These are determined by the Ruler in Council in nine states or by the Governer with the advice and consent of the State Council in the remaining four states.

Such rules include:

(i) the fixing of rents, premiums and fees
(ii) regulation of mining operations
(iii) the issueing of mining licences.

The Mines Department, although a federal body, serves the individual states and administers their rules. There are four inspectorate centres: north - covering Perlis, Kedah, Penang and Perak; south - Selangor, Melaka, Negeri Sembilan and Johor; east - Pahang, Terengganu and Kelantan; and east Malaysia - Sabah and Sarawak. Each has a senior inspector, who is a federal officer. The Deputy and support staff are provided by the states. Within each inspectorate there are subdivisional districts.

1.3 Duties and revenues

The Federal Government levies duties on exported minerals and finished products. Both Federal and State Government levy royalties on mining operations. Recent figures are not available but the decline in tin production will have significantly reduced the amounts of royalty whilst the closure of mines will have lessened state revenues.

The collection of revenue connected with mining administration is shared between the Department of Mines, the State Land Offices and the Treasury. In 1983 royalties coming to the treasury were MS$336,255.

Export duty on tin is based on the metal price per ton, with an ad valorem tax per ton for tin concentrates. All movements of concentrates to the smelters in Penang and Butterworth are deemed as exports.

Other minerals are either exempt or have an ad valorem rate of duty from 2,5 to 10 per cent (1983). Gold and barite and copper concentrates have royalties. Minerals which are tin derivatives have exemptions from tin duty up to certain maximum tin content levels.

2. Operation of TNCs

Unlike many other non-ferrous metals producing countries, TNCs play a negligible role in Malaysia. The tin mining industry divides between very many small mines, each employing relatively few people and the private sector quasi national enterprise, MMC, which is a very large concern indeed.

Until the introduction of the NEP measures, the dredge mining operations in Malaysia were largely foreign-owned. The London Tin Corporation, Anglo-Oriental and Associated Mines, owners of the Tronoh group of mines, Ayer Hitam, Berjuntai and Sungei Besi, had largely been brought under the ownership of the TNC Charter Consolidated Ltd. Some dredge and gravel pump mines belonged to the very long established (1894) Gopeng Group, managed by Messrs. Osborne and Chappel Ltd of Ipoh, but then still registered in London. The remaining gravel pump mines - many hundreds of them - were Chinese-owned.

When Pernas moved into the market during the 1970s, the stockholders of the London Tin Corporation and other companies were bought out. An accommodation was reached with Charter Consolidated whereby they retained a 20 per cent holding in the newly formed Malaysia Mining Corporation together with two seats on the main Board. The Charter holding was subsequently reduced to 15 per cent. In 1986 Charter closed their Kuala Lumpur office. One of their representatives retired from the MMC Board whilst the other was based permanently in London. This reflected Charter's declining interest in tin rather than their relationships within Malaysia. They have pulled out of tin mining elsewhere in the world as exemplified by the 1985 sale of their majority holding in South Crofty and Wheal Pendarves Mines in Cornwall to the Rio Tinto Zinc Corporation (RTZ). Charter still retain their shareholding in MMC, but given the depressed state of the market, 1986 was hardly the time to sell. RTZ and Conzinc Rio Tinto of Australia (CRA), have a joint venture of their two Malaysian companies - Perangsang Rio Tinto (M) Sdn Bhd and Pacific Tin Consolidated Corporation. The venture is a dredge mine in Kuala Langat, Selangor, which employs 137 workers. CRA - as Conzinc Holdings (M) Sdn Bhd, is a corporate member of the Chamber of Mines, as are the other two Malaysian companies.

The Mamat copper mine in Sabah, which has been open since 1975, comes nearer to the more usual 'model' for TNCs. The mine, which employs over 1,000 workers, is operated by Overseas Mineral Resources Development (Sabah) Bhd. (OMRD). The company is a joint venture between Malaysia and Japan, owned 49 per cent by the state-owned Sabah Economic Development Corporation (SEDC) and 51 per cent by a Japanese consortium predominantly Mitsubishi (a specific exception to NEP criteria). The mine produced approximately 100,000 tons of copper concentrates in 1981, plus 2.4 tons of associated gold and 12 tons of silver. The copper concentrates, worth MS$159 million in 1981 were shipped to

Japan. Copper is now Sabah's fourth largest export earner after crude oil, timber and palm oil.

It is the smelting and refining rather than the mining sector that TNCs and non-Malaysian companies figure more significantly. Both Datuk Keramat Smelting and Malaysia Smelting Corporation have foreign majority ownership. In both cases the size of holding exceeds the level recommended in the NEP. Fifty per cent of Datuk Keramat is held jointly by Amalgamated Metals/Preussag AG. Malaysia Smelting is owned 42 per cent by MMC and 58 per cent by the Straits Trading Company of Singapore.

The MMC has an important transnational role that should be considered. At the time of its incorporation MMC 'inherited' the overseas holdings of Anglo-Oriental Ltd. These included an interest in Amalgamated Tin Mines of Nigeria, subsequently disposed of to Nigeria. At present MMC has mining and exploration projects and options in Australia, Thailand and Indonesia.

In Australia, all MMC Group's interests have been held since 1981 through its associate company Ashton Mining Ltd. in which MMC has an equity participation of 46.3 per cent. Ashton's major involvement continues to be its 38.2 per cent share in the Argyle Diamond Mines Joint Venture (ADMJV). This is an extremely successful venture. The sale of ADMJV's diamond production is handled through Ashton's 40 per cent owned associate Argyle Diamond Sales (ADS), most of it under contract with the London based Central Selling Organization. For the financial year ending 31 December 1985, Ashton made a profit of Aus$9.011 million, compared with a profit of Aus$9.591 million in year ending 31 December 1984 (after equity accounting the results of ADS).

During 1985, MMC had two exploration projects in Thailand. The first of these - in the deep Water Areas off Takuapa - has reached the stage where mining lease applications have been lodged for two selected areas. Further development of this project will depend not only upon tin prices, but also on successful design of a suitable all-weather sea going dredge. The second exploration project is for gold in the Toh Moh area where old underground workings exist. A further project for gold at Kabinburi has not yielded satisfactory results and has been terminated. MMC's interest in these projects are held through Aokam Tin, Aokam Thai and Tongkah Holdings' company Tongkah Harbour Ltd. which has investment in two Thai registered companies - Cholsin Ltd and Mashbumi Ltd.

## V. LEGAL AND INSTITUTIONAL ASPECTS

### 1. Legislation

The pre-eminent legislative measure for the mining sector of the non-ferrous metals industry is the Federation of Malaya Mining Enactment (FMS Cap 147). This was first passed in 1929, updated in 1934, amended and re-printed in 1962 and extended in 1967. Under the amended Act the individual states have passed their own Mining Enactment. The Borneo Territories Mining Legislation 1934 (Cap 83) with a similar history of amendments covers Sabah and Sarawak.

Under FMS Cap 147, the Mining Rules 1934 (FMS GN 2426/34) defines the Rules and Powers of Mines Inspectors for the operation of Mining and of Health and Safety. The original Enactment was modelled closely on British Metalliferous Mines Regulation legislation. Inspectors of Mines are given wide powers to arrest without warrant persons in breach of the provisions and to carry out various duties.

Other legislative powers lie with the states. Possibly the most important is the granting of mine leases. Many mining companies feel that the Lease periods, usually five or six years, are too short to encourage long term planning and investment. It is also argued that longer leases would encourage greater environmental conservation.

## VI. STRATEGIES FOR DEVELOPMENT AND CO-OPERATION

### 1. Non-exploited deposits

Prospecting and exploration for new deposits of non-ferrous minerals is already given priority in Malaysia. Active exploration programmes are also carried out in the commercial sector, notably by MMC. At present, when a deposit has been clearly examined by the Geological Survey the details are passed on to the commercial sector for exploitation.

Exploitation is being undertaken as joint ventures between commercial companies and local state government with increasing frequency. Many states have established their own Economic Development Boards to facilitate this, and similar activities.

Infrastructural development, where not undertaken by the states for wider purposes, also usually proceeds as joint ventures between state and company. A recent example of this is the Mamat copper mine in Sabah. Although the mining company provided the necessary infrastructure for the mine's development, that same company has the Sabah Economic Board as major shareholder.

Further exploitation of known reserves largely depends upon two things - a change in the top priority of Malaysia in government policy away from industrialisation and towards non-ferrous mining (current scarce resources necessitate trade-off); and secondly improvement in the world price of non-ferrous metals.

Industrial development has had mixed results in developing countries, often exacerbating rural/urban drift, using up excessive amounts of foreign exchange and contributing to balance of payments and debt problems. Some industrial projects in the Malaysian context have caused these issues to be raised here. It would seem however that it is the nature and type of industrialisation project, rather than industrialisation policies per se that is problematic.

Improvement in the world price of metals is far more pertinent to the exploitation of non-ferrous minerals. The world price of metals is heavily dependent upon the economic situation of the industrial countries, and for many metals, the trading action of the world commodity markets. Attempts to stabilise price such as the International Tin Agreements, discussed above, by their failure underline the importance of a new strategy for pricing.

The extent of Malaysia's non-ferrous metals resources cannot be given with any accuracy. In part because of mining companies quite understandable desire to keep details of their reserves confidential; in part because such estimates are so frequently completely wrong. This has been particularly true in the case of Malaysian tin reserves. In 1939, for example, it was estimated that there were total reserves of about

1 million long tons of metal. Between then and 1964 over 1 million long tons were mined. In 1953, another estimate put reserves at 1,5 million long tons of metal. If that estimate had been correct exhaustion would have occurred by the 1980s.

In addition, such estimates do not take into account technological changes either in mining, separation or refining which may allow lower grades of ore to be exploited. Furthermore, the development of undersea mining has greatly increased the possibility of reserves in territorial waters. The MMC joint venture in Thailand for Deep Water Dredging, gives some indication of the potential in this area. Malaysia has taken a prominent stand on the issue of undersea minerals. At the UN Conference on the Law of the Sea, and elsewhere, Malaysia has urged that deep sea minerals be declared a National heritage of the country in whose waters they be found.

The development of undersea minerals has already raised issues of relevance to the study of the world non-ferrous metals industry. Nodules rich in manganese, nickel, cobalt etc. can be found on the Deep Sea bed. Exploitation of these tremendous resources depends on al least three things: new technology; relationships between countries with such deposits off shore and the mining TNCs; a strong upturn in the price of minerals.

2. Alternative strategies for development and co-operation

The Malaysian tin industry at mining, refining and smelting level, is mature, developed and integrated into the economy and society. It employs a large number of people with a wide range of skills. It operates all over the country buth in rural and urban areas.

There is complete national sovereignty over mineral resources. Foreign equity is limited and foreign/TNC involvement minimal. The industry has a mature and coherent national productive system. There are local centres engaged in research and development and close involvement in regional and international research for tin use.

There are areas of co-operation that have been in existence for some time. The fact that the world's three largest tin producers - Malaysia, Indonesia and Thailand - share proximity means that the tin industry is an area of common interest within ASEAN. At an international level, Malaysia is a member of the ATPC and ITC. Malaysia helps fund, through ATPC, the International Tin Research Institute, based in London.

Mining no longer dominates the Malaysian economy as it did in colonial days. Less than 2 per cent of the working population are employed in that sector. The largest employment sector remains agriculture, forestry and fishing (36 per cent), but 15 per cent of workers are in the manufacturing sector and a further 15 per cent in the wholesale, retail, hotel and restaurant sector. Nonetheless, mining still provides 10 per cent of GDP. There is every reason for exploring ways in which this might be expanded.

Strategies for development and co-operation can be discussed in two contexts: internal and external to Malaysia. In both these contexts there are two dimensions: expansion of the tin mining industry and expansion of demand for tin using products.

Within Malaysia, any expansion of the industry would raise the key question - by whom? Improvements in the price of tin would bring back into

operation many mines now, either on care or maintenance or closed. But it would leave unresolved the relationship between the gravel pump mines and the dredge companies, predominantly MMC. The ethnic dimensions that characterise politics in Malaysia are relevant here. Malaysia's agreement to the ATPC request to control production has already brought this into focus. The (Chinese) Association of gravel pump mine owners has already raised the question as to how any quotas are to be shared out. The grating of new mining leases by state governments is also an area where this issues applies.

Clearly, the industry would benefit by expansion of demand for tin using products. Greater vertical integration between mining and manufacture would help ensure that this expansion used local, rather than imported, tin. One such opportunity for co-operation in vertical integration could arise from the research on organo-tin compounds for pesticide.

The world price of tin has been a constant theme throughout this country case study. There is nothing new or innovative in stating that what is required is a stable price, high enough to ensure efficient continuation of mining, but not so high as to encourage overproduction. There has been strategies for international co-operation to achieve this. But with the collpase of the ITC, and with the UNCTAD Common Programme for Commodities, an apparent non-starter these are in eclipse.

Producer organisations, such as ATPC, may provide a way forward. Or their unity may collapse once the current overhang is used up, and the industry be left to the wrokings of market forces. "Survical of the Fittest" is a strategy already being considered by those who feel they come into that category.

The strategies most likely to achieve the objectives of the Lima Declaration would seem to be those which will shift a major proportion of financial and manufacturing investment to the South. Economic development that stimulates local and regional consumption of locally manufactured products may do more for the world non-ferrous industry than strategies that specifically focus upon it.

## 3. The economics of the tin industry

### 3.1 National use of tin production

This is the area where opportunities exist for expansion. At present Malaysia's tin consumption is well below the amount of tin produced.

The present most important use of tin is tinplate. The Asean region as a whole only consumes about 5.5 per cent of total world tinplate consumption. Consumption in Malaysia, elsewhere, has been affected by the switch to substitute packaging material and has declined since 1978. Domestic tinplate manufacture began in 1983 and could expand.

Production of solder has increased since 1983. There is a new plant manufacturing electronics quality solder. This uses between 500-600 tons of tin. The bulk of its output is exported.

The other main use of tin - pewter - is largely for decoration and souvenirs. Production uses about 200 tons of tin metal per year. This area might expand since Malaysia has placed considerable emphasis on tourism as a foreign exchange earner, but hardly to a level which could have any significant impact on tin production.

Internal manufacture of tin using products, such as steel castings and tin plate already takes place. The companies are part of the MMC group's downstream diversification. Expansion depends on increased demand both internally and externally.

# THE NON-FERROUS METALS INDUSTRY IN INDIA

## A. COPPER INDUSTRY

### I. INTRODUCTION

Hindustan Copper Limited (HCL), a public sector undertaking, is the sole producer of primary refined copper in India. Some State mining corporations i.e. Chitradurge Copper Company, Karnataka, Andhra Pradesh Mining Corporation Limited (AMPC), and Sikkim Mining Corporation (SMC) have also developed small mines with matching concentrators for production of copper concentrates. The copper concentrates produced by these companies are supplied to HCL for both smelting and refining. Another mine at Ambamata (Gujarat) is being developed by Gujarat Mineral Development Corporation (GMDC). The copper concentrates from the poly-metallic ore of this mine will not be of the quality required for the domestic smelter and therefore will have to be toll-smelted abroad.

HCL planned to raise the capacities of the Khetri and Ghatsila smelters from 31,000 and 16,500 tons per year to 45,000 and 20,000 tons per year respectively. Khetri expansion was to enable it to handle the concentrate from the newly-opened Malanjkhand concentrator. Expansion has still not been accomplished; a part of Malanjkhand concentrate is toll-smelted abroad. The company intends to enhance capacities through oxygen enrichment of process air.

In addition, there is a possibility of setting up a 50,000 tons per year smelter based on integrated development of the Singhbhum Copper belt in Bihar. In early 1983, the company issued a global tender for preliminary studies to exploit the copper deposits in the region. The first phase of the programme proposes developing a new mine and installing matching concentration capacity. Mosabani, Pathargora, Surda and Rakha mines already exploit some of the deposits of the Singhbhum belt.

HCL expects that planned new refinery capacities at Khetri and Ghatsila will produce enough by-product trace elements to warrant a new recovery facility. The existing by-product plant at Ghatsila will be expanded and modernised to handle the load from both refineries. About 185 tons of anode slimes would be treated annually.

## II. MINERAL RESERVES

The reserves of 6.3 million tons of copper in India are not of great significance. The copper reserves are summarized in Table 10.

Table 10. Summary of copper ore and metal resources in India as of 31.3.1983

| | In situ reserves/resources | | | Number of deposits/ projects | Average reserves/ resources per deposit in 000 tons | |
|---|---|---|---|---|---|---|
| | Ore (million tons) | Metal (000 tons) | Grade % Cu | | Ore | Metal |
| 1. Working mines | | | | | | |
| HCL mines | 252.12 | 3,081 | 1.22 | 10 | 25,210 | 308 |
| Other mines | 7.22 | 88 | 1.22 | 6 | 1,200 | 15 |
| Sub-total | 259.34 | 3,169 | 1.22 | 16 | 16,210 | 198 |
| 2. Project under consideration/ formulation | | | | | | |
| Rakha phase II | 46.56 | 582 | 1.25 | 1 | 46,560 | 582 |
| Others | 10.04 | 156 | 1.55 | 3 | 3,350 | 52 |
| Sub-total | 56.60 | 738 | 1.30 | 4 | - | - |
| 3. Deposits apparently viable | | | | | | |
| Bihar | 97.17 | 1,299 | 1.34 | 7 | 13,880 | 186 |
| Rajasthan | 12.49 | 180 | 1.43 | 4 | 3,120 | 45 |
| Madhya Pradesh | 7.00 | 105 | 1.50 | 1 | 7,000 | 105 |
| Other States | 1.03 | 26 | 2.52 | 2 | 515 | 13 |
| Sub-total | 117.69 | 1,610 | 1.37 | 14 | - | - |
| 4. Para-marginal and sub-marginal prospects | | | | | | |
| (a) Above 0.60% Cu | 47.84 | 534 | 1.11 | 37 | 1,296 | 14 |
| (b) Below 0.60% Cu | 84.79 | 242 | 0.29 | 3 | 28,263 | 81 |
| Sub-total | 132.63 | 776 | 0.59 | 40 | - | - |
| 5. All India total | | | | | | |
| (a) Above 0.60% Cu | 481.47 | 6,051 | 1.26 | 71 | - | - |
| (b) Below 0.60% Cu | 84.79 | 242 | 0.29 | 3 | - | - |
| Total | 566.26 | 6,293 | 1.11 | 74 | - | - |

## III. EXPLOITED MINES

Copper ore in India is mined exclusively by the public sector undertaking. HCL operates 10 major working mines. Six other relatively smaller mines are operated by the State Government undertakings. The mines exploited by HCL have reserves of 3,081 million tons of copper and 252 million tons of ore with an average grade of 1.22 per cent Cu. The other six working mines have only 88,000 tons of copper metal resources and 7 million tons of ore. The location-wise distribution of reserves in exploited mines is indicated in Table 11.

Table 11. Location-wise distribution of reserves and exploited mines

| Location (State) | Number of exploited mines | Resources: Ore (million tons) | Resources: Metal (000 tons) | Distribution percentage: Ore | Distribution percentage: Metal |
|---|---|---|---|---|---|
| Bihar | 5 | 66.27 | 975 | 25.6 | 30.8 |
| Rajasthan | 4 | 70.22 | 799 | 27.1 | 25.2 |
| Madhya Pradesh (MP) | 1 | 115.63 | 1,307 | 44.6 | 41.2 |
| Others | 6 | 7.22 | 88 | 2.7 | 2.8 |
| Total exploited mines | 16 | 259.34 | 3,169 | 100.0 | 100.0 |

The mines in Bihar have the richest ore with an average copper content of 1.47 per cent. Next in importance is the mechanised large-scale open pit in Madhya Pradesh with a copper content of 1.22 per cent. The ore in the mines of Rajasthan has a copper content of 1.14 per cent. The operation in mines under "others" category is limited to concentration of ore. The concentrates from these mines are transferred to HCL for smelting.

On the basis of 50 per cent *in situ* reserves as recoverable, the present known reserves in working mines would be exhausted in 24 years at a depletion rate of 65,000 tons per year.

## IV. INTERMEDIARY CONSUMPTION PER TON OF CONCENTRATES

The different inputs consumed per ton of concentrates in the case of HCL are summarized in Table 12.

Table 12. Inputs consumed for production of one ton of copper concentrates in the concentrators operated by HCL during the period 1979-1980 to 1984-1985

| Item | Unit | Quantity per ton | Cost in Rs. per ton of concentrates | Cost in Rs./ Rupee value of concentrates |
|---|---|---|---|---|
| 1. Ore | ton | 19.75 | 3,443.13 | 0.90 |
| 2. Reagent | | | 43.37 | |
| 3. Electricity | kWh | 476.00 | 157.08 | |
| 4. Lubricants | kg | 2.35 | 18.00 | |
| 5. Spares | | | 60.83 | |
| 6. Grinding media | kg | 11.47 | 43.11 | 0.10 |
| 7. Liners | kg | 2.29 | 33.10 | |
| 8. Manpower | | | 45.35 | |
| 9. Others (not specified) such as: | | | 5.03 | |
| - Screen cloth | $m^2$ | 0.0075 | | |
| - Conveyor belt | m | 0.0186 | | |
| | | | 3,831.00 | 1.00 |

Ore, electricity, reagents and manpower are the main inputs required for concentration of copper ore; ore itself accounts for 90 per cent of the total value of production.

The consumption of inputs in smaller concentrators operated by small mines in Karnataka and Andhra Pradesh is practically the same. However, on account of economies of scale, the cost of the ore, reagents and manpower vary marginally.

## V. PRODUCTION OF COPPER ORE

The production of copper ore in India during the period 1975-1984 increased from 1,838,468 tons to 3,893,651; however, it decreased between 1979 and 1981. Table 13 shows the production of copper ore.

Table 13. Production of copper ore in India 1975-1984
(tons)

| Year | All India | A.P. | Bihar | Karnataka | M.P. | Orissa | Rajasthan | Sikkim |
|---|---|---|---|---|---|---|---|---|
| 1975 | 1,838,468 | 2,739 | 1,038,086 | 61,055 | - | - | 736,588 | - |
| 1976 | 2,395,275 | - | 1,185,095 | 71,935 | - | - | 1,137,445 | - |
| 1977 | 2,551,888 | 5,050 | 1,280,669 | 69,365 | - | - | 1,196,154 | 650 |
| 1978 | 2,132,098 | 939 | 1,086,031 | 57,229 | - | - | 987,870 | 29 |
| 1979 | 2,156,552 | - | 988,167 | 45,744 | - | - | 1,124,471 | 170 |
| 1980 | 2,005,436 | - | 1,145,386 | 42,981 | - | - | 816,669 | 400 |
| 1981 | 2,109,007 | 1,972 | 1,247,482 | 51,662 | - | - | 807,241 | 650 |
| 1982 | 2,478,935 | 1,861 | 1,347,895 | 50,007 | 462.443 | - | 616,439 | 290 |
| 1983 | 3,423,555 | 1,015 | 1,300,378 | 61,288 | 1,110,976 | 160 | 949,532 | 206 |
| 1984 | 3,893,651 | 1,872 | 1,298,467 | 62,928 | 1,296,427 | 780 | 1,232,707 | 470 |

Source: Indian Bureau of Mines, Mineral Statistics of India, April 1985.

## VI. PROCESSING OPERATIONS

### 1. Smelting and refining of copper

In India, copper is currently being produced exclusively by pyrometallurgical operations using flash furnace technology offered by M/s. Outokumpu of Finland. The smelters are located at:

- Khetri in Rajasthan with an installed capacity of 31,000 tons per year; and
- Ghatsila in Bihar with an installed capacity of 16,000 tons per year.

The production of wirebars registered less than 50 per cent of capacity utilisation except once in the period 1975-1984. The low capacity utilisation is attributed to low production from the mines. Table 14 shows the production of wirebars and the level of capacity utilization.

Table 14. Production of wire-bars, level of capacity utilisation and value of production (1975-1984)

| Year | Production (tons) | Capacity utilisation Percentage | Value of production (Rs./ton) |
|---|---|---|---|
| 1975 | 12,228 | 31.03 | 20,219.6 |
| 1976 | 17,012 | 43.18 | 22,737.0 |
| 1977 | 21,069 | 53.47 | 23,640.2 |
| 1978 | 11,754 | 29.83 | 25,722.2 |
| 1979 | 14,707 | 37.33 | 30,136.8 |
| 1980 | 17,021 | 43.20 | 32,092.1 |
| 1981 | 14,787 | 37.53 | 30,773.3 |
| 1982 | 15,066 | 38.24 | 27,252.3 |
| 1983 | 19,585 | 49.70 | 36,658.3 |
| 1984 | 18,651 | 47.34 | 35,902.0 |

Source: Government of India, Indian Bureau of Mines, Mineral Statistics of India, April 1985.

Since melting of copper concentrates is through exothermic reactions, no energy is consumed in smelting. Copper concentrates, electricity, manpower, spare parts, etc. constitute the major inputs. The consumption of these inputs is furnished in Table 15.

Table 15. Average of inputs consumed for production of one ton of copper anode during the period 1979-1985 in smelters operated by HCL

| Item | Unit | Quantity per ton | Cost in Rs. per ton | Cost in Rs./ Rupee value of anode |
|---|---|---|---|---|
| 1. Concentrates | ton | 5.17 | 19,806.27 | 0.79 |
| 2. Power | kWh | 1,394.00 | 460.02 | 0.02 |
| 3. Manpower | | | 710.00 | 0.03 |
| 4. Others (including spare part, reagents, etc.) | | | 4,028.71 | 0.16 |
| | | | 25,005.00 | 1.00 |

2. Copper and copper alloys and semis

Currently 80 per cent of the total copper consumption in India is in the form of wrought products, while the rest is accounted for by other industries such as castings, forgings and chemicals.

## 2.1 Winding wires and strips

Although the electric wire industry in India is over 60 years old, the major growth in the industry has occurred only during the last three decades. At present, there are a dozen large-scale manufacturers in this field besides a host of medium-scale and small-scale manufacturers. There are a few manufacturers who have developed into integrated units making semis to finished products. Average annual production of strips during the last decade is furnished in table 16.

Table 16. Average annual production of winding wires and winding strips during 1975-1976 to 1984-1985

| Region | Organized sector Winding wires | Winding strips | Total | S.S. Sector Winding wires and strips | Grand total |
|---|---|---|---|---|---|
| Western | 9,980 | 4,365 | 14,345 | 2,500 | 16,845 |
| Southern | 2,500 | 800 | 3,300 | 1,800 | 5,100 |
| Northern | 2,200 | 370 | 2,570 | 1,500 | 4,070 |
| Eastern | 2,600 | 1,280 | 3,880 | 1,200 | 5,080 |
| Total | 17,280 | 6,815 | 24,095 | 7,000 | 31,095 |

Source: Indian Non-ferrous Metals Manufacturers Association, Bombay.

It is observed that about 13 to 17 per cent process scrap is generated by winding wire/strips units. This is recycled and converted into wire bars for wire drawing. Copper oxide, which is generated at an average 2 per cent of melted metal, is sold out.

## 2.2 Flat products

Among the other wrought products manufacture, sheets and strips form a sizeable portion of copper-based semis. It meets 80 per cent of the indigenous requirements. Yet, this utilizes only 45 per cent of the capacity of installed manufacturing units. Licensed capacity in this area is around 46,000 tons.

Nearly 50 per cent of the production comes from three units in the organized sector located in Bombay. The trade sources estimate the capacity of unorganized sector at about 2,000 tons per year. The units in the informal sector generally have more sophisticated rolling mills, electric annealing facilities, apart from general purpose machine shops and auxiliary facilities.

The units in the informal sector use operative processes which are normally outdated and consequently concentrate in products which are thicker in gauge and are used by the non-industrial sector. More sophisticated products, such as thinner gauge materials or alloys of phosphor-bronze, nickel silver etc., are not taken up in such units, since these require more sophisticated melting, rolling and annealing facilities.

## 2.3 Extruded and drawn products of copper and copper alloys

These products have been facing severe competition from imports. This industry is still in a primary stage and the installed capacity is about 28,000 tons in both the organized and small-scale sectors.

Although there is sufficient installed capacity for production of tubes, sections, solid etc., almost 15,000 tons of the Indian requirement is met through imports. Electrical power disalination and other tube-utilizing industries will increase the demand to about 25,000 tons by the late eighties and the indigenous production capabilities should match this requirement. The problem is not one of having sufficient capacity, but whether the industry is capable of producing economically the desired quality components such as cupro-nickel tubes for condensor applications. Another problem which plagues the manufacturers is the variety of specifications which are pinpointed in various collaborations for the manufacture of tube-utilizing components.

The indigenous production capacity for other types of wrought products, including alloy rods and wires, sintered products etc., is indeed very low. They account for a total copper consumption of about 5,000 tons per year.

# VII. SOME LINES OF ACTION TO DEVELOP THE MINES AND COPPER INDUSTRIES

Unless new deposits of large reserves like Malanjkhand are discovered, the chances are remote of meeting even 50 per cent of the demand (except for short periods when a new mine-smelter complex comes up). Therefore, the shortfall in demand has to be met by one or a combination of alternatives such as:

(a) Imports
(b) Increased use of scrap
(c) Smelting and refining of imported concentrates at new smelters/ refineries located in suitable areas
(d) Marine resources development, if possible, and
(e) Removing the imbalances between mining, concentration and smelting capacities; this may ease linkages in different regions.

The first two points are receiving adequate attention and both together are taking care of nearly 60 to 65 per cent of all demand for copper metal. The other alternatives are of longer gestation.

## B. ALUMINIUM INDUSTRY

### I. INTRODUCTION

In India, primary aluminium is currently produced by four companies, accounting for a total of 362,000 tons per year installed capacity. Of these, the Bharat Aluminium Company in the Public Sector (BALCO) has a capacitity of 100,000 tons per year. The three private sector companies are:

(a) Indian Aluminium Company (INDAL) with 117,000 tons per year capacity;
(b) Hindustan Aluminium Corporation (HINDALCO) with 120,000 tons per year; and
(c) Madras Aluminium Company (MALCO) with 25,000 tons per year.

These entities in the private sector have substantial foreign equity participation. Aluminium Company of Canada (ALCAN) holds 50.6 per cent of INDAL; Kaiser Aluminium and Chemical Corporation of the United States of America holds 26.7 per cent of HINDALCO, and Aluminium Italia has 20 per cent of the equity in MALCO.

Despite the large share of private ownership, control of the pricing, production and distribution policy is in the hands of the Government. Imported aluminium is made available to consumers at the same price as the domestic metal by suitable fiscal adjustments. This is to protect the interest of local producers while ensuring a fair price to the consumer.

The retention pricing system is the Government's method of keeping a tight control on the aluminium industry. Retention prices are fixed for each aluminium producer on the basis of its cost of production and a specified return on capital. A sale price is also fixed by the Government. If the retention price for a particular unit is lower than the sale price, the excess amount collected has to be credited to an aluminium regulation account. Similarly, if the retention price is more than the sale price, i.e. its cost of production is higher than the controlled price, the difference is reimbursed from the aluminium regulation account.

### II. EXPLOITED MINES

In India, there are 95 working mines at present. Nearly one third of the mines are small mines with an annual production of 1,000 tons or less, while at the other end of the scale 9 large mines account for 65.48 per cent of production.

Table 17. Percentage contribution of bauxite production - frequency groups

| Production Group | Number of mines | Percentage contribution in production |
|---|---|---|
| Up to 1,000 | 33 | 0.56 |
| 1,000 - 3,000 | 18 | 1.88 |
| 3,001 - 5,000 | 6 | 1.18 |
| 5,001 - 10,000 | 8 | 2.71 |
| 10,001 - 25,000 | 12 | 10.84 |
| 25,001 - 50,000 | 9 | 17.35 |
| 50,001 and above | 9 | 65.48 |
| | 95 | 100.00 |

Of the 30 mines falling within the last three groups, a significant number are captive mines of aluminium industry. Captive mines contributed about 1.84 million tons out of a total of 2.35 million tons of bauxite in 1985.

The grade-wise production of bauxite in India is as follows:

| $Al_2O_3$ (percentage) | Percentage contribution |
|---|---|
| Above 60 | 0.69 |
| 55 - 60 | 12.06 |
| 50 - 55 | 25.94 |
| 45 - 50 | 59.57 |
| 40 - 45 | 0.23 |
| 35 - 40 | 0.03 |
| Below 35 | 1.48 |
| | 100.00 |

Nearly 85 per cent of bauxite produced in India falls within the $Al_2O_3$ of 45 to 55 per cent; production of special high grade with $Al_2O_3$ content above 60 per cent is negligible.

## III. INTERMEDIARY CONSUMPTION OF THE PRODUCTION OF BAUXITE

Because of the varied geological habitat and the degree of the mechanization adopted consumption of inputs per ton of bauxite mined varies appreciably. Consumption of inputs in open-cast mining of bauxite practised in India is directly related with the stripping ratio, distance of laterite dumping place from the working benches and location of crushing and loading unit. Mechanized/semi-mechanized mining of bauxite is carried out in Bihar, Madhya Pradesh and Maharashtra States, while in other States the ore is won through manual operations. Consumption of inputs in mechanized bauxite mines with different annual capacity is shown in tables 18 and 19.

Table 18. Weighted average of inputs consumed for production of one ton of run-of-mine during the period 1973-1974 to 1984-1985 in a mechanized bauxite mine with annual capacity of 0.45 million tons per year (private sector)

| Item | Unit | Quantity per ton | Cost in Rs. per ton | Cost in Rs. per Rupee value of bauxite |
|---|---|---|---|---|
| A. Consumable store | | | | |
| - High explosives | kg | 0.40 | 3.43 | 0.14 |
| - Detonators | Nos | 0.06 | - | - |
| - Drill bits | Nos* | 3.00 | 0.17 | 0.01 |
| B. Maintenance store | | | | |
| - Spare parts | | | 5.58 | 0.22 |
| - Lubricants | | | 0.63 | 0.03 |
| - Others | | | 0.27 | 0.01 |
| C. Fuels | litres | 0.90 | 1.41 | 0.06 |
| D. Electricity | kWh | 0.70 | 0.51 | 0.02 |
| E. Manpower deployed | | | 4.01 | 0.16 |
| - Managerial and supervisory (22 Nos) | | | 1.25 | |
| - Skilled (74 Nos) | | | 1.54 | |
| - Semi-skilled (35 Nos) | | | 0.83 | |
| - Unskilled (15 Nos) | | | 0.31 | |
| - Others (10 Nos) | | | 0.08 | |
| F. Other items (not specified) | | | 9.01 | 0.35 |
| | | | 25.02 | 1.00 |

Note: * Indicates the number consumed per thousand tons of bauxite.

Table 19. Weighted average of inputs consumed for production of one ton of run-of-mine during the period 1973-1974 to 1984-1985 in a mechanized bauxite mine with annual capacity of 0.20 million tons per year (private sector)

| Item | Unit | Quantity per ton | Cost in Rs. per ton * | Cost in Rs. per Rupee value of bauxite produced ** |
|---|---|---|---|---|
| A. Consumable store | | | | |
| - Cement | kg | 0.18 | 0.12 | - |
| - Explosives and detonators | | | 3.21 | 0.12 |
| - Drill bits | Nos.*** | 1.68 | 0.07 | |
| B. Maintenance store | | | | |
| - Spare parts | | | 12.54 | 0.44 |
| - Lubricants | litres | 0.15 | 1.41 | 0.05 |
| C. Fuels | litres | 2.29 | 4.07 | 0.14 |
| D. Electricity | kWh | 3.62 | 2.28 | 0.08 |
| E. Manpower employed | | | | |
| - Managerial and supervisory (20) | | | 4.83 | 0.17 |
| - Skilled (50) | | | | |
| - Semi-skilled (27) | | | | |
| - Unskilled (80) | | | | |
| - Others (28) | | | | |
| | | | 28.33 | 1.00 |

Note: * Cost refers to the average cost prevailing during the period.
** Value refers to the ex-mine value of production, excluding duties and royalties.
*** Consumption refers to thousand tons of output.

## IV. PRODUCTION OF BAUXITE

During the last ten years, the production of bauxite has remained practically stagnant because:

(a) there has been no addition to the smelting capacity during this period;
(b) indigenous production was subject to vagaries of power shortages and interruptions; and
(c) export of bauxite could not be sustained till 1979-1980 due to the development of other sources of supply, particularly Australia, which ou[illegible]-priced Indian bauxite because of proximity of its bauxite re[illegible]ources near the ports and the economics accruing due to the amenability of its deposits for bulk mining operations.

Table 20. Production of bauxite in India (1975-1984)

| Year | Production in tons | Value of production in 000 Rupees | Value of production in Rupees/ton |
|---|---|---|---|
| 1975 | 1,274,432 | 34,060 | 26.72 |
| 1976 | 1,448,961 | 42,853 | 29.58 |
| 1977 | 1,518,685 | 45,949 | 30.26 |
| 1978 | 1,883,251 | 60,253 | 32.00 |
| 1979 | 1,951,933 | 76,813 | 39.35 |
| 1980 | 1,784,899 | 87,220 | 48.86 |
| 1981 | 1,554,650 | 104,025 | 66.91 |
| 1982 | 1,997,508 | 125,440 | 62.80 |
| 1983 | 1,576,055 | 122,147 | 77.50 |
| 1984 | 2,072,197 | 148,340 | 71.59 |

Source: GOI, Indian Bureau of Mines (IBM), Mineral Statistics of India, April 1985.

Note: The value refers to the pit's mouth value furnished by the mine owners to IBM in the Statutory Annual Returns.

## V. PROCESSING OPERATIONS

The origin of the aluminium industry in India dates back to 1938. The Aluminium Production Company of India Limited - which later turned out to be the precursor of the present day INDAL - started with the production of sheets from imported ingots. According to the latest available information, INDAL has a smelting capacity of 117,000 tons per year spread over three smelters located at Hirakud (Orissa), Alupuram (Kerala) and Belgaum (Karnataka). In addition, the company has downstream facilities in rolled products, extrusions, wire rods and foils located in Belur (West Bengal), Taloja (Maharashtra) and Alupuram Alwaye (Kerala).

The growth performance of HINDALCO has been a landmark in the development of the aluminium industry in India. In the year 1959 the company started with a modest smelting capacity of 20,000 tons per year at Renukoot (UP). Today HINDALCO has the distinction of being the single largest integrated plant in the country with a smelting capacity of 120,000 tons per year and a captive power plant of 270 MW capacity. The company, in addition, has a semi-fabrication capacity of 37,800 tons per year in rolled products, extrusions and wire rods. Plans are under way to increase the smelting capacity to 150,000 tons per year.

The public sector joined the industry in 1965 with the setting-up of BALCO. Initially it was proposed to set up the integrated plants - one at Ratnagiri (Maharashtra) and the other at Korba (Madhya Pradesh). The proposed Ratnagiri plant could not go beyond the planning stage because of the huge reserves discovered in the Eastern coast and comparative advantage in setting up a plant somewhere in the Eastern region. This, in fact, is the genesis of

the NALCO project. The Korba plant has a smelting capacity of 100,000 tons per year and a semi-fabrication capacity of 82,000 tons per year. The semi-fabrication product-mix of the company includes rolled products, extrusions and wire rods. In the early years the performance characteristics of the company were badly hit because of the inadequate availability of power from the public utility system. Plans are under way for setting up a captive power plant of 270 MW.

In 1965 MALCO set up a plant with a capacity of 10,000 tons per year at Mettur (Tamil Nadu). The company increased the installed capacity to 25,000 tons per year, but has shown signs of growth since then. It is the smallest producer of the metal in the country. The semi-fabrication capacity is 17,500 tons per year in the area of rolled products, extrusions and wire rods.

The significance of the public sector in the industry will receive a boost with the commissioning of the NALCO project which includes a bauxite mining capacity of 2.4 million tons per year, an alumina capacity of 800,000 tons per year, and a smelting capacity of 218,000 tons per year. The project will have a captive power plant of 600 MW capacity. In addition, it would have port facility for the import of 146,000 tons per year of caustic soda and export of 325,000 tons per year of alumina in the existing berth of Vishakapatnam port. The company proposes setting up semi-fabrication capacity of 149,000 tons per year and the product-mix would include rolled products, extrusions, wire rods and foils. With the production at NALCO reaching its full capacity, the public sector's share in the total aluminium smelting at 318,000 tons per year would be 55 per cent.

The growth in the installed capacity and production of aluminium in India is given in table 21.

Table 21. Growth in the installed capacity and production of aluminium in India

| Year | Capacity | | Production | | Capacity utilization (%) |
|---|---|---|---|---|---|
| | Quantity (000 tons) | Rate of growth (%) | Quantity (000 tons) | Rate of growth (%) | |
| 1950 | 5.0 | - | 4.0 | - | 80.00 |
| 1960 | 18.0 | 16.24 | 18.0 | 16.24 | 100.00 |
| 1970 | 185.0 | 26.22 | 169.0 | 25.00 | 91.24 |
| 1975 | 241.0 | 1.21 | 174.2 | 0.51 | 72.28 |
| 1976 | 256.0 | 6.22 | 209.8 | 19.98 | 81.95 |
| 1977 | 268.0 | 4.69 | 196.4 | (-) 6.39 | 73.28 |
| 1978 | 299.0 | 11.59 | 204.9 | 4.33 | 68.53 |
| 1979 | 321.0 | 7.36 | 210.7 | 2.83 | 65.64 |
| 1980 | 321.0 | - | 171.6 | (-) 18.51 | 53.86 |
| 1981 | 341.0 | 6.23 | 208.2 | 21.33 | 61.06 |
| 1982 | 341.0 | - | 208.3 | - | 61.09 |
| 1983 | 362.0 | 6.16 | 213.6 | 2.54 | 59.01 |
| 1984 | 362.0 | - | 220.0 | 2.99 | 60.77 |
| 1985 | 362.0 | - | 276.5 | 25.68 | 76.38 |

Until 1970 the industry reported a high capacity utilization and was marked with rapid strides in development and growth. This was made possible through the adequate availability of power, efficient production management as well as favourable market conditions. The declining trend started in the seventies and became significant in the latter half of the decade. Except for HINDALCO - which established its captive power plant in the mid-seventies - all other plants were badly hit by inadequate power supplies, resulting in falling capacity utilization.

Under the Aluminium (Control) Order of 1970 all primary producers are required to keep aside 50 per cent of their metal production as EC grade. The consumption of EC grade, after having touched 61 per cent of the total consumption in 1976-1977, came down to 34.8 per cent in 1984-1985. This trend warrants a careful look at the Aluminium (Control) Order in the perspective of prevailing conditions. In fact, the existing allocation system will have little relevance in the emerging over-supply situation consequent to the commissioning of NALCO in 1987-1988. The producers of metal could be left alone to deal with the demand for EC grade aluminium purely on the basis of the market developments.

Most of the modern semi-fabrication capacity is with the primary producers of the metal. The distribution of semi-fabrication capacity between primary and secondary manufacturers in the year 1983-1984 was as given in table 22.

Table 22. Distribution of semi-fabrication capacities
(000 tons)

| Product | Primary producers | Secondary producers | Total |
|---|---|---|---|
| Extrusion | 18.7 | 19.3 | 38.0 |
| Wire rods | 63.5 | 92.8 | 156.3 |
| Rolled products | 93.2 | 17.4 | 110.6 |
| Foils | 4.0 | 5.9 | 9.9 |

As against these capacities, the production of rolled products and extrusion has been as follows:

| | Rolled products (tons) | Extrusion products (tons) |
|---|---|---|
| 1965-1966 | 34,000<br>(5,908) | 6,056 |
| 1970-1971 | 62,130<br>(16,030) | 10,535 |
| 1975-1976 | 64,200<br>(17,790) | 11,813 |
| 1980-1981 | 75,090<br>(18,910) | 45,035 |
| 1982-1983 | 88,078<br>(19,770) | 35,432 |

Note: Figures in brackets indicate production of rolled products obtained by melting of scrap.

Use of scrap in rolled products has been continuously increasing. Since the use of aluminium scrap involves one fifteenth of energy used in production of primary metal, the Government has increased the use of scrap by categorizing its imports under OGL. To promote extensive use of the metal, the licensing policy has been liberalized. Broad banding of some of the semis has been permitted to be covered under the licensed capacity. The primary producers are at an advantageous position in identifying new areas of use and developing the product. They have the necessary expertise and resources to go in for development of alloys and their semis. These producers have the technical and financial back-up to develop products having future applications.

## VI. LINKAGES BETWEEN THE ALUMINIUM INDUSTRY AND THE OTHER SECTORS OF THE ECONOMY

The links between the aluminium industry and the other sectors of the economy can be defined in terms of consumption of aluminium in different sectors of the economy as shown in table 23.

Table 23. Consumption of aluminium in different sectors of Indian economy (000 tons)

| Sector | 1950-1951 | 1960-1961 | 1970-1971 | 1980-1981 |
|---|---|---|---|---|
| 1. Electrical | 2.9<br>(20) | 17.5<br>(40) | 84.0<br>(48) | 164.6<br>(52) |
| 2. Transport | 0.9<br>(06) | 5.7<br>(13) | 14.0<br>(08) | 34.0<br>(11) |
| 3. Household and commercial | 7.7<br>(52) | 10.5<br>(24) | 49.0<br>(28) | 60.1<br>(19) |
| 4. Building and consumption | 0.3<br>(02) | 0.9<br>(02) | 3.5<br>(02) | 19.0<br>(06) |
| 5. Packaging and container | 1.5<br>(10) | 4.8<br>(11) | 14.0<br>(08) | 19.0<br>(06) |
| 6. Machinery, equipment and others | 1.5<br>(10) | 4.4<br>(10) | 10.5<br>(06) | 19.0<br>(06) |
| All sectors | 14.8 | 43.7 | 175.2 | 316.6 |

Source: NCAER, Aluminium Industry in India, Problems and Prospects, 1985.

Note: Figures in parenthesis indicate percentages.

There has been a significant shift towards a larger use of aluminium in the electrical sector. This has come about through the increasing substitution of copper conductors by aluminium, and the growth of the power sector during the successive five-year plans and the consequent increased demand for electrical grade aluminium. However, the increase in the use of aluminium in the electrical sector took place mainly during the fifties and sixties. Among the non-electrical sectors, there has been some improvement in transport and building and construction, but in the case of other categories the share of aluminium consumption has been either on the decline or tended to remain stagnant.

The use pattern in various sectors observed in India is very much at variance with those prevailing in the developed countries as well as in several other developing countries. A comparative assessment can be made from the proportions shown in table 24.

Table 24. Comparative use pattern of aluminium - India and other countries

| Sector of economy | India (1980-1981) | Developing countries (1979-1980) | Developed countries (1979-1980) |
|---|---|---|---|
| Electrical | 52 | 15 | 12 to 16 |
| Transport | 11 | 22 | 17 to 32 |
| Household and commercial | 19 | 12 | 10 to 20 |
| Building and construction | 6 | 23 | 10 to 30 |
| Packaging and container | 6 | 10 | 7 to 15 |
| Machinery equipment and others | 6 | 18 | 15 to 28 |

## VII. PROSPECTS OF GROWTH OF THE ALUMINIUM INDUSTRY

Capital investment in the Seventh Plan would be of the order of Rs. 33,146 million. A brief description of the projects which are under planning/implementation during the Seventh Plan period is the following:

### 1. Aluminium complex of NALCO

NALCO has been established with the objective of exploiting the bauxite reserves of Panchpatmali in Orissa. About 400,000 tons of alumina will be converted into aluminium metal while balance alumina is planned to be exported. Out of the 218,000 tons of metal it is proposed to convert 100,000 tons as EC grade wire rods and the balance of 118,000 tons as pigs for production of semis. These are expected to be commissioned in phases between 1987 and 1989. The estimated cost of the project is Rs. 24,400 million.

### 2. Downstream facilities for NALCO

The setting-up of value-added downstream facilities is considered conducive to improving the economic viability of the NALCO complex. The feasibility report for downstream facilities is under preparation. The estimated cost of the projects is Rs. 2,320 million for the production facilities as furnished below:

| | Capacity (000 tons per year) |
|---|---|
| Rolled products | 25 |
| Extrusion products | 10 |
| Foils | 5 |
| EC grade wire rods | 100 |

3. Aluminium-silicon plant for BALCO

A feasibility report for setting up the plant with a capacity of 90,000 tons per year was prepared in 1980 by VAMI of the Union of Soviet Socialist Republics in collaboration with Indian Rare Earths (IRE) with UNIDO assistance. Production of the alloy was envisaged through the electrothermic process using sillimanite concentrate available as a by-product of mining of ilmenite from beach sand. Subsequently, a techno-economic evaluation was done by VAMI in 1983 for the plant down-scaled to 30,000 tons per year. The plant is now slated to be implemented by NALCO at Angul in Orissa by 1988-1989. The investment would be of the order of Rs. 390 million.

4. Gandhamardan bauxite project of BALCO

Gandhamardan bauxite deposits are located at Sambalpur and Bolangir districts of Orissa. Presently, BALCO is developing a 600,000 tons per annum mine in this deposit at an estimated cost of Rs. 526 million. The project was scheduled to be completed by October 1986. The bauxite will be transported to the Korba alumina plant through ropeway and railways.

5. Captive power plant for BALCO

Inadequate power supply from Madhya Pradesh State Electricity Board has hitherto resulted in underutilization of installed capacity of the Korba smelter. BALCO has, therefore, decided to set up a captive power plant of 270 MW capacity. The project is under implementation. The likely cost of the project is of the order of Rs. 4,212 million.

6. Balancing facilities and replacement need for BALCO

(a) Korba unit

For fuller utilization of capacity of 100,000 tons per year of smelter, 35,000 tons of properzi rods, 40,000 tons of rolled products, 7,000 tons of extruded products, and the balance of 18,000 tons as ingots, the following balancing facilities need to be installed at Korba:

(i) Augmentation of facilities to generate steam required for alumina plant;
(ii) Modification of leaching process to suit the characteristics of bauxite available from the Gandhamardan mine;
(iii) Provision of additional cold rolling units to match the hot rolling mill;
(iv) Installation of slitting-cum-rewinding line to meet the market demand of low weight spoolless coils.

Metallurgical and Engineering Consultants (India) Limited (MECON) is presently engaged in carrying out a comprehensive study of these aspects.

(b) Bidhan Bagh unit (Erstwhile ALUCOIN, Jaykaynagar, West Bengal)

It has been decided to activate the semi-fabrication facilities of the unit (which has been closed for the last 15 years). To improve the financial performance of the unit as a whole, it is proposed to provide facilities like dieshop, homogenizing furnace, etc. in the extrusion plant. The foil plant which was set up later than the other fabrication facilities is in good condition.

7. Research and development in BALCO

Augmentation of facilities in the Research and Development Section of Korba is planned for development and testing of sophisticated aluminium alloys and semi-fabricated products for defence and strategic purposes.

Proposals are under consideration for demonstration units for:

(i) energy conservation in rotary calcinar for alumina;
(ii) utilization of red mud; and
(iii) production of first grade aluminium.

Preliminary action for these proposals have been completed through UNDP and UNIDO assistance.

8. New scheme of BALCO

(a) Andhra aluminium project

A feasibility report for setting up an alumina plant in Andhra Pradesh with an annual capacity of 600,000 to 800,000 tons was prepared by the Union of Soviet Socialist Republics in 1980. Subsequently in 1982 it was modified to include an export-oriented bauxite mine of 2.3 million tons per year to supply the required mineral to the alumina plant. The project, emerging on the basis of discussions, hitherto envisages development of a 2.3 million tons per year bauxite mine in Andhra Pradesh for export of bauxite to the Union of Soviet Socialist Republics on a long-term basis. Later an expansion of the bauxite mine to 4 million tons per year, and setting up an export-oriented alumina plant with a capacity of 600,000 tons per year is planned. The project is yet to be implemented.

The estimated cost for the total project comprising the export-oriented mine and the alumina plant along with railway and port facilities etc. is likely to be of the order of Rs 8,000 million. This project is considered as a potential Seventh Plan project subject to financing arrangements and agreement on long-term export of alumina to the Union of Soviet Socialist Republics at an acceptable pricing formula.

(b) Expansion of Korba plant

BALCO plans to initiate action to expand its smelter capacity by 25,000 tons per year at a cost of Rs. 550 million.

9. Gujarat alumina plant

M/s. ALUTERV-FKI of Hungary prepared a feasibility report in 1979 for the establishment of an alumina plant of 0.3 million tons capacity based on Kutch deposits in Gujarat. Location of alumina in the Kandla Free Trade Zone will cost Rs. 1,580 million and at Devpar location about Rs. 1,670 million. GMDC wanted the alumina produced to be toll-smelted by M/s. Hungarian Alumina Corporation. The establishment of the project depends on satisfactory financing of the project and buy-back at a mutually satisfactory price.

10. Aluminium Research Development and Design Centre

The existing aluminium industry in the country is based almost entirely on foreign know-how. Though a certain amount of research and development work on various technological issues is being carried out by the aluminium industry as well as certain research laboratories, a co-ordinated effort in research and development would be essential to attain self-reliance in the alumina and aluminium technology for the development of the aluminium industry.

A preparatory project report for setting up a centre has been prepared by ALUTERV-FKI assisted by MECON. UNIDO has rendered all assistance for preparation of this report. The estimated cost for the centre is Rs. 490 million.

11. Ratnagiri aluminium project

The Ratnagiri aluminium project with a capacity of 50,000 tons per annum was sanctioned by the Government in April 1974, at a total cost of Rs. 748 million. However, because of financial constraints, implementation of the project could not be undertaken.

12. Investment in the private sector

Information in respect of future investment in the private primary sector is shown below:

| | HINDALCO | INDAL | MALCO | Total |
|---|---|---|---|---|
| | | (Rs. million) | | |
| New capacities/expansion of capacities | 950 | 900 | - | 1,850 |
| Modernization and replacements | 450 | 240 | 10 | 700 |
| Total | 1,400 | 1,140 | 10 | 2,550 |

# THE NON-FERROUS METALS INDUSTRY IN THAILAND

## I. INTRODUCTION

Thailand produces about thirty different non-ferrous minerals and gem stones in commercial amounts. Of those refined locally by far the largest production of metal comes from Zinc, - 62,108 tons ingot in 1985. Tin, which will be discussed separately below, had a production of 17,996 tons of metal in 1985; lead 7,536 tons ingot and antimony 135 tons. In addition, 455 tons metallurgical grade and 3,930 tons battery grade manganese were produced in 1985. Other minerals such as columbite, ilmenite and wolfram were also found and in some cases produced.

The commercial production of almost all these minerals, except tin, is comparatively recent, reflecting Government policy over the past ten years both to increase foreign exchange from minerals production and to gain a greater value added from refining. Tin and gold on the other hand, have both been mined for centuries, although at present the gold deposits are not being formally worked. The very large output of zinc - 276,909 tons of ore in 1985 - comes only from one mine in the Mae Sot District, Tak Province. This mine and its associated processing plant was first opened in 1984.

The impact of Export Controls established on Tin from 1983 by the International Tin Council (ITC) resulted in the closure of many mines over the following years. This had a knock-on effect on the output of associated metals. Production of columbite-tantalite fell from 549 tons in 1983 to 477 tons in 1984 and to 268 tons in 1985. Ilmenite production fell from 205 tons in 1983 to 148 tons in 1984 with no production at all in 1985. Production of columbite-tantalum was more erratic having risen from 10 tons in 1982 to 275 tons in 1983. It then fell to 30 tons in 1984 with, like ilmenite, no production in 1985. The collapse of the international tin market in October 1985 and the consequent further closure of almost half the tin mines has led to the virtual cessation of associated minerals production.

Much emphasis has been given in recent years to accelerating development of energy minerals, petroleum, natural gas and coal, to reduce the burden of oil imports. Mining ventures yielding ores utilizable by local industry have also been given Government encouragement. For example, 1,273,459 tons of gypsum (used by the construction industry) and 104,586 tons of feldspar (used in ceramics) were mined in 1984. However, it was tin that dominated in value the non-ferrous metals sector. At the time of imposition of Export Control, tin comprised more than 80 per cent of income from Thailand's entire ore exports, and contributed about US$300 million to foreign exchange. Thus, the relative newness of much non-ferrous metals mining, and the important and long established place of tin mining both in the economy and in international affairs has made us focus our analysis of the non-ferrous sector basically on that mineral.

## II. EXPLOITED MINES

The mining activity in Thailand has demonstrated that it has 97 per cent of recoverable deposits which lie in places derived from the weathering of tin lodes. These are mainly found along the western side of the country. There are also extensive offshore deposits derived from residual tin concentrations following shredding of material from the submerged granite ridges. Mining is undertaken by dredge, both on and offshore, by suction boat, by gravel pumping and hydraulicking, by ground sluicing and dulang washing (panning). There was one underground mine - Sichon Mine, owned by Fairmont State Ltd. - in 1983 producing tin and tungsten. Before the ITC collapse there were 513 tin mines - mainly in the Southern region - and 183 tin/tungsten mines (see Table 25).

The production relationship between the different types of mining operation has changed over recent years. In 1981, suction boats accounted for 32.9 per cent of production, gravel pumping for 31 per cent and dredging for 16.4 per cent (11.7 per cent offshore, 4.7 per cent inland). By 1985 the percentage of production from suction boats had declined to 15.9 per cent whilst gravel pumping had risen to 33.4 per cent and dredging to 22.5 per cent (15.9 per cent offshore, 6.6 per cent inland). Overall production had itself been falling over those years from 42,968 tons of concentrates in 1981 to 23,022 tons in 1985 (see Tables 26 and 27).

These figures do not portray the whole picture. There is in Thailand a sizeable informal mining sector. Most of these are shallow water operations, either suction boat or simply diving rafts, but some work the waste deposits of inland dredges. Gold mining, mainly panning, is also done informally inland. Much of the output was previously 'laundered' through the registered tin mining companies. This practice was curtailed with the imposition of Export Controls and the informal sector had to seek new outlets. Tin from the informal mining sector of Thailand formed a very substantial amount of the 11,000 tons of smuggled concentrates that reached the market in 1984. Thus, some of the decline in suction boat operations in the official statistics may have been more apparent than real.

However the overall decline in tin mining is real enough. Since the collapse of the tin market over 50 per cent of mines are estimated to have closed. Numbers of workers officially employed have fallen from 46,411 in 1981 to 30,118 in 1985 and continued to fall thereafter. Moves to lower the Tin Royalty rate in December 1985 helped the beleagured industry, as has the more recent upturn in price, but the shrinkage has occured nonetheless. The informal sector has also declined. In 1979 when tin prices reached an all time high there were an estimated 4,000 boats whereas now there are only a few hundred.

The decline in mining has had a knock-on effect for the subsidiary industries linked to tin mining. These backward linkages are mainly in the form of small foundries and light engineering operations, making and repairing mining equipment, machinery and spare parts. The bulk of engineering production for the mining industry is in the hands of these locally owned firms. These local workshops are helped by there being a small import duty on engineering goods. The only significant imports are of specially commissioned new offshore dredges. Such commissions have not been recently made. Suction boats are made locally. The other main backward linkage is for fuel consumption. Onshore dredges use electricity, offshore dredges and gravel pumps use mainly diesel. Here too there has been a decline.

Table 25. Number of active tin mines by province

Tonnes

| | 1981 | 1982 | 1983 | 1984 | 1985 |
|---|---|---|---|---|---|
| Northern Region | | | | | |
| Chiang Mai | 3 | 5 | 4 | 1 | 2 |
| Chiang Rai | 4 | 10 | 5 | 1 | 2 |
| Lampang | 2 | 2 | 3 | 3 | 3 |
| Tak | 2 | 3 | 2 | 2 | 1 |
| Uthai Thani | 1 | 6 | 7 | 5 | 11 |
| Central Region | | | | | |
| Kanchanaburi | 20 | 25 | 28 | 37 | 38 |
| Phetchaburi | 1 | 2 | 2 | 3 | 2 |
| Prachuap Khiri Khan | 21 | 24 | 15 | 22 | 26 |
| Ratchaburi | 27 | 33 | 36 | 28 | 26 |
| Rayong | 2 | 2 | 2 | - | - |
| Southern Region | | | | | |
| Chumphon | 21 | 26 | 24 | 24 | 21 |
| Krabi | - | 1 | 1 | - | - |
| Nakhon Si Thammarat | 8 | 9 | 7 | 8 | 7 |
| Narathiwat | 3 | 6 | 3 | 2 | 3 |
| Pattani | 3 | 3 | 2 | 3 | 3 |
| Phangnga | 47 | 56 | 49 | 49 | 50 |
| Phuket | 40 | 44 | 51 | 46 | 52 |
| Ranong | 47 | 46 | 49 | 47 | 43 |
| Songkhla | 26 | 34 | 32 | 26 | 22 |
| Surat Thani | 20 | 23 | 22 | 21 | 26 |
| Takua Pa | 113 | 153 | 136 | 134 | 123 |
| Trang | 31 | 28 | 31 | 33 | 28 |
| Yala | 19 | 24 | 24 | 20 | 24 |
| Total | 461 | 565 | 535 | 515 | 513 |

Source: DMR.

Table 26. Production of tin concentrates by mining method

| | Tonnes | | | | |
|---|---|---|---|---|---|
| | 1981 | 1982 | 1983 | 1984 | 1985 |
| Dredging Inland | 1,993 | 1,728 | 1,495 | 1,845 | 1,531 |
| Offshore | 5,036 | 4,915 | 4,175 | 5,086 | 3,663 |
| Suction Boat | 14,145 | 9,830 | 5,467 | 7,240 | 3,661 |
| Gravel Pumping | 13,330 | 10,710 | 7,893 | 8,797 | 7,682 |
| Hydraulicking | 211 | 216 | 286 | 269 | 322 |
| Ground Sluicing | 1,330 | 1,290 | 922 | 662 | 430 |
| Others | 5,252 | 5,126 | 4,839 | 4,940 | 4,521 |
| ..... Washing | 1,671 | 1,829 | 2,148 | 1,140 | 1,212 |
| Total Production | 42,968 | 35,644 | 27,225 | 29,979 | 23,022 |

Table 27. Production of tin concentrates by off-shore dredging: Southern region

| | 1981 | 1982 | 1983 | 1984 | 1985 |
|---|---|---|---|---|---|
| Phangnga | 2,953 | 3,124 | 2,306 | 3,079 | 2,232 |
| | 11,524* | 6,962* | 2,994* | 3,427* | 1,639* |
| Phuket | 1,832 | 1,619 | 1,521 | 1,637 | 1,321 |
| Takua Pa | 251 | 172 | 348 | 370 | 110 |
| | 2,621* | 2,865* | 1,470* | 3,813* | 2,022* |
| | 5,036 | 4,915 | 4,175 | 5,086 | 3,663 |
| Total | 14,145* | 9,827* | 5,464* | 7,240* | 3,661* |

* Suction Boat.

## III. PROCESSING OPERATIONS

### 1. Smelting and Refining

The international location of smelting activity has changed over the past 25 years. During the colonial period, concentrates were sent to the British and Western European smelters. Only Malaysia, where two smelters had been established before World War I, was an exception. By 1977 all the South East Asian tin producers had achieved self-sufficiency in smelting, with additions to capacity being made in 1978-1981.

Apart from the period of Japanese occupation, all tin concentrates had gone to Malaysia for smelting. In 1965, the American company Union Carbide began construction of a smelter in a 70/30 partnership with a Thailandese company. The Thailand Smelting and Refining Company (Thaisarco) opened on the island of Phuket with an initial capacity output of 25,000 tons of tin metal per annum. All Thailand miners were required to deliver their ore to Thaisarco, and since then very few concentrates have left Thailand. In 1970 the owner of the Thaisarco company sold its share to the Dutch company Billiton NV. At the same time Billiton bought a 20 per cent interest from Union Carbide so that the two foreign concerns had a 50/50 share.

After the change of Government in 1973, Union Carbide left Thailand in 1974. The following year the Government revoked Thaisarco's monopoly on smelting and gave permission for two new local smelters to be constructed. These were to have a total projected capacity of over 12,000 tons per annum. Both are owned by Thailand companies, Thai Pioneer and Thai Present. However, a subsidiary of the German TNC Metallgesellschaft has constructed the Thailand Pioneer smelter. By 1986, with the opening of the Sutin Seja Wongse and the Liang Ngiab Co operations Thailand had five smelters of which Thaisarco remained the biggest with an increased capacity of about 35,000 tons. All are currently working under capacity.

Most recently, there has been an attempt to open a Tantalum processing plant at Pukhet. Thailand has the largest known resources of tantalum mostly recoverable from tin slags after smelting. Tantalum from tin slags in Thailand account for as much as 30 per cent of total world tantalum production. It is estimated that approximately 5 million pounds of tantalum is potentially recoverable. The plant, using technology from the Federal Republic of Germany and costing US$90 million, was expected to come into production in 1986. However, there has been strong opposition, basically on the location of the processing plant, near to the tourist centres of Pukhet. Another argument against the establishment of the plant is related to the environmental implications arising from tantalum processing. At present, it appears that the plant may be relocated.

Local development of smelting has not been yet significant to strengthen the control of the internal forward linkages. Smelting adds only about 1 to 5 per cent of output value of alluvial mining, but it saves about 25 per cent weight in shipping.

## 2. Users of Production and Exports

Domestic consumption of tin metal in Thailand is very low. In 1985 it was only 640 tons. Consumption has fallen from 784 tons in 1981 to 705 tons in 1982 and 703 tons in 1983. There was a sudden increase to 870 tons in 1984. Domestic consumption by tin producing countries overall is very small. Indeed of the seven countries who are members of ATPC per capita consumption is only 0.019 kg which is less than many single industrialised countries. The United States of America for example consumed 0.17 kg per capita tin in 1984 and Japan 0.27 kg.

Thailand exported a total of 17,359 tonnes of tin metal in 1985 with a value of Baht 5,462.1 million. The Netherlands was the principle importer. The United States of America was the second largest importer, importing 6,218 tons in 1985, and Japan the third with 3,879 tons. Exports have declined markedly, and have more than halved over the past five years from the 32,007 tons exported in 1981. This decline reflects the decline in demand consequent upon the recession in the industrialized nations; the cutbacks and crisis within the ITC and the concomitant decline in Thailand's mining productive capacity.

In addition to tin metal Thailand exports a variety of smelting by-products, such as slags, roaster tin dust, tin dross, etc. Exports of slags follow no clear pattern although there has been a dramatic decline of final slag exports to the USA which had been a large importer. In 1981 2,043 tons of final slag was exported to the USA. This rose to 2,344 tons in 1982, fell to 1,577 tons in 1983, to 417 tons in 1984 and was only 28 tons in 1985. The Federal Republic of Germany has been the only other significant destination for exported tin slag. In addition, in 1984 and 1985 there were exports of 391 tons and 1,352 tons of tin dross to the United Kingdom. Mexico imports a (decreasing) amount of roaster tin dust and in 1983 and 1984 also imported small amounts of Furnace Brick containing tin. The Federal Republic of Germany and the United Kingdom also imported Furnace Brick, although the United Kingdom imports ceased in 1985.

Thailand also exports a small amount of tin/lead alloy. Singapore has consistently been the largest importer of this, although the 625 tons imported in 1984 had fallen to 490 in 1985. The USA imported only 18 tons in 1984 but 706 in 1985. Other destinations include South Korea (165 tons in 1985), Japan (162 tons) and Taiwan (109 tons).

## IV. ANALYSIS OF MAIN ACTORS

### 1. Government: structure and policies

The Government of Thailand is committed to the development of the mineral industry through the private sector. Policy and legislation is administered through the Department of Mineral Resources (DMR) which also provides technical assistance for the conduct of mining operations, and, where necessary initiates mining ventures. There are two state mining enterprises, the Mines Organization and the Offshore Mining Organization. These carry out their own operations in the same manner as the private sector and are meant to have no special privileges whatsoever.

The Department of Mineral Resources is a department of the Ministry of Industry. It is responsible for the administration, promotion and developemnt of the mineral industry of Thailand. The scope of its work includes conducting geological surveys; technical research on mining technology, mineral benefaction and metallurgy; exploration and development of ground water and research and analysis of mineral fuels. Detailed exploration and development of accessible mineral resources are left to the private sector. The Department of Mineral Resources grants prospecting licenses and mining leases. It enforces the mining laws and regulations and collects the royalties levied on minerals produced in the country.

The Department was first established in 1891 as the "Royal Department of Mines and Geology", but, despite the title, little geological work was done, the main function being the granting of mining concessions in the southern tin fields. Qualified geologists and mining engineers first joined the department in 1938, but these were few. It was not until 1942 that a Geological Survey division was created. Today, the Department of Mineral Resources employs a total of 4112 persons of whom 181 are geologists and 127 engineers. The administration of the department is divided into three: the central administration in Bangkok, the provincial administration and four regional centres.

The policy guidelines issued by the Department of Mineral Resources for the mining sector in 1978 and 1982 emphasised the importance of accelerated development of economic and export-oriented mineral resources to attract more foreign exchange. The need for increased domestic processing of mineral exports was also stressed. To achieve these ends, foreign capital and expertise were to be encouraged and used. A Mineral Resources Development Corporation was to be set up to facilitate joint ventures between foreign investors and local partners, as well as helping small and medium-sized miners with the development work necessary to obtain loans or credit.

In 1983, a new institution, the Council of Mines was established. This body was to complement and supplement the work of the Department of Mineral Resources and, as a private sector body, to be to some extent independent of it. The Department of Mineral Resources envisaged the Council exercising some degree of control over the industry to help enforce conformity to the laws and regulations, as well as acting as liaison for mines involved with other government departments.

2. International and regional organizations

Thailand co-operates with various international and regional organizations concerned with price stabilization, with the exchange of technology and for research and development. International memberships include the ITC and ATPC. Through ATPC, Thailand helps fund the International Tin Research Institute (ITRI) in London, United Kingdom, and the South East Asian Tin Research and Development Centre (SEATRAD) at Ipoh, Malaysia.

At the regional level Thailand is a member of the Asean Experts' Working Group on Minerals (COIME) and the Committee for Co-ordination of Joint Prospecting for Mineral Resources in Asean Offshore Areas (CCOP). In addition, the country also belongs to the Regional Mineral Resources Development Centre (RMRDC) at Bundung, Indonesia, which aims to promote economic co-operation among developing countries in Asia and the Pacific.

Locally, the Department of Mineral Resources (DMR) itself receives funding from the Belgian Government to help with a project for Promotion of Utilisation of Non-ferrous Minerals, and from the Canadian Government to help with training in aerial geological surveying. In addition, the various institutions of higher learning in Thailand such as King Chulalongkorn University, undertake research relevant to the non-ferrous metals industry.

3. Operation of TNCs

Despite the increase in local involvement in smelting, the bulk of tin smelting and marketing is still in the hands of Billiton/Royal Dutch Shell. Billiton is also active in mining and marketing other metals. Other TNCs, such as Metallgesellschaft are involved in smelting but on a minority holding/technical adviser basis. Billiton's superior position was clearly shown in 1985 when Thaisarco was active in the grey market and in arranging back-to-back dealings that enabled the Thailand industry to continue to sell its tin. At that time it was suggested that a formal trading market might be established at Pukhet, but this was largely hindered in late 1986 by the Kuala Lumpur Tin Market in Malaysia altering its rules to allow trading in Thailand and Indonesian tin. A small amount (10 tons) of Thaisarco tin was sold on the KLTM in January 1987. Full trading would require membership of the KLTM, a step to which Thailand agreed in principle in early 1987.

In the mining sector the Rio Tinto Zinc Corporation is present, via its subsidiary Pacific Tin in a joint venture with Thai nationals. This is the gravel pump Sierra Mining Company. A more significant presence is MMC, via its holding company Aokam Tin Bhd in which it has a 42.9 per cent interest. MMC, through the TASK group, operates important dredging mines as well as undertaking various prospecting ventures, for gold in the Toh Moh and Kabinburi areas and for tin in the deep water areas off Takuapa 1/.

Whilst TNC involvement in the non-ferrous metals industry of Thailand is likely to continue, it is unlikely to increase in size or power. There will continue to be interaction between TNCs and Thai mining companies and government mining organizations. However, the existence of local capital, growing local expertise, and a large number of small-scale formal and informal operations limit TNC scope. Also the growing horizontal co-operation among the Asean tin producing countries may make neighbouring MMC a more attractive long-term option than the mining TNCs of the industrialized world.

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1/ Fairmont State Ltd. which owns the Siamese Tin Syndicate dredge mines, the Bangun dredge mines and the Sichon underground mine is controlled by the

## V. ROYALTIES

The Government, as the sole owner of all minerals and natural fuels, benefits through taxation and through the system of royalty collection. Royalties on minerals are normally levied as a percentage of posted prices. Tin is an exception to this, with royalty levied at different rates on six parts of a posted price, based on the Penang/KL tin metal price. Royalty is collected on the actual tin content of concentrates producing 60 kilogrammes, assuming tin in concentrates is 73.4 per cent.

In addition to royalties, tin miners are subject to payment of a special fee at the rate of 5 per cent royalty paid for the tin concentrates produced. This special fee is kept by the DMR as an expense budget ostensibly for restoration of mined out areas, for use as local development funds in the mining provinces and for the prevention and suppression of offences prohibited under the Minerals Act.

There have been frequent complaints, both locally and from foreign investors, that the rate of royalty and taxation of the mining sector is too high. Whilst all miners everywhere raise this complaint from time to time, it can be said that Thai tin mine production costs are noticeably raised by the level of duty (Table 28). A recent example of this dissatisfaction occured in 1987. The German TNC Metallgesellschaft announced that it had decided to suspend its major lead/zinc exploration programme due to slowness of government response to its request for reductions in both royalty and business tax. Nonetheless, the government did respond to appeals from the tin industry following the price collapse of October 1985. Royalty rates below Baht 11,000 were substantially reduced from December (Table 29).

Table 28. Production costs in Southeast Asian tin mines
(M$/kg)

| Country | 1984 Operation costs | 1984 Export duty | 1984 total | 1985 Operation costs | 1985 Export duty | 1985 total |
|---|---|---|---|---|---|---|
| | | | dredges | | | |
| Malaysia | 19,58 | 6,42 | 26,00 | 17,5 | 0,95 | 18,45 |
| Thailand: | | | | | | |
| offshore | 15,31 | 9,16 | 24,47 | 16,38 | 5,45 | 21,83 |
| onshore | 20,53 | 9,16 | 29,69 | 18,85 | 5,45 | 24,30 |
| Indonesia: | | | | | | |
| offshore | 16,84 | 3,35 | 20,19 | 21,40 | 2,74 | 24,14 |
| onshore | 25,26 | 3,35 | 28,61 | 19,60 | 2,75 | 22,35 |
| | | | gravel pump mines | | | |
| Malaysia | 27,42 | 6,42 | 33,84 | 22,11 | 0,95 | 23,05 |
| Thailand | 23,62 | 9,16 | 32,78 | 22,74 | 5,37 | 28,11 |
| Indonesia | 33,10 | 3,35 | 36,45 | 27,73 | 2,75 | 30,48 |
| | | | underground mines | | | |
| Malaysia | 34,41 | 7,10 | 41,51 | 35,03 | 0,24 | 35,99 |
| Australia | 25,66 | 0,57 | 26,12 | 27,61 | 0,96 | 27,85 |

Source: ATPC

Table 29. Tin royalty rates effective 16 December 1985

| Price of Tin metal | | | |
|---|---|---|---|
| 0 - 3,000 | Baht | = | nil |
| 3,001 - 7,000 | Baht | = | 0.1% |
| 7,001 - 9,000 | Baht | = | 5% |
| 9,001 - 11,000 | Baht | = | 15% |
| 11,001 - 14,000 | Baht | = | 30% |
| 14,001 - 17,000 | Baht | = | 40% |
| 17,001 - 20,000 | Baht | = | 50% |
| above 20,000 | Baht | = | 60% |

Source: TMC.

## VI. LEGISLATION

The legislation governing prospecting and mining is the Minerals Act B.E. 2510 (1967) and its subsequent amendments, the Minerals Act (No. 2) B.E. 2516 (1973) and the Minerals Act (No. 3) B.E. 2522 (1979).

The Act applies to all minerals, including coal, oilshales, marble, metals, and slags obtained from metallurgical processes, rock, clay and sand. It does not include petroleum, water, salt efflorescence, and lateristic rock clay or sand.

Under the Act there are three types of prospecting licence that can be obtained:

- The Prospecting Atchayabat (PA). Is valid for one year and gives the right to prospect for minerals within a certain area. The area may cover a whole district (Amphoe);
- The Exclusive Prospecting Atchayabat (EPA). As its name suggests it gives exclusive rights. It is valid for one year. Onshore the area cannot exceed 20,000 rai (1=0.16 hectare), whilst offshore it must not exceed 500,000 rai. Anyone seeking prospecting rights for an area larger than that must apply for a:
- - Special Prospecting Atchayabat (SPA). For this the applicant must state the 'prospecting obligations', that is the amount of money to be expended each year of the validity of the SPA. The applicant may also suggest what special benefits there will be for the State should a SPA be granted. If at the end of each year the SPA holder has not fully complied with the prospecting obligations, then a sum of money must be paid to the DMR within 30 days, equal to the amount not yet incurred in that year. Should the SPA holder have incurred expenses in excess of the prospecting obligations, then the amount can be deducted from the subsequent obligations year. SPAs are valid for 3 years with possibility of renewal for a further 2 years. The holder of a SPA must commence prospecting within 90 days of receiving the licence and must report the results to the DMR every 90 days.

All these licences are issued by the Ministry of Industry, but applications have to be made through the Local Mineral Resources Office (LMO).

The mining lease - the PRATHANABAT - is also issued via the LMO. It is necessary to poduce evidence that the mineral desired to mine has been discovered or exists in the area applied for. Validity is for 25 years only. The area onshore must not exceed 300 rai, but offshore this is increased to not exceeding 50,000 rai. There are no limits to the number of Prathanabat that any one person can hold. A Provisional Prathanabat, valid for one year only can be issued to allow commencement of mining operations before the Prathanabat has been received.

In addition, the Minerals Act covers the issue of licences for the purchase, storage and transporting of minerals as well as for their dressing, smelting, selling and exporting.

## THE NON-FERROUS METALS INDUSTRY IN GUINEA

### I. BAUXITE ORES

The Republic of Guinea possesses approximately 60% of the world's highest-grade bauxite deposits. Its reserves are estimated at approximately 8 to 10 billion tonnes. According to the Guinean Ministry of the Economy, the reserves are as follows:

Table 1. Guinean bauxite reserves

| Site | Reserves (1000's tonnes) | Grade of ore Al2 03 | Si 02 |
|---|---|---|---|
| Boké (e) | 2000 | 58 to 62% | 0,8 to 11% |
| Fria (e) | 500 | 45 to 48% | 2 to 3% |
| Kindia (e) | 100 | 48 to 52% | 2 to 3% |
| Tougue | 4000 | 47 to 52% | 3 to 4% |
| Dabola */ | 1000 | 48 to 52% | 2 to 3% |
| Pita | 200 | 48 to 52% | 2 to 3% |
| Dinguiraye | 60 | 45 to 48% | 3 to 4% |
| Siguiri | 30 | 45 to 48% | 3 to 4% |
| Forecoriah | 10 | 44 to 47% | 4 to 5% |
| Gaoul-Aye Koye */ | 1300 | 58 to 62% | 0,8 to 1% |

(e) Presently exploited

*/ Projected

Guinea, with approximately half the Australian production of bauxite, but with a very high-grade ore (content) is the western world's largest exporter of bauxite. In 1983, out of an export total of approximately 25.6 million tons, Guinea exported 10.9 million, Australia 4.1 million, Brazil 4 million, Jamaica 3.1. million and Greece 1.4 million tons.

A comparison of the quality of Guinean bauxite with other sources of ore is given in Table 2.

Table 2. Comparison of bauxite ores from five sources

| Area | Ore grade % (Al2 03) | Silicon (Si 02) | Bauxite consumption per tonne of aluminium |
|---|---|---|---|
| Boké (Guinea) | 60 | inferior to 2% | 4 t |
| Weipa (Australia) | 58 | 5.5% | 4.5 t |
| Ver (France) | 50-52 | 7-9% | 5.3 t |
| Jamaica | 50 | 0.7-1.6 | 4.3 t |
| Kwinana (Australia) | 27-29 | inferior to 2% | 8.5 t |

Source: L'adaptation industrielle dans l'industrie de l'aluminium de première fusion. OECD. Paris, 1977. Quoted by GRESEA: Géopolitique de l'Aluminium, Bruxelles, 1983, p. 234.

## II. MINING AND PROCESSING ACTIVITIES. THE MAIN ACTORS

In 1948 and 1950, Guinean bauxite was shipped in small quantities to Alcan's Saguenay - Lac. St. Jean smelters in Quebec. Production continued until 1961 when installations were nationalized by the new Guinean Government which became independent in 1958.

During the colonial period, another important project had begun at Fria under the leadership of the French firm Pechiney Ugine. Although initiated in 1957 by colonial interests, by 1963 the site was controlled by an international consortium in which Olin Mathieson Chemical Corp. (U.S.A.) held the dominant place with 48.5% of shares; Pechiney Ugine, 26.5%; and the remaining shares were distributed among British Aluminium Co., 10%; Aluminium Industrie A.G. (Switzerland), 10%; and Vereinigte Aluminium Werke A.G. (Germany), 5%. Alumina production began in 1960, and reached 460,000 tonnes in 1962, representing 58% of the total value of Guinean exports.

In November 1961, the Government took possession of the Kassa and Boké sites from the private firm Bauxites du Midi (a 100 per cent subsidiary of Alcan). The project was to be taken up by Harvey Aluminium of Delaware.

Harvey's agreement with the Guinean Government, signed in October 1963, was to become the prototype for other sites. A semi-public corporation was formed, called the Compagnie des Bauxites de Guinée (CBG), in which the Guinean Government held 49% of shares, and the remaining 51% were divided among the private partners as follows: Alcan Aluminium Inc., 27%; Aluminium Company of America, 27%; Harvey Aluminium Inc., 20%; Pechiney Ugine, 10%; Vereinigte Aluminium Werke A.G., 10%; and Montecatini Edison, 6%. The operations at the Boké site began in 1973. All output was exported as raw bauxite and purchased in proportions reflecting the shares of the private partners.

The site of the Débélé in the Kindia area is operated as a joint project by the Soviet Union and the Guinean Government. The agreement signed in November 1969 set the price of the ore, and stipulated the following:

- the Guinean State is 100% owner of the capital of the resulting enterprise: OBK (Office des Bauxites de Kindia);
- the Soviet Union is responsible for the construction of the mine and the railway, and is to be reimbursed by receiving 50% of the ore extracted;
- a further 40% of the ore is destined to the Soviet Union according to the terms of a long-term trade or clearing agreement between the two countries (i.e. for the purchase of goods and equipment destined to OBK);
- the remaining 10% may be disposed of by the Government of Guinea on the markets of its choice. In fact, because of the integrated structure of western firms, this part goes almost totally to eastern European countries.

OBK is, therefore, the property of the Guinean Government. The initial investment of 85 million roubles was put up by the Soviet Union at an interest rate of 2%. The Soviet Union has subsequently committed new funds, most recently for mine, railway, and port improvements 1/.

Production began in 1974 and, although figures vary with different sources, output and exports have evolved approximately as follows:

Table 3. Production and exports of bauxite from OBK
(in tonnes)

| Year | Production | Exports |
|---|---|---|
| 1976 | 2,400,000 | |
| 1977 | 2,250,000 | |
| 1978 | 2,300,000 | |
| 1979 | 2,500,000 | 2,306,000 |
| 1980 | 1,800,000 | 1,884,000 |
| 1981 | 1,502,000 | 1,501,000 |
| 1982 | 2,375,000 | 2,444,000 |
| 1983 | 2,701,000 | 2,543,000 |
| 1984 | 3,000,000 * | 3,000,000 * |

* Estimate
Source: Bulletin de l'Afrique Noire, No. 1272, May 17, 1985.

1/ Mining Annual Review, 1985.

The Ayékoyé project in the Boké area, considered a priority of the former Guinean Government, would permit mining 9 million tonnes per year of very high-grade bauxite. Depending on the source of information, projections vary; but it is generally estimated that approximately 4 million tonnes of the total would be transformed locally into alumina, and the rest exported in the first phase of the project. In the second phase, depending on the source of information, the project would permit the production of not only 1,200,000 tonnes of alumina, but also between 75,000 and 150,000 tonnes of aluminium. The project is intimately linked with the development of new sources of hydro-electric power which is abundant in the area concerned. The resources of the Konkouré River were the object of studies during the colonial period by the French administration, and were subsequently kept secret after the break-off with France.

An agreement concerning the Ayékoyé project was signed in July 1976 creating the Société guinéo-arabe d'alumine in which the Guinean Government held 50% of shares in association with the Egyptian, Saudi Arabian, Kuwaiti, Iraqi, Libyan, and United Arab Emirates Governments. In August 1976 it was announced that Alusuisse would take part in the project. This participation was to be confirmed in 1977, and Alusuisse undertook a study of the Ayékoyé project at the request of its partners.

According to Guinean sources, the results of the Alusuisse study were favourable to the project [2/], but its scale created an important financial obstacle. As a condition for obtaining financial support, notably from the World Bank as well as from other donors, further studies were requested.

The $2.2 billion project was scaled down following new studies undertaken in 1981 by Sir Alexander Gibb and Partners (U.K.), and Bechtel of the United States. Capacity of the power station was to be halved to 375 Mw and the aluminium smelter to 100,000 tonnes from 150,000 tonnes [3/].

While it is difficult to obtain information concerning the results of the Bechtel studies, the project remained of sufficient interest for France's Pechiney Aluminium to sign a contract (November 1983) with the Guinean Government to update the feasibility studies by the end of 1984. At that time, if the results were positive, it was anticipated that production could start at the end of the 1980's [4/].

However, it is important to note that if the 1960's and 1970's the emphasis of the Guinean mining policies was on local transformation, events in the 1980's seem to have rendered this objective more and more remote.

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2/ Republic of Guinea, Ministry of Energy and the Konkouré, Project Intégré - Konkouré, June 1981.

3/ The Financial Times, May 11, 1984.

4/ Ibid.

In spite of the many studies mentioned above, the Konkouré hydro-electric scheme which would make possible the Ayékoyé smelter with a view of producing alumina and aluminium in Guinea, the Konkouré project has recently been set aside.

The Aughinish smelter, [5/] that began being developed in 1974 by Alcan Aluminium Limited (control of 40% of shares) [6/] initiated its production in 1983. However, production decreased in 1985 and 1986, and there is now discussion about the eventual abandonment of this extremely expensive project. The difficulties at Aughinish are invoked not only in an attempt to bring down the costs of fuel, but also to reduce the price of the bauxite it uses. In 1985, the companies operating Aughinish were seeking to reduce the payments made to the Guinean Government in respect of bauxite purchases from $35 to $25 per tonne.

Friguia's output and exports of alumina decreased after 1980. Table 4 shows the evolution of these two variables in the 1980's.

Table 4. Production and exports of alumina at Friguia

| Year | Production | Exports |
|---|---|---|
| 1980 | 692,000 | 715,000 |
| 1981 | 670,000 | 608,000 |
| 1982 | 530,000 | 540,000 |
| 1983 | 624,000 | 583,000 |
| 1984 | 551,000 | not available |

Source: Afrique-Industrie, September 1, 1984 (for 1980 to 1982)

5/ Annual capacity of Aughinish is 800,000 tonnes of alumina.

6/ Alcan's partners in the project were initially Billiton, of the Group Royal Dutch Shell (35%), and Anaconda, of the Group Atlantic Richfield (25%). The three associates formed Aughinish Alumina. In December 1981, Aluminium Co. of Canada bought the shares which were held by the present company, Alcan Aluminium Ltd, thus gaining control of 40% of the shares of Aughinish Alumina. In January 1985, when Alcan Aluminium acquired most of Atlantic Richfield's properties in aluminium, this included ARCO's 25 per cent stake of the Aughinish smelter.

The projected expansion of Friguia which would have doubled capacity from 700,000 to 1,350,000 tonnes has been set aside. However, in an attempt to improve the quality of the alumina produced, Friguia is to adapt its alumina refinery to produce an upgraded product using a modified version of the Bayer process.

The emphasis in the 1980's at Friguia has, therefore, been on modernizing existing capacity, improving quality of the alumina, and reducing costs rather than on expansion.

It is also important to mention that in 1984 Halco and the Guinean Government renegotiated some of the terms of the purchase contract for Boké bauxite. In return for greater flexibility to tonnages it is committed to take, Halco undertook the expansion of mine capacity to around 11 million tonnes per year 7/. During 1985 the proposed expansion which had, by then, been incorporated into the new Government of Guinea's national economic plan, was set aside by Halco.

With the Konkouré dam project set aside and, consequently, the setting aside of important new sources of hydro-electric power for local transformation at the Ayékoyé site, the abandonment of the projects of expansion at Friguia and of transformation and expansion at the Boké site, the issue of negotiations between the integrated transnationals (notably Halco) and the new Guinean Government has now changed. In an attempt to further cut costs, and in the context of a tightening of the international structure of the industry, the integrated transnationals are at present in a good position in the renegotiation of the Guinean bauxite levy.

## III. GUINEAN POLICY TO PROMOTE DOMESTIC PROCESSING

In an attempt to encourage the implementation of Guinean mining policy in favour of local processing, a new tax system on the export of raw bauxite was introduced in the mid-1979's. In order to understand the context in which those taxes were set, it is essential to recall that Guinean high-grade ore had been sold at far lower prices than bauxite from other sources since the 1960's, and that this situation continued during the 1970's as the tables below demonstrate:

Table 5. The price of bauxite exported to Canada
($ per long tonne)

| | 1964 | 1969 |
|---|---|---|
| Average price | 8.7 | 10.3 |
| Origin: Guinea | 4.6 | 5.2 |
| Origin: Guyana | 8.0 | 9.7 |

Source: B. Reysset, Le Marché mondial de l'aluminium, Caisse Centrale de Coopération économique, Services des études économiques et financières, avril 1974. Annexe XI. Quoted in Minerals Yearbook.

7/ Metal Bulletin, October 11, 1985, p. 15.

Table 6. Price in 1973 of a metric tonne of bauxite
(in dollars)

| | |
|---|---|
| Australia | 7.20 |
| Jamaica | 6.00 |
| Guinea | 6.00 |
| Guyana | 8.70 |
| France | 8.35 |
| Greece | 8.76 |
| Yugoslavia | 11.02 |
| U.S.A. | 13.95 |
| Dominican Republic | 10.52 |
| Sierra Leone | 7.35 |
| Turkey | 8.49 |
| Italy | 10.32 |
| Average | 7.60 |

Source: Annales des Mines, December 1975, p. 95.

From the above, it may be seen that Jamaica and Guinea were in a similarly disadvantageous situation in 1973. To redress this situation, Jamaica introduced a bauxite levy in the spring of 1974. In an attempt to encourage foreign partners to process local bauxite to alumina, Guinea introduced its levy on exports of raw bauxite and alumina in January 1975.

The Guinean export levy is linked to the international price of aluminium, and varies with the degree of transformation in such a way that the levy increases inversely with the degree of transformation. The schedule was set as follows: 8/

1. 0.50 per cent of the price of a ton of aluminium ingot per ton of bauxite with 45 per cent or less alumina content;

2. 0.55 per cent of the price of a ton of aluminium ingot per ton of bauxite with 46-50 per cent alumina content;

8/ Quarterly Economic Review, Senegal, Mali, Mauretania and Guinea, No. 1, 1975, p. 6.

3. 0.65 per cent of the price of a ton of aluminium ingot per ton of bauxite with 51-55 per cent alumina content;

4. 0.75 per cent of the price of a ton of aluminium ingot per ton of bauxite with 56 per cent or more alumina content;

5. 1 per cent of the price of a ton of aluminium ingot per ton of alumina.

While improving the situation slightly, the Guinean levy was very moderate: 0.5% to 0.75%, depending on the grade of ore compared with the 7.5% production levy introduced by Jamaica. Consequently, even after the introduction of its levy, the price of Guinean bauxite remained inferior to average prices in 1975.

Table 7. Average value of U.S. imports of crude and dried bauxite in 1975

| Port of shipment (f.a.s) | | Delivered to U.S. ports (c.i.f) |
|---|---|---|
| Australia | 8.79 | 17.57 |
| Dominican Republic | 18.84 | 21.74 |
| Guinea | 13.82 | 20.95 |
| Guyana | 18.88 | 33.19 |
| Haiti | 27.80 | 24.47 |
| Jamaica | 22.50 | 25.18 |
| Surinam | 21.44 | 28.56 |
| Others | 10.73 | 16.42 |

Source: "Bauxite and Alumina", by Horace Kurtz, Minerals Yearbook, United States Department of the Interior, Bureau of Mines. Preprint 1975, p. 7.

## IV. THE ECONOMICS OF NON-FERROUS METALS

The revenue in foreign currency obtained through mining activities and, in particular, from the bauxite sector, plays a central role in the Guinean economy. Moreover, it is the receipt of foreign currency which allows the Guinean state to accumulate public savings in currency, and to obtain the foreign loans which are essential to finance its investments. Any reduction of currency would, consequently, threaten the very basis of what is already a rather fragile economy. Without adequate revenue obtained with sufficient predictability, the only remaining solution of the Plan of National Reform left to the Government would be stringent austerity, stripped of the elements which are essential to improve the global economic situation. One could no longer expect economic growth/improvement in the population's living conditions, etc. There would be a very strong possibility that the Guinean state would be unable to meet its foreign obligations.

The income in foreign currency of the public sector, both current and forecasted, depends basically on the exports of bauxite and alumina and, more specifically, on the exports of the Compagnie des Bauxites de Guinée (CBG). Table 8 summarizes the public sector accounts, Table 9 the origin of State revenue in foreign currency.

Table 8. State revenue in foreign currency from the bauxite/alumina sector (estimated, in millions of $)

| | 1984 | 1985 | 1986 | 1987 |
|---|---|---|---|---|
| (1) Bauxite and Alumina Sector | 232 | 259 | 269 | 272 |
| (2) Total | 248.5 | 276.2 | 290.2 | 294.2 |
| (1)/(2) % | 93.4 | 93.8 | 92.7 | 92.5 |

Table 9. Origin of State revenue in foreign currency

(estimated, in millions of $)

| | 1984 | 1985 | 1986 | 1987 |
|---|---|---|---|---|
| CBG | | | | |
| - Bauxite levy | 113 | 124 | 130 | 132 |
| - Taxes on profits | 35 | 40 | 44 | 45 |
| FRIGUIA | | | | |
| - Bauxite levy and taxes on profits | 14 | 15 | 15 | 15 |
| OBK | | | | |
| - Debt paid in kind */ | 40 | 46 | 46 | 46 |
| - Revenue in roubles | 30 | 34 | 34 | 34 |
| DIAMONDS (15% of turnover) | 6 | 6 | 9 | 10 |
| GOLD | - | 0.7 | 1.2 | 1.2 |
| INDIRECT TAXES (in currency) | 4 | 4 | 4 | 4 |
| TAXES ON IMPORTS OF MINING SECTOR (5.6%) | 6.5 | 6.5 | 7 | 7 |
| TOTAL | 248.5 | 276.2 | 290.2 | 294.2 |

*/ Reimbursement in kind of debt to U.S.S.R.

Source: Programme intérimaire de Redressement National, op. cit. p. 65.

The revenue which accrues to the Guinean State through the activities of CBG comes from taxes on profits as well as from the bauxite levy which is directly proportional to the quantities exported. This levy represented $13.1 per tonne in 1984. Planning estimates had anticipated that the levy would be $12 per tonne as of 1986, which represented an important reduction in real value, if one takes account of inflation.

The suppression of the Guinean bauxite levy solely on the activities of the Compagnie des Bauxites de Guinée (CBG) would place the country in a difficult economic and financial situation. In 1987 the deficit of the balance of trade would reach 27 per cent of export revenue; the deficit of the current account balance 40 per cent: the overall negative balance would reach 38 per cent; and debt service, a ratio of 47 per cent.

## V. ALTERNATIVE STRATEGIES

For a short period covered by the First Economic Plan (1960-1963), there was an attempt to base development on a pattern of national accumulation, however this orientation was not sustained. During 1968 to 1970, and again in the 1973 to 1978 Five Year Plan, the initiative for growth was clearly placed in the hands of foreign resources.

The situation with which the new Government of Guinea was confronted after the political changes of April 3rd, 1984, was an extremely difficult one. The country was ill-equipped; the infrastructure (roads, communications, energy, buildings/housing, etc.) were in need of repair; agricultural production had deteriorated; the industrial sector was not at all well-developed and operating very much at under-capacity; and mining activities, the country's principal source of wealth, totally enclaved. Finally, the country was very indebted. The official public debt in 1984 (1.2 billion US$) and the arrears (200 million US$) represented approximately the value of the country's G.D.P. 9/.

Guinea, however, is not short of resources. As has been seen, it possesses very important mineral wealth (bauxite, diamonds, gold, iron); favourable climatic conditions, good soils for agriculture and raising cattle; fish and forest wealth; very important hydro-electric potential; and, finally, a young population, and a considerable number of trained people not only within, but also outside the country. The development of this potential will, however, entail considerable efforts of reorganization, restoration, and investment.

In an attempt to deal with the difficult situation, the new Government has adopted an interim Plan of National Reform (Programme Intérimaire de Redressement National 1985-1987). The Plan was drawn up under the auspices and assistance of international organizations (IMF, UNDP, the World Bank) all of which are very much involved with the Guinean planning process, both at the level of financing as well as in providing technical assistance.

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9/ The above description is taken from Chapter I, "The Economic and Social Situation in Guinea in 1985", Republic of Guinea: Programme Intérimaire de Redressement National 1985-1987. Conakry, November 1985.

The overall orientation of the Plan may be summarized by the following characteristics:

- an option in favour of economic liberalism;
- the reduction of the public service and the withdrawal of the State from productive sectors;
- a monetary reform accompanied by a devaluation;
- the realignment of salaries and prices in such a manner as to bring price changes more favourable to producers;
- a strong programme of investment which favours the restoration and repair of existing capacity before undertaking new projects which seek to extend capacity; the investment programme is centered around rural development, infrastructural development, and human resources.

The Government is well aware that the above reforms will not be easy to implement. To implement the investment programme, the critical aspects rest in the fluctuation of the foreign currency obtained from the exports of bauxite. This is due to the country's extreme dependence vis-à-vis revenue from bauxite.

The explanation of this situation is to be found in a complex set of factors - the most important among which are the country's historical and colonial heritage. A solution to this problem has, in fact, been proposed. Other sources of currency exist and could potentially be made available through the export of bananas, pineapple, coffee, cocoa, livestock, etc. It is precisely this kind of a process of diversification which is the object of Guinea's most recent programme of investment with the far-reaching implications that this entails for the improvement of agricultural production and rural development. The implementation of a more diversified export programme will, however, necessitate years of investment and effort. To interrupt the programme at this stage, and to disorganize the public accounts to the extent entailed by the suppresion or a reduction of the bauxite levy would be to ensure that the country remains in a state of total dependence vis-à-vis its mining sector.

# THE NON-FERROUS METALS INDUSTRY IN ZAMBIA

## I. MINING

Several minerals are produced in Zambia, the principal ones being copper, cobalt (a by-product of copper mining), lead, zinc and coal. Production data for these minerals for the year 1964, 1974 and 1984 are presented in Table 10, from which it is apparent that the Zambian mining industry is dominated by non-ferrous metals. In 1984 they constituted 84 per cent of the total value of mineral production and copper alone accounted for 80 per cent.

Table 10. Production of principal minerals: 1964, 1974 and 1984

| Mineral | Value (KZK)*/ | | | Volume (Ktons) | | |
|---|---|---|---|---|---|---|
| | 1964 | 1974 | 1984 | 1964 | 1974 | 1984 |
| Copper: | | | | | | |
| blister | 59286 | 42808 | - | 145.3 | 33.5 | - |
| electrolytic | 220576 | 833856 | 1224724 | 496.9 | 668.6 | 523.3 |
| Cobalt (tons) | 3006 | 9461 | 123061 | 1362.3 | 1964.0 | 3472.0 |
| Zinc | 10252 | 26375 | 49395 | 46.8 | 58.3 | 29.2 |
| Lead | 2290 | 8027 | 5923 | 13.2 | 24.5 | 8.8 |
| Coal | - | 7930 | 27930 | - | 809.5 | 510.6 |
| Other | 3357 | 7747 | 94592 | nap | nap | nap |
| Total | 298766 | 936205 | 1526625 | | | |

*/ Zambian Kwacha.

## II. PROCESSING OPERATIONS

All the non-ferrous metals are processed in their pure form before export to the world market. Further transformation beyond refining is minimal. About 2 per cent of copper production is transformed into rod before export and less than 1 per cent is used by the local market mainly in the form of wire and cable. Roughly 25 per cent of lead and 2 per cent of zinc production is consumed in the country.

A small quantity of tin is mined in the tin belt of southern Zambia from pegmatites and related eluvial placers. Reserves are estimated at 215 tons of cassiterite in widely scattered small deposits. It has been mined since 1935 and in 1983 production was 22 tons of cassiterite concentrate. Non-ferrous Metal Works Ltd. in Ndola produces a small amount of low grade tin metal for the manufacture of solder, but the quality is not high enough for tin plating.

1. Labour 10/

Non-ferrous metals account for 97 per cent of the total mining industry workforce and copper mining alone makes up 93 per cent. The non-ferrous expatriate labour force was 16 per cent of the total in 1964 and steadily declined to 3.1 per cent in 1984 and has further declined since then. This reduction came about principally due to a rapid increase in mining company in-house treining programmes since independence. In 1985 there were 105 Zambians undertaking training programmes overseas sponsored by Zambian Consolidated Copper Mines (ZCCM). The creation of the School of Mines at the University of Zambia in 1971 also increased the number of Zambian professionals in the mining industry.

Table 11. Employment: non-ferrous metals

| Year | Copper (cobalt) Zambian | Expat. | % | Lead/Zinc Zambian | Expat. | % | Total Non-ferrous | % Expat. |
|---|---|---|---|---|---|---|---|---|
| 1964 | 39203 | 7326 | 15.7 | 1828 | 490 | 21.1 | 48847 | 16.0 |
| 1968 | 43198 | 4845 | 10.1 | 2118 | 366 | 14.7 | 50527 | 10.3 |
| 1972 | 46245 | 4600 | 9.1 | 2175 | 295 | 11.9 | 53315 | 9.1 |
| 1976 | 53082 | 4060 | 7.1 | 2744 | 224 | 7.6 | 60110 | 7.1 |
| 1980 | 55258 | 2485 | 4.3 | 2593 | 123 | 4.5 | 60459 | 4.3 |
| 1984 | na | na | | na | na | | 58104 | 3.1 |

Sources: CISB, 1968-80. ZCCM, 1984.

## III. THE MAIN ACTORS AND THE PROCESS OF LINKAGES BETWEEN NON-FERROUS ACTIVITIES AND THE REST OF THE ECONOMY

In this chapter an analysis is made of the main actors in the different operations of the non-ferrous activities such as mining and processing (smelting, refining), the most important actors in transformation activities, as well as the main input suppliers.

The analysis of the main actors in the mining and processing operations draws a picture of the process of vertical integration between the non-ferrous operations; the analysis of the actors in the transformation operations underlines the connection between non-ferrous operations and the sectors that are end users of the final non-ferrous products; and the study of the main suppliers of inputs points out the linkages between the non-ferrous activities with those economic sectors producing the inputs.

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10/ Includes labour in mining

1. The main actors in mining and processing

ZCCM accounts for all Zambia's copper, cobalt, lead, zinc and pyrites production. The company is 60 per cent state owned via the state holding company Zambia Mining and Industrial Corporation (ZIMCO). The only significant minority shareholding is 27 per cent held by Zambia Copper Investment Ltd. which is owned by Anglo American and De Beers of South Africa via their subsidiary Minorco in Bermuda.

In 1982 Nchanga Consolidated Copper Mines and Roan Consolidated Mines were merged to form ZCCM. RCM and NCCM had been the major companies from the beginning of large scale copper mining in the early 1930's. Table 12 gives a financial summary of the company for the years 1971 to 1985.

In 1971 the long-term debt represented 7 per cent of total capital employed but with the fall in copper prices in 1975 this proportion rose to 20 per cent and the debt became increasingly foreign denominated. By 1985 91 per cent of the long-term debt was foreign, most of it in US dollars (58 per cent) and had increased to 30 per cent of capital employed.

Table 12. ZCCM: Economic and financial profile
(constant 1981 MUS$)

| Year 31:03 | Gross Sales | Capital Employed | Profit (pre tax) | Tax 1/ | Dividend | Debt 2/ | Interest Payments | Cost lb.Cu 3/ |
|---|---|---|---|---|---|---|---|---|
| 1971 | 935 | 757 | 404 | 200 | 102 | 50 | 1 | 84 |
| 1972 | 755 | 882 | 224 | 60 | 80 | 111 | 3 | 84 |
| 1973 | 936 | 1095 | 285 | 81 | 105 | 153 | 9 | 78 |
| 1974 | 1493 | 1217 | 775 | 477 | 172 | 183 | 11 | 71 |
| 1975 | 1161 | 1497 | 277 | 136 | 37 | 285 | 12 | 77 |
| 1976 | 859 | 1750 | (90) | (84) | 0 | 360 | 39 | 81 |
| 1977 | 1028 | 1511 | 83 | 54 | 0 | 314 | 42 | 67 |
| 1978 | 808 | 1296 | (75) | (48) | 0 | 244 | 40 | 60 |
| 1979 | 1116 | 1688 | 126 | 13 | 6 | 267 | 48 | 61 |
| 1980 | 1329 | 1715 | 284 | 112 | 29 | 234 | 39 | 68 |
| 1981 | 1312 | 1852 | 42 | (26) | 11 | 337 | 50 | 83 |
| 1982 | 1061 | 1714 | (186) | 3 | 0 | 502 | 72 | 85 |
| 1983 | 767 | 1332 | (97) | 4 | 0 | 465 | 47 | 68 |
| 1984 | 803 | 1057 | 55 | 54 | 0 | 442 | 64 | 66 |
| 1985 | 711 | 1549 | 55 | 55 | 0 | 467 | 56 | 61 |

1/ Tax paid or recovered. 2/ Long-term debt. 3/ US cents per lb Cu.

Note: for 1971-82 the US dollar Manufacturing Unit Value Index deflator was used and from 1983-85 the US GNP deflator was used.

Sources: Radetzki, 1985 (for 1971-82): ZCCM, 1985 (for 1983-85).

Although copper accounted for 85 per cent of ZCCM's sales revenue for the six months ending September 1985, its contribution to total profits was only 35 per cent (Table 4). Cobalt on the other hand, accounted for 12 per cent of total revenue but a massive 69 per cent of profits. The production of this by-product is therefore vital to the profitability of copper mining as a whole. Both lead and zinc are loss makers for the company even though Kabwe is one of the richest Pb/Zn mines in the world. Precious metals, principally gold, silver and selenium, were less than 0.5 per cent of costs but 4 per cent of sales (Table 13).

Table 13. ZCCM: profitability by metal
(for six months ending September 1985)

| | Total | | Copper | | Cobalt | | Lead | | Zinc | | Prec.Metals | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | MZK | % | MZK | % | MZK | % | MZK | % | MZK | % | MZK | % |
| Sales Revenue | 920.8 | 100 | 778.2 | 85 | 110.3 | 12 | 3.7 | 1/ | 20.9 | 2 | 7.6 | 1 |
| Cost of sales | 795.8 | 100 | 733.3 | 92 | 23.6 | 3 | 8.8 | 1 | 27.3 | 3 | 2.7 | 1/ |
| Profit (loss) | 125.0 | 100 | 44.9 | 35 | 86.7 | 69 | -5.1 | -4 | -6.4 | -5 | 4.9 | 4 |

| | KZK/ton | KZK/ton | KZK/ton | KZK/ton |
|---|---|---|---|---|
| Sales | 3.36 | 53.66 | 0.97 | 2.07 |
| Cost of Sales | 3.16 | 11.49 | 2.30 | 2.71 |
| Profit (loss) | 0.19 | 42.16 | (1.32) | (0.64) |
| Cost of Production | 2.97 | 10.21 | 2.16 | 2.39 |

1/ Less than 0.5%.

In terms of profit per ton cobalt was 42 KZK and copper 0.19 KZK, but lead is produced at a loss of 1,320 KZK/ton and zinc at a loss of 0.64 KZK/ton.

Source: ZCCM (unpublished).

## 1.1 Copper

In 1984 ZCCM had seven operating divisions, namely Nkana, Nchanga, Mufulira, Luanshya, Chambishi, Konkola and Kabwe. In April 1985 Kalulushi Division was dissolved and its mines were incorporated into Nkana and Nchanga divisions. Table 14 shows the copper ore treated and grade.

Table 14. ZCCM: copper ore treated and grade

| Year | Nchanga Mtcn | Nchanga %* | Mufulira 1/ Mton | Mufulira 1/ %* | Nkana Mton | Nkana %* | Luanshya 2/ Mton | Luanshya 2/ %* | Other Mton | Other %* | Total Mton | Total %* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1972 | 10.2 | 3.72 | 5.9 | 2.15 | 5.6 | 1.78 | 6.3 | 1.55 | 5.2 | 3.36 | 33.2 | 2.65 |
| 1974 | 9.8 | 3.45 | 7.1 | 2.17 | 5.5 | 1.66 | 7.1 | 1.38 | 6.4 | 3.04 | 35.9 | 2.46 |
| 1976 | 9.6 | 3.61 | 6.6 | 2.36 | 4.8 | 1.61 | 6.1 | 1.45 | 5.7 | 3.08 | 33.1 | 2.57 |
| 1978 | 9.1 | 3.34 | 6.3 | 2.31 | 4.2 | 1.55 | 5.7 | 1.55 | 5.9 | 2.78 | 31.2 | 2.46 |
| 1980 | 9.1 | 3.33 | 5.7 | 2.10 | 4.2 | 1.53 | 5.9 | 1.44 | 6.4 | 2.27 | 31.2 | 2.29 |
| 1982 | 9.8 | 2.85 | 5.7 | 1.86 | 4.1 | 1.47 | 6.0 | 1.41 | 6.4 | 2.29 | 31.9 | 2.18 |
| 1984 | 10.4 | 2.84 | 4.4 | 2.13 | 3.9 | 1.61 | 5.5 | 1.44 | 5.3 | 1.93 | 29.5 | 2.15 |
| %+ | 35.3 | | 14.9 | | 13.2 | | 18.6 | | 18.0 | | 100.0 | |

1/ Excluding slag. 2/ Including Baluba Mine.
*) % metal content; +) total production in 1984

Source: CSO, 1985.

Luanshya division: Luanshya is the oldest continuously operated Copperbelt mine. It started production in 1931 and had reserves of roughly 1 Mtons of contained copper in 1985. The ore is drawn from the Luanshya (Cu) and the Baluba (Cu/Co) ore bodies before being sent to the concentrator. In 1984/5 5.3 Mtons were milled with a recovery of 95.9 per cent, which included 2.4 Mtons of Baluba ore. In 1984/5 the smelter treated 205.8 Ktons of copper concentrates which produced 61.3 Ktons of blister. The smelter was scheduled to close in June 1986 as part of the general ZCCM rationalisation plan but will re-open in December 1986 while the Mufulira smelter undergoes repairs, before finally shutting down in 1987. The cobalt concentrates are railed to the Nkana or Chambishi Cobalt Plants. The blister from the smelter is sent to the Ndola refinery for electro-winning.

Mufulira division: Mining started in 1933. In 1984 it milled 4.4 Mtons of ore grading 2.13% Cu. The Division is self-contained comprising an underground mine, a concentrator, a smelter (electric furnace) and an electrolytic refinery. In 1985 reserves stood at 86.8 Mtons of ore grading 3.05% Cu, 42 per cent down on the 1975 reserves. In 1984-85 194.5 Ktons of concentrates were produced from 4.3 Mtons of ore grading 2.1% Cu. In the same year the smelter output was 141.1 Ktons of blister and the refinery produced 153.4 Ktons of high grade cathodes (excluding toll-refined production).

The Ndola Copper Refinery, which includes the precious metals recovery plant, is administered by Mufulira Division. In 1984-85 it produced 91.7 Ktons of cathodes and the Precious Metals Plant produced 21.1 tons of silver, 0.34 tons of gold and 19.5 tons of selenium from anode slimes.

Konkola division: this division is due to be dissolved under the 1986 rationalisation plan. Mining started in 1957, and although it is a high grade mine (3.8% Cu), mining costs are high as it is one of the wettest mines in the world and pumps about 400,000 cubic metres of water daily. In March 1985 reserves stood at 51.8 Mtons grading 3.82% Cu and in 1984/5 1.56 Mtons of ore were milled from which 93.2 Ktons of concentrate were produced (recovery rate of 86.2 per cent). These mainly go to the Nkana smelter.

Nchanga division: Mining started on the Chingola mine in 1939 and it is ZCCM's largest copper producer with the highest grade ores. It is also a significant cobalt producer. At the end of March 1985 reserves stood at 91.7 Mtons grading 3.92% Cu and 0.77 Co. The ore comes from both open pit (70%) and underground (30%) operations. In 1984/5 10.3 Mtons of ore grading 3.03% Cu were milled, producing 890.8 Ktons of concentrates (70% recovery).

The high grade oxide concentrates are railed to the Nkana smelter and the lower grade concentrates are treated at the Nchanga High Grade Leach Plant (HGLP) then electro-won onto cathodes. In 1974 the Tailings Leach Plant (TPL20 was commissioned to treat current tailings and some tailings from the old tailings dams. By 1984/5 it produced 75.1 Ktons of copper from 10 Mtons of tailings grading 1.24% Cu and the HGLP output was 30.7 Ktons from 485 Ktons of oxide concentrates grading 11.6% Cu (Table 14). The new Nchanga TLP3 plant will be commissioned in 1986.

Nkana division: Mining commenced in 1932 and in 1985 it had 81.7 Mtons of reserves grading 2.38% Cu and 0.14% Co. Nkana includes one concentrator (a second shut down in March 1986), a cobalt plant, a smelter, a refinery and an acid plant. In 1984/5, 3.8 Mtons of ore grading 1.55% Cu and 0.10% Co were milled by the sulphide concentrator from the three shafts at Mindola. The closed-down oxide concentrator used to treat ore from the open pits which have now closed down.

Chibuluma mine also comes under Nkana division. Mining started in 1959 on two ore bodies (two flanks of an anticline). In 1985 reserves stood at 8.8 Mtons (3.35% Cu, 0.23% Co) compared to 8.4 Mtons (4.58% Cu) in 1975 and in 1984/5 635 Ktons of ore grading 2.34% Cu and 0.15% Co were milled to produce 40 Ktons of copper concentrates and 33 Ktons of cobalt concentrates. Most of the concentrates go to the Nkana smelter and cobalt plant.

The Chambishi operation is under the juristriction of Nchanga Division for mining and under Nkana Division for the cobalt and acid plants. Mining will be suspended in 1987 but the plants will continue.

In 1984-85 the Nkana smelter treated 688.7 Ktons of concentrates grading 33.9% Cu to produce 214 Ktons of copper blister (anodes) most of which were refined by the Nkana refinery with some going to the Ndola and Mufulira refineries. Cathode production from the Nkana Refinery was 171 Ktons in 1984/5. In the same year the Cobalt plant treated 127.4 Ktons of concentrate grading 7.68% Cu and 2.29% Co producing 1,973 tons of cobalt and the Acid Plant produced 293.4 Ktons of sulphuric acid using sulphur from the smelter converters, cobalt plant off-gasses and roasting of Nampundwe pyrite.

1.2 Lead and zinc

Kabwe division: this mine used to be known as Broken Hill due to its similarity to the Australian deposit and is one of the highest grade lead/zinc mines in the world. Mining started in 1906 making it the oldest operating mine in Zambia. Lead and zinc are produced with silver as a by-product (about 3t/an). Table 15 shows the lead and zinc production.

Table 15. ZCCM: Kabwe Division
Lead and zinc: production profile

| Production | | 1972/3 | 1980/1 | 1981/2 | 1982/3 | 1983/4 | 1984/5 |
|---|---|---|---|---|---|---|---|
| Ore milled (Kt) | | 355 | 217 | 237 | 210 | 229 | 159 |
| Grade (% Zn) | | 21.8 | 17.6 | 20.2 | 25.0 | 23.3 | 22.8 |
| Grade (% Pb) | | 11.1 | 6.4 | 9.0 | 11.0 | 11.2 | 10.2 |
| ISF[1/] Lead Bullion | 34.2 | | 13.7 | 15.8 | 21.3 | 18.8 | 17.2 |
| ISF[1/] Zinc (Zn4Kt) | 32.0 | | 23.9 | 25.5 | 28.4 | 22.0 | 21.0 |
| EZP[2/] Zinc (Zn2Kt) | 23.8 | | 10.5 | 13.7 | 11.7 | 12.0 | 9.1 |
| Refined Lead (Kt) | 30.3 | | 10.0 | 11.4 | 15.2 | 11.6 | 10.3 |
| Labour, local | 2191 | | 2354 | 2330 | 2248 | 2113 | 2100 |
| expat. | 298 | | 120 | 110 | 104 | 77 | 74 |

1/ Imperial Smelting Furnace.
2/ Electrolytic Zinc Plant.

Sources: NCCM, 1973; ZCCM, 1982-85.

2. The main actors in transformation

2.1 Copper

The only significant refined copper consumer in the country is Metal Fabrication of Zambia Ltd. (ZAMEFA).

This company is based in Luanshya and started operations in 1970. It is 51% owned by INDECO (state), 15% by Phelps Dodge (US), 5% by Svenska Metallverken (Swedish), 9.8% by Amax Zambia (US), 9.8% by ZAMIC (AAC) and 9.4% by Continental Ore Resources Ltd. (local). Both Phelps Dodge and Svenska Metallverken provide management and technical services to the company, the former on the extrusion and rod section and the latter on the wire and cable section.

Copper consumption for 1986 is planned at 10 Ktons of cathodes and 80 tons of billets, representing about 2% of Zambian refined copper production. In-house manufacture of billets (both copper and brass) is under investigation as Nkana division plans to stop their billet production. This would require two new furnaces. They pay ZCCM the high grade LME price for copper minus the transport costs in Europe, estimated

at roughly 140 UKP/ton. They also consume about 300 tons per annum of aluminium billets and rod. Small amounts of tin are imported from Zimbabwe after local tin produced by Non-ferrous Metal Works proved to be unsuitable due to its low quality.

The bulk of their production is continuous cast copper rod (CCR), 90% of 8mm diameter, mainly for export. For this an Outokumpu continuous caster was acquired in 1983, which replaced the previous extruded rod process. Other products include copper cable and wire including telephone cable. Power cable is manufactured up to a limit of 3 KV, but the company plans to produce 11 KV by the end of 1987. About 130 tons of finished production, excluding rod, is manufactured monthly. Of this telephone cables make up 25% of production, power cables 60% and building wire 15%.

Almost all of their non-rod output is for the domestic market, although there is some export of telephone cables to the regional market, mainly to Malawi. CCR constitutes 98% of their exports and about 60% of their turnover.

Other production includes copper and brass shapes, flats, bars and rod, aluminium extrusions (pipes and profiles) and PVC pipes and ropes. They supply the mining industry with cables, trolley contact wire, PVC blasting wire and detonator cable.

The company has a tentative plan for increasing their aluminium products output by manufacturing complete irrigation systems. A winding wire project due to come into operation at the end of 1986, will initially produce wires with a diameter range of 0.2 to 0.9mm and will supply local motor winding needs, initially at the rate of 200 tons/annum, but the plant will have a capacity of 320 tons/annum.

The company has been trying to penetrate the regional (SADCC/PTA) market but with very little success. The main reason for this is that many of the cable consuming power projects in the region are financed by tied aid, but they have also lost open tenders to western countries, partly due the inability of the Bank of Zambia to offer competitive credit facilities. The regional market for copper semis was estimated at 21 Ktons in 1984 (Vingerhoets, 1985). This would seem to indicate that there is a substantial scope for expansion into this market, but it is limited due to the factors mentioned, plus the fact that several of the other states in the region have some copper semis manufacturing capability, especially Zimbabwe where the capacity is possibly superior to that of Zambia (Jourdan, 1985). In addition it appears that both countries are at present expanding their capacity with the regional market in mind. It would therefore be in the interest of regional integration if an organisation like the SADCC were to attempt to rationalise the production of copper semis and manufactures in the region.

ZCCM owns 50% of Société de Coulée Continue de Cuivre (SCCC) in France, a CCR producer, via its wholly-owned subsidiary in the UK, ZAL Holdings Ltd, which also owns ZES. The other 50% of SCCC is held by Thomson Brandt SA of France. In 1984/5 the total issued share capital of SCCC was 36 MFF and ZCCM's share of retained profits was 1.2 MZK from sales of 164.14 Ktons of CCR. About 60% of the rod is sold in France and the rest is exported.

2.2 Lead

Kabwe division produces lead sheet and extruded lead piping for the domestic market and production plans for 1986 include 1250 tons of sheet and pipe. In 1984/5 Zambian companies accounted for 25% of total sales of lead of 10.4 Ktons. The principal planned local customers for 1986 are Chloride Technical Products Zambia Ltd. (batteries), 1280 tons, and Simms Electrical and Diesel Services Ltd. (Tudor batteries), 120 tons, with sundry foundries and solder manufacturers accounting for 110 tons. Sheet sales are about 1200 tons per year, mainly to the ZCCM refineries and Kafironda explosives, as an acid resistant material.

2.3 Zinc

Local sales of zinc accounted for 3.3% of total sales of 30.3 Ktons in 1984/5. Zinc is sold in two grades: Zn2 (99.95%) and Zn4 (98.5%). Projected sales for 1986 of Zn4 are 357 tons of which 264 tons will go to Galco (Zambia) Ltd. (Chandaria Group) in Ndola, 60 tons to Monarch (INDECO) in Kitwe, both for galvanizing, and 33 tons to ZCCM as a sealant for cone crushers. The galvanizing market is highly dependent on sheet steel availability. Galco used to consume 900 tons a year before the restrictions on sheet steel imports.

Domestic sales for 1986 of Zn4 are projected at 1124 tons of which 400 tons will go to Mansa batteries (INDECO) for dry cell batteries, 88 tons to Pipeco (Chandaria) in Lusaka for galvanizing, 600 tons to Metoxide (Chandaria) also in Lusaka, for the manufacture of zinc oxide for paints and tyres, and 33 tons to assorted consumers including the non-ferrous foundries.

2.4 Tin

Non-ferrous Metal Works (Zambia) Ltd., in Ndola produce a small amount of low grade metal, mainly for the manufacture of solder for the local market.

3. The main actors in inputs production for the non-ferrous activities

Local production of inputs to the mining industry is fairly diversified. In general there exists a significant ability to manufacture locally a wide range of spares and equipment for the mining industry. The major constraint faced by the companies concerned is the shortage of foreign currency to import the necessary raw materials especially the various grades of steels, though this problem seems to have diminished somewhat recently since the introduction by the Bank of Zambia of the system for foreign currency tendering (auctioning).

ZCCM has extensive in-house repair and maintenance capabilities in the divisional workshops and several of the raw materials consumed by ZCCM are produced within the company, by a subsidiary of the company or by a subsidiary of its mother company ZIMCO. The same applies to pyrites mining at Nampundwe for the manufacture of sulphuric acid at the Nkana Acid Plant and the Kafue fertilizer plant. Lead sheeting for the electrolytic refineries is produced by Kabwe division and from in-house scrap.

The Ndola Lime Company. This is a ZCCM subsidiary and ZCCM is its major customer though it also supplies to Nitrogen Chemicals of Zambia (NCZ) Ltd., Zambia Sugar Co. Ltd. and the building and farming industries. In 1984/5 the company quarried 836.9 Ktons of limestone from which it produced 221.3 Ktons of quicklime and 14.9 Ktons of hydrated lime of which 7.3 Ktons were exported. An after tax profit of 1.6 MZK was made.

Copperbelt Power Company. This company, a subsidiary of ZCCM, maintains gas turbine alternator installations for emergency use with a capacity of 80 MW. Sales to the mining industry were 4191 million KWh in 1984/5, up to 1.6% on 1981/2.

Mpelembe Drilling Company Ltd., is another ZCCM subsidiary and was formed principally from Deep Drilling Ltd. (AAC). It does contract work for ZCCM mainly in the field of underground development, shaft sinking and exploration. In 1984/5 its turnover was 15.1 MZK, of which 10.5 MZK was from mining and 4.6 MZK from its drilling activities (ZCCM, 1985).

Zambia Engineering Services (ZES) Ltd. This ZCCM subsidiary is based in Great Britain and provides a wide range of engineering, procurement, construction and training services not only for the company but also for the Zambian government and other organisations through its subsidiary in Zambia, Technical Management Services of Zambia (TMSZ) Ltd.

Parts manufacturing facility: in 1984 ZES carried out a feasibility study for ZCCM on the creation of a factory for the manufacture of spares for the mining industry presently imported. This new facility will manufacture roughly 800 items that have a large turnover and are of medium to high value. It will employ approximately 700 workers (8% expatriates) and have an output of about 2.5 Ktons/annum of mainly spares to the mining industry but will be versatile in terms of taking on work for industry in general.

Circuit Holdings Ltd. This ZCCM subsidiary is the holding company for the Circuit group of companies which include Circuit Engineering and Tooling Ltd. in Kitwe. They produce integrated steels, drill bits and occasional crusher spares for the mining divisions. They make about 200 integral steels per day for which they have to import about 300 tons of special steels per year.

Another company belonging to this group is Circuit Construction Ltd., which contracts for major civil engineering projects mainly to the ZCCM mining divisions. In 1984/5 its turnover was 14.5 MZK.

Circuit Sawmilling and Joinery Ltd., is another Circuit subsidiary and its principal function is to supply sawn timber for underground supports and rail sleepers to the mining divisions. In 1984/5 they sold 21427 cubic metres of timber.

Scaw Ltd. This foundry is based in Kitwe and is owned by ZAMIC, an AAC subsidiary. It is basically an iron and steel foundry with some non-ferrous castings, usually from scrap. The foundry produces about 30 Ktons/an. of castings including 24 Ktons/an. of carbon steel mill balls. Their workshop machines castings to produce spares for both the mining industry and the general engineering sector. Their castings include carbon steels, abrasion resistant alloys, manganese steels and cast iron.

United Machining Works Ltd. This private Zambian company based in Chingola is probably the best machine shop in the country. It is mainly involved in heavy machining jobs and is the licensed manufacturer of Symons gyratory crusher components (USA) and P&H shovel parts (USA), but is capable of manufacturing complete crushers. It also has a small non-ferrous foundry for casting bronze and brass components usually from scrap.

Lutanda Holdings Co. Ltd., in Kitwe is a local company and has two subsidiary companies, Jung and Co. Ltd. in Kitwe, which does fabrication and machining, and Foundry and Engineering Ltd. in Luanshya. The foundry does ferrous and non-ferrous castings, mainly for the mining industry, generally using scrap. Most of the raw materials are local but reagents, ferrosilicon and mould coating are imported from Zimbabwe. The 1985 turnover was about 4.5 MZK and their main products in terms of revenue are cast iron 30%, bronze 40%, brass 5% and aluminium.

Mitchell Cotts Zambia Ltd., is a foreign company in the field of engineering contracting, mainly to the mining industry. They have recently diversified into mining spares (pumps and crushers) manufacture as ZCCM increasingly does its own contracting work. Of their manufactured products ZCCM accounts for 60% of sales and about 70% of imported spares.

There are several other companies supplying general engineering and foundry services to the mining industry. It should be noted that most of the repair and maintenance, and some spares manufacture for the mining industry are undertaken by the extensive engineering workshops of the mining divisions themselves.

Numerous other non-engineering companies also supply considerable inputs to the mining industry, for example, protective clothing and safety equipment, rubber products, etc.

Diacarb Division, Boart (Zambia) Ltd. is owned by Boart of the RSA, an AAC-DeBeers subsidiary and is based in Ndola. They are the sole manufacturers of diamond rock drilling bits for ZCCM and manufacture spares for drilling equipment. They also produce drilling accessories such as extension rods and tungsten carbide bits.

Kafironda Ltd. is 54% owned by INDECO and is based in Mufulira. It is the fourth largest explosives factory in the world and in 1984 it manufactured 22.5 Ktons of explosives (half nitro-glycerine based and half ammonium nitrate based), about one million detonators and 5.2 million capped fuses for the mining industry. The ammonium nitrate is supplied by Nitrogen Chemicals of Zambia, also an INDECO subsidiary.

From the preceding it is apparent that a substantial local capacity exists for supplying the necessary inputs to mining, but that this resource is underutilized due to the shortage of imported inputs to these industries, caused by the national shortage of foreign exchange, which is in turn caused by the rapid decline in the real value of copper over the last decade.

The single most important imported raw material shortage of this sector is iron and various grades of steels. A local iron and steel industry has been considered for the past twenty years and at one point was on the verge of being created, but the plan has now been adandoned. Attention is now being given to a regional facility based in Zimbabwe, but the problem of foreign exchange will remain as Zambia does not produce products to export to Zimbabwe to generate PTA credits, except for a limited amount of lead and zinc.

The inability of the mining inputs industries to supply the mining industry with a substantial proportion of its needs has resulted in the ZCCM needing to retain a large part of their foreign exchange earnings (about 40%) to finance imports of mining inputs in order to operate efficiently.

## IV. THE ECONOMIES OF NON-FERROUS METALS

The economy is heavily dependent on the mining industry. Although its contribution to GDP decreased from 42% in 1965 to 14% in 1984 it still generates 93% of exports and constitutes 15% of formal employment (Table 16).

Table 16. GDP by industry at current prices (MZK)

| Year | Total GDP | Agriculture | Mining | Manufacturing |
|---|---|---|---|---|
| 1965 | 649.9 | 8.2% | 42.3% | 7.3% |
| 1970 | 1185.3 | 7.2% | 36.8% | 10.4% |
| 1980 | 3063.6 | 14.2% | 16.5% | 18.5% |
| 1984 | 4733.3 | 14.7% | 14.0% | 20.9% |

Source: CSO, 1974 and 1985.

Declining copper prices over the last 5 years have put severe restraints on the economy. In real terms the price of copper has fallen 60% since 1970 and 41% since 1960. Zambia's real earnings from copper have fallen 65% since its independence (1964) and 689% since 1970.

Since the onset of the decline in mineral export earnings, Zambia's foreign indebtedness has increased considerably. Foreign disbursed debts in US dollars increased 460% between 1970 and 1984 while debt servicing as a percentage of total exports increased 470% over the same period. The buying power of the Kwacha decreased by 80% from 1970 to 1984.

## V. LEGISLATION

The laws governing exploration for, and exploitation of minerals are contained in Chapter 329 of the Laws of Zambia, namely the Mines and Minerals Act of 1976. This Act was principally drafted for large scale base metal mining. It was amended in 1984 specifically for small mining operations of industrial, precious and semi-precious minerals to include area charges (on prospecting and mining), utilization fees (on industrial mineral mining) and licence fees (flat fee per mineral mined).

Mining companies are liable for income tax at the company tax rate of 45 per cent of their taxable income. Mineral tax is not payable for the first five years of operation. In 1982 an equity levy was introduced at 1.5 per cent of the Government's shareholding in any parastatal company.

Repatriation of dividends to foreign shareholders is allowed, after the payment of withholding tax, at the rate of 50 per cent of after tax profits accruing to non-resident shareholders or 15 per cent of external paid up capital, whichever is the lesser. Foreign companies may borrow locally up to the amount that was brought into the country.

## VI. ALTERNATIVE STRATEGIES

The paramount role of the non-ferrous metals industry of Zambia has been as the capital generator and foreign exchange earner for the development of the rest of the economy. It has provoked virtually no downstream development of non-ferrous metal based manufacturing industries in its 55 years of existence. In 1985 over 98% of refined copper production was exported, while less than two per cent was further transformed in the country, of which about half was exported. The national and regional off-take of lead has been increasing over the last decade, but the lead reserves are almost exhausted. Local consumption of zinc is about 3% of sales, though sales to the east and southern African region have increased from 7.6% of total sales in 1983/4 to 31.3% in 1984/5.

From 1964 to 1974, during the period of relatively high copper prices, non-ferrous mining supplied the capital to support a rapid expansion in the manufacturing sector. It also generated the foreign exchange for the imported raw materials of those new industries. Due to the high copper earnings between 1965 and 1973 copper mining was able to support an average annual real growth rate of GDP of 3% and real per capita incomes increased by about 20% over the same period.

From 1975 copper earnings began to fall and the average annual growth of GDP from 1973 to 1983 was only 0.2%, a decrease of 93% on the preceding decade.

Falling terms of trade for copper over the last decade have caused the whole economy to stagnate, bringing into sharp focus the dangers of a development strategy based on raw material exports. The non-ferrous metals industry of Zambia is vertically integrated into the developed market economies rather than supplying the raw materials for local and regional industry.

The local and regional markets are clearly not large enough to absorb Zambia's total copper production even if all imported copper-based products were manufactured in the region. However, a significant increase in the production of copper semis and manufactures for export onto the world market would appear to be feasible based on the significant transport costs discount on the LME price for the copper inputs that would apply. The world market for finished copper-based products is more stable than that for copper.

An alternative role for the non-ferrous sector would be to provide the basis for a resource-based industrialization strategy. This strategy would entail first, the production of non-ferrous based products for the local market; secondly, the supply of metal inputs to the regional industries; and thirdly, the export of non-ferrous products to the world market. For copper, the local market could absorb about 2% of production, the regional market about 10% and if a further 40% of production could be transformed before export, it would leave only half of production to be exported as metal with declining terms of trade. For lead and zinc, a regional resource base industrialization programme would enable the absorption of the bulk of production, especially after the planned production cut backs (50%) in three years time.

Over the last decade there has been an alarming stagnation of the Zambian agricultural sector and the resultant drift to the urban areas of farmers. In 1974, cereal imports amounted to 93 Ktons but by 1983 this had risen 266% to 247 Ktons (World Bank, 1985). Maize was exported until 1976 (61 Ktons), but since then imports have had to be made to make up the shortfall. Tobacco exports fell 70% from 1973 to 1983 when 1.5 Ktons were exported (CSO, 1985). Average food production per capita decreased by 26% from 1974-76 to 1981-83, though admittedly the country was in the throes of a drought in the latter period (World Bank, 1985). The decline in agriculture has resulted in a movement of the rural population to the urban areas. By 1983 the urban population was estimated at 43% of the total, while at the same time earnings and employment in the urban areas have been declining.

The deterioration of the agricultural sector has been in part due to the fall in export earnings provoking a shortage of agricultural inputs, but it is also the result of low producer prices for agricultural commodities. Over the last three years producer prices have increased substantially in an effort to encourage production and at the same time real earnings of urban workers have been falling. Hopefully the combination of these two factors will halt and eventually reverse the drift to the urban areas.

Due to the extremely high dependence of the Zambian economy on non-ferrous metals mining, the restructuring of its economy must not only attempt to restructure the non-ferrous metals sector itself in terms of downstream processing, but must also develop the country's other major resource, agriculture, in order to balance what is presently a lopsided copper economy. Doing this within the present situation of chronic foreign exchange shortages and a massive foreign debt burden is going to be extremely difficult. A regionally integrated approach to the problem could well have a higher chance of success.

# THE NON-FERROUS METALS INDUSTRY IN ZIMBABWE

## I. MINING

Today a wide range of minerals are mined in Zimbabwe. In 1984 the most important in value were gold (Z$214.1 million) [11/], asbestos (Z$80.8 million), nickel (Z$59.7 million), coal (Z$58.3 million), copper (Z$33.8 million), chromite (Z$29.7 million), tin (Z$18.5 million), iron ore (Z$14.5 million) and silver (Z$9.0 million). The total value of mineral production in that year was Z$546.5 million, excluding quarrying and it contributed 8.0% of the GDP in 1983 (see Table 17).

Table 17. Mineral Production: 1975, 1979 and 1984

| Mineral | Value (thousand Z$)[1/] | | | Volume (Ktons) | | |
|---|---|---|---|---|---|---|
| | 1975 | 1979 | 1984 | 1975 | 1979 | 1984 |
| Gold (tons) | 31956 | 80912 | 214120 | 11.3 | 12.0 | 15.3 |
| Asbestos | 41701 | 65864 | 80778 | 261.5 | 259.6 | 165.3 |
| Nickel | 9121 | 45077 | 59704 | 9.1 | 14.6 | 10.3 |
| Coal | 18677 | 25843 | 58264 | 3300 | 3188 | 3109 |
| Copper | 24686 | 35149 | 33764 | 47.6 | 29.6 | 22.6 |
| Chromite | 22056 | 16139 | 29719 | 875.7 | 541.8 | 476.4 |
| Tin (tons) | 3971 | 9946 | 18510 | 997 | 967 | 1209 |
| Iron ore | 3033 | 7387 | 14532 | 1246 | 1202 | 925 |
| Other | 12144 | 28484 | 34713 | nap | nap | nap |
| Total | 177838 | 314801 | 546467 | | | |

The mining activities are largely in the hands of the mining transnational companies, the most important being Anglo American Corporation (AAC) of South Africa (nickel, ferrochrome and coal), Union Carbide Corporation of the United States (ferrochrome and gold), Rio Tinto Zinc PLC (RTZ) of the United Kingdom (gold), Lonrho PLC of the United Kingdom (gold and copper) and Turner Newall PLC of the United Kingdom (asbestos).

Since independence (1980) there has been a considerable increase of State participation in the mining industry. The state has the largest shareholding in coal mining (Wankie Cockery), though the AAC still provides management and technical services. The State also controls the iron and steel industry (ZISCO), and the mining (Kamativi).

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11/ Zimbabwean dollars.

In 1984 the newly formed State Mining Enterprise, the Zimbabwe Mining Development Corporation (ZMDC) bought out the local mining interests of the Messina (Transvaal) Development Company Ltd (MTD) of South Africa giving it control of most of the national copper production (Mhangura Copper Mines). The State also set up the Mineral Marketing Corporation of Zimbabwe (MMCZ), which handles all mineral and metal exports with the exception of gold, which is bought by the Reserve Bank of Zimbabwe.

## II. NON-FERROUS MINING, SMELTING AND REFINING

### 1. Production

The three non-ferrous metals produced in Zimbabwe are nickel, copper and tin. Due to the depressed prices of copper and nickel over the last few years there has been a contraction of these industries. Copper production has steadily declined from 52 Ktons in 1973 to 22.6 Ktons in 1984 (-56%), while nickel production has fallen from a high of 16.7 Ktons in 1977 to 10.3 Ktons in 1984 (-38%). Tin production, on the other hand, increased slightly from around 1000 tons/annually in the 1970s to 1200 tons in 1984, due to the increase in real price of tin until late 1985. Since the collapse of the International Tin Council (ITC), the outlook for tin mining in Zimbabwe is bleak.

Both copper and nickel production showed a slight increase from 1983 to 1984 in response to the marginally improved world market situation, but their longer term price decline is expected to resume in 1986.

Production volumes and values for 1945, 1950, 1955 and yearly for the period 1960 to 1984 are presented in Table 18. It should be noted, however, that until 1981 copper was mainly exported in the form of blister (the Alaska refinery opened in November 1980).

Table 18. Non-Ferrous metal production: 1960-1984

| Year | Copper Ktons | Copper Z$ (million) | Nickel Ktons | Nickel Z$ (million) | Tin Tons | Tin Z$ (million) |
|---|---|---|---|---|---|---|
| 1945 | 0.2 | * | - | - | 200" | 0.1 |
| 1950 | 0.1 | * | - | - | 105" | 0.1 |
| 1955 | 1.2 | 0.5 | 0.2" | * | 334" | 0.5 |
| 1960 | 15.1 | 5.1 | 0.1" | * | 724 | 1.0 |
| 1961 | 15.0 | 5.3 | 0.3" | * | 807 | 1.1 |
| 1962 | 15.2 | 5.5 | 0.4" | * | 795 | 1.4 |
| 1963 | 18.5 | 6.5 | 0.6" | * | 591 | 0.9 |
| 1964 | 16.5 | 8.3 | 0.8" | 0.1 | 520 | 1.3 |
| 1965 | 18.0 | 12.6 | 4.2" | 0.4 | 511 | 1.4 |
| 1966 | 16.0 | 13.7 | 4.0" | 0.5 | 689 | 1.7 |
| 1967 | 22.2 | 16.1 | 3.2" | 0.2 | 875 | 2.0 |
| 1968 | 21.0 | 15.1 | 0.3" | 0.3 | 928 | 2.0 |
| 1969 | 28.7 | 24.5 | 5.8 | 9.4 | 972 | 2.4 |
| 1970 | 30.0 | 24.8 | 8.6 | 15.5 | 1094 | 2.5 |
| 1971 | 34.4 | 20.5 | 9.3 | 16.7 | 1118 | 2.5 |
| 1972 | 46.5 | 25.8 | 10.1 | 17.7 | 990 | 2.2 |
| 1973 | 51.9 | 39.9 | 10.9 | 18.4 | 1138 | 2.5 |
| 1974 | 47.5 | 45.8 | 10.7 | 20.5 | 1089 | 3.8 |
| 1975 | 47.6 | 24.7 | 9.1 | 19.6 | 997 | 4.0 |
| 1976 | 41.3 | 29.5 | 14.6 | 35.2 | 915 | 4.9 |
| 1977 | 34.8 | 22.0 | 16.7 | 42.8 | 920 | 6.2 |
| 1978 | 33.8 | 23.0 | 15.7 | 39.5 | 945 | 8.2 |
| 1979 | 29.6 | 35.2 | 14.6 | 45.1 | 967 | 9.9 |
| 1980 | 27.0 | 35.4 | 15.1 | 55.6 | 934 | 9.9 |
| 1981 | 24.6 | 27.9 | 13.0 | 51.7 | 1157 | 11.3 |
| 1982 | 24.8 | 26.8 | 13.3 | 49.8 | 1197 | 11.6 |
| 1983 | 21.6 | 32.9 | 10.2 | 43.1 | 1235 | 16.2 |
| 1984 | 22.6 | 33.8 | 10.3 | 59.7 | 1209 | 18.5 |
| 1978-84 | 184.0 | | 92.2 | | 7644 | |

" concentrates * less than 0.05 MZ$

Sources: CSO, 1985a; MMCZ, (unpublished); CMZ, 1970.

## 2. Exports

Export figures for the period 1978 to 1984 are presented in table 19. Both copper and nickel declined in 1984 to 21.5 Ktons and 11.3 Ktons respectively, although a surprising 16.2 Ktons of nickel were exported in 1983, but this was due to held-over stocks and nickel refined from Cu-Ni matte from Botswana (3 Ktons). Table 3 also gives exports as a pecentage of production for each year and for the whole period. This is not a good indicator of local consumption due to held-over stocks and refinery feed from outside the country, but the figure for the whole period gives a better indication, namely that virtually no nickel is consumed locally, about 10% of copper and a similar percentage of tin goes into local industry.

Table 19. Exports of non-ferrous metals: 1978-1984

| Year | Copper | | | Nickel | | | Tin | | |
|---|---|---|---|---|---|---|---|---|---|
| | Ktons | MZ$ | % 1/ | Ktons | MZ$ | % 1/ | Tons | MZ$ | % 1/ |
| 1978 | 35.9 | 26.5 | 106 | 16.5 | 36.5 | 105 | 748 | 6.3 | 79 |
| 1979 | 26.6 | 31.3 | 90 | 13.9 | 37.9 | 95 | 865 | 8.5 | 90 |
| 1980 | 22.7 | 24.6 | 84 | 14.5 | 52.8 | 96 | 891 | 8.6 | 95 |
| 1981 | 17.9 | 18.3 | 73 | 11.7 | 46.8 | 90 | 950 | 8.3 | 82 |
| 1982 | 22.7 | 21.7 | 92 | 12.0 | 45.5 | 90 | 1030 | 9.2 | 86 |
| 1983 | 24.9 | 33.7 | 115 | 16.2 | 67.8 | 159 | 1094 | na | 90 |
| 1984 | 21.5 | 31.1 | 95 | 11.3 | 63.0 | 110 | 981 | 16.6 | 93 |
| 1978-84 | 172.2 | | 94 | 84.8 | | 104 | 6559 | | 83 |

1/ Exports as a percentage of production (volume).

Sources: CSO, 1985a and 1985c; MMZ, 1964; MMCZ, (unpublished).

## 3. Investment

Net capital expenditure peaked at Z$39.9 million in 1981, before falling to Z$7.1 million in 1982 (Table 20), although that for tin increased between 1977 and 1982. For tin, capital expenditure as a percentage of net output fell to a low of 7.6% in 1979, before recovering to a high of 41.1% in 1982, presumably due to the improved real price of tin over this period. For copper and nickel, capital expenditure as a percentage of net output fell to an all-time low of 12.2% in 1982, due to the depressed world market.

Table 20. Net capital expenditure
(thousand Z$)

| Year | Tin 1/ | Capital expenditure as percentage of net output | Copper and nickel 1/ | Capital expenditure as percentage of net output |
|---|---|---|---|---|
| 1975 | 1078 | 37.9 | 18869 | 50.7 |
| 1976 | 1153 | 39.7 | 20134 | 43.9 |
| 1977 | 938 | 20.2 | 9545 | 25.3 |
| 1978 | 904 | 18.1 | 7960 | 21.1 |
| 1979 | 698 | 7.6 | 37884 | 69.2 |
| 1980 | 1223 | 12.8 | 14043 | 20.3 |
| 1981 | 2798 | 28.8 | 37083 | 68.7 |
| 1982 | 3245 | 41.1 | 3792 | 12.2 |

1/ Includes mining, smelting and refining.

Source: CSO, 1985b.

## 4. Energy

The principal forms of energy consumed by mining, smelting and refining are electricity, coal, petrol and diesel. Of these the most important is electricity supplied by the Electricity Supply Commission (ESC).

In 1983, 45% (about 2000 mkWh) of the total ESC supply went to mining if the ferrochrome smelters are included and in 1983/4, non-ferrous metal mining and processing consumed 519 mkWh, 43% of the total for mining, excluding ferrochrome (Table 21). Nickel mining consumption fell 16% from 1982/3 to 1983/4 due to the closure of the Base Metals Refinery (BMR) in September 1983.

Table 21. Non-ferrous mining, esc sales (m kWh)

| Consumer | 1982/3 | 1983/4 | % Change |
|---|---|---|---|
| Nickel | 378.59 | 318.52 | -15.87 |
| Copper | 156.28 | 155.48 | - 0.51 |
| Tin | 44.78 | 45.30 | + 1.16 |
| Total non-ferrous | 579.65 | 519.30 | -10.41 |
| Total mining*/ | 1255.45 | 1199.98 | - 4.42 |
| % Non-ferrous | 46.17 | 43.28 | - 2.89 |

*/ Excluding ferrochrome smelting.

Source: ESC, Annual Report 1984.

Electricity charges have increased almost five-fold in current terms since 1979. In real (deflated) terms electricity charges have more than doubled since 1979. These increases have put severe pressure on non-ferrous mining, especially as they came as the world recession set in.

## III. THE MAIN ACTORS IN MINING, SMELTING AND REFINING

### 1. Nickel

Presently all nickel mining is controlled by the Anglo American subsidiary Bindura Nickel Corporation (BNC), but until 1983 it was also mined by Rio Tinto Zimbabwe (Empress Nickel Mine). The RTZ refinery (BMR, Eiffel Flats) is still running on matte from Botswana (BCL Ltd.).

#### (a) Bindura Nickel Corporation Ltd. (BNC)

The BNC is 63% owned by AAC Zimbabwe which is in turn 34% owned by Charter Consolidated PLC in London. Charter is 30% owned by Minorco in Bermuda which is controlled by Anglo American-De Beers of South Africa. Anglo American Services (Zimbabwe) Ltd. supplies management and technical services to the company.

In 1984 the total capital employed by the company was Z$178.6 million, turnover was Z$76.9 million, and an after-tax loss of Z$9.9 million was made, Z$15.4 million being carried over from 1983. The debt burden of the company has increased drastically since the onset of the world recession: from Z$4 million in 1980 to Z$56.6 million in 1984, representing 48% of fixed assets. Virtually no tax has been paid by the company since its inception, as by the time its tax grace period had finished, the world recession with low nickel prices had set in, leaving very little or no taxable profit.

(b) Rio Tinto Zimbabwe Ltd. (RTZim.)

RTZim. used to own a major nickel producer, the Empress Nickel Mine. The mine was established in 1967 as the first significant nickel producer in the country. At that time ore reserves were estimated to be 14.33 million tons grading 1.43% Ni+Cu. Production started in 1969 and was expected to continue for twenty years. However, in 1981 the mine declared reserves for three more years. This decrease in the life of the mine was due to an increase in operating costs, to difficulties in mining the significant reserves locked in pillars, to a failure to discover any extensions to the original body and to the steady decline in the price of nickel.

The mine closed at the end of 1982, and the Base Metals Refinery (BMR) at Eiffel Flats shut down in September 1983 after matte supplies from BCL Ltd. in Botswana ceased. The refinery re-opened in August 1985 to toll-refine 4.5 Ktons of nickel and 5 Ktons of copper in Ni-Cu matte/an. from BCL Ltd. The toll-refining operation will generate Z$16 million in foreign exchange in the form of treatment fees for Zimbabwe. The metals are marketed by the owners in Switzerland (Centametall).

The Empress Nickel Mine became a wholly-owned subsidiary of Rio Tinto Zimbabwe in 1980, when the other shareholders in the company were given R.T.Zimbabwe Ltd. shares in exchange for their Empress Nickel Mining Co. Ltd. shares.

For the years 1973 to 1982 the company paid virtually no taxes, as the end of the grace period coincided with the demise of the mine. The escalating debt during the final two years of the mine is not reflected as by that time it was a wholly-owned subsidiary of RTZim. which handled the loans. In 1982 the Government supplied RTZim. with a loan of Z$2.7 million repayable any time up to 1987, at which date it would have the right to convert the unpaid balance into equity. By the end of 1984 this loan stood at Z$3.43 million. The total medium and long term debt of the mother company was Z$29.3 million in 1982, Z$25.1 million in 1983 and Z$22.4 million in 1984.

2. Copper

Most of the country's copper production comes from mines under the parastatal, the Zimbabwe Mining Development Corporation (ZMDC), with smaller amounts coming from Lonrho (Inyati) and as a by-product of nickel mining.

(a) The Zimbabwe Mining Development Corporation (ZMDC)

The ZMDC was established in terms of the Zimbabwe Mining Development Corporation Development Act of 1982 to invest in the mining industry and to plan, coordinate and implement mining development projects on behalf of the state. It commenced operations in November 1983. In November of the following year it took over the Zimbabwean copper mining interests of The Messina (Transvaal) Development Company Ltd. of South Africa (messina). The present structure of the group is presented in Figure 1.

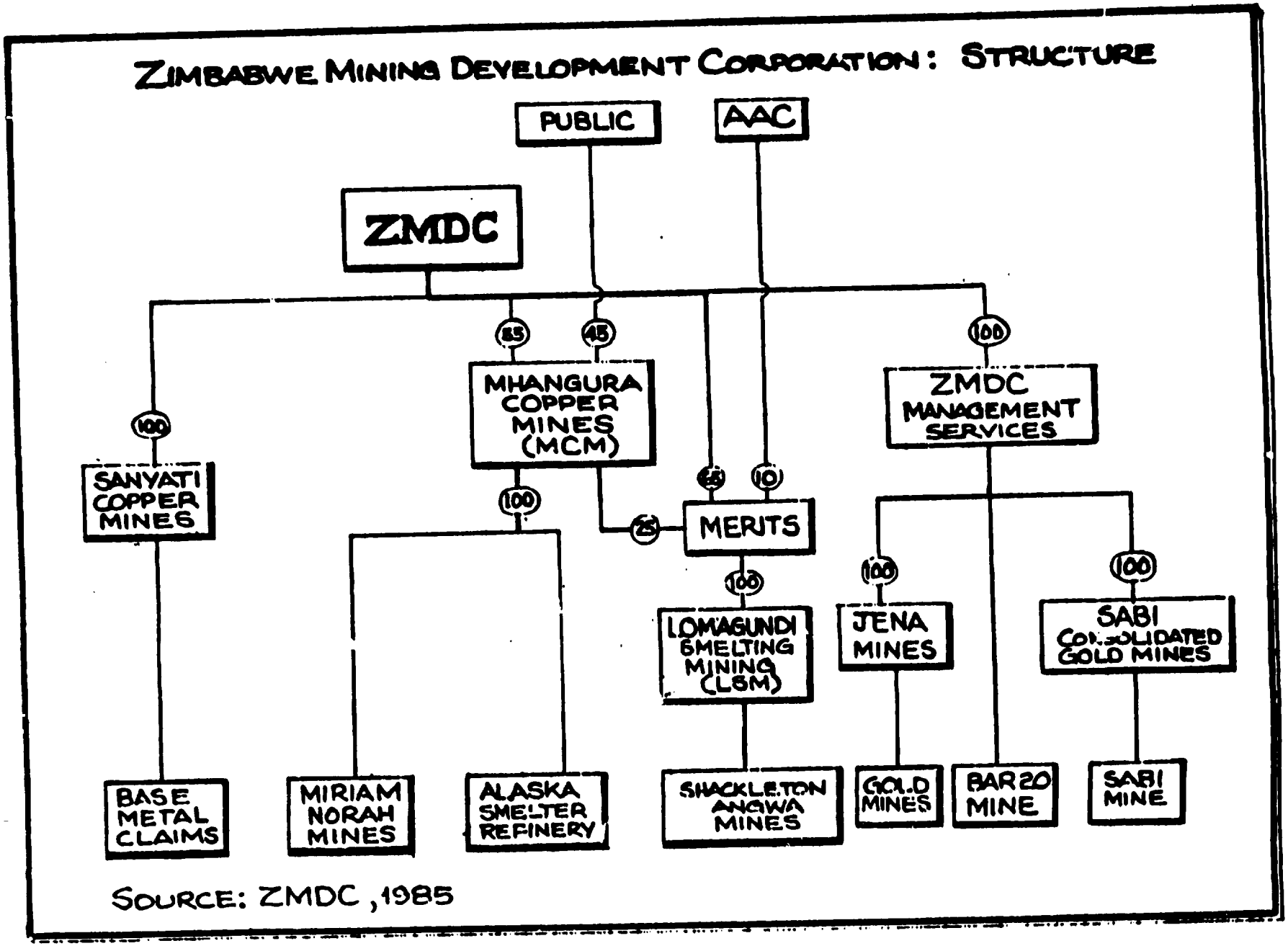
ZIMBABWE MINING DEVELOPMENT CORPORATION: STRUCTURE
PUBLIC
AAC
ZMDC
85
45
100
MHANGURA COPPER MINES (MCM)
ZMDC MANAGEMENT SERVICES
100
SANYATI COPPER MINES
100
65
10
MERITS
25
100
100
100
LOMAGUNDI SMELTING MINING (LSM)
JENA MINES
SABI CONSOLIDATED GOLD MINES
BASE METAL CLAIMS
MIRIAM NORAH MINES
ALASKA SMELTER REFINERY
SHACKLETON ANGWA MINES
GOLD MINES
BAR 20 MINE
SABI MINE
SOURCE: ZMDC, 1985

Figure 1.

(b) Corsyn Consolidated Mines Ltd. (Lonrho)

Inyati copper mine is owned by Corsyn Consolidated Mines Ltd. which is a wholly-owned subsidiary of Coronation Syndicate Ltd. registered in South Africa, which is in turn owned by Lonrho PLC of the United Kingdom.

The mine has its own small smelter and refinery on site. The whole complex has been operating at a loss since 1980 due to low copper prices on the world market. A working loss is also forecast for 1985. Capital expenditure on the mine, smelter and refinery has fallen off radically since 1981.

Ore production has fallen significantly since the mid-seventies, copper output has halved and the total workforce is down to 39% of its 1975 level. Output per worker for mining as well as for smelting/refining seems to be recovering after a low in 1982. The future of the operation is not very secure and it is expected to have to close down in a few years if low copper prices persist. The cut-off ore grade has already been increased from 1 to 2% copper, which decreased the reserve base considerably.

3. Tin

(a) Kamativi Tin Mining Company (IDC)

Almost all production comes from this mine. It is controlled by the state Industrial Development Corporation (IDC) which holds 91.3% of the equity. Negotiations are underway for its sale to the ZMDC at its book value.

The present capitalisation of the company is roughly Z$3 million and losses have been incurred since 1981, even with the relatively high price of tin over that period. The recent collapse of the ITC and the world tin price is likely to make the operation a major loss.

This means that the Government will most probably have to decide whether to subsidise the present underground operation to maintain employment and foreign earning, or allow it to convert to opencast only, thereby radically reducing production costs but at the same time necessitating substantial redundancies. Table 22 shows the evolution of the main economic and financial parameters of the Kamativi Tin Mining Co. for the period 1973-1983.

Table 22. Kamativi Tin Mining Co. (91.3% IDC)

| Year 31 Dec. | Output Tons Tin | Profit 1/ (Loss) | Capital 1/ Expend. | Tax | Labour 2/ | Tons per worker |
|---|---|---|---|---|---|---|
| 1975 | 997 | 5.21 | 1.25 | 0 | 1548 | 0.64 |
| 1976 | 915 | 0.70 | na | 0 | 1396 | 0.66 |
| 1977 | 920 | 1.34 | 0.94 | 0 | 1388 | 0.66 |
| 1978 | 945 | 2.14 | 0.90 | 0 | 1578 | 0.60 |
| 1979 | 967 | 3.45 | 1.48 | 0.5 | 1627 | 0.59 |
| 1980 | 934 | 2.75 | 2.46 | 0.4 | 1635 | 0.57 |
| 1981 | 1157 | 1.39 | 2.85 | 0 | 1692 | 0.68 |
| 1982 | 1197 | (3.00) | na | 0 | 1709 | 0.70 |
| 1983 | 1235 | (0.78) | na | 0 | 1688 | 0.73 |

1/ Profit and capital expenditure is expressed in Z$ million.
2/ Output data is for the calendar year and labour for the year ending 31 March. Hence labour data from the following year has been used, vis: 1975 output over 1976 labour.

Sources: The Industrial Development Corporation, Annual Reports; CSO, 1985a (output data); Chamber of Mines (labour).

## IV. THE MAIN ACTORS IN NON-FERROUS METAL TRANSFORMATION

There is a myriad of companies that consume non-ferrous metals, only the principal ores which consume significant amounts will be treated here.

### a) Central African Cables (Cafca)

This company, based in Harare, is by far the largest consumer of copper in the country. In 1985 roughly 2.2 Ktons of copper were purchased from MCM and Inyati. The company is 75% owned by BICC of the United Kingdom with 18% local equity and 5% South African. The main products are copper and aluminium cable and wire, insulated and bare. The technology employed is medium to high and the company receives some technical assistance from the mother company. The main processes are wiredrawing, extrusion and stranding.

Most of Cafca's production is for the local market (90%) mainly to the Electricity Supply Commission (ESC) and to the National Railways of Zimbabwe (NRZ), for the rail electrification scheme. Exports are usually about 10% of production but fluctuate significantly, going up to a maximum of 45% of production, depending on orders which are usually "one-off" rather than regular. Most export is to the regional market.

b) Non-ferrous Metal Works (Zimbabwe) (Pvt) Ltd.

This company, based in Harare, is 100% owned by Metramet of the United Kingdom. It began operations in 1957 and by 1983 its turnover was Z$3.3 million with a total capital employment of Z$1 million. In the same year profits stood at Z$0.7 million and the company employed 110 people. The principal mineral inputs are silicon (RSA), antimony (RSA), lead, zinc (Zambia), copper scrap (Zimbabwe) and aluminium billets (Aluminium Industries, Zimbabwe). In 1982 consumption of inputs was: roughly 2.5 Ktons of non-ferrous scrap, 75 tons of lead, 50 tons of zinc, 10 tons of silicon and 3 tons of antimony.

The principal products are non-ferrous alloys and cast copper and aluminium alloys. Present production is at 80% of capacity, of which 60% is for the home market and the rest is exported.

c) All Metal Founders (Pvt) Ltd.

This is a private company based in Bulawayo with a turnover in 1983 of Z$900 thousand, fixed assets of Z$180 thousand and profits of Z$150 thousand. Production in terms of turnover is: ferrous castings 25%, non-ferrous castings 5%, sanitary ware 15%, agricultural implement components 10%, brake drums 10%, phosphor bronze 10%, and solid fuel stoves 10%. The company holds 20% of the local market for sanitary ware and nearly 100% for presses.

d) Menashe and Son (Pvt) Ltd.

This is a small private company in Bulawayo. The production lines are: general engineering, 75% of turnover, resincord solder 20% and casting moulds 5%. The annual turnover is roughly Z$200 thousand. The main inputs are lead (Zambia), tin (Kamativi), pig iron (Zisco), aluminium (Al Industries) and brass (Radiator and Tinning). All production is for the home market except for solder, of which 25% is exported.

e) Non-ferrous Die Casting (Pvt) Ltd.

This is a private company which started up in Norton (near Harare) in 1971 and by 1982 had a turnover of roughly Z$1.0 million. Production in terms of turnover is: plumbing fittings 50%, electrical fittings 20%, marine fittings 10%, irrigation fittings 20%. The principal customers are the building industry 50%, ESC and Capco 20%, irrigation equipment manufacturers 20% and boat builders 10%. All production is for the local market except for marine fittings which are exported to the Republic of South Africa. All of the staff of 100 are local.

f) Flowerday Industries (Pvt) Ltd.

This company commenced operations in Bulawayo in 1966 and had a turnover of roughly Z$1.5 million in 1982. The products are destined largely for the building and furniture trade: brass stampings 50%, pressure die castings 5%, domestic fittings 22% and fancy goods 23%. All production is for the local market except for window fittings, where about 40% goes to the Republic of South Africa and 2% to Malawi. The work force of roughly 130 is all local.

g) Cecon Enterprises (Pvt) Ltd.

This is also a Bulawayo company and is 30% owned by the IDC and is a major producer of non-ferrous metal based products. In 1983 sales were Z$1.4 million and profits were Z$128 thousand. The principal products are copperoxychloride 660 tons/annum (fungicide for coffee plants), copper sulphate 500 tons/annum (activator for flotation and for animal feeds), zinc sulphate 250 tons/annum (trace element for fertilizers), zinc chloride 130 tons/annum, zinc ammonium chloride 70 tons/annum (both for galvanizing and soldering) and zinc dust and shavings 160 tons/annum (for processing gold ore and for paints). A major investment of Z$5 million is underway which will increase capacity for the regional market (at present 5.4% of output). Once completed copperoxychloride production will increase to 1320 tons/annum, zinc sulphate to 500 tons/annum, zinc chloride to 260 tons/annum, zinc ammonium chloride 140 tons/annum, zinc dust and shavings 200 tons/annum.

h) Radiator and Tinning (Pvt) Ltd.

Also based in Bulawayo, this company is 100% owned by the Hodgskin family. The company started out in 1956 and has a present annual turnover of roughly Z$5 million and fixed assets of about Z$1.6 million. The principal production lines are radiators (70% of turnover), metal fabrication (20%) and non-ferrous metal and alloy products (10%), mainly extruded brass tubes, bar, sheets and rods. The main customers are vehicle assembly plants, engineering shops, brass processors and hardware wholesalers. Transport takes roughly 20% of production, industry 75% and agriculture 5%.

i) Tinto Industries Ltd.

This is a wholly-owned subsidiary of Rio Tinto Zimbabwe Ltd. and produces a wide range of products, principally ferrous, but has a small non-ferrous section. The main non-ferrous products are aluminium irrigation equipment, brass castings and domestic copper fittings.

j) Chloride Zimbabwe (Pvt) Ltd.

This manufacturer is a major consumer of lead for the production of wet cell batteries. The company is based in Harare and is owned by the mother company in the United Kingdom. The company had a turnover of about Z$3 million in 1984, almost all as batteries. At present the company is liaising with Lonrho regarding the possible production of lead concentrate from the Redwing gold ores.

k) Aluminium Industries Ltd.

This plant is the country's principal aluminium consumer and is 38% owned by the IDC, 49% by Huletts Aluminium of South Africa and 13% by Zimbank. In 1983 it had sales to the value of 9.8 MZ$ and profits of Z$944 thousand which was down on 1982 (11.7 and Z$1.81 million) due the low demand for irrigation equipment caused by the drought. The company started out in 1968 virtually as the local agent for Alcan products, then progressively started to manufacture various Al semi and finished goods from imported billets and sheet. In 1982 it acquired Toolmaking and Diecasting (Pvt) Ltd. for Z$400 thousand, increasing its range of products.

Output in terms of turnover is: foil 12%, extruded Al products 39%, extruded 13 mm rod for Cafca 32%, sheet for resale 6% and seam-weld tube for irrigation 11%. The diecasting division produces roughly 100 tons/annum of Al casts, mainly irrigation fittings.

The company holds virtually 100% of the market for its main products. Its principal customers are agriculture (irrigation), the building industry (frames and fittings), energy (Cafca, Al rod) and transport (Zambezi Coachworks-Lonrho).

## V. LEGISLATION

Mineral rights: the right of searching for and mining of all minerals is vested in the President, in terms of the Mines and Minerals Act. To prospect a prospecting licence or an Exclusive Prospecting Order (EPO) must be obtained.

Taxation: in terms of tax, repatriation of profits and other fiscal matters, the mining companies fall under the general laws governing these aspects for the whole of the economy. Income tax is 45% of the taxable income of the company. In terms of mining companies the following allowances apply: they can deduct the initial capital expenditure as it is incurred or over a number of years over the life of the mine up to a maximum of ten years; expenditure incurred in exploration can be deducted immediately or carried forward and allowed against subsequent mining income; a depletion allowance of 5% of the value of mineral production is also deductable, as is a replacement allowance for later capital expenditure.

Repatriation: new foreign venture capital may be fully repatriated after two years after deducting amounts already remitted. The balance can then be remitted over six years in equal amounts. Existing foreign companies can repatriate 50% of after tax profits as dividends which are then subjected to a non-residents shareholders tax of 20%. An exemption exists in the case of mining companies which may apply for a larger portion to be remitted in view of the wasting asset nature of the investment.

Borrowing: companies with more than 15% foreign ownership may not borrow locally more than 15% of the shareholders funds or they lose the right to repatriate profits. This is to encourage foreign concerns to bring new, foreign, capital into the country for new capital investment. It also encourages locally incorporated foreign companies to raise capital for local expansion by increasing the equity base locally, thereby diluting the foreign holding.

## VI. LINKAGES WITH THE REST OF THE ECONOMY AND ALTERNATIVE STRATEGIES

Zimbabwe has a considerable capacity for producing non-ferrous semi and finished goods, but generally on a small scale for the local market. The forward linkages to the other sectors of the economy, such as agriculture, transport, energy and construction are high, while the backward linkages to local metal suppliers are low. More than half the non-ferrous metal inputs to the transformation industries are imported even though three are mined in the country. Although about 15% of copper and 10% of tin production is consumed locally, significant amounts of these metals are still imported as for example copper sheeting and tin plate. Almost no nickel is consumed locally as the local steel industry does not as yet produce steel alloys.

Non-ferrous mining and mineral processing are generally assumed to have two principal roles in the industrialization of a developing country. By far the most important is usually to export minerals to the developed economies and thereby generate capital in the form of foreign currency for the development of the rest of the economy. In some cases mines are opened by companies from the industrialized nations specifically to supply raw inputs to their industrial plants in their country of origin. The second, and usually minor role, is to supply the necessary mineral raw materials for local resource-based industrialization.

Zimbabwe exports over 90% of the total value of its non-ferrous minerals. In 1983 mineral and crude metal products constituted 44% of total exports of raw iron and steel, ferrochrome and other alloys, coke and cement are included, of which non-ferrous mining contributed 23%. Crude minerals constituted 8.0% of total exports, refined metals, alloys, cement and coke 26.8% and gold 9.1%, thereby making the mining sector the largest generator of foreign exchange (Z$504 million in 1983), followed by agriculture.

A small fraction of the non-ferrous metals is consumed by local industries. The situation is somewhat better for iron and steel (20%), coal (90%) and a high proportion of some of the minor minerals is used locally (e.g. phosphates, bauxite, limestone and other industrial mineral).

It can therefore be stated that the bulk of the non-ferrous mining industry is vertically integrated into the economies of the industrialized countries rather than into the local economy and that where there is some local transformation of minerals into finished products, these are for the limited local market.

This situation whereby the mining industry generates the (foreign) capital for the development of the rest of the economy would be feasible except for two drawbacks: the first is that unlike agriculture, mining is consuming non-renewable resources so that the lifespan of the exploitation of a mineral is limited and mineral resources exhausted for export today could well have to be imported in the future when the economy has developed to a point where these minerals are necessary. The second and major drawback is that for developing countries the terms of trade value of most minerals are constantly falling, meaning that progressively greater volumes have to be exported to maintain the same level of imports.

Between 1979 and 1984 the average value per ton of non-ferrous metals produced in Zimbabwe increased by 65% in terms of Z$ but decreased by 26% in terms of US$ and it should be noted that the real (deflated) value of the US dollar also decreased substantially over this period meaning that the real loss in value was well above this.

From the above it is apparent that a non-ferrous mining sector which is vertically integrated into the industrialized economies (by supplying raw materials to them and purchasing finished capital goods from them) is, in the long run, caught in a cycle of deteriorating terms of trade. The alternative role of non-ferrous mining, that of generating the raw materials for local industrialization, avoids the problems of declining terms of trade but comes up against the obstacle of economies of scale. For Zimbabwe to develop a capital goods industry, thereby integrating a larger proportion of its mining industry, would be extremely costly given the limited demand for these goods on the local market, but in some instances the cost may be justified.

Possibilities of exporting finished capital goods onto the world market are pretty limited, given Zimbabwe's land-locked situation and the present recession in world trade, but the region (SADCC, PTA) offers not only a greater market but also a larger resource base. The most feasible method of breaking out of the stagnating and crisis ridden one-sided integration into the industrialized economies, is by collective self-reliance in a regional resource-based industrialization strategy.

The establishment of the regional Preferential Trade Area (PTA) has gone some way in reducing tariff barriers and encouraging interregional trade, but in the end most of the countries in the region do not have the foreign currency to pay for much needed imports from their neighbours who in turn are not in a position to provide soft export credits, so must turn to the developed world to import their goods on easier terms. A regional resource-based industrialization strategy would go beyond trade by establishing regionally integrated industries in which case trade balances would be more equitable.

Limited regional co-operation in non-ferrous metal refining has already taken place in the case of copper-nickel matte from Botswana being refined in Zimbabwe and copper concentrates from Mozambique will soon be smelted and refined in Zimbabwe. But in both these cases Zimbabwe is adding value to a raw material from a neighbour. For regional integration to be successful the benefits clearly need to balance for the countries participating.

At present both Zambia and Zimbabwe are attempting to penetrate the same, fairly limited, regional market for copper and copper alloy semis and finished goods. Regional integration of the tranformation of non-ferrous metals would necessitate the planning of the location of manufacturing plants to achieve an equitable distribution of the benefits and to avoid costly duplication.

THE NON-FERROUS METALS INDUSTRY IN LATIN AMERICA

# THE NON-FERROUS METALS INDUSTRY IN BOLIVIA

## I. NON-FERROUS MINERAL RESERVES

Bolivia possesses enormous mineral wealth throughout the country, above all:

Tin: This is the country's most important mineral from the economic standpoint. Bolivia has proven/probable reserves of 636,000 MTF (metric tons fine content) with a tin content of between 1.18 per cent and 1.37 per cent. The potential reserves are estimated at 783,800 MTF, making the total reserves 1,420,700 MTF.

Copper: There are reckoned to be 26,600 MTF of proven/probable low-grade copper reserves and 247,900 MTF of potential reserves.

Silver: Bolivia has 1,981 MTF of proven/probable and 1,635 MTF of potential silver reserves, making a total of 3,616 MTF.

Zinc: The proven reserves amount to 1,007,700 MTF and the potential reserves to 627,700 MTF, with a zinc content ranging from 9.9 per cent to 10.14 per cent.

Lead: The lead reserves amount to 106,700 MTF of proven reserves and 309,100 MTF of potential reserves. The lead content is estimated at between 2.12 per cent and 2.30 per cent fine content.

Wolfram: 24,600 MTF of proven reserves with a $WO_3$ content of 0.7 per cent and 63,100 MTF of potential reserves.

Bismuth: Bolivia, the world's principal producer, has 13,600 MTF of proven reserves and 2,200 MTF of potential reserves.

## II. MINING AND METALLURGICAL PRODUCTION

The trend of the mining and metallurgical sector in Bolivia during the period 1976-1985 was generally unfavourable. Tin, the mineral with the greatest impact on the Bolivian economy, showed negative growth throughout the period, with the lowest declines in 1984 and 1985, when production dropped by 21.3 per cent and 19.1 per cent respectively. Production of the other two relatively high-output non-ferrous metals, zinc and lead, also fell away in the period under consideration. Zinc production dropped from 48.5 million metric tons in 1976 to 38.1 in 1985. Lead production fell from 16,400 metric tons in 1976 to 6,200 in 1985. Copper production, which is not significant, also fell from 4,800 metric tons in 1976 to 1,700 in 1985. Further details can be found in table 1.

With regard to growth prospects in the non-ferrous metals sector, there are currently nc medium-term or long-term plans and the prospects for the mining and metallurgical sector are essentially based on the projects which are now being implemented.

## III. STRUCTURE OF OWNERSHIP AND MAIN PARTICIPANTS IN THE SECTOR

Since the three principal mining enterprises were nationalized, in 1952, the entrepreneurial structure of the sector has remained unchanged, with three groups of producers:

- Bolivian Mining Corporation (COMIBOL);
- Medium-scale mining;
- Small-scale mining.

Table 1. Bolivian mining production - 1976, 1979-1985
(in thousand of metric tons fine content)

| | | | | | | | | | Average percentage variation | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1976 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1979/ 1976 | 1980/ 1979 | 1983/ 1980 | 1984/ 1983 | 1985/ 1984 |
| Tin (concentrate) | 29.8 | 27.6 | 27.3 | 29.8 | 26.8 | 25.3 | 19.9 | 16.1 | -2.5 | -1.1 | -2.4 | -21.3 | -19.1 |
| Copper (concentrate) | 4.8 | 1.8 | 1.9 | 2.6 | 2.3 | 2.0 | 1.6 | 1.7 | -20.8 | 5.6 | 1.8 | -20.0 | 6.3 |
| Lead (concentrate) | 16.4 | 15.4 | 17.2 | 16.8 | 12.4 | 11.8 | 7.4 | 6.2 | -2.0 | 11.7 | 10.5 | -37.3 | -16.2 |
| Zinc (concentrate) | 48.5 | 44.1 | 50.3 | 47.0 | 45.7 | 47.1 | 37.8 | 38.1 | -3.0 | 14.1 | -2.1 | -19.7 | 0.8 |
| Wolfram (concentrate) | 3.0 | 3.1 | 3.4 | 3.4 | 3.2 | 3.1 | 2.4 | 2.1 | 1.1 | 9.7 | -2.9 | -22.6 | -12.5 |
| Silver (concentrate) | 0.1 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.1 | 0.1 | 33.3 | 0.0 | 0.0 | -50.0 | 0.0 |
| Antimony (concent.) | 15.3 | 13.0 | 15.5 | 15.3 | 14.0 | 10.0 | 9.3 | 8.9 | -5.0 | 19.2 | -11.8 | -7.0 | -4.3 |
| Gold (kg fine) | 810 | 948 | 1,620 | 2,064 | 1,249 | 1,531 | 1,270 | 561 | 5.7 | 71.0 | -1.8 | -17.0 | -55.8 |

Source: Ministry of Mining and Metallurgy.

There is also another group of mining producers, described as "other exporters". These are mine operaters, generally small-scale or occasionally medium-sized, with direct export licences.

A. Bolivian Mining Corporation (COMIBOL)

This enterprise, owned by the Bolivian State, was set up as a result of the nationalization of the mines in October 1952, under which all properties and installations belonging to the Patiño, Hochschild and Aramayo consortia, which had until then made up the country's large-scale mining operations, reverted to State control.

COMIBOL is the largest mining enterprise in Bolivia and is still the largest individual employer. It has 23 production operations and five service enterprises.

Traditionally, COMIBOL has been and continues to be the principal tin producer in Bolivia and it also produces other minerals sold in concentrate form: lead, copper, silver complexes, cadmium, bismuth, zinc, wolfram and others.

In its 33 years of existence, it has earned about two-thirds of the foreign exchange obtained from mining. In 1975, COMIBOL exported nearly 67 per cent of the country's total mining exports (the highest level achieved) and, on average, it accounted for 57 per cent of total exports throughout the period 1965-1985.

B. Medium-scale mining

This production sub-sector is made up primarily of 20 to 25 private enterprises, accounting for about 20 to 25 per cent of total mining exports. In recent years, its share of various minerals has been approximately as follows:

| | |
|---|---|
| Antimony | 75-79 per cent of the nation's total |
| Tin | 20-23 per cent of the nation's total |
| Silver | 10-12 per cent of the nation's total |
| Lead | 18-25 per cent of the nation's total |
| Wolfram | 50 per cent of the nation's total |
| Zinc | 35-50 per cent of the nation's total |
| Gold | 40 per cent of the nation's total. |

This group of enterprises is able to respond more readily to changes in international markets and variations in wage and monetary policies.

C. Small-scale mining

The inventory of "small mines" carried out in 1974-1975 indicated the existence of 5,000 small mining properties.

With the passage of time, this sub-sector (which in the past accounted for 15 per cent of the value of exports) has accounted over the last decade for some 12 per cent, with fluctuations between 8.5 per cent and 21.5 per cent.

Small-scale mining is particularly significant with respect to antimony and tin. Its production of lead and copper has declined dramatically because of the drop in the price of these metals.

A feature of Bolivian mining which is worth mentioning and which distinguishes it from mining in the other Latin American countries is its essentially national character. Foreign investment has not yet reached the proportions it has assumed in other countries of Latin America. Foreign capital participation, amounting to about 5 per cent in the medium-scale mining sector, amounts to only 1 per cent nationally.

## IV. THE ECONOMIC IMPORTANCE OF NON-FERROUS METALS

In recent years the Bolivian economy has gone through a severe crisis, due both to political and economic factors (highest inflation rate in history) and to external factors, with the drop in ore prices, which have had a negative impact on economic recovery.

The share of the mining and metallurgical sector in the total GDP for the years 1970-1983 is indicated in table 2. In the present decade it accounted for about 7 per cent of total production, with tin, zinc, silver, lead and antimony production being the most important. The farming and livestock sector contributed an average of 18 per cent in this period, whereas the industrial sector (including craft enterprises) contributed 15 per cent.

It should be noted, however, that the mining and metallurgical sector, despite its relatively low share in the GDP, makes a decisive contribution to the country's foreign exchange earnings and is thus a very significant factor in the overall economy.

The trend of the volume and value of mining exports is indicated in table 3, which shows (for the period 1979-1985) that the largest contribution was made by tin, followed by silver and wolfram, among others.

Tin accounts for almost 70 per cent of Bolivia's mining exports, with an average of 50 per cent in the present decade represented by tin metal (production of which was recently started in 1975) and the remaining 20 per cent tin concentrates.

The recent decline in tin exports (1983-1985) was due to the enormous financial and administrative difficulties COMIBOL had to face during the inflationary period 1983-1985. Inflation affected mining production in general, but its greatest impact was on the State enterprise. October 1985 saw the closing of the London Metal Exchange's tin market and the price of tin fell from US$5.40/pound fine to US$2.40/pound fine, causing the most serious crisis since 1930.

The 1985 statistics reflect the effects of this situation only partially and we still have not seen its true impact on coming years, both domestically and world-wide. Various tin mining operations in Bolivia have already been shut down and others are in the process of closing or of being scaled down. Consequently, it is to be assumed that 1986 will see a drastic reduction in tin production, estimated at some 8,000 to 10,000 tons fines.

Next in importance comes silver, which contributed 11 per cent of total exports on average over the same period, the lowest export volumes being 80 MTF in 1984 and 52 MTF in 1985.

Next come wolfram, accounting for 8.6 per cent (1970), 5.2 per cent (1984) and 3.9 per cent (1985) of total exports, and antimony, with an export value of US$30,926,000 (15.1 per cent of the total) in 1970, dropping to US$15,900,000 by 1985 (6 per cent of the total).

Table 2. Gross domestic product by branch of economic activity
Years 1970-1983
(in millions of pesos at constante 1970 prices and in percentage)

| | 1970 | 1975 | 1980 | 1981 | 1982 | 1983 |
|---|---|---|---|---|---|---|
| Agriculture, hunting, forestry and fishing | 18.1 | 17.9 | 17.0 | 18.4 | 19.7 | 16.6 |
| Mining and quarrying a/ | 10.3 | 10.0 | 7.1 | 7.3 | 7.3 | 7.8 |
| Manufacturing industry | 14.5 | 15.1 | 16.3 | 15.8 | 14.7 | 14.7 |
| Commerce | 17.6 | 16.0 | 13.7 | 14.7 | 16.1 | 12.9 |
| Services | 17.3 | 17.8 | 18.5 | 18.7 | 19.7 | 21.5 |
| Other | 22.2 | 23.2 | 27.4 | 25.1 | 22.5 | 26.5 |
| TOTAL GDP (millions of Bolivian pesos at 1970 prices) | 12,370.0 | 16,417.0 | 19,212.0 | 19,030.0 | 17,368.0 | 16,049.0 |

Source: Latin American Statistical Bulletin - 1984 edition - ECLA

a/ Includes oil production, which accounted for 1 per cent on average throughout the period.

Table 3. Volume and value of Bolivian mining exports 1970-1985
(in metric tons fine content and thousands of US$)

| | 1970 | % | 1975 | % | 1980 | % | 1981 | % | 1982 | % | 1983 | % | 1984 | % | 1985 | % |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1) Tin concentrate | | | | | | | | | | | | | | | | |
| Volume | 29,379 | | 18,944 | | 8,313 | | 5,525 | | 3,238 | | 2,509 | | 4,663 | | 4,434 | |
| Value | 102,024 | 49.8 | 129,730 | 41.5 | 139,349 | 21.7 | 77,199 | 13.9 | 41,015 | 9.8 | 32,442 | 9.3 | 56,975 | 15.7 | 52,721 | 20.0 |
| 2) Tin metal | | | | | | | | | | | | | | | | |
| Volume | 6 | | 7,497 | | 14,937 | | 19,446 | | 19,026 | | 13,968 | | 15,818 | | 12,173 | |
| Value | 23 | 0.0 | 51,738 | 16.4 | 251,234 | 39.2 | 272,716 | 49.0 | 240,743 | 57.4 | 178,868 | 51.5 | 193,425 | 53.1 | 136,960 | 52.0 |
| 3) Copper | | | | | | | | | | | | | | | | |
| Volume | 8,853 | | 5,989 | | 1,676 | | 2,545 | | 2,139 | | 1,926 | | 1,333 | | 1,245 | |
| Value | 12,499 | 6.1 | 7,262 | 2.3 | 3,535 | 0.6 | 4,402 | 0.8 | 3,126 | 0.7 | 2,978 | 0.9 | 1,837 | 0.5 | 1,709 | 0.7 |
| 4) Lead | | | | | | | | | | | | | | | | |
| Volume | 25,757 | | 16,796 | | 16,212 | | 15,613 | | 11,557 | | 9,342 | | 2,549 | | 1,369 | |
| Value | 7,806 | 3.8 | 7,356 | 2.4 | 14,450 | 2.3 | 11,459 | 2.1 | 6,540 | 1.6 | 4,007 | 1.2 | 1,007 | 0.3 | 537 | 0.2 |
| 5) Zinc | | | | | | | | | | | | | | | | |
| Volume | 46,537 | | 48,702 | | 46,236 | | 44,681 | | 44,543 | | 41,352 | | 36,868 | | 33,941 | |
| Value | 14,319 | 7.0 | 39,631 | 12.7 | 36,679 | 5.7 | 40,423 | 7.3 | 38,395 | 9.2 | 33,372 | 9.6 | 37,278 | 10.2 | 29,486 | 11.1 |
| 6) Wolfram | | | | | | | | | | | | | | | | |
| Volume | 2,410 | | 2,551 | | 3,435 | | 3,091 | | 3,272 | | 2,584 | | 2,471 | | 1,644 | |
| Value | 17,577 | 8.6 | 22,253 | 7.1 | 47,369 | 7.4 | 42,955 | 7.7 | 3,776 | 8.1 | 20,008 | 5.8 | 18,940 | 5.2 | 10,291 | 3.9 |
| 7) Silver | | | | | | | | | | | | | | | | |
| Volume | 186 | | 203 | | 176 | | 204 | | 151 | | 158 | | 80 | | 52 | |
| Value | 10,531 | 5.1 | 28,511 | 9.1 | 118,328 | 18.5 | 71,694 | 12.9 | 37,067 | 8.8 | 58,264 | 16.7 | 21,441 | 5.9 | 10.192 | 3.9 |
| 8) Gold | | | | | | | | | | | | | | | | |
| Volume | 155 | | - | | - | | 2 | | - | | 44 | | 911 | | 534 | |
| Value | 169 | 0.1 | - | 0.0 | - | 0.0 | 34 | 0.0 | - | | 651 | 0.2 | 9,798 | 2.7 | 5,505 | 2.1 |
| 9) Antimony Concentrate & metal | | | | | | | | | | | | | | | | |
| Volume | 11,576 | | 11,917 | | 12,623 | | 17,760 | | 10,891 | | 12,919 | | 10,888 | | 7,750 | |
| Value | 30,926 | 15.1 | 17,141 | 5.5 | 26,433 | 4.1 | 34,305 | 6.2 | 17,769 | 4.2 | 16,316 | 4.7 | 22,932 | 6.3 | 15,989 | 6.0 |
| 10) Bismuth Concentrate & metal | | | | | | | | | | | | | | | | |
| Volume | 623 | | 612 | | 547 | | 2 | | | | | | | | | |
| Value | 7,958 | 3.9 | 7,528 | 2.4 | 2,670 | 0.4 | 9 | 0.0 | - | - | - | - | - | - | - | - |
| 11) Other | | | | | | | | | | | | | | | | |
| Value | 1,069 | 0.5 | 1,703 | 0.6 | 1,079 | 0.1 | 850 | 0.1 | 918 | 0.2 | 410 | 0.1 | 407 | 0.1 | 428 | 0.1 |
| TOTAL EXPORTS (thousands of US$) | 204,901 | 100 | 312,493 | 100 | 641,128 | 100 | 656,046 | 100 | 419,349 | 100 | 347,316 | 100 | 384,040 | 100 | 283,757 | 100 |

Source: El Sector Minero de Bolivia. JUNAC - La Paz, Bolivia, 1986.

The share of zinc, whose gross value averaged approximately 8 per cent of exports over the past 20 years, is in fact far smaller, since Bolivia itself receives only 25 per cent of the gross value, the remainder being spent on transport, contract processing ("maquila") and refining abroad.

Exports of various minerals fell considerably during this period, owing to low production levels. For example, bismuth, with an average share of 3 per cent of the gross value of exports up to 1975, ceased to be exported in 1981. The production of bismuth metal ceased in 1978 with the closure of COMIBOL's Telamayu bismuth smelting works. This decline was caused by the drop in prices because health damage had been detected in the principal market for this metal, i.e. in pharmaceuticals. In 1985, production was resumed as the price had shown signs of significant recovery. Bolivia possesses the world's largest reserves of this metal and is the only country producing primary bismuth, i.e. as bismuth ore and not as a by-product.

Lead, which had accounted for 2.8 per cent of the value of exports between 1970 and 1980, with an average annual level of 19,590 MTF, dropped to 1.1 per cent in the period 1981-1985, with an average export level of 8,090 MTF. The main reason for this, apart from the fall in lead prices, was the difficulty of finding new reserves. This is currently a serious problem and it has hindered the start-up of the Karachipampa lead and silver smelter, which requires a supply of 51,000 metric tons of lead concentrates with a content of about 25,000 MTF. The Government of the Federal Republic of Germany, which provided the financing for the Karachipampa smelter, has recently set up a co-operation programme to develop new lead and silver reserves.

Copper, which had production levels of almost 6,000 MTF until 1975, has dropped substantially since 1980, when a number of private operations shut down as a result of the fall in copper prices. COMIBOL's Corocoro mine, producing native copper, is currently operating only on a precarious basis. This is one of the enterprises which will probably close shortly.

Overall, the increase in foreign currency earnings between 1975 and 1980 was due solely to price rises and not to a rise in production levels. In the period 1982-1985 there was also a drop in production volumes because of the low prices, which led to a reduction in foreign currency earnings from exports.

Mining imports account for between 7 per cent and 14 per cent of the country's total imports. The proportion is rising, particularly with respect to processed ores, which accounted for between 90 per cent and 96 per cent of imported ores in the same period (see table 4). The mining and metallurgical sector provides few jobs, employing only 4 per cent of the working population.

## V. LEGAL POSITION AND MARKETING

The main legal provisions governing mining activities in Bolivia are embodied in the Mining Code, which was approved by Decree-Law 7148 of 7 May 1965.

The Mining Code covers substantive aspects and procedures relating to prospecting, mine working, ore processing, rights and obligations of concession holders, their relationship with the State and the owner of the land, easements, expropriation, termination of concessions, contracts, marketing of ores, etc.

There are also further laws and regulations that fill a number of statutory and administrative gaps, primarily with reference to the functioning of the principal enterprises in the mining sector, such as COMIBOL (Bolivian Mining Corporation), which administers the entire State mining sector, the Bolivian Mining Bank, the National Smelting Enterprise, etc., which reflect the main mining policies adopted by the Government.

Table 4. Mining imports 1980-1982
(in millions of US$)

| | 1980 | % | 1981 a/ | % | 1982 a/ | % |
|---|---|---|---|---|---|---|
| Crude ores | 5.5 | 10 | 6.8 | 7 | 2.4 | 4 |
| Processed ores | 54.5 | 90 | 100.8 | 93 | 65.4 | 96 |
| A) Total mining imports | 60.0 | 100.0 | 107.6 | 100.0 | 67.8 | 96 |
| B) Total imports | 833.2 | | 901.0 | | 486.0 | |
| A/B Mining share of total imports (%) | 7 | | 12 | | 14 | |

Source: Instituto Nacional de Estadística

a/ Estimate.

This shows that the State has a predominant role in mining in Bolivia. In addition to its interest in the Bolivian Mining Corporation (COMIBOL), it maintains a number of other production or service enterprises which are under the supervision of the Ministry of Mining and Metallurgy:

- The National Smelting Enterprise (smelting of tin and antimony - currently incorporated in COMIBOL).

- The Bolivian Mining Bank (financing and marketing agency, principally for small-scale and co-operative mining).

- The National Prospecting Fund (agency providing venture capital for prospecting and development of reserves).

- The Bolivian Geological Service (primarily active in prospecting and regional geology, well-drilling, geotechnology and some provision of technical assistance for small-scale mining operations).

- The Institute of Mining and Metallurgical Research (metallurgical research to develop concentration processes, ore processing, pyro- and hydro-metallurgy. Mining School for middle-level technical specialists).

- SIDERSA (is investigating the possibility of establishing an iron and steel industry in Bolivia).

Ore marketing in Bolivia is carried out by COMIBOL and medium-scale mining enterprises, which export their production directly. The production of the smaller is marketed by the Bolivian Mining Bank (BAMIN). However, in order to strengthen State control over Bolivia's mineral exports, it was decided that the Mining Bank would continue to have a monopoly of the trading and marketing of the following minerals: gold, tin, lead, silver, antimony, wolfram, bismuth, zinc, sulphur and complexes of these minerals. 1/

It was also decided that other minerals not included in the above list could be developed and marketed by those legally authorized to do so. To do so, they were required only to pay, through the Bolivian customs offices, the royalties in force at the time of export. Such persons had to apply to the Government for a special permit and satisfy certain requirements. This made it possible to regulate trading methods in the country which had not previously been standardized.

With regard to the domestic marketing of minerals, Supreme Decree 6258 of 19 October 1962 authorized dealings in mineral concentrates with up to 10 per cent metal content in Bolivia provided they were for use in national smelters or concentrating plants of proven capacity. However, the decree also established an obligation to notify COMIBOL or the Mining Bank in advance of any such transactions.

Both decrees were promulgated before the Mining Code came into force in 1965 with an appreciably liberating effect on mining and metallurgical activities and mineral marketing, allowing producers to market their ores freely within Bolivia and abroad and to sell them to the purchaser of their choice, with the exception of the small-scale producers who remained under the supervision of the Mining Bank.

Later, in 1969, a monopoly in the export of ores and metals, both by State and private enterprises, was established in favour of the Mining Bank, although this did not function in practice.

The current situation is one of marketing freedom, under the provisions of Supreme Decree 21060 of 29 August 1985.

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1/ Supreme Decree 5697 of 3 February 1961.

# THE NON-FERROUS METALS INDUSTRY IN PERU

## I. NON-FERROUS MINERAL RESERVES

Peru has large reserves of non-ferrous minerals, principally copper, lead, zinc, silver and gold.

The country's copper reserves amount to approximately 27.724 million metric tons. The potential reserves amount to 103,000 million MTF.

The reserves of lead, found in association with zinc, silver, copper and other metals, total 5,181,862 metric tons. The potential reserves are estimated at 12 million MTF.

Zinc is also found together with silver, copper and other metals in multi-metal deposits. The country's total reserves amount to 14,293,000 metric tons. The potential reserves are calculated to be of the order of 25,800,000 MTF.

Silver is principally found in association with other metals. The country's reserves amount to 858,400,000 ounces. The potential reserves are calculated at 68,725 MTF.

Gold, a precious metal of great strategic interest both for the domestic and for the foreign market, is also found in considerable quantities in Peru. The main reserves are in the forest regions (3,297,000 ounces), in Arequipa (2,029,000 ounces), in La Libertad (3,016,000 ounces) and in Puno (3,970,000 ounces).

There are also smaller reserves of metals in combination, e.g. nickel, in association with copper (prospective reserves of approximately 250,000 metric tons); arsenic, in association with copper, silver and lead (reserves of 201,140 MTF); antimony, in association with copper, silver and lead (reserves of 111,600 MTF); bismuth, in association with copper, zinc and lead (reserves of 11,250 MTF).

## II. MINING AND METALLURGICAL PRODUCTION

Non-ferrous mining and metallurgical production in Peru comprises principally copper, lead, zinc and silver. Table 5 shows the production levels for these products in their various forms for the period between 1950 and 1984. Table 6 shows the growth rates for the various products.

Among the various non-ferrous products the highest growth rate was recorded by copper in the period 1950-1960. The annual rate of increase was 45.2 per cent. The growth rate then declined up to 1979 and dropped by 13 per cent in 1981 before recovering in 1982.

Lead, like copper, saw its greatest growth in the period between 1950 and 1960, with an annual rate of increase of 11.2 per cent. Thereafter there was a slight growth until 1983, but a drop of 1.7 per cent in 1984.

Zinc production rose in the two decades between 1950 and 1970 by 10.3 per cent and 9 per cent respectively. It then continued to increase, but at a slower rate, but without any decline being recorded. In 1984, zinc production rose by a mere 0.3 per cent despite reaching its highest price: 40.7 US cents per pound.

Silver production remained constant at an average level of 46 million troy ounces per annum during the period 1980-1984.

Table 5. Volume of production of the principal mining products, 1950-1984

| | 1950 Volume MT | 1960 Volume MT | 1970 Volume MT | 1980 Volume MT | 1981 Volume MT | 1982 Volume MT | 1983 Volume MT | 1984 Volume MT |
|---|---|---|---|---|---|---|---|---|
| COPPER | 33,327 | 183,988 | 220,225 | 379,600 | 329,300 | 355,000 | 317,000 | 354,700 |
| Refined | 20,799 | 30,236 | 36,178 | 223,488 | 200,400 | 224,536 | 194,669 | 225,649 |
| Blister | 2,548 | 133,552 | 140,741 | 125,100 | 101,934 | 98,107 | 99,659 | 100,642 |
| Concentrates y Ores | 9,980 | 20,200 | 13,306 | 31,012 | 26,966 | 32,357 | 22,672 | 28,409 |
| LEAD | 61,837 | 131,234 | 156,770 | 176,130 | 171,700 | 179,800 | 184,000 | 180,900 |
| Refined | 31,883 | 72,913 | 72,509 | 77,796 | 72,357 | 69,315 | 63,865 | 70,190 |
| Concentrates y Ores | 29,954 | 58,321 | 84,261 | 98,335 | 99,343 | 110,485 | 120,135 | 110,710 |
| ZINC | 77,494 | 157,254 | 299,136 | 426,200 | 437,500 | 465,000 | 476,000 | 477,600 |
| Refined and smelted products | 1,344 | 32,554 | 71,011 | 63,652 | 128,937 | 164,873 | 153,906 | 152,081 |
| Concentrates y Ores | 76,150 | 124,700 | 228,125 | 362,548 | 308,563 | 300,127 | 322,094 | 325,519 |
| SILVER (thousands of troy ounces) | 13,432 | 32,654 | 39,836 | 43,074 | 43,150 | 45,300 | 48,000 | 51,100 |
| Refined | 6,239 | 13,519 | 17,308 | 22,356 | 21,237 | 23,661 | 20,693 | 23,492 |
| Sterling | 766 | 689 | 838 | 161 | — | 66 | 8 | 43 |
| Blister y mixed bars | 588 | 2,467 | 3,760 | 2,830 | 2,339 | 2,351 | 2,132 | 2,471 |
| Concentrates y Ores | 5,839 | 15,979 | 17,930 | 17,727 | 19,674 | 19,222 | 25,167 | 25,094 |

Source: Sociedad Nacional de Minería y Petróleo

* Production began in 1953.

Table 6. Mining production
Average annual growth

| | 1950-60 (%) | 1960-70 (%) | 1970-80 (%) | 1980-81 (%) | 1981-82 (%) | 1982-83 (%) | 1983-84 (%) |
|---|---|---|---|---|---|---|---|
| Copper | 45.2 | 2.0 | 7.2 | -13.3 | 7.8 | -10.7 | 11.9 |
| Lead | 11.2 | 1.9 | 1.2 | - 2.5 | 4.7 | 2.3 | -1.7 |
| Zinc | 10.3 | 9.0 | 4.2 | 2.7 | 6.3 | 2.4 | 0.3 |
| Silver | 14.3 | 2.2 | 0.8 | 0.2 | 5.0 | 6.0 | 6.5 |

Source: Based on table "Producción de Principales Productos Mineros".

## III. LINKS BETWEEN THE NON-FERROUS METALS SECTOR AND THE OTHER SECTORS OF THE ECONOMY

### 1. Demand for goods and services in the mining and metallurgical sector

The non-ferrous metals sector, both at the ore extraction and concentration stage and at the processing stage, consumes considerable amounts of inputs from other sectors. In 1984, consumption during the ore extraction and concentration stage amounted to approximately $547.7 million and consumption during the processing stage to $626.4 million.

The non-ferrous metals sector is closely linked to the manufacturing sector. Approximately 53 per cent of the inputs used for ore extraction and concentration activities are provided by the manufacturing sector. For the processing stage, consumption of industrial products accounts for approximately 28 per cent of the total inputs. Table 7 shows the demand for goods and services in the mining and metallurgical sector.

### 2. Demand for mining and metallurgical products

Because of their metal content, the basic non-ferrous mining and metallurgical products are needed for virtually all the economic activities considered, principally for use in the production of intermediate manufactures and as inputs for the preparation of other products.

These products are primarily: refined silver, refined copper in the form of wire bars, cathodes and wire, refined lead and zinc in ingot form, as well as other secondary products such as bismuth, cadmium, indium, selenium and telurium, the last-mentioned being produced in the Centromín refinery by secondary recovery of anodic sludges.

The metal concentrates and ores of copper, zinc, lead, silver and other minerals (US$326,976,400) are sought as such by the non-ferrous metals processing sector for use in the preparation of basic products.

There is also a strong demand for non-metallic minerals (US$115,071,900), such as limestone, gypsum, clay and barytine, for use in various economic activities, but mainly in construction (US$83,303,800 - approximately 73 per cent of the total).

From table 8 it will be seen that there are important economic activities, whose basic product needs may be considered to be incipient, since they show a lower level of consumption. This is due to Peru's critical industrial situation.

### 3. Links between the mining and metallurgical sector and the energy sector

The supply of non-renewable energy in Peru has increased faster than has the supply of renewable energy. This is particularly so in the case of the most expensive resource, which is petroleum. However, the trend of world consumption of petroleum is precisely the opposite, i.e. diminishing.

Wood, bagasse, etc., have remained practically constant, in absolute terms, accounting for 28 per cent of the energy used, compared with a mere 6 per cent for hydro-energy, a resource that is available in abundance in Peru.

The proven reserves of coke and anthracite for generation of electricity in Peru are considerable and sufficient to provide an adequate supply for several decades. Nevertheless, the amount used represents just 0.5 per cent of the total for all sources.

Table 7. Demand for goods and services in the mining and metallurgical sector (1984 - thousands of US$)

| Goods and Services | Economic activity Mining and Metallurgical sector | Ore extraction and concentration Demand | % | Processing a/ of non-ferrous metals Demand | % |
|---|---|---|---|---|---|
| Farming and livestock products | | 3,096.0 | 0.57 | 418.9 | 0.07 |
| Mining products | | 801.5 | | 320,330.9 | |
| Copper concentrates and ores | | - | | 96,918.6 | 15.47 |
| Zinc concentrates and ores | | - | | 36,510.7 | 5.83 |
| Silver concentrates and ores | | - | | 169,179.5 | 27.01 |
| Other metallic concentrates and oros | | - | | 17,180.6 | 2.74 |
| Non-metallic minerals | | 801.5 | 0.15 | 541.5 | 0.09 |
| Manufactured products | | 290,874.2 | 53.11 | 173,561.5 | 27.70 |
| Electricity and water | | 71,446.0 | 13.04 | 72,288.8 | 11.54 |
| Construction | | 93.8 | 0.02 | 131.6 | 0.02 |
| Transport and communications | | 51,901.6 | 9.48 | 17,391.2 | 2.78 |
| Finance and insurance | | 13,048.8 | 2.38 | 13,881.4 | 2.22 |
| Miscellaneous services | | 116,398.1 | 21.25 | 28,403.6 | 4.53 |
| TOTAL CONSUMPTION | | 547,660.0 | 100.0 | 626,407.9 | 100.0 |
| REMUNERATION | | 191,378.8 | | 57,126.9 | |
| TOTAL PERSONNEL EMPLOYED | | 56,648 | | 11,550 | |
| | PAID | 45,800 | | 11,550 | |
| | UNPAID | 10,848 | | 0 | |

Source: BCR Report 1984-1985
Instituto Nacional de Estadística

a/ Excluding silver.

Table 8. Demand for mining and metallurgical products
(1984 - thousands of US$)

| Goods / Economic activity | Ores and concentrates: Copper | Zinc | Lead/Silver and others (*) | Non-metallic ores | Basic production non-ferrous metal ores (**) | TOTAL Demand | % |
|---|---|---|---|---|---|---|---|
| Farming and livestock, hunting and forestry | - | - | - | 3,546.2 | - | 3,546.2 | 0.62 |
| Fisheries | - | - | - | | 98.9 | 98.9 | 0.02 |
| Oil production | - | - | - | 421.8 | - | 421.8 | 0.07 |
| Ore extraction | - | - | - | 801.5 | 2,182.3 | 2,983.8 | 0.523 |
| Manufacture of dairy products | - | - | - | - | 280.8 | 280.8 | 0.05 |
| Fish processing and preservation | - | - | - | - | 339.3 | 339.3 | 0.06 |
| Processing of fishmeal and fish oil | - | - | - | - | 256.2 | 256.2 | 0.045 |
| Sugar processing and refining | - | - | - | 10.9 | 38.7 | 49.6 | 0.008 |
| Manufacture of other food products | - | - | - | 1,274.9 | 53.4 | 1,328.3 | 0.23 |
| Production of beverages and tobacco products | - | - | - | 17.3 | 514.1 | 531.4 | 0.093 |
| Textile manufacture | - | - | - | - | 16.4 | 16.4 | 0.003 |
| Footwear manufacture | - | - | - | - | 56.5 | 56.5 | 0.009 |
| Manufacture of wood and metal furniture | - | - | - | - | 770.9 | 770.9 | 0.13 |
| Manufacture of paper and paper products | - | - | - | 126.7 | 713.5 | 840.2 | 0.15 |
| Printing and publishing | - | - | - | 15.0 | 929.0 | 944.0 | 0.16 |
| Manufacture of basic chemicals and fertilizers | - | - | - | 3,731.7 | 11,126.4 | 14,858.1 | 2.59 |
| Manufacture of pharmaceuticals and medicines | - | - | - | 111.4 | 363.5 | 474.9 | 0.082 |
| Manufacture of other chemicals | - | - | - | 382.9 | 1,888.6 | 2,271.5 | 0.40 |
| Manufacture of rubber and plastics products | - | - | - | 205.1 | 673.4 | 878.5 | 0.15 |
| Manufacture of non-metallic mineral products | - | - | - | 13,904.8 | 172.8 | 14,077.6 | 2.46 |
| Iron and Steel | - | - | 5,817.4 | 4,355.7 | 6,503.2 | 16,676.3 | 2.91 |
| Proc. of non-ferrous metals | 96,918.6 | 36,510.7 | 186,360.1 | 541.5 | 29,931.6 | 347,262.5 | 60.58 |
| Manufacture of miscellaneous metal products | - | - | - | 353.7 | 11,892.1 | 12,245.8 | 2.14 |
| Construction of non-electrical machinery | - | - | - | 32.9 | 869.9 | 902.8 | 0.16 |
| Construction of electrical machinery and equipment | - | - | - | 10.7 | 27,213.2 | 27,223.9 | 4.75 |
| Construction of transport equipment | - | - | - | 56.3 | 7,184.9 | 7,241.2 | 1.26 |
| Manufacture of other misc. manufactured products | - | - | 1,369.6 | 10.7 | 28,288.8 | 29,669.1 | 5.18 |
| Production and distribution of electricity and water | - | - | - | 4.6 | 243.5 | 248.1 | 0.043 |
| Construction | - | - | - | 83,303.8 | 1,087.9 | 84,391.7 | 14.72 |
| Commerce | - | - | - | 271.5 | - | 271.5 | 0.05 |
| Transport and communications | - | - | - | 458.5 | 314.7 | 773.2 | 0.13 |
| Private health | - | - | - | - | 23.0 | 23.0 | 0.004 |
| Providers of Government services | - | - | - | 1,121.8 | 145.4 | 1,267.2 | 0.22 |
| TOTAL CONSUMPTION | 96,918.6 | 36,510.7 | 193,547.1 | 115,071.9 | 131,152.9 | 573,201.2 | 100.0 |
| PERCENTAGE | 16.91 | 6.37 | 33.76 | 20.08 | 22.88 | 100 | |

Source: BCB Report 1984-1985. Instituto Nacional de Planificacion; Instituto Nacional de Estadistica.

(*) Also includes tungsten, molybdenum, tin and antimony.
(**) The term "basic products" refers to high-purity products (refined).

If we look at demand we find the typical structure for a developing country, with the highest consumption levels in the residential and commercial sectors (38.7 per cent). The industrial sector consumes only a small percentage (17.9 per cent). In 1980 the mining and metallurgical sector accounted for barely 7.4 per cent of the total. Among other things, this reflects the low added value of the ore exported by Peru. This is critical, considering that about 50 per cent of the country's total exports come from mining. Table 9 shows the energy demand by sector.

## IV. OWNERSHIP STRUCTURE OF THE SECTOR

In 1968, the shares of gross national production were held as follows: foreign enterprises located in Peru - 31 per cent; Peruvian private enterprises - 55 per cent; State enterprises - 13 per cent. These figures changed in 1975 with an increase in direct State participation in production. The foreign enterprises reduced their share of production to 20 per cent, giving ground both to Peruvian private enterprises and to the State. The foreign share was cut by more than half, from 87 per cent in 1968 to 33 per cent in 1975 (see table 10).

Mining in Peru can be divided into three main sections: large-scale mining, medium-scale mining and small-scale mining. The large-scale mining section comprises four principal enterprises: Minero Perú, Hierro Perú, Centromín Perú and Southern Peru Copper Corporation. The first three belong to the public sector and the fourth is a consortium made up of foreign companies and the private sector. It is mainly concerned with development of copper and iron, accounting for an average of 89 per cent of the former (principally from the Toquepala and Cuajone deposits belonging to Southern, the Cerro Verde deposit of Minero Perú and the Cobriza, Yauricocha and Morococha deposits of Centromín Perú) and 100 per cent of the latter (from Marcona). It also accounts for the entire production of molybdenum. Its market share for lead and zinc is 40 per cent in each case (see table 11). In the last five years it accounted for 69.4 per cent of the gross production value, 59.3 per cent of the added value, 57 per cent of tax payments and 46.6 per cent of the manpower 2/.

The medium-scale mining section is primarily multi-metal and most of the share capital is Peruvian-owned. It is made up of 40 enterprises (6 of which have foreign capital). On average it produces 51 per cent of the lead, 64 per cent of the silver and 52 per cent of the zinc produced by Peru and contributes 25 per cent to the gross production value, utilizing 43 per cent of the sector's manpower.

Small-scale mining, the basic section pioneering the prospecting and discovery of new mines which then become part of the medium-scale and large-scale mining sections, is made up of 300 enterprises considered to be small mining producers and 2,000 individual miners, all with Peruvian capital (principally involved in working the Madre de Dios goldfield). It contributes 6 per cent of the value of the gross production and utilizes 10.3 per cent of the manpower. As regards ore production, it contributes an average of 2 per cent of the copper, 7 per cent of the lead, 7 per cent of the silver and 5 per cent of the zinc. It accounts for 50 per cent of total gold production.

## V. PRINCIPAL STATE AGENCIES PROMOTING THE DEVELOPMENT OF NON-FERROUS METALS

Four State bodies have been established to promote mining development: COFIDE, MINERO PERU, MINPECO and the BANCO MINERO.

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2/ Anuario de la Minería Peruana 1984-85 (Peruvian mining yearbook, 1984-1985), Wilfredo Huayta.

Table 9. Energy demand by sector
(In thousand tons oil equivalent - TOE)

| Sector | 1970 TOE | 1970 % | 1980 TOE | 1980 % | Annual growth 1970-1980 |
|---|---|---|---|---|---|
| Residential y commercial | 3,190 | 40.6 | 3,822 | 38.7 | 1.8 |
| Public sector | 164 | 2.1 | 321 | 3.2 | 6.9 |
| Transport | 1,679 | 21.4 | 2,260 | 22.8 | 3.0 |
| Farming and livestock and agro-industry | 553 | 7.0 | 351 | 3.6 | -4.4 |
| Fisheries | 662 | 8.4 | 305 | 3.1 | -7.4 |
| Mining and metallurgy | 367 | 4.7 | 734 | 7.4 | 7.1 |
| Industry | 1,101 | 14.0 | 1,776 | 17.9 | 4.9 |
| Non-energy* | 146 | 1.8 | 331 | 3.3 | 8.5 |
| TOTAL | 7,862 | 100.0 | 9,900 | 100.0 | 2.3 |

Compiled from de "Balance Nacional de Energía" series 1970-80. Ministry of Energy and Mines.

* Includes gas processing centre products such as hexane and gas for the production of fertilizers and the production of refined products, such as asphalt, solvents, oils, fats and bagasse for panels.

Source: Expansion Magazine, No. 3. Oct. 85/Jan. 86 - page 57.

Table 10. Peru: Breakdown of gross domestic product by form of ownership (percentage)

| Enterprises | 1968 | | | | | 1975 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Agriculture | Fisheries | Mining | Industry | TOTAL GDP | Agriculture | Fisheries | Mining | Industry | TOTAL GDP |
| Foreign | 25 | 25 | 87 | 37 | 31 | 0.3 | 10 | 33 | 30 | 21 |
| Private National | 75 | 75 | 12 | 55 | 55 | 50 | 10 | 17 | 45 | 46 |
| State-owned | — | — | 1 | 8 | 13 | — | 80 | 50 | 19 | 23 |
| Self-managing | — | — | — | — | 1 | 50 | — | — | 6 | 10 |

Source: Instituto Nacional de Planificacion, Concentracion de la Produccion y Estructura de la Propiedad. Cuadernos de Planificacion No. 3, Cuadro No. 31, (Concentration of production and patterns of ownership. Planning series No. 3, table 31), Lima 1980.

Table 11. Structure of mining production by category of deposit (percentage)

| | 1950 | 1960 | 1970 | 1980 | 1984 |
|---|---|---|---|---|---|
| COPPER (MT) | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 |
| Large-scale mining | 62.15 | 83.84 | 76.26 | 87.58 | 91.92 |
| Medium-scale mining | 32.15 | 14.06 | 20.72 | 10.51 | 6.51 |
| Small-scale mining | 4.93 | 2.10 | 3.29 | 1.89 | 1.55 |
| LEAD (MT) | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 |
| Large-scale mining | 35.13 | 25.43 | 30.84 | 39.14 | 38.38 |
| Medium-scale mining | 60.96 | 70.08 | 64.68 | 51.96 | 54.74 |
| Small-scale mining | 3.90 | 4.47 | 4.46 | 8.90 | 6.87 |
| ZINC (MT) | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 |
| Large-scale mining | 69.85 | 41.16 | 42.25 | 41.02 | 40.59 |
| Medium-scale mining | 28.64 | 56.89 | 55.91 | 53.36 | 54.58 |
| Small-scale mining | 1.50 | 3.12 | 1.83 | 5.60 | 4.82 |
| SILVER (thousands of ounces) | 100.0 | 100.0 | 100.0 | 100.0 | |
| Large-scale mining | 33.18 | 20.48 | 26.73 | 26.74 | 26.87 |
| Medium-scale mining | 61.49 | 73.15 | 68.00 | 68.67 | 65.06 |
| Small-scale mining | 5.32 | 6.36 | 5.25 | 4.57 | 8.07 |
| IRON | 100.0 | 100.0 | 100.0 | 100.0 | |

Source: Sociedad de Mineria y Petroleo.

1. Cofide

Cofide was established under article 24 of the Law of 12 June 1981 to act as a financial intermediary for the promotion of projects and the financing of new undertakings in accordance with State policy and plans.

As a general rule, the lines of credit administered by Cofide may not be used to finance investment in prospecting, development and preparation of mines. Its resources are to be used principally to finance the purchase of machinery and equipment for mines and processing plants, for which purpose, in addition to its own resources, it has lines of credit granted by the World Bank, the Export Development Corporation of Canada, the Regional Investment Fund, etc. - with preference going to medium-scale mining.

2. Minero Perú

Under article 3 of the Law of 4 March 1981, Minero Perú can invest in other enterprises with the aim of carrying out mining projects both inside and outside Peru.

There is no reliable information regarding the amount of the investments made. In general, however, it can be said that these investments have been very limited, given the difficult economic situation of Minero Perú.

3. Minpeco

As a result of the loss of monopoly control over the marketing of ores and metals, Minpeco has carried out a programme of short-term financing for medium- and small-scale mining in the form of working capital, as an advance for ore at plant and mine level, to ensure continuity of production. It is carrying on this activity in a very dynamic manner using funds from its commercial operations, repayable in six months with interest at market rates.

4. Banco Minero

The resources administered by Banco Minero are for use in small- scale and medium-scale mining projects, with emphasis on the former, to help in financing the purchase of machinery and equipment and concentration plants to provide working capital. It also finances investment connected with prospecting, development and preparation of mines.

VI. THE ECONOMIC IMPORTANCE OF NON-FERROUS METALS

Mining is considered a strategic sector in the development of the Peruvian economy. It is the largest generator of foreign exchange through exports. It also has an appreciable impact on State revenue through tax payment and the direct and indirect creation of employment. It also plays an important role in stimulating other sectors of the nation's economy.

In the 1970s, the mining and metallurgical sector contributed an average of 6 per cent to the gross domestic product, a share which then declined to between 4 per cent and 5.4 per cent. Inclusion of the basic metals industries makes this share 7.8 per cent for 1970, 9.3 per cent for 1980 and 9.9 per cent for 1985.

In the period 1978-1980, Peruvian mining's share of world exports amounted to 6.9 per cent for copper, 8.2 per cent for lead, 6.8 per cent for zinc and 1.4 per cent for iron.

The mining and metallurgical sector provides over 40 per cent of Peru's total exports. The main export products are copper, lead, zinc, silver and iron. Of these, copper brings in the largest amount of foreign exchange - over the last 30 years contributing approximately half the total income from mining exports (see table 12).

## VII. POLICIES

Generally speaking, there are at present no medium-term or long-term plans for mining and metallurgical development. The last plans were drawn up in 1979 ("Long-term mining development plan 1979-1990, projection to the year 2000") and in 1982 (Medium-term sectoral plan 1982-1985). The sector is at present essentially governed by emergency laws. The present Government has designated the mining sector as the source of finance for national development and has set the following main objectives:

- Development of potential and new reserves and diversification of mining and metallurgical production by promoting an increase in the added value of mineral products in order to boost the country's industry and increase exports.

- Encouragement of the development of more stable mineral products, both in the medium and in the long term. The same applies to multi-metal deposits because of their greater diversification capability.

- Promotion of the development of large-scale mining, an increase in the realization of gold and multi-metal projects by medium-scale mining and support for small-scale mining production through an increase in the number of mining units in order to achieve overall development of the sector.

- Attraction of foreign investment and increased domestic investment for development of the sector.

It is believed that all these objectives can be achieved by adopting the strategies outlined below:

- Encouraging the participation of private enterprise in development of the State sector's working of known deposits - with emphasis on those minerals having better commercial prospects.

- Arranging appropriate financing for the medium-scale mining sector and, above all, for the small-scale mining sector.

The projects which will be given priority by the Government include the following:

(1) San Antonio de Poto and Madre de Dios washing project (gold).

(2) Antamina (multi-metal).

(3) Tambo Grande (multi-metal).

(4) Bayovar (phosphates for Peruvian agriculture).

(5) Alto Chicama (coal).

(6) Marcona washing project (cobalt).

(7) Macusani, Carabaya Province, Puno (uranium).

Table 12. Principal mining and metallurgical exports (FOB)
(million US dollars and percentage)

| | 1950 * | | 1960 | | 1970 | | 1975 | | 1979 | | 1980 | | 1981 | | 1982 | | 1983 | | 1984 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | $ | % | $ | % | $ | % | $ | % | $ | % | $ | % | $ | % | $ | % | $ | % | $ | % |
| Copper | 10 | 5 | 95 | 21 | 278 | 27 | 165 | 13 | 689 | 20 | 624 | 16 | 529 | 16 | 460 | 14 | 443 | 15 | 442 | 14 |
| Silver | 8 | 4 | 24 | 5 | 29 | 3 | 83 | 6 | 223 | 6 | 76 | 2 | 313 | 10 | 206 | 6 | 391 | 13 | 227 | 7 |
| Zinc | 11 | 6 | 17 | 4 | 47 | 5 | 173 | 14 | 154 | 5 | 191 | 5 | 272 | 8 | 263 | 8 | 307 | 10 | 341 | 11 |
| Lead | 12 | 6 | 22 | 5 | 63 | 6 | 74 | 6 | 290 | 8 | 333 | 8 | 219 | 7 | 216 | 7 | 293 | 10 | 233 | 7 |
| Iron | * | | 32 | 7 | 67 | 6 | 55 | 4 | 86 | 2 | 80 | 2 | 93 | 3 | 108 | 3 | 75 | 2 | 58 | 2 |
| Total mining and metallurgical exports | 41 | 21 | 190 | 43 | 484 | 47 | 550 | 43 | 1442 | 41 | 1304 | 33 | 1425 | 44 | 1258 | 38 | 1509 | 50 | 1301 | 41 |
| Other exports | 152 | 79 | 253 | 57 | 550 | 53 | 741 | 57 | 2049 | 59 | 2594 | 67 | 1830 | 56 | 2035 | 62 | 1506 | 50 | 1846 | 59 |
| Total exports | 193 | 100 | 443 | 100 | 1034 | 100 | 1291 | 100 | 3491 | 100 | 3838 | 100 | 3255 | 100 | 3293 | 100 | 3015 | 100 | 3147 | 100 |

Source: 1950-60: Peru's national accounts. BCR 1950-65. Page 53
1970-81: JUNAC statistics
1982-84: IMF: International Financial Statistics. Yearbooks 1980-85.

Note *: Production starts in 1953.

# THE NON-FERROUS METALS INDUSTRY IN CHILE*

## I. NON-FERROUS ORES

### 1. Reserves

CODELCO, the copper corporation of Chile, is the owner of the copper deposits in Chuquicamata, Salvador, Rio Blanco and El Teniente. Chuquicamata has the most important reserves, however its copper content is the lowest. Salvador, which has the smallest deposit has the highest copper content. The following table shows the reserves and copper content of the different deposits.

Table 13. Copper Reserves
(million tons)

| Deposits | Initial Reserves | Copper content | Reserves 1985 | Copper content |
|---|---|---|---|---|
| Chuquicamata | 5,974 | 0.97 | 4,909 | 0.81 |
| Salvador | 466 | 1.19 | 257 | 1.12 |
| Andina | 1,501 | 1.08 | 1,430 | 1.06 |
| El Teniente | 5,523 | 1.08 | 4,858 | 0.98 |

### 2. Evolution of the non-ferrous ores

The global production of the mines under study increased in the period 1975-1984 from 46,324 thousand tons to 83,037 thousand tons. An increase in production of 28.6 per cent also took place between 1980 and 1984. In 1981 there was a decrease of production due to a strike of approximately 42 days in the mine El Teniente. Table 14 shows the evolution of the mining production of CODELCO.

### 3. Labour force

The labour force employed in the mines is approximately 7329 persons. El Teniente has the highest level of employment with 3143 and Andina the lowest with 735 persons. In the concentrating operation the employment generated is 2074 persons, of which 830 are employed in El Teniente, 727 in Chuquicamata, 287 in Salvador, and 230 in Andina. Table 15 indicates the employment in the mining and concentrating operations.

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* This study of the non-ferrous industry in Chile will only focus on copper produced by the State Enterprise CODELCO-Chile.

Table 14. Mining production
(thousand tons)

| Years | Chuquicamata 1/ | Salvador | Andina | Teniente | TOTAL CODELCO |
|---|---|---|---|---|---|
| 1975 | 14,522 | 8,567 | 4,215 | 19,020 | 46,324 |
| 1976 | 20,413 | 8,606 | 4,516 | 20,476 | 54,011 |
| 1977 | 27,050 | 8,624 | 4,825 | 20,226 | 60,715 |
| 1978 | 26,479 | 8,543 | 4,365 | 20,664 | 60,051 |
| 1979 | 29,589 | 8,651 | 4,328 | 21,122 | 63,690 |
| 1980 | 29,810 | 8,728 | 4,982 | 21,024 2/ | 64,544 |
| 1981 | 28,685 | 9,021 | 5,318 | 19,627 2/ | 62,651 |
| 1982 | 36,493 | 11,838 | 5,267 | 23,250 | 76,848 |
| 1983 | 38,982 | 12,191 | 5,615 | 24,136 | 80,924 |
| 1984 | 38,727 | 12,495 | 7,251 | 24,564 | 83,037 |

1/ Sulphur + Oxyd

2/ Strike 12 days in 1980 and 42 days in 1981

Table 15. Employment in mining and concentration

| Division | Mine | Concentrating plant |
|---|---|---|
| Chuquicamata | 1,545 | 727 |
| Salvador | 1,906 | 287 |
| Andina | 735 | 230 |
| El Teniente | 3,143 | 830 |

4. Intermediary consumption in mining and concentration

The main purchases in mining activities are electricity, petroleum, explosives, concrete and wood. In table 16 the main purchases of each of the different mines are shown. With regard to the concentrating operation, the main purchases are electricity, steel and chemicals (reactives, etc.).

Table 16. Intermediary consumption in mines

| Chuquicamata | 1980 | 1981 | 1982 | 1983 | 1984 |
|---|---|---|---|---|---|
| Explosives (tons) | 18,495 | 19,880 | 18,072 | 18,184 | 22,525 |
| Tyres (units) | — | — | — | — | 705 |
| Petroleum ($m^3$) | 43,384 | 44,935 | 49,589 | 46,761 | 51,265 |
| Electric energy (mKWH) | 66,387 | 56,464 | 61,833 | 62,224 | 74,567 |

| Salvador | 1980 | 1981 | 1982 | 1983 | 1984 |
|---|---|---|---|---|---|
| Explosives (tons) | 1,143 | 1,186 | 1,218 | 1,251 | 1,529 |
| Petroleum ($m^3$) | — | — | — | — | 1,257 |
| Wood (thousand feet) | 2,898.9 | 2,425.7 | 1,575.8 | 1,779.2 | 1,943.6 |
| Steel | — | — | 2,246 | 3,134 | 3,758 |
| Concrete ($m^3$) | 24,293 | 27,669 | 35,716 | 35,503 | 33,689 |
| Electric energy (mKWH) | 32,258 | 32,722 | 32,705 | 37,159 | 41,463 |

| Andina | 1980 | 1981 | 1982 | 1983 | 1984 |
|---|---|---|---|---|---|
| Explosives (tons) | 282.2 | 308.5 | 179.0 | 212.0 | 251.0 |
| Petroleum ($m^3$) | — | — | 791 | 1,235 | 898 |
| Concrete ($m^3$) | — | — | 4,748 | 4,491 | 2,618 |
| Electric energy (mKWH) | 15,504 | 16,009 | 12,672 | 13,850 | 15,408 |

| El Teniente | 1980 | 1981 | 1982 | 1983 | 1984 |
|---|---|---|---|---|---|
| Explosives (tons) | 1,069 | 898.5 | 1,170.2 | 1,376.1 | 1,374.3 |
| Petroleum ($m^3$) | — | — | 683.9 | 917.5 | 1,345.8 |
| Wood (thousand feet) | 4,175.2 | 3,983 | 3,374.2 | 3,186.2 | 3,364.6 |
| Electric energy (mKWH) | 68,203 | 64,226 | 68,001 | 76,710 | 83,339 |

Table 17. Intermediary consumption in concentration

| Chuquicamata | 1980 | 1981 | 1982 | 1983 | 1984 |
|---|---|---|---|---|---|
| Electricity (KWH x $10^6$) | 309.1 | 297.7 | 386.4 | 431.4 | 431.0 |
| Steel grinder | 20,340 | 19,260 | 25,860 | 28,700 | 28,860 |
| Lime (100% CaO) TM | 17,300 | 17,000 | 29,400 | 30,900 | 33,000 |
| Reactive Flot. Copper TM | 2,260 | 2,200 | 2,610 | 2,640 | 2,920 |
| Reactive Flot. Molib. TM | 16,700 | 16,700 | 16,900 | 16,100 | 15,000 |

| Salvador | 1980 | 1981 | 1982 | 1983 | 1984 |
|---|---|---|---|---|---|
| Electricity (KWH x $10^6$) | 134.5 | 133.3 | 162.4 | 166.9 | 167.7 |
| Steel grinder | 6,650 | 6,800 | 8,630 | 8,810 | 8,370 |
| Lime (100% CaO) TM | 20,200 | 22,700 | 30,000 | 27,600 | 34,500 |
| Reactive Flot. Copper TM | 530 | 530 | 710 | 1,090 | 1,230 |
| Reactive Flot. Molib. TM | 2,930 | 2,900 | 3,090 | 2,930 | 2,890 |

| Andina | 1980 | 1981 | 1982 | 1983 | 1984 |
|---|---|---|---|---|---|
| Electricity (KWH x $10^6$) | 104.5 | 106.2 | 102.4 | 113.4 | 143.1 |
| Steel grinder | 4,070 | 4,340 | 4,030 | 4,450 | 5,500 |
| Lime (100% CaO) TM | 6,320 | 7,920 | 4,110 | 5,180 | 7,840 |
| Reactive Flot. Copper TM | 285 | 308 | 276 | 285 | 315 |
| Reactive Flot. Molib. TM | 1,150 | 1,130 | 1,450 | 1,280 | 2,360 |

| El Teniente | 1980 | 1981 | 1982 | 1983 | 1984 |
|---|---|---|---|---|---|
| Electricity (KWH x $10^6$) | 418.6 | 386.1 | 459.4 | 448 | 495.8 |
| Steel grinder | 15,620 | 13,090 | 15,440 | 15,180 | 16,180 |
| Lime (100% CaO) TM | 20,700 | 21,400 | 17,800 | 28,600 | 24,400 |
| Acid (100% $H_2SO_4$) TM | 43,700 | 37,800 | 39,200 | 29,900 | 39,300 |
| Reactive Flot. Copper TM | 1,970 | 1,790 | 1,800 | 1,870 | 2,090 |
| Reactive Flot. Molib. TM | 2,600 | 2,610 | 2,790 | 2,850 | 2,970 |

## II. PROCESSING OPERATIONS

### 1. Capacity of production

The installations for processing copper are the smelters of Chuquicamata, Salvador and El Teniente; and the refineries of Chuquicamata and Salvador. The installed capacity of the smelters is measured in relation with the quantity of concentrates that can be smelted to produce blister and the refineries in relation with the production of cathodes. The following table shows the installed capacity of the smelters and refineries.

Table 18

| | Smelters | Refineries |
|---|---|---|
| Chuquicamata | 3,100 MT/day | 365,000 MT/year |
| Salvador | 900 MT/day | 100,000 MT/year |
| El Teniente | 2,800 MT/day | ..... |

The percentage of copper recovery of the different processing installations varies from 92 to 96 per cent. The installations of Chuquicamata increased their percentage of recovery from 93.7 in 1981 to 94.3 per cent in 1985. The installations of Salvador improved their recovery from 95.5 per cent to 96 per cent during the same period, and El Teniente from 95.3 per cent to 96 per cent.

The percentage of copper recovery of CODELCO increased between 1976 and 1984 by approximately 23 per cent. The production increased from 854.1 metric tons in 1976 to 1,049.7 metric tons in 1984.

### 2. Investment

The investment to increase the capacity of smelting in the period 1976 to 1984 was US$106.1 million. To increase the capacity of refinement for the same period, there was an investment of US$22.2 million.

In the period under analysis there was also a large investment to improve the existing processing installations in order to increase the productivity of the existing assets. The investments made were US$154 million to improve the existing smelters, and US$43.6 million to increase the efficiency of the refineries. Table 19 shows the investments in the period 1976-1984.

Table 19. Investments
(million dollars of 1984)

| | 1976 | 1977 | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | Total |
|---|---|---|---|---|---|---|---|---|---|---|
| 1. Investment to improve existing installations | | | | | | | | | | |
| a) smelting | 27.1 | 23.1 | 35.7 | 19.2 | 19.4 | 10.3 | 7.1 | 6.3 | 5.8 | 154.0 |
| b) refinery | 3.2 | 4.9 | 4.7 | 7.7 | 6.2 | 6.7 | 4.2 | 3.5 | 2.5 | 43.6 |
| sub-total | 30.3 | 28.0 | 40.4 | 26.9 | 25.6 | 17.0 | 11.3 | 9.8 | 11.3 | 197.6 |
| 2. Investment to increase capacity | | | | | | | | | | |
| a) smelting | 3.2 | 7.1 | 0.0 | 16.6 | 5.8 | 15.2 | 28.6 | 18.3 | 11.3 | 106.1 |
| b) refinery | 0.2 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 8.9 | 13.1 | 22.2 |
| sub-total | 3.4 | 7.1 | 0.0 | 16.6 | 5.8 | 15.2 | 28.6 | 27.2 | 24.4 | 128.3 |
| Total | 33.7 | 35.1 | 40.4 | 43.5 | 31.4 | 32.2 | 39.9 | 37.0 | 35.7 | 325.9 |

3. Intermediary consumption

The main inputs used in the smelting and refining processes are electricity and refractories. The processing operations of Chuquicamata increased their electricity consumption from 247.7 KWHx$10^6$ to 298.2 KWHx$10^6$ in the period 1980 to 1984. In Salvador, the consumption of electricity was practically the same, 65 KWHx$10^6$ in 1980 and 68.6 KWHx$10^6$ in 1984, and in El Teniente there was a decrease from 210.9 KWHx$10^6$ to 198.6 KWHx$10^6$ in the same period.

In the period under analysis, the consumption of fuel registered a decline in the cases of Chuquicamata and El Teniente, and a relatively small increase was observed in the processing operations of Salvador. The consumption of refractories was relatively stable. Table 20 shows the consumption of the main inputs by the different processing installations.

Table 20. Consumption of main inputs

| Chuquicamata | | 1980 | 1981 | 1982 | 1983 | 1984 |
|---|---|---|---|---|---|---|
| Electricity | KWH x $10^6$ | 247.7 | 247.4 | 274.7 | 275.1 | 298.2 |
| Combustibles | T M x $10^3$ | 115.0 | 107.0 | 103.9 | 102.0 | 96.1 |
| Refractories | T M x $10^3$ | 3.2 | 3.2 | 3.7 | 3.3 | 3.0 |

| Salvador | | 1980 | 1981 | 1982 | 1983 | 1984 |
|---|---|---|---|---|---|---|
| Electricity | KWH x $10^6$ | 65.0 | 63.9 | 62.5 | 59.1 | 68.6 |
| Combustibles | T M x $10^3$ | 39.6 | 41.4 | 42.0 | 45.4 | 45.2 |
| Refractories | T M x $10^3$ | 0.9 | 0.8 | 1.0 | 1.4 | 1.4 |

| El Teniente | | 1980 | 1981 | 1982 | 1983 | 1984 |
|---|---|---|---|---|---|---|
| Electricity | KWH x $10^6$ | 210.9 | 184.7 | 169.9 | 183.0 | 198.6 |
| Combustibles | T M x $10^3$ | 83.5 | 67.5 | 66.0 | 69.2 | 61.8 |
| Refractories | T M x $10^3$ | 4.5 | 3.7 | 3.3 | 3.7 | 3.8 |

## III. STRATEGY OF DEVELOPMENT

Copper exports represent the main source of foreign income for the Chilean economy; this permits the imports of capital goods, consumer goods and services needed for the process of reproduction. In this context the mining and copper processing constitutes the main pillar of the economy.

The development of copper mining and processing is mainly oriented towards exports, thus obtaining a high level income of foreign currency.

This outward strategy of development is based on the assumption that the exports of copper can increase at the world wide level, due essentially to the low mining costs in Chile compared with other copper producing countries. This strategy also takes into account that the low costs in Chile can compensate for the decreases in the prices of copper in the world market.

The expansion of the copper activities is based on the development of new projects of high rentability with a substantial participation of foreign capital. In this context the following projects are being developed:

a) Quebrada Blanca

The investment required to develop the mining deposit of Quebrada Blanca is US$500 million of which 49 per cent belong to the Chilean Government and the remainder to a group of foreign investors constituted by The Superior Oil Co, Falconbridge Mines Ltd., Canadian Superior Oil Ltd. and McIntyre Mines Nevada Ltd. The enterprise in charge of the implementation of this project is Doria Ines Ltda.

b) Collahuari

In June 1985 a joint venture was signed by the firm Cia. Minera Dona Ines de Collaguari S.A. to exploit the mining deposit of Collahuari located north-east of Quebrada Blanca.

c) Los Pelambres

The investment of this project was evaluated at approximately US$1,100 million in June 1983. For the development of this project a contract has been signed between Anaconda Chile Inc. and the Chilean Government.

d) La Escondida

In May 1982, Minera Getty Mining Chile Inc. and Minera Utah de Chile Inc. signed an agreement with the Chilean Government to develop prefeasibility studies and a programme of exploitation. At the end of 1984 Texaco (United States) bought the participation of Getty Mining and Utah was acquired by Broken Hill of Australia. Finally, in 1985, Broken Hill bought the participation of Texaco in the project.

e) Cerro Colorado

The Cerro Colorado project will begin its operations in 1988-89 with an investment of approximately US$500 million.

Nippon Mining Ltd was in charge of the exploration of this deposit between 1975 and 1980 and since 1981 Company Cerro Colorado S.A. have been responsible for its development. In this company there is foreign participation through the Compania Minera Riochulex Ltda., which is a subsidiary of Rio Algorn Ltd, which, in turn, is a subsidiary of Rio Tinto Zinc.

The operation of further processing of copper is mainly based on the possibility of increasing the exports. The production of semi for exports has been considered to be an important line of development. In this context, attention should be given (1) to the location of certain joint processing plants in the principal consuming countries, with the aim of removing barriers to sales in such markets, and (2) to the promotion of new uses of copper world-wide in order to increase the consumption at the world level. For this there is a need for co-operation between the main producers of copper.

# THE NON-FERROUS METALS INDUSTRY IN BRAZIL

## I. NON-FERROUS MINERAL RESERVES

In 1979 Brazil's bauxite reserves were calculated at 2,532 million tons, of which almost 90 per cent are located in the areas of Onximina and Paragominas in the state of Pará. Brazil possesses the world's third largest bauxite reserves.

The level of the tin reserves is calculated at 172 million tons, with a tin content of 876 grammes per cubic metre, the main deposits being in the states of Rondonia, Pará, Amazonas and Góias.

Brazil has only small reserves of copper. In 1984 they amounted to 734 million tons, principally located in the Marabá area in Pará. The reserves there amount to 400 million tons, with a copper content of 9.85 per cent. Reserves of 155 million tons, containing 0.40 per cent copper, have been detected at Mara Rosa in the state of Góias.

The measured nickel reserves amount to 237.4 million tons, containing 3.5 million tons of lateritic-type nickel, located mainly in the state of Góias and having an average nickel content of 1.4 per cent.

The gold reserves are calculated at 350 million tons of ore. The measured zinc reserves amount to 20.5 million tons of zinc ore.

## II. MINING AND METALLURGICAL PRODUCTION

During the present decade the growth of mining and metallurgical production has been considerable: in 1983 it was 14.5 per cent higher than in 1982 and in 1984 it was 27.3 per cent higher than in the previous year (see tables 21 and 22).

In the non-ferrous minerals sector, aluminium production achieved annual growth rates in 1982 and 1983 of 18.1 per cent and 28.5 per cent respectively, due to the increase in installed capacity for export. The growth rates in the subsequent years have also been impressive.

The installed capacity in 1980 was divided among three main producers: Cía. Brasileira de Aluminio SA (CBA), with a capacity of 85,000 metric tons/year, Alcoa with 90,000 metric tons/year and Alcan with 88,000 metric tons/year. Even with all these plants working at full output it was not possible to satisfy the demand and some 80,000 metric tons had to be imported. It is hoped that the start-up of a number of large projects will meet the increasing domestic demand.

Copper production has been variable during the last decade. In 1983 it increased by 81.3 per cent over the previous year and in 1985 by 46.8 per cent over 1984. There was a slight drop in 1984 because of the technical problems at Caraiba Metais only refining plant, located in the Camacari - Bahía industrial complex.

Copper supplies were obtained mainly through imports from the United States and Chile (since 1975), but it is expected that the start-up of current projects will make it possible to achieve an annual production level of 270,000 metric tons/year copper content.

Lead production rose by 18.1 per cent, 13.6 per cent and 13.9 per cent in the latest years, with this upward trend being somewhat limited by the environmental restrictions placed on lead smelting by the Government. The capacity of the COBRAC plant is 41,000 metric tons/year and it is not being fully utilized.

Table 21. Mining and metallurgical production

| | 1975 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 |
|---|---|---|---|---|---|---|---|
| 1) Aluminium | 145,111 | 310,711 | 292,458 | 345,394 | 443,780 | 503,945 | 594,658 |
| - Primary | 121,856 | 260,611 | 256,418 | 299,054 | 400,744 | 454,999 | 549,830 |
| - Secondary | 23,255 | 50,100 | 36,040 | 46,280 | 43,016 | 48,946 | 44,828 |
| 2) Lead | 62,722 | 90,418 | 70,764 | 53,398 | 63,066 | 71,621 | 81,575 |
| - Primary | 37,538 | 44,519 | 34,657 | 21,943 | 20,581 | 25,965 | 29,811 |
| - Secondary | 25,184 | 45,899 | 36,107 | 31,455 | 42,485 | 45,656 | 51,764 |
| 3) Copper | 33,309 | 63,000 | 45,000 | 56,812 | 103,003 | 97,334 | 142,880 |
| - Primary | 1,309 | — | — | 4,812 | 63,083 | 61,334 | 93,880 |
| - Secondary | 32,000 | 63,000 | 45,000 | 52,000 | 39,920 | 36,000 | 49,000 |
| 4) Tin | 6,518 | 8,796 | 7,789 | 9,298 | 12,960 | 18,877 | 24,701 |
| - Primary | 6,518 | 8,796 | 7,789 | 9,298 | 12,960 | | 24,701 |
| - Secondary | — | — | — | — | — | — | — |
| 5) Nickel | 2,279 | 2,504 | 2,334 | 4,813 | 10,740 | 12,176 | 13,166 |
| - Primary | 2,279 | 2,505 | 2,334 | 4,813 | 10,740 | 12,176 | 13,166 |
| - Secondary | — | — | — | — | — | — | — |
| 6) Silicon | 824 | 13,302 | 18,957 | 17,921 | 20,609 | 25,884 | 29,291 |
| - Primary | 824 | 13,302 | 18,957 | 17,921 | 20,609 | 25,884 | 29,291 |
| - Secondary | — | — | — | — | — | — | — |
| 7) Zinc | 39,434 | 96,025 | 110,830 | 110,434 | 110,958 | 114,449 | 120,737 |
| - Primary | 31,434 | 78,359 | 91,830 | 96,037 | 98,913 | 106,927 | 16,136 |
| - Secondary | 8,000 | 17,666 | 19,000 | 14,397 | 11,045 | 7,522 | 4,601 |
| 8) Iron (thousands of tons) | ND | 134,045 | 107,964 | 108,217 | 106,309 | 139,957 | 156,512 |
| - Primary | ND | 92,162 | 72,275 | 72,561 | 65,831 | 87,368 | 98,263 |
| - Secondary a/ | ND | 41,883 | 35,689 | 35,656 | 40,478 | 52,589 | 58,249 |

Source: Statistical Yearbook. Metallurgical sector. CONSIDER. MIC 1983, 1986.

a/ The iron and steel industry.

Table 22. Growth of mining and metallurgical production

(1975, 1980-85)
(percentage)

| | 1975-80 | 1981 | 1982 | 1983 | 1984 | 1985 |
|---|---|---|---|---|---|---|
| Aluminium | 22.8 | -5.9 | 18.1 | 28.5 | 13.6 | 18.0 |
| Lead | 8.8 | -21.7 | -24.5 | 18.1 | 13.6 | 13.9 |
| Copper | 17.8 | -28.6 | 26.2 | 81.3 | -5.5 | 46.8 |
| Tin | 7.0 | -11.4 | 19.4 | 39.3 | 45.8 | 30.9 |
| Nickel | 9.9 | -6.8 | 106.2 | 123.1 | 13.4 | 8.1 |
| Silicon | 301.9 | 42.5 | -5.5 | 15.0 | 25.6 | 13.2 |
| Zinc | 28.7 | 15.4 | -0.4 | 0.5 | 3.1 | 5.5 |
| Iron | ND | -19.5 | 0.2 | -1.8 | 31.7 | 11.8 |
| Total mining production | 6.9 a/ | 0.2 | 6.7 | 14.5 | 27.3 | ND |

Source: Based on table 13.

a/ Latin American Statistical Yearbook. ECLA 1984.

Tin production has recorded unprecedented growth since 1982, when it rose by 19.5 per cent, then going on to achieve an annual rate of increase of 46 per cent in 1984 and 31 per cent in 1985, attaining primary ore production levels of 18,900 and 24,700 tons in 1984 and 1985 respectively. This dynamic trend can be explained by the increase in domestic and external demand for tin.

"The installed capacity is 50 per cent greater than the effective production level, owing to the relatively low investment costs and the price differential between tin metal and the tin contained in casiterite, which provide an incentive for export and integration of the enterprises in the mining and metallurgical sector." 3/

Up to 1980, nickel production was in the hands of Cía. Morro do Níquel, which, with an installed capacity of 2,600 metric tons/year, fully met the local ferro-nickel demand. Only electrolytic nickel had to be imported. The year 1981 saw a slight drop in production of 6.8 per cent, but this was regained in the following years, with growth levels of 106.2 per cent and 123.1 per cent in 1982 and 1983 respectively, following the start of production by Cía. de Níquel Tocatins with an initial capacity of 5,000 metric tons/year, to be expanded to 10,000 metric tons/year. This level was exceeded in 1983 by the production of 10,740 metric tons of metal. Production has since remained steady. This is nevertheless one of the minerals holding out the greatest prospects for Brazil. It could also become a significant export item; a project is in fact in preparation to produce 55,000 tons of ferro-nickel annually.

The trend of zinc production shows considerable growth in 1980, when a production level of 96,025 tons was achieved as a result of the start-up of operations by Cía. Paraibuna de Metais, with an initial smelting capacity of 30,000 tons (to be expanded up to 60,000 metric tons). The level dropped slightly in 1982 and moderate growth was then maintained with 3.1 per cent and 5.5 per cent in 1984 and 1985, in which years 140,000 and 120,000 tons respectively were produced.

## III. GROWTH PROSPECTS

Brazil has a portfolio of wide-ranging projects for implementation in the coming years, mainly relating to aluminium and nickel, of which Brazil possesses large potential reserves. This will make the country a main exporter of these minerals, thus helping its trade balance by reducing the need to import these products.

According to a survey carried out by ECLA in 1982, aluminium production is expected to rise by 12 per cent per annum between 1986 and 1990, as new projects come on stream. Domestic demand is also expected to rise by 12 per cent, assuming sustained economic growth and an increase in per capita consumption of aluminium as the latter can be used as a substitute for other minerals. A deficit is not expected until 1989, but, provided the timetable of operations for the ALUMAR and ALUNORTE projects is observed, this deficit can be covered.

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3/ Exports were also encouraged by tax advantages which compensated for the higher price of imported concentrate (Doc. E/CEPAL/SEM.3/R.7 page 51).

Forecast of aluminium supply and demand, 1986-1990
(thousands of tons)

| | | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 |
|---|---|---|---|---|---|---|---|
| (1) | Domestic demand | 383 | 520 | 580 | 650 | 730 | 820 |
| | Production | 595 | 824 | 994 | 1094 | 1144 | 1304 |
| | - Primary | 550 | 764 | 924 | 1014 | 1054 | 1204 |
| | - Secondary | 45 | 60 | 70 | 80 | 90 | 100 |
| (2) | Exports | 219 | 250 | 363 | 428 | 468 | 596 |
| (3) | Balance | 7 | 54 | 51 | 16 | (54) | (112) |

In the case of copper, the recent primary production level recorded since 1982 will increase by 25 per cent in 1986 and by 128 per cent as from 1987, when the Carajás project comes into operation. It is expected that imports will then be reduced to 33,000 tons per annum.

Forecast of copper concentrate supply and demand
(thousands of tons)

| | | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 |
|---|---|---|---|---|---|---|---|
| (1) | Domestic demand (for primary copper) | 187 | 150 | 210 | 300 | 300 | 300 |
| | - Production | 94 | 117 | 117 | 267 | 267 | 267 |
| (2) | Exports | -- | -- | -- | -- | -- | -- |
| (3) | Balance | (24) | (33) | (93) | (33) | (33) | (33) |

As regards copper metal, it has been calculated that production will increase by 14 per cent annually in the five-year period 1986-1990, on the basis of the production of the Caraiba project (now in operation) and the start-up of the ELUMA project in 1987-1988, which will greatly reduce external dependence on refined copper.

Forecast of copper metal supply and demand
(thousands of tons)

| | | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 |
|---|---|---|---|---|---|---|---|
| (1) | Domestic demand | 320 | 350 | 385 | 425 | 475 | 525 |
| | Production | 230 | 235 | 305 | 405 | 420 | 430 |
| | - Primary | 150 | 150 | 210 | 300 | 300 | 300 |
| | - Secondary | 80 | 85 | 95 | 105 | 120 | 130 |
| (2) | Exports | -- | -- | -- | -- | -- | -- |
| (3) | Balance | (90) | (115) | (80) | (20) | (55) | (85) |

The trend of nickel production is as impressive as that of tin production. It is hoped that, as the project promoted by BAMINCO with the participation of INCO and a German consortium is defined, Brazil will become a major exporter of ferro-nickel. Furthermore, with the consolidation of various small tin mining projects, together with the installed overcapacity in smelting plants, there should be considerable scope for exports.

## IV. OWNERSHIP STRUCTURE OF THE SECTOR

The pattern of ownership of the main enterprises involved in mining and metallurgical activities is as follows:

| | | Type of capital (%) | | |
|---|---|---|---|---|
| | | Private | Private Foreign | State |
| **Aluminium** | | | | |
| 1. | Cia. Brasileira do Aluminio S.A. | 100.0 | --- | --- |
| 2. | Aluminio do Brasil S.A. (ALCAN) | --- | 100.0 | --- |
| 3. | ALCOMINAS | 26.5 | 73.5 | --- |
| 4. | ALCOA | --- | 100.0 | --- |
| 5. | Mineraçao Rio do Norte S.A. | 10.0 | 44.0 | 46.0 |
| 6. | Aluminio do Norte do Brasil S.A. | --- | 39.2 | 60.8 |
| **Copper** | | | | |
| 1. | Cia. Brasileira de Cobre (CBC) | --- | --- | 100.0 |
| 2. | Cia. Brasileira de Zinco (CBZ) | --- | --- | 100.0 |
| 3. | Caraiba Metais S.A. | --- | --- | 100.0 |
| **Tin** | | | | |
| 1. | Cia. Estanífera do Brasil (CESBRA) | 4.0 | 96.0 | --- |
| 2. | Mineraçao Brasileira S.A. (MISBRASA) | --- | 100.0 | --- |
| 3. | Cia. de Mineraçao Jacundá | 4.0 | 96.0 | --- |
| 4. | Mamoré Mineraçao e Metalurgia | 100.0 | --- | --- |
| **Lead** | | | | |
| 1. | Companhia Brasileira de Chumbo (COBRAC) | --- | 100.0 | --- |
| 2. | Mineraçao Boquira S.A. | --- | 100.0 | --- |
| 3. | Plumburn S.A. | --- | 100.0 | --- |
| 4. | Mineraçao Morro Agudo S.A. | 40.0 | | 60.0 |
| **Zinc** | | | | |
| 1. | Cia. Mercantil e Industrial (INGA) | 100.0 | --- | --- |
| 2. | Cia. Mineira de Metais-CMM (Metal) | 100.0 | --- | --- |
| 3. | Mineraçao Arciense S.A. | 100.0 | --- | --- |
| 4. | Mineraçao Boquira S.A. | --- | 100.0 | --- |

It will be seen that there is both State and private participation in development of all the minerals, with the exception of copper, which is in the hands of the State. There is also considerable foreign participation in mining enterprises in Brazil.

## V. THE ECONOMIC IMPORTANCE OF NON-FERROUS METALS

The share of mining and metallurgical GDP in the country's total product was very small in the period 1960-1984. In 1960 it contributed a mere 0.4 per cent, rising to 0.9 per cent and 1.0 per cent in 1983 and 1984 respectively. However, the priority given to new investment in mining and metallurgy means that this sector's share in the national product will tend to increase in the future.

Excluding iron ore and iron manufactures, the main export of the mining and metallurgical sector is aluminium, which contributed virtually 60 per cent of mining exports in 1983, dropping to 54 per cent and 47 per cent in 1984 and 1985, as can be seen in table 23. Next in importance comes tin which, in 1979, accounted for an export value of US$70,220,000, rising until 1985, when it reached US$230,565,000, and accounted for 40 per cent of the total non-ferrous metal exports. Third comes copper which, in 1962, had exports with a value of US$23,152,000. This figure was almost tripled by 1984, when exports amounted to US$61,690,000 (on average, 10 per cent of total exports).

Mining and metallurgical exports of non-ferrous minerals accounted for 0.8 per cent of Brazil's total exports in 1981 and 1982. This figure rose to 2.2 per cent in 1985. Approximately 60-70 per cent of these exports were primary ores.

Table 24 shows the degree of Brazil's external dependence on primary ores. The highest dependence relates to lead for which the figure was 906.3 per cent in 1984 but dropped substantially in 1985 to a mere 6.9 per cent. Copper, however, shows a level of external dependence of 35 per cent to 60 per cent. Brazil must also import substantial amounts of magnesium and zinc. Most of the zinc (and of the copper) is imported from Peru.

Table 23. Principal non-ferrous mineral exports of the mining and metallurgical sector (thousands of US$ FOB)

| | 1975 | 1979 | 1980 | 1981 | | 1982 | | 1983 | | 1984 | | 1985 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Value | % | Value | % | Value | % | Value | % | Value | % |
| 1) Aluminium | 4,894 | 22,800 | 40.171 | 67,398 | 35.3 | 56,984 | 36.0 | 261,947 | 59.4 | 323,549 | 53.8 | 272,497 | 47.4 |
| - Primary | 15 | — | — | 2,527 | 1.3 | 4,480 | 2.8 | 159,175 | 36.1 | 194,951 | 32.4 | 189,685 | 33.0 |
| - Secondary | 4,879 | 22,800 | 40,171 | 64,871 | 34.0 | 52,504 | 33.2 | 102,772 | 23.3 | 128,598 | 21.4 | 82,812 | 14.4 |
| 2) Lead | 10 | 406 | 677 | 235 | 0.1 | 51 | 0.0 | 89 | 0.0 | 28 | 0.0 | 334 | 0.0 |
| - Primary | - | 201 | 632 | 135 | 0.1 | 4 | 0.0 | 18 | 0.0 | 1 | 0.0 | 320 | 0.0 |
| - Secondary | 10 | 205 | 45 | 100 | 0.0 | 47 | 0.0 | 71 | 0.0 | 27 | 0.0 | 14 | 0.0 |
| 3) Copper | 2,679 | 15,527 | 13,786 | 26,088 | 13.7 | 23,152 | 14.6 | 31,554 | 7.2 | 61,690 | 10.3 | 35,733 | 6.2 |
| - Primary | 102 | 834 | 1,162 | 326 | 0.2 | 315 | 0.2 | 152 | 0.1 | 861 | 0.2 | 428 | 6.2 |
| - Secondary | 2,577 | 14,693 | 12,624 | 25,762 | 13.5 | 22,837 | 14.4 | 31,402 | 7.1 | 60,829 | 10.1 | 35,305 | 6.2 |
| 4) Tin | 24,214 | 70,220 | 63,750 | 67,350 | 35.3 | 57,168 | 36.1 | 111,053 | 25.2 | 176,319 | 29.3 | 230,565 | 40.1 |
| - Primary | 24,137 | 23,294 | 46,547 | 64,516 | 1.5 | 55,920 | 35.4 | 110,777 | 25.1 | 176,039 | 29.3 | 230,306 | 40.0 |
| - Secondary | 77 | 46,926 | 17,203 | 2,834 | 33.8 | 1,248 | 0.7 | 276 | 0.1 | 280 | 0.0 | 259 | 0.1 |
| 5) Nickel | 4,217 | 513 | 458 | 2,614 | 1.4 | 2,529 | 1.6 | 19,571 | 4.4 | 16,296 | 2.7 | 12,020 | 2.1 |
| - Primary | 4,001 | 118 | 107 | 2,323 | 1.3 | 1,894 | 1.2 | 19,102 | 4.3 | 15,548 | 2.6 | 11,682 | 2.0 |
| - Secondary | 216 | 395 | 351 | 291 | 0.1 | 635 | 0.4 | 469 | 0.1 | 748 | 0.1 | 338 | 0.1 |
| 6) Silicon | 353 | 2,219 | 8,619 | 15,477 | 8.0 | 15,969 | 10.2 | 14,728 | 3.3 | 19,460 | 3.2 | 24,211 | 4.2 |
| 7) Zinc | 81 | 220 | 526 | 11,864 | 6.2 | 2,316 | 1.5 | 2,038 | 0.5 | 3,805 | 0.7 | 119 | 0.0 |
| - Primary | - | 133 | 227 | 2,400 | 1.3 | 2,003 | 1.3 | 34 | 0.0 | 34 | 0.0 | 1 | 0.0 |
| - Secondary | 81 | 87 | 299 | 9,464 | 4.9 | 313 | 0.2 | 2,004 | 0.5 | 3,771 | 0.7 | 118 | 0.0 |
| a) Total mining exports | 36,448 | 111,905 | 127,987 | 191,026 | 100.0 | 158,169 | 100.0 | 440,980 | 100.0 | 601,147 | 100.0 | 575,479 | 100.0 |
| - Primary | 28,608 | 26,799 | 57,294 | 87,704 | 46.0 | 80,585 | 51.0 | 303,986 | 69.0 | 406,894 | 68.0 | 456,633 | 79.3 |
| - Secondary | 7,840 | 85,106 | 70,693 | 103,322 | 54.0 | 77,584 | 49.0 | 136,994 | 31.0 | 194,253 | 32.3 | 118,846 | 20.7 |
| b) Total exports | 8'670,000 | 15'244,000 | 20'132,000 | 23'680,000 | | 20'213,000 | | 21'900,000 | | 27'005,000 | | 25'639,000 | |
| A/B Share of total exports (%) | 0.4 | 0.7 | 0.6 | 0.8 | | 0.8 | | 2.0 | | 2.2 | | 2.2 | |

Source: Statistical Yearbook. Metallurgical sector 1983 and 1986. Ministry of Industry and Trade.

Table 24. Level of external dependence in the mining and metallurgical sector (tons)

| Metal | Primary Production (1) | Imports (2) | Exports (3) | Apparent Consumption 4=1+2-3 | Coefficient of external dependence 2/4 (%) | Production (1) | Imports (2) | Exports (3) | Apparent Consumption 4=1+2-3 | Coefficient of external dependence 2/4 (%) |
|---|---|---|---|---|---|---|---|---|---|---|
| Aluminium | 454,999 | 9,665 | 212,685 | 300,925 | 3.2 | 519,830 | 6,980 | 218,792 | 382,846 | 1.8 |
| Lead | 25,965 | 655 | 7 | 72,289 | 906.3 | 29,811 | 5,971 | 1,179 | 86,367 | 6.9 |
| Copper | 61,334 | 98,224 | 36,070 | 159,488 | 61.6 | 93,880 | 64,496 | 20,402 | 186,974 | 34.5 |
| Tin | 18,877 | 6 | 14,612 | 4,271 | 0.1 | 24,701 | 10 | 20,067 | 4,644 | 0.2 |
| Magnesio | 1,195 | 4,016 | 0 | 5,211 | 77.1 | 2,615 | 3,132 | — | 5,747 | 54.5 |
| Nickel | 12,716 | 498 | 4,515 | 8,699 | 5.7 | 13,166 | 1,392 | 2,731 | 11,827 | 11.8 |
| Silicon | 25,884 | 4 | 17,268 | 8,620 | 0.0 | 29,291 | 15 | 22,547 | 6,759 | 0.2 |
| Zinc | 106,927 | 5,434 | 3,702 | 116,181 | 4.7 | 116,136 | 28,767 | 136 | 149,368 | 19.3 |
| Iron a/ (million tons) | 87,368 | 103 | 90,881 | 27,515 b/ | 0.4 | 98,263 | 103 | 87,417 | 25,460 | 0.4 |

Source: Statistical Yearbook. Metallurgical sector. CONSIDER. Ministry of Industry and Trade.

a/ Bolivian Embassy.

b/ Sales in the domestic market.

## THE NON-FERROUS METALS INDUSTRY IN VENEZUELA

The non-ferrous metals industry in Venezuela is based mainly on the development of the aluminium industry. This industry has an installed capacity eight times higher than the rest of the non-ferrous metals industry. Due to the above reasons, this study will concentrate on the aluminium industry.

### I. THE BASIC INDUSTRY OF ALUMINIUM

The development of the aluminium industry is strongly linked to the desire of the Government of Venezuela to create a pole of development in the city of Guayana. The development of this industry is mainly in the charge of the "Corporacion Venezolana de Guayana" (CVG), which is also trying to integrate the development of the aluminium industry with the other sectors of the economy, mainly the iron and steel and hydroelectric sectors.

In 1961 CVG created the enterprise "Aluminio del Caroni" (ALCASA) with the main objective of establishing and operating a plant of alumina to produce ingots. In 1965 the original idea was complemented in order to produce and distribute aluminium products. In this second phase of development of ALCASA, Aluminium Reynolds International Inc. played an important part with 50 per cent. The plant began operation in 1967, with a capacity of 11,500 metric tons per year, which was increased to 54,000 in 1973. ALCASA, motivated by the low cost of electricity in Venezuela, expanded to a capacity of 120,000 metric tons per year, as well as with a rolling capacity of 30,000 metric tons. In 1981, Venezuela, through the CVG and the Fund of Venezuelan Investments (FIV), increased its participation in the social capital of the enterprise to 72.12 per cent.

In 1973, another aluminium plant was created in order to produce and export aluminium - Industria Venezolana de Aluminio (VENALUM). This plant was established with an 80 per cent participation in capital of Japanese companies (Showa Denko K.K. y Kobe Steel Ltd.) and with 20 per cent of the Venezuelan Government through CVG. In the following year, the participation was changed, with the Venezuelan Government (CVG and FIV) controlling 80 per cent of the capital. At that time it was decided to increase the initial capacity of 150,000 metric tons to 280,000 metric tons per year.

The present installed capacity of aluminium is 400,000 metric tons and the technology is basically supplied by Reynolds International Inc.

The alumina used in ALCASA and VENALUM was imported up to 1983, when the enterprise "Interamericana de Alumina C.A. INTERALUMINA" began to operate. This is a company with a participation of 90.4 per cent of the social capital of FIV, 5.1 per cent of CVG and 4.5 per cent of ALUSUISSE. This last company supplied the technology.

In 1979, CVG and FIV created the enterprise Bauxita Venezolana C.A. (BAUXIVEN) in order to provide INTERALUMINA with bauxite. In that way a vertical integration of the aluminium industry was achieved.

The production of aluminium in 1985 was 395,794 metric tons, of which ALCASA produced 121,17[illegible] metric tons and VENALUM 274,623 metric tons (Table 25). The number employed in 1984 by that industry was 6,937 persons and the global investment reached an amount of 9,247.7 million bolivares in 1986. Of that total investment, ALCASA had a share of 1,440.6 million bolivares, VENALUM of 2,407.1 million bolivars and INTERALUMINA 5,400 million bolivars. For the period 1986-89 an investment of 7,156 million bolivars is estimated.

Table 25. Production of primary aluminium 1/
(metric tons))

| YEAR | ALCASA | VENALUM | TOTAL |
|---|---|---|---|
| 1980 | 105.832 | 222.069 | 327.901 |
| 1981 | 111.298 | 202.225 | 313.523 |
| 1982 | 92.545 | 181.088 | 273.633 |
| 1983 | 104.524 | 230.780 | 335.304 |
| 1984 | 119.848 | 265.310 | 385.158 |
| 1985 | 121.171 2/ | 274.623 | 395.794 |

1/ Boletin informativo Industria del Aluminio, No. 12, 1985.

2/ Ven. M.M., No. 66, Ene-Feb., (1968), p.51.

1. Exports

ALCASA and VENALUM were created for the main purpose of orienting their production to exports. In 1967, ALCASA exported 3893 metric tons to Colombia and Argentina, and in 1980 its exports reached 65,862 metric tons and were exported to a wide range of countries. The exports of that enterprise cover the markets of the Andean Group, Mexico, Uruguay, Brazil, United States, Central America and the Caribic, Japan and Europe. The main client of ALCASA is Japan, with which it has long-term agreements.

The main markets of VENALUM are Japan and the United States. In 1974 VENALUM subscribed a contract with Japan to provide that country with 160,000 metric tons per year over 10 years starting in 1978. At present, VENALUM is trying to diversify its exports mainly to the United States' market, thereby reducing its dependency on Japan's market. The new policy of exports of VENALUM is to reduce the amount of exports to Japan agreed upon in the contract of 1978 and increase the production oriented to the domestic market and to the United States. Table 26 shows the relative importance of the aluminium exports in the global exports of the country.

## II. ALUMINIUM PROCESSING

The main supplier of aluminium to the domestic market for its transformation was traditionally ALCASA. However, in the last six years, VENALUM has also become an important supplier of aluminium to the domestic market. The main products that they provide are ingots and laminas.

In 1968, the consumption of ingots was 3870 metric tons, in 1981 it increased to 34,700 metric tons and the present estimation is 61,000 metric tons. The ingot has been used to manufacture pieces of different kinds and also to produce electric conductors. The percentage of annual consumption for extrusion is 14,000 metric tons, 70 per cent of which is used by the construction sector.

The present annual consumption of laminas of aluminium is estimated to be 45,000 metric tons which is covered mainly by domestic production and complemented by imports. The market increased strongly in the 1980s with annual rates of growth of over 20 per cent.

The sector in charge of the transformation of aluminium has more than 170 enterprises, but more than 70 per cent are small enterprises doing mainly metal structural work.

Table 26 1/. Importance of the aluminium exports (million Bs)

| | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 2/ |
|---|---|---|---|---|---|---|
| Aluminium | 756 | 1.724 | 1.754 | 1.322 | 2.594 | 308 |
| Total | 61.456 | 82.507 | 86.388 | 70.821 | 68.219 | 15.847 |
| Participation of aluminium in total exports | 1.23 | 2.09 | 2.03 | 1.87 | 3.80 | 1.94 |
| Participation of petroleum and its derivatives in total exports | 95.2 | 94.9 | 94.6 | 94.7 | 87.9 | 93.36 |

1/ BCV Boletin Estadistico

2/ US dollars.

## III. LEGAL ASPECTS

The main legal dispositions that regulate the non-ferrous industries in Venezuela are in the following:

### 1. Environment

The congress is at present discussing a law "Ley organica del ambiente" to protect the environment, that will regulate the treatment and recovery of the wastes of the aluminium industry. This is also a special legislation oriented to preventing the pollution of the Maracaibo lake.

### 2. Foreign capital

Foreign capital is regulated in Venezuela according to the 24th Decision ("Decision 24 del Acuerdo de Cartagena") that norms the participation of the foreign capital, royalties, trademarks and licenses in the Andean Group countries.

In order to implement the regulations of foreign capital contained in Decision 24, the Government of Venezuela established a unit called Superintendencia de Inversiones Extranjeras - SIEX, where the feasibility studies for the implementation of new foreign investments have to be provided in order to analyse and clarify the new project.

### 3. Working conditions

The labour relations are normed by the law of work of 1966 and its regulations of 1973. This law stipulates the working hours, the salaries, the activities of the unions, the health and security conditions as well as other aspects related to the conditions in the working place.

## IV. DEVELOPMENT AND CO-OPERATION STRATEGIES

### 1. On-going projects

According to the plan to increase the vertical integration of the aluminium industry, it has been programmed to begin the exploitation of the deposit Cerro Páez - Los Pyiguaos, which will provide the bauxite needed for the operation of INTERALUMINA. This project will creat 523 jobs in the mining operation and 150 jobs for the river traffic. It has been estimated that this project will contribute in the period 1984-94 with a value added of 10.435 million bolivares [4/]. It has also been

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4/ "Programas Básicos de Guayana", Ven. Met. Mm. Ene-Feb, No. 66 (1986), p.43

estimated that the effect on the balance of payments in the first 20 years of operation of the project will be of a surplus of US$140 million due to import substitutions.

2. Main lines of development

The aluminium industry was developed from its beginning to increase the levels of exports of the country and also to diversify the exports that were mainly based on petroleum.

The process of vertical integration of the aluminium industry was made with the objective to increase the national value added exported. Also important emphasis was placed on the role that the aluminium industry had to play in the regional development.

In order to achieve the objective of an outward oriented development of the aluminium industry, there has always been a relatively large amount of foreign capital in the creation of the main enterprises of this industry in order to obtain the technology and external markets.

In the implementation of this strategy of development, the State plays a key role in the ownership of the main enterprises as well as in the marketing of the products and in the institutional organization. At present there is an idea to create a holding of the aluminium industry that could permit the centralization of the main activities of the different enterprises with state ownership that would allow rationalization of the economic expenses and facilitate the financing of the operations and future expansion of the aluminium industry.

# THE NON-FERROUS METALS INDUSTRY IN COLOMBIA

## I. NON-FERROUS MINERAL RESERVES

Colombia has relatively few proven reserves, compared with the country's potential reserves, which cannot yet be quantified.

The main mineral resources in Colombia are: gold, emeralds, coal, limestone, nickel, phosphoric rock, copper, iron and bauxite.

Gold:

Only very rough figures are available. At the Marmato mine it has been calculated that there are possible reserves of 6 million tons of ore, containing between 7 and 10 grammes of gold per ton.

In 1983, 84 per cent of this precious metal was supplied by small-scale producers. It is mined in the departments of Antioquía (78 per cent), Chocó (9 per cent), and Nariño (4 per cent), as well as in other areas such as Caldas, Santander and Tolima.

Emeralds:

There is no exact estimate of the reserves because of insufficient prospecting. Emeralds are obtained principally from the Muzo, Coscuez, Chivor and Gachala deposits.

Coal:

Colombia's coal reserves have been estimated at 16,523 million tons according to INGEOMINAS surveys which took account of the main areas of Boyacá, Cundinamarca, Antioquía, Valle, Cauca and North Santander.

Nickel:

It is calculated that there are reserves of 24.9 million metric tons in the Cerromatoso deposit. In view of its enormous economic potential, this project is being considered as part of the Government's development plans for the next few years.

Phosphoric rock:

The proven/probable reserves are estimated at 49.5 million tons, located at Tota Pesca (29.0), Sardinata (9) and Aipe y Tesalia (11.5).

Uranium:

Systematic surveys are being carried out for this ore and it has been calculated that the central and eastern mountain areas of Colombia possess probable reserves of the order of 40,000 tons of uranium.

Copper:

Rich copper reserves have been found in the following deposits: Mocoa, 160 million metric tons of ore with a copper content of 0.42 per cent and a molybdenum content of 0.067 per cent; Pantanos-Pegadorcito, 200 million metric tons of porphyritic copper with copper contents of 0.7 per cent and 1.2 per cent; Alisales, 400,000 metric tons with copper contents of 0.3 per cent to 1 per cent.

Bauxite:

According to surveys carried out by INGEOMINAS, it is estimated that in the Cauca area there are reserves amounting to 375 million tons, with a 40 per cent alumina content.

## II. MINING AND METALLURGICAL PRODUCTION

The trend of mining and metallurgical production in Colombia has varied. In the period 1970-1975 there was negative growth of 2.7 per cent, as can be seen in table 27. In 1980 production picked up (13.7 per cent) because of the increase in the international price of gold and the output increased from 308,676 troy ounces in 1975 to 610,439 troy ounces in 1980. This also affected silver, production of which also rose considerably that year (see table 28).

Since 1981, however, the continuing decline of international metals prices has brought about negative growth levels of between 13.3 per cent and 10.7 per cent for gold (in 1981 and 1982 respectively). Platinum continued to increase by 3.2 per cent in 1981, before falling by 19.7 per cent in 1982 and 13.3 per cent in 1983.

However, production of emeralds recorded sustained growth of 8 per cent, 32 per cent and 155 per cent in 1981, 1982 and 1983 respectively.

Other minerals which seem promising for the country's mining development are nickel and copper, which improved by 532 per cent and 84 per cent respectively in 1983, compared with 1982. Production of bauxite, which is also considered to be a mineral, with strategic potential, increased by 1,220 per cent in 1982. Production of coal, Colombia's main energy-providing mineral, continued to increase and it is expected that it will develop further because of coal's strategic importance for the country.

The value of production is shown in table 29, where it will be seen that the non-metallic minerals account on average for the largest share of mining production, with 36 per cent. They are followed by coal (32 per cent), gold (27 per cent) and emeralds (1.2 per cent).

Table 27. Growth of mining production a/

| Years | Rate of growth (Average annual rates) per cent |
|---|---|
| 1950-60 | 5.3 |
| 1960-65 | 3.9 |
| 1965-70 | 0.2 |
| 1970-75 | -2.7 |
| 1975-80 | 1.8 |
| 1980 | 13.7 |
| 1981 | 3.0 |
| 1982 | 5.4 |
| 1983 | 5.3 |

Source: Latin American Statistical Yearbook - 1984.

a/ Including oil.

Table 28. National mining production - 1970-1975-1980, 1983

| | Unit | 1970 | 1975 | 1980 | 1981 | 1982 | 1983 a/ | Percentage variation 81/80 | 82/81 | 83/82 |
|---|---|---|---|---|---|---|---|---|---|---|
| **Precious stones and metals** | | | | | | | | | | |
| Gold b/ | Oz. troy | 201.518 | 303.676 | 610.439 | 529.214 | 472.674 | 438.579 | -13.3 | -10.7 | -7.2 |
| Silver | Oz. troy | 75.871 | 87.871 | 151.542 | 142.740 | 136.043 | 98.945 | -5.8 | -4.7 | -27.3 |
| Platinum | Oz. troy | 26.036 | 22.114 | 14.345 | 14.804 | 11.896(R) | 10.303 | 3.2 | 19.7 | -13.3 |
| Emeralds c/ | Kilates | 2,222.812 | 248.715 | 272.115 | 299.006 | 386.660 | 1,011.345 | 8.7 | 32.4 | 156.4 |
| **Metallic minerals** | | | | | | | | | | |
| Iron ore | ton | 453.000 | 386.000 | 506.289 | 433.411 | 489.850 | 456.000 | -14.4 | 8.4 | -2.9 |
| Lead (concentrate) | ton | 585 | 272 | 312 | 256 | 391 | 308 | -17.9 | 52.7 | -21.2 |
| Zinc (concentrate) | ton | 389 | 18 | 303 | 303 | — | — | - | - | - |
| Copper (concentrate) | ton | 200 | 272 | — | 315 | 293(R) | 540 | -28.7 | -7.0 | 84.3 |
| Manganese | ton | 5.743 | 6.660 | 21.400 | 20.300 | — (R) | — | -5.1 | - | - |
| Nickel ore | ton | — | — | — | — | 86.308 | 545.618 | - | - | 532.1 |
| Asbestos ore | ton | — | — | — | — | 55.616 | 70.322 | - | - | 26.4 |
| Bauxite | ton | — | — | — | 50 | 660(R) | 680 | - | 1220 | 3.0 |
| **Fuel minerals** | | | | | | | | | | |
| Coal | ton | 2,706.200 | 3,227.300 | 3,901.800 | 3,990.400 | 4,421.600 | 5,053.200 | 2.3 | 10.8 | 14.3 |
| **Non-metallic minerals** | | | | | | | | | | |
| Limestone | ton | 5,007.000 | 7,800.000 | 9,760.000 | 10,053.000 | 10,620.200 | 10,625.000 | 3.0 | 5.6 | 0.6 |
| Clay and kaolin | ton | 708.660 | 860.000 | 786.384 | 810.000 | 856.684 | 762.000 | 3.0 | 5.6 | -10.9 |
| Sea salt | ton | 141.309 | 741.233 | 491.017 | 398.686 | 201.587 | 291.381 | -18.8 | -49.4 | 44.5 |

Source: Ministry of Energy and Mines

a/ Provisional

b/ Function-based

c/ Recorded exports

(R) Revised.

Table 29. National mining production 1983-1984
(Million pesos at constant 1975 values)

| | 1983 | | 1984 | | |
|---|---|---|---|---|---|
| | Value | % | Value | % | Variation |
| Precious metals | 636.0 | 22.2 | 1126.8 | 29.7 | 77.2 |
| Precious stones (Emeralds) | 54.4 | 1.9 | 19.0 | 0.5 | -65.1 |
| Metallic minerals | 117.5 | 4.1 | 140.4 | 3.7 | 19.5 |
| Fuel minerals (Coal) | 925.4 | 32.3 | 1263.4 | 33.3 | 36.5 |
| Non-metallic minerals | 1131.7 | 39.5 | 1244.4 | 32.8 | 10.0 |
| TOTAL | 2865.0 | 100 | 3794.0 | 100 | 32.4 |

Source: Ministry of Energy and Mines.

## III. GROWTH PROSPECTS

The growth prospects of the mining sector are particularly encouraging. A positive and dynamic change is taking place in Colombia's economic activities in this sector, as the country has abundant domestic resources which have yet to be explored (INGEOMINAS is carrying out a mining inventory covering only 25 per cent of the national territory).

There are a number of projects, some of which are already being implemented while others are still on the drawing board. The following is a brief outline of the production of each metal:

### 1. Gold

#### (a) Marmato project

This project, for which INGEOMINAS is responsible, has been in operation since 1980 in the Caldas area. It has two sections: upper and lower. The upper section includes technical assistance, equipment repair and new laboratory and smelting systems. The lower section includes development work and surveys for equipment of the plant, which is to process 100 metric tons of ore per day. It is about to be put into operation with the assistance of the United States mining company Phelps Dodge.

Up to 1981 some $36 million had been invested in the upper section infrastructure and a production level of 1,960 troy ounces was achieved, 86 per cent more than in 1980.

In the lower section, between 1980 and 1981, proven reserves of 150,000 metric tons and probable reserves of 444,000 metric tons, with a silver content of 5.7 grammes per ton, were discovered.

Some 120 million pesos have been invested in the smelting plant with the aim of achieving a production level of 5,000 troy ounces of gold per year.

#### (b) El Chocó project

Mineros del Chocó SA experienced serious administrative, technical and financial problems which led to its liquidation in 1978. This company had been formed to work the gold- and platinum-bearing alluvium of the San Juan and Atrato river basins. In 1982 INGEOMINAS was given the task of seeking a solution. It made a survey which concluded that it was necessary to provide approximately 900 million pesos to reactivate the company.

In 1984, ECOMINAS provided Mineros del Chocó with $246 million to reactivate the company. This was in the form of a loan supervised by the Board of Creditors, IFI and the Banco de la República.

#### (c) Others

ECOMINAS' plans include the development of other mining zones with gold-bearing deposits, such as those located in the areas of Guainía, Vaupés and Guarrare, which have been declared a special reserve. In conjunction with INGEOMINAS, ECOMINAS plans to undertake activities designed to attract national and/or foreign investment so that these zones can be explored and evaluated.

2. Emeralds

Special emerald reserve zone

The aim of this project is to carry out systematic prospecting of the special zone in the Muzo area of the Boyacá region.

The project has been planned in three stages: choice of areas of interest, prospecting of selected areas, selection of methods of working and design standards. The total duration of the project is estimated at four years and the cost at $100 million. Financing is currently being sought.

3. Phosphoric rock

Industrial development of phosphoric rock

The objective was to carry out a technical and economic feasibility study of the industrial development of phosphoric rock at the Pesca deposit in Boyacá and at the Sardinata deposit north of Santander. The study was carried out by Singmaster and Breyer Inc., a subsidiary of SNC of Canada.

It is planned to install two 250 ton/day sulphuric acid plants, a 250 ton/day $P_2O_5$ phosphoric acid plant and two 700 ton/day granulation plants.

4. Copper

(a) Copper-molybdenum project (Mocoa)

This is located in the area of Putumayo. It is being carried out by INGEOMINAS, ECOMINAS and UNDP under a tripartite programme. It has reached the economic pre-feasibility study stage, with an estimated investment requirement of US$4 million (ECOMINAS' participation being $560,000).

(b) Pantanos-Pegadorcito

This project is located in Antioquia. The partial surveys carried out indicate reserves with a low copper content. This fact, together with the logistical infrastructure, has meant that the project has been postponed until the market improves.

(c) Caño Negro multi-metal project (Meta)

Reserves of 1.6 million tons of copper (0.14 per cent) have been found in "Cerro del Cobre". Other reserves have been found in the area between Boyacá and Cundinamarca: gold (0.23 grammes/ton), silver (20.4 grammes/ton), vanadium (0.01-1.0 per cent) and uranium (0.01-1.6 per cent).

5. Coal

(a) El Cerrejón

This is Colombia's largest coal project. It is located in the area of Guajira, in the north-east of the country. The enterprises responsible for it are CARBOCOL and INTERCOR. The project is of great economic and political importance for Colombia and it will call for:

- Production of coal suited to the needs of the market (high quality);

- Low-cost production on an international scale (maximum operating efficiency);

- Creation and maintenance of Colombia's image as a serious and reliable supplier;

- Implementation of the Mining Plan so as to permit optimum development of the entire deposit.

In view of the project's special characteristics and the geographical location of the deposits, a number of mine, harbour and transport infrastructure building operations had to be carried out, the completion date being 1986.

The planned production capacity is 15 million tons per year according to the following production schedule:

| Year | Coal (thousand tons) | Sterile material (thousand $m^3$) | Ratio |
|---|---|---|---|
| 1985 | 2 776 | 26 387 | 9.5 |
| 1986 | 6 143 | 50 718 | 8.2 |
| 1987 | 9 304 | 62 248 | 6.7 |
| 1988 | 12 000 | 71 071 | 5.9 |
| 1989 | 15 000 | 80 440 | 5.3 |

The productive lifetime will be 23 years, i.e. beyond the year 2000.

The total investment required for the project is calculated at $3,600 million, of which $1,680 million have already been committed for the infrastructure and assembly work.

(b) Carbones del Caribe Ltda.

This is located at Alto San Jorge in the region of Córdova from where the coal is exported. In 1983 the production level was 250,000 tons. There are plans to increase production in order to supply the cement industry, with the surplus being exported.

6. Nickel

Cerromatoso

This mining and metallurgical complex is of great strategic importance for Colombia. It is operated by Compañía Cerromatoso SA, which was established in 1979 to extract this mineral.

The total investment amounts to $400 million. The proven nickel reserves are calculated at 28 million tons with an average nickel content of 2.7 per cent and 21 million metric tons with a nickel content of up to 1.5 per cent.

The plant's capacity is 42 million pounds of nickel per year and the product will be ferro-nickel in ingot form with an average nickel content of 37.5 per cent.

7. Bauxite

A deposit with possible bauxitic clay reserves of the order of 275 million tons has been identified in the areas of Morales and Cajibío (Cauca) and San Antonio, Villa Colombia, Bitaco and La Cumbre (Cauca valley). Hungary has expressed interest in participating in the financing of the project.

IV. MAIN PARTICIPANTS

The most important commercial and industrial enterprises, connected with the State, are:

- ECOMINAS - "Empresa Colombiana de Minas"

  Responsible for receiving and utilizing allocations for mining made by the State. Also responsible for carrying out geological surveys and studies that are needed in order to take full advantage of the mineral substances worked (it is responsible for the extraction of precious stones and metals).

- CARBOCOL - "Carbones de Colombia SA"

  Responsible for carrying out all activities and operations connected with coal.

- COLURANIO - "Compañía Colombiana de Uranio SA" (now Carboriente)

  Its objectives are to prospect for, extract, process and market uranium.

- ECONIQUEL - "Empresa Colombiana de Niquel Limitada"

  Responsible for all operations and business affairs connected with the mining of nickel at all stages.

The semi-State enterprises with major interests in the mining and metallurgical sector are:

- ALCO - "Alcalis de Colombia Limitada"

- Empresa de Fosafatos de Bogotá SA

- Mineros del Chocó

- PROCARBON - "Productora de Carbón de Occidente".

V. THE ECONOMIC IMPORTANCE OF THE MINING AND METALLURGICAL SECTOR

In Colombia, the mining and metallurgical sector has not played a very significant role in recent years, when its results are compared with the production of other economic sectors, particularly commerce and services (which account for almost 50 per cent of the total), followed by the farming and livestock sector (25 per cent).

Mining accounts for 2.7 per cent of the GDP in 1970, the highest level for its share, which fell to between 1.7 per cent and 1.3 per cent in the period 1975-1981.

The mining and metallurgical sector accounted on average for only 10 per cent of Colombia's exports in the years 1980-1982.

Within the mining sector the main source of foreign exchange was the export of gold, which brought in US$310.2 million in 1980 and US$263.0 million in 1981. Next came emeralds, with an export value of US$106.2 million in 1979, and accounting for 55 per cent of the sector's total exports.

Owing to the sector's low level of development, it is a relatively small employer in national terms, occupying only 44,230 persons (0.7 per cent of the total workforce).

## VI. LEGAL POSITION

Mining in Colombia is currently governed by the Mining Statute based on Law 60 of 1967, Decree 292 of 1968, Law 20 of 1969, Decree 1275 of 1970 and subsequent amendments thereto.

These provisions establish the following as the primary objectives:

- To intensify technical prospecting of the national territory, encourage geological surveys and facilitate the economic development of the country's mineral resources;

- To give priority to meeting domestic requirements for raw materials of mineral origin and manufactured metallurgical and processed materials, with a view to replacing imports and increasing exports;

- To create new sources of employment;

- To stimulate investment in the various branches of mining and to encourage foreign investment provided the latter is associated with domestic capital and undertakes projects which cannot be carried out with Colombian resources.

- To promote small-scale mining, by providing technical assistance free of charge. Operators whose limited economic resources prevent them from undertaking prospecting or developing their concessions fall into the small-scale mining category.

# NON-FERROUS METALS INDUSTRY IN NICARAGUA

## I. NON-FERROUS ORES

The main deposits of non-ferrous minerals in Nicaragua are located in the area of Bonanza. The evaluation of the mineral reserves of that area in 1966 showed that there were 1.5 x $10^6$ tons of materials with 12 per cent of zinc, 60 per cent of lead and also good content of copper, gold and silver. The exploitation of zinc, lead and copper began in 1971. The production of those mineral ores in 1977 was 7121 tons of zinc, 699 tons of lead and 270 tons of copper. In 1978, due to technical problems and price-decline the production of those metals was stopped.

The present Government of Nicaragua, through the Nicaraguan Institute of Mining (INMINE) signed a contract with the Bulgarian Government for an amount of US$19.8 million to develop activities of exploration in the area of the Vesubio Mine and to reactivate the non-ferrous ore production at Bonanza that will permit a production of 164 thousand tons of zinc concentrates, 34 thousand tons of concentrates of lead, 73 tons of silver and 14 tons of gold, over the period 1986-2000.

## II. PROCESSING OPERATIONS

The non-ferrous industries in Nicaragua can be classified mainly in two groups. Industries that process scrap to produce spare parts and industries that fabricate accessories for the construction sector and kitchenware.

At present, there are five small enterprises that produce approximately 26 tons/year of copper alloys and 20 tons/year of aluminium alloys. These enterprises produce under request and generally with old machinery and equipment.

The plants that produce domestic utensils and for the construction sector are in general small enterprises with simple technology, producing mainly with hand tools. Most of the raw materials they process are imported.

The production of the non-ferrous industries in Nicaragua is projected to increase by approximately 23.9 per cent between 1983 and 1986. The increase of production in this period will be mainly due to the rise in production of the industries producing non-ferrous products to the construction sector. Table 30 shows the production in the period 1983-1986.

Table 30. Production in 1983-1986
(thousands of Cordovas)
(Base year 1983)

| | 1983 | 1984 | 1985 | 1986 |
|---|---|---|---|---|
| Fundición Industrial | 9,834.5 | 3,020.9 | 4,624.0 | 5,548.8 |
| Taller de la Perla | 4,219.9 | 4,331.8 | 2,605.5 | 3,474.0 |
| Alumisa | 17,085.0 | 15,019.1 | 12,530.5 | 15,036.6 |
| Aluminio Standard | 3,017.2 | 2,591.2 | 2,106.0 | 4,752.7 |
| Criscasa | 7,431.0 | 2,336.7 | 4,521.3 | 17,389.8 |
| Aluminio Arquitectonico | 7,481.6 | 5,337.7 | 5,660.6 | 13,680.6 |
| Aluvisa | 6,555.8 | 6,977.8 | 3,863.9 | 7,752.7 |
| Dacal | 6,276.2 | 6,919.7 | 5,338.8 | 9,045.8 |
| Total | 61,901.2 | 46,534.9 | 41,250.6 | 76,681.0 |

The labour force in the non-ferrous industry increased by 20 per cent between 1983 and 1985. The personnel employed in that industry was 270 persons in 1983 and 324 in 1985.

## III. LINKS BETWEEN THE NON-FERROUS METALS INDUSTRIES AND THE REST OF THE ECONOMY

The industries producing doors and windows and kitchen utensils have weak linkages upstream with the other sectors of the economy because all their inputs are imported. Downstream they are linked with the construction sector.

Those non-ferrous industries that work with scrap existing in Nicaragua to produce copper and aluminium alloys, are mainly linked with the capital goods and consumer durable industries. They produce mainly different types of valves, pillow blocks, gears, spare parts for the light industry, accessories for bombs, and spare parts for the automobile industry.

## IV. DEVELOPMENT OF PROJECTS IN THE NON-FERROUS METALS INDUSTRY

In Nicaragua there are several non-ferrous deposits whose exploitation has been stopped or the stage of detailed exploration has not yet begun. The Rosita Mine, located in North Zelaya, 415 km from the capital, Managua, began its operation in 1957 to obtain copper. The total production of that mine until its closure was 5,924.572 tons with an average of 2.06 per cent of copper. At present, a great part of the equipment and machinery used in the mine has been transferred to other mining centres. Apart from this mine, there are other mine deposits (Cobre del San Juan; Bambana; Tipipan; Bulawas; El Puente; Zanate; Zanate Central), whose detailed exploration will depend to a great extent, on world prices of non-ferrous metals as well as on the financial capability of the country.

The projects that are more viable for implementation are - in the mining activity the programme for integrated development of mining in North Zelaya, and - in the transformation activities - the establishment of a new foundry of non-ferrous metals.

The mining project consists of making a detailed exploration of the mining reserves in the North Zelaya area that can ensure a continuous operation of the enterprise until the year 2000. Depending on the exploration results, the second stage of the project will be the rehabilitation, modernization and expansion of the extraction capacity of the region.

The project to establish a new foundry has as its main objective, to produce spare parts of a better quality than those already existing. The investment will be approximately US$688,800 and will generate an employment of 53 persons in two shifts.

## V. LEGAL AND INSTITUTIONAL ASPECTS

At present there is a project of law to norm the foreign investment. This project has not yet been discussed at Congress. In the case of the mines, in order to prevent contamination, all the wastes must be deposited in special reservoirs built for that purpose. Those containers will be increased in the future according to the expansion in the mining activity.

There is also large effort being made to norm and improve conditions of work, health and security in the mining and transformation operations.

The State promotes the development of the mining activities through the "Instituto Nicaraguense de la Mineria" (INMINE) that has the same level as a Ministry.

The transformation activities are promoted and developed by the Ministry of Industry, through the Directorship of Metalmechanics.

## VI. STRATEGIES OF DEVELOPMENT

The main lines of development of the Nicaraguan Government are oriented towards increasing the linkages, in the first instance, with the industry and agricultural sectors, through the supply of spare parts to those sectors. Production of accessories for the construction sector has the second priority.

In this context, the general objectives defined by the Government are the following. Non-ferrous activities must:

1. become a basis for the development of the industry, agroindustry, agriculture and construction through the supply of inputs as well as spare parts;

2. contribute to the increase in the vertical integration by increasing the level of the domestic transformation of the national raw materials;

3. contribute to an increase in employment and to the improvement of the balance of payments of the country by increasing the import substitution as well as the exports. Table 31 shows the imports and exports of the non-ferrous metals in the period 1975-1982.

The specific objectives are oriented mainly towards expanding the production capacity of the non-ferrous industries as well as to diversifying the production in order to satisfy the domestic consumption and increase the exports. Stress is also laid on the importance of increasing the technological capacity to master the basic processes of fabrication: refining, and heat treatment.

According to the above objectives, the main lines of action are oriented towards creating a technical infrastructure to produce spare parts; to increase the knowledge and capability in the operation and management of the basic processes of a foundry; and to developing services and installations to improve the quality control of the foundry products.

In order to carry out the main lines of development of the strategy there is an urgent need to establish programmes of co-operation in the fields of mining exploitation, training of personnel at the management and operation levels for the operations of mining and transformation, and co-operation for the implementation of a new foundry of non-ferrous metals.

Table 31. Imports and Exports of the Non-Ferrous Metals
(thousand US dollars)

| Period | Imports | Exports |
|---|---|---|
| 1975 | 3,590.0 | 590.0 |
| 1976 | 3,932.0 | 733.0 |
| 1977 | 5,266.0 | 870.0 |
| 1978 | 3,849.0 | 1,203.0 |
| 1979 | 1,826.0 | 317.0 |
| 1980 | 321.0 | 348.0 |
| 1981 | 502.9 | 39.0 |
| 1982 | 664.3 | 2.0 |

Source: Ministerio de Industria, Dirección General Rama Metal-Mecánica.

# THE NON-FERROUS METALS INDUSTRY IN HUNGARY

## INTRODUCTION

Hungary has practically no heavy non-ferrous metal ore resources of its own. Whatever heavy non-ferrous metal is used in this country it has either to be imported or to be remelted from collected scrap. On the other hand, Hungary possesses rich bauxite reserves, on which a fully integrated aluminium industry is now based, operated by the Hungarian Aluminium Corporation.

At this point it may be added that copper and copper alloys are processed at an up-to-date standard to rolled and drawn rods, wires, tubes and strips at the Csepel Works at an annual capacity of 60,000 tons. The production of lead and zinc semi-manufactures is not significant. As for processing nickel, no official statistical returns are available.

For these reasons the present survey deals essentially with the aluminium industry and copper metallurgy in Hungary.

In tables 1 to 4, the country's non-ferrous metal resources, exports, imports and domestic consumption are summed up as shown by official statistics.

Table 1. Production

| Item | Unit | 1970 | 1975 | 1980 | 1981 | 1982 | 1983 |
|---|---|---|---|---|---|---|---|
| Bauxite | 1,000 t | 2,022 | 2,890 | 2,950 | 2,914 | 2,627 | 2,917 |
| Alumina | 1,000 t | 441 | 756 | 805 | 792 | 743 | 836 |
| Aluminium | ton | 66,029 | 70,221 | 73,498 | 74,253 | 74,221 | 74,039 |

Table 2. Imports
(tons)

| Item | 1975 | 1980 | 1981 | 1982 | 1983 |
|---|---|---|---|---|---|
| Copper and its semi-manufactures | 44,529 | 28,962 | 35,799 | 33,428 | 31.785 |
| Zinc | 26,513 | 24,329 | 26,660 | 19,291 | 26,904 |
| Zinc products | 6,296 | 7,215 | 6,927 | 7,027 | 5,892 |
| Lead | 12,392 | 12,891 | 11,033 | 13,647 | 11,930 |
| Tin | 1,786 | 1,662 | 1,369 | 1,772 | 2,038 |
| Aluminium ingots x/ | 147,000 | 188,000 | 154,000 | 137,000 | 163,000 |
| Aluminium semi-manufactures | 9,916 | 7,923 | 5,759 | 6,262 | 4,997 |

Table 3. Exports
(tons)

| Item | 1975 | 1980 | 1981 | 1982 | 1983 |
|---|---|---|---|---|---|
| Bauxite | 603,000 | 542,000 | 498,000 | 467,000 | 431,000 |
| Alumina x/ | 686,000 | 686,000 | 626,000 | 542,000 | 659,000 |
| Aluminium ingots | 60,821 | 84,216 | 85,741 | 48,363 | 57,822 |
| Aluminium semi-manufactures | 46,628 | 28,861 | 31,230 | 42,289 | 48,479 |
| Aluminium castings | 1,985 | 1,670 | 1,320 | 1,312 | 985 |
| Aluminium scrap | 17,627 | 9,372 | 8,709 | 8,740 | 6,498 |

x/ Under the Hungarian-Soviet alumina/aluminium agreement, an annual capacity of 330,000 tons of alumina is exported to the USSR and 165,000 tons of aluminium ingots are imported from there to Hungary.

Table 4. Consumption of non-ferrous metals and products

| Item | Unit | 1975 | 1980 | 1981 | 1982 | 1983 | 1984 |
|---|---|---|---|---|---|---|---|
| Copper products: | ton | 21,000 | 22,000 | 28,000 | 27,000 | 27,000 | 26,000 |
| therefrom by industry | | 20,000 | 21,000 | 27,000 | 26,000 | 26,000 | 24,000 |
| Brass products: | ton | 15,000 | 15,000 | 16,000 | 16,000 | 16,000 | 16,000 |
| therefrom by industry | | 15,000 | 15,000 | 15,000 | 15,000 | 15,000 | 15,000 |
| Zinc: | ton | 25,463 | 24,974 | 27,393 | 26,004 | 25,730 | 25,681 |
| therefrom by industry | | 25,343 | 24,619 | 27,025 | 25,560 | 25,399 | 25,140 |
| Lead: | ton | 13,939 | 12,273 | 11.753 | 13,653 | 13,272 | 13,153 |
| therefrom by industry | | 13,228 | 10,824 | 10,869 | 12,801 | 10,776 | 11,056 |
| Tin: | ton | 1,666 | 1,607 | 1,C47 | 1,585 | 1,609 | 1,420 |
| therefrom by industry | | 1,282 | 1,092 | 1,095 | 1,060 | 919 | 792 |
| Bauxite | 1000t | 2,277 | 2,437 | 2,368 | 2.238 | 2,504 | 2,555 |
| therefrom by industry | | ditto | ditto | ditto | ditto | ditto | ditto |
| Alumina | 1000t | 170 | 188 | 189 | 187 | 189 | 189 |
| therefrom by industry | | ditto | ditto | ditto | ditto | ditto | ditto |
| Aluminium ingot, slab and billet | 1000t | 166 | 166 | 168 | 177 | 182 | 193 |
| therefrom by industry | | 166 | 166 | 158 | 170 | 173 | 186 |
| Rolled aluminium strip and sheet | 1000t | 62 | 75 | 77 | 77 | 76 | 80 |
| therefrom by industry | | 56 | 68 | 70 | 68 | 67 | 71 |
| Extruded and drawn aluminium products | 1000t | 54 | 56 | 59 | 58 | 55 | 64 |
| therefrom by industry | | 51 | 53 | 56 | 54 | 50 | 60 |

# I. HUNGARIAN COPPER METALLURGY

## 1. Copper and its alloys

The consumption of copper per capita in Hungary is from 4,6 to 5,0 kg. It is smaller than the corresponding figure in the industrialized countries, i.e. 9 to 10 kg, and similar to the relevant index of the medium developed nations.

The following aspects limit the use of copper in Hungary:

- there is no active copper mine in the country;
- importation of this relatively expensive metal is not promoted by the current economic regulations;
- since the country possesses substantial aluminium assets, copper is gradually being replaced by aluminium;
- in the less important or luxury areas, copper consumption is in accordance with the level of the country's development, for instance: water pipes, building industry and carpentry, etc.;
- the special characteristics of the country's industrial structure only permit a /relatively modest consumption in the vehicle and electronics industry compared with that of the industrialized countries/.

Copper metallurgy is based on century-old traditions in Hungary. However, due to its natural endowments it is only concerned with the secondary metallurgy of copper scrap. At the end of the 19th century, Hungarian non-ferrous, semi-finished metal production was concentrated in Csepel/Budapest, where Manfred Weiss established a factory. It originally processed metals from scrap for the canning industry but later switched over to ammunition manufacturing. Since its establishment, the Csepel Metalworks have been the basis of the Hungarian copper metallurgy. During the two World Wars, the production equipment and the buildings suffered heavy losses. The damages caused by the Second World War were repaired in the late 1940's, but only the minimum reconstruction was financially possible.

The growth of the country's demands and the widening of the financial possibilities coincided with the world-wide modernization of technology, the revolution of electrotechnology, pneumatics, hydraulics and control-technics.

Following the world-wide technological development, advanced production technology was introduced instead of the traditional production methods. The modernization of production led to increased efficiency of labour, to the better satisfaction of consumers' demands, a process going hand in hand with a significant improvement of quality and dynamic and constant development of semi-finished metals production.

In the copper metallurgy and semi-production, 55 hours were needed in 1955 for manufacturing 1 ton of metal. It dropped to 25 hours in 1975 and to 14 hours by 1984.

The Csepel Metalworks currently produces more than 50 thousand tons of non-ferrous semis of which 10 to 12 thousand tons are exported. Domestic demands for strips and wires are by and large satisfied; only certain sheets and certain types of tubes and rods are imported in a quantity of approximately 2,5 thousand tons.

The production, export and main raw material import figures of the Csepel Metalworks are shown in Table 5, which also includes the figures of the bar mouldcast, sandcast, die-cast and centrifugal cast-castings.

Some revealing indexes of the Csepel Metalworks production are presented in Table 6. They show that parallel to a 45% improvement of returns from sales, between 1975 and 1985, the work-force was reduced by 31%.

The per capita returns from sales were more than twice as much in 1985 to those in 1975. It is characteristic of the expenses that the material costs in 1980 were 79.9%, while in 1985 they stood at 77.7%. It is attributable to energy economizing measures that energy expenses increased from 4.5% to only 5.5%, in spite of the major rise in prices.

Manpower costs increased from 3.4% to 4.7% while there was only a minimum change in other types of expense.

Table 5. The consumption and production of copper products and raw materials in Hungary

CONSUMPTION

thousand tons

| Denomination | 1960 | 1970 | 1975 | 1980 | 1981 | 1982 | 1983 | 1984 |
|---|---|---|---|---|---|---|---|---|
| Copper basic materials | | | 44 | 49 | 58 | 58 | 54 | 54 |
| Copper products rolled, pressed and drawn | 11 | 18 | 21 | 22 | 28 | 27 | 27 | 26 |
| Brass products rolled, pressed and drawn | 7 | 12 | 15 | 15 | 16 | 16 | 16 | 16 |

PRODUCTION

thousand tons

| Denomination | 1960 | 1970 | 1975 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 |
|---|---|---|---|---|---|---|---|---|---|
| Copper wire | 1,6 | 17 | 12 | 22,2 | 28,7 | 25,9 | 22 | 21,5 | 24,5 |
| Rolled sheets and strips | 3,4 | 4,7 | 7,2 | 9,3 | 10,3 | 11 | 10,3 | 11 | 10,1 |
| Tube, rod and wire | 3,4 | 9,4 | 19,5 | 17,9 | 17 | 17,5 | 16,5 | 17,3 | 18,1 |
| Others: billet | 0,7 | 4,7 | 4,7 | 5,4 | 5,3 | 5,8 | 5,2 | 5,9 | 6,5 |
| casting | 1,4 | 1,2 | 4,6 | 2,6 | 3,3 | 3,4 | 2,9 | 2,7 | 2,6 |
| Total | 10,5 | 37,0 | 48,0 | 57,4 | 64,6 | 63,6 | 56,9 | 58,4 | 61,8 |

Table 6. Financial data of the Csepel Metalworks

| | 1975 | 1980 | 1985 |
|---|---|---|---|
| Returns from sales | 100 % | 126,5% | 145,6% |
| Profit | 100 % | 61 % | 173 % |
| Profit related to income | 5.6% | 2.7% | 4.1% |
| Total number of employees | 100 % | 83 % | 69 % |
| Average wages of labourers | 100 % | 134 % | 225 % |
| Average wages of staff | 100 % | 141 % | 259 % |
| Productivity | 100 % | 152 % | 210 % |

Century old manufacturing experience in the Csepel Metalworks combined with the most modern production facilities not only ensure the development of Hungarian production, but also makes significant engineering work possible.

The Csepel Metalworks has its own road, rail and public utility network in its Budapest plant. Raw materials are transported on an industrial railway and in trucks. Ready products are shipped out of roofed storage rooms, where railway wagons and trucks can be loaded. Generally the port of Hamburg is used for shipments to other continents. The changes in transportation costs to Hamburg are shown below:

1975 45,500.- Ft/20 t
1980 48,500.- Ft/20 t
1985 52,000.- Ft/20 t

at present US$1 = approx. 48.- Ft.

The domestic copper industry is supplemented with major international co-operation. On the basis of a long-term agreement with the Soviet Union, the Csepel Metalworks exports brass condenser tubes to that country, from which they buy hot-rolled copper and brass coils. It has thus been possible to avoid construction of parallel capacities in both countries. Sheets are imported from Bulgaria and Hungary exports copper wire to Czechoslovakia and the Soviet Union, thus taking advantage of mutual free capacities.

## 2. Consumption of copper based semi-finished products

Copper and its alloys are proportionally used in the different branches of Hungarian industry as shown below:

| | |
|---|---|
| Machine industry | 4.8% |
| Electric industry | 62.9% |
| Telecommunications industry | 11.6% |
| Precision engineering | 4.7% |
| Metal mass products industry | 12.7% |
| Automobile industry | 3.3% |

There has been little if any change in the consumption ratio in Hungary according to industries in the past ten years.

## II. ALUMINIUM PROCESSING INDUSTRY IN HUNGARY

### 1. General development of aluminium processing in Hungary

The aluminium industry in Hungary looks back on a relatively long tradition. It celebrated its 50th anniversary in 1985. This jubilee, however, is related to the beginning of the metallurgical processing of aluminium, for aluminium processing proper dates further back.

In Hungary, aluminium industrial activities began with semi-finished and finished products, namely with the manufacturing of kitchenware in 1911.

The extraction of bauxite started during the First World War, but at the beginning it was processed abroad. Bauxite mining stopped after the First World War. In 1921, the manufacturing of aluminium conductor wire began. The extraction of bauxite was resumed in 1926 in Transdanubia when new mines were opened. In the early stages bauxite was processed abroad, but in 1934 a plant for alumina production was established, and in 1935 the first smelter operations with a capacity of 1,300 tons began. This plant, however, was closed long ago.

The manufacturing of semi-finished products commenced before the beginning of the metallurgical processing of local aluminium ore. Production of semis started in 1928, and that of foil in 1929, using imported coils. 1930 saw the beginning of wire production and 1932 was the year in which rolled semis made their appearance in Hungary.

During the years before the Second World War the demand for aluminium increased in Hungary, due to the war preparations. Hence, in addition to the development of the Magyaróvár Alumina Plant, two new alumina plants were established: one at Almásfüzitő
and the other at Ajka. The latter was integrated with a smelter, and another metallurgical plant was erected in the mining city of Tatabánya.

These plants still constitute the basis of the Hungarian aluminium industry. They have been expanded and modernised with the passage of time, and only the plant at Inota, which was established in the early 1950's, has been built since.

The production of finished items and that of semis began to increase, based on local metallurgical processing. The largest actual industrial unit is the Székesfehérvár Light Metal Works which was launched in 1943, though with a much smaller capacity than today.

The aluminium industry suffered great damages during the Second World War, but as early as 1949 the volume of production had already surpassed the pre-war output. After 1949 the aluminium industry began to develop by leaps and bounds. The German equities were taken over by the Soviet Union after the Second World War, and in 1946 a joint Hungarian-Soviet enterprise was established in that industrial branch. In 1955, Hungary acquired full ownership of that venture. The vertical structure - bauxite, alumina, ingots, semis - of the state-owned Hungarian Aluminium Industry, operating within the framework of the Aluminium Board of the Ministry of Mining and Energy was retained.

The Hungarian Government endeavoured to develop the aluminium industry in proportion to the available local bauxite. It was also recognized that neither the energy resources available for that purpose, nor the required background in the engineering industry were suitable for the development of the industry. Appropriate international co-operation were conceived in order to cope with those problems.

As a first step, during the Hungarian-Soviet joint venture period, significant co-operation was established with Czechoslovakia. The Czechoslovak partner made it possible to increase electric energy utilization in Hungary by connecting the electric network of the two countries with transmission lines. Furthermore they supplied part of the equipment and materials needed for the development of the Hungarian aluminium industry. In exchange, Hungary delivered alumina in the early stages and later bauxite was supplied for the Czechoslovak aluminium industry, and technical assistance was given for the erection of the Ziar smelter. In 1960, an agreement was signed with the Polish aluminium industry, under which Hungary delivered alumina in exchange for aluminium ingots.

The experience gained from the above co-operation led in 1962 to the Hungarian-Soviet alumina-aluminium agreement, which brought about a considerable increase in the metal resources of the Hungarian aluminium processing industry. Under that agreement, Hungary, a country lacking energy, sends the alumina for processing to the Soviet Union instead of developing its own aluminium smelting industry. The vigorous development of semi-manufacturing facilities in Hungary was based on the increased metal resources which were made available under the quoted inter-governmental agreement.

Before 1945, the Hungarian aluminium processing industry imported German know-how and technology. After 1945, and especially during and after the joint-venture period, they were imported from the Soviet Union. That process ran parallel with Hungary increasingly relying on its own development efforts. The progress of the Hungarian semis production was considerably furthered by the relevant know-how purchased from the French CEGEDUR company.

With increased metal resources having been made available for the Hungarian aluminium industry, organizational changes had to be carried out. The Hungarian Aluminium Corporation (HAC) which has been operating since then, was established to co-ordinate aluminium industry activities in the country.

HAC is in charge of the operation of all the bauxite mines, alumina refineries, smelters and semi-producing factories, two finished products manufacturing plants, one machine factory, bauxite geological survey, the institute for research and design, and a trading company.

In 1970, on the initiative of HAC, the Government approved a Central-Industrial Development Programme to promote the progress of the Hungarian Aluminium Industry. In addition to covering the HAC affiliated companies, this programme is also valid for those finished-product manufacturing enterprises lying outside the scope of HAC.

A relatively important preferential credit was granted to promote the implementation of that programme. It financed the development of semi-products, which were the most important from the aspect of consumers' demands, as well as the modernization, expansion and automation of manufacturing in the finished-products industry.

ALUTERV-FKI, the research and design institute of HAC, took a major part in developing the manufacture of finished products; in addition, the Aluminium Advisory Service, which was founded in 1947, was also of great assistance. That service is actually operating as an integral part of ALUTERV-FKI, and its main task is to foster proper fulfilment of consumers' demands, and to orient their requirements towards more up-to-date and economic aluminium utilization areas.

For this reason it is engaged in intensive publicity activities, runs post-graduate courses for engineers, organizes courses and lectures, and takes an active part in manufacturing prototypes.

The Hungarian aluminium industry has been granted credits on several occasions, according to the Government's intentions and preferences, to foster its development both in terms of quality and quantity. The credits have come from State banks, i.e the State Development Bank and the Hungarian National Bank. Those credits made various development programmes possible such as, for instance, the intensification of the production of the alumina factory in Ajka; the expansion of the Light Metal Works in Székesfehérvár; the introduction of high-pressure casting, the development of foil-production; the promotion of pigment; powder and paint production; etc.

## 2. Bauxite mining

Today, Hungary's bauxite operations are designed to furnish an annual quota of 2.5 million tons of ore for use by domestic alumina plants to meet their complete bauxite demand. In addition, a volume of 500,000 tons of lower grade bauxite is set aside each year for export. Total annual output is thus of the order of 3 million tons.

The bauxite to alumina export price ratio is 1:6.5, approximately equal to that of general world market trends. Bauxite is exported to Czechoslovakia, the German Democratic Republic and Poland.

Although bauxite exploration has good prospects, no rise in the present export quota is envisaged. The bauxite is of mono-hydrate-boehmite type, with varying goethite content. Trihydrate mixed type bauxites also occur. In bauxite mining and exploration there is a total workforce of 4,000, including personnel operating in auxiliary workshops. Compared to mining sites working under similar geological circumstances abroad, the operations of Hungarian bauxite mines may be considered to be of high standard, supervised and directed by a staff of competent technicians and engineers. At present, one third of the ore is won by opencast quarrying and two thirds by underground mining. Conditions under which the ore is won are difficult. In opencast mining an overburden of 7-10 cubic metres has to be stripped off to win one ton of ore.

Notwithstanding the severe conditions referred to above, productivity of underground mining is relatively high, amounting to 5 tons per shift for all hands employed in underground operations, and 24 tons per shift for workers directly working such deposits. These figures are due to the high degree of mechanization. On the debit side, however, there are heavy maintenance and repair costs.

The ore is transported by road within a radius of 50 kilometres and by rail for distances beyond this figure.

Executives of the Hungarian Aluminium Corporation and the mining companies, as well as authorities and organs such as the National Labour-Safety Inspectorate, and the Trade Unions, regularly check and supervise whether the labour-safety, health and operational safety regulations are strictly adhered to. There is no bauxite levy in Hungary.

## 3. Production

Production of the alumina plants has been raised in several successive stages to reach today's level of 880,000 tons per annum (Ajka 475,000 tons, Almásfuzitó 330,000 tons and Magyaróvár 75,000 tons per annum).

At present the alumina plants are operating at almost full capacity. More than 20% of output is devoted to domestic ends and about 80% to exports. Hungarian alumina plants use medium-grade boehmitic bauxites

of a $\frac{Al_2O_3}{SiO_2}$ ratio of 7 - 7.5 to be processed to alumina

by the Bayer process. Per ton alumina performance data for 1985 averaged as follows: bauxite 2.92 tons, steam 2.98 tons*, caustic soda 0.16 tons.

Profits after tax are devoted in the first place to investments aimed at maintaining and improving available facilities, e.g. the construction of red mud yards, etc., with a fair share appropriated to promote the welfare of workers, social and cultural amenities, financial contributions to housing.

The Government refunds taxes in respect of exports, as provided for by standing fiscal regulations.

The labour force engaged in alumina operations at Ajka is 1500, at Almásfüzitó 1,130 and at Magyaróvár 690. Productivity is 320 tons per annum and capita at Ajka, 290 tons per annum and capita at Almásfüzitó, and 109 tons per annum and capita at Magyaróvár; discrepancies in these figures are due to variations of scale. Productivity in the period 1960-1980 increased more than three-fold.

The aluminium industry has a Research and Engineering Institute, catering for every stage of vertical integration. Its alumina division used to play an active part in developing domestic alumina plant facilities and adapting suitable technologies, as well as in transferring know-how and engineering to implement various alumina projects abroad, such as at Korba/India, Tulcea/Romania, Lauta/German Democratic Republic, and several others in Yugoslavia.

Manpower at the alumina plants is competent and suitably trained. Some 7% of the total staff are graduates of higher education.

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* (8.14 Gigajoule).

In conjunction with alumina production, Magyaróvár is also a major manufacturer of abrasive grains - 22,000 tons per annum, refractory furnace lining blocks - 8,000 tons per annum, mullite - 10,000 tons per annum, and aluminium sulphate - 63,000 tons per annum.

In alumina manufacture some further expansion of the Ajka and Almásfüzitő facilities is now being envisaged. Also efforts are being made to raise the output and selection of several well-marketable special alumina brands to be used for different ends.

## 4. Aluminium smelting

At present the country's total primary aluminium capacity amounts to 75,000 tons per annum, the actual output slightly above 74,000 tons/year comes quite near to the nominal.

The electrolytic furnaces installed in Hungarian smelters are based on the side- and vertical-stub Soederberg anode system originally patented by Elektrokemisk A/S of Norway; in the 1940's it was considered to be the most advanced type of its kind from the point of view of furnace design and electrical performance.

In the reconstruction of the potlines, most of the heavy labour involved in manipulating the furnaces has been mechanized and up-to-date silicon-diode rectifiers have been installed to furnish d.c. current. However, compared to latest developments in this field, the design and operation of electrolytic furnaces are of a medium standard. Nevertheless, some performance data arrived at by the present facilities are quite remarkable, e.g. the average d.c. power consumption recorded in 1985 was 15,257 kWh/ton.

As for processing the molten metal on site, up-to-date continuous casting technologies were introduced, along with possibilities of a further processing of strip and rod wire won by such technologies. Today 52% of smelter production is sold either in the form of continuous cast products, and/or locally reprocessed to semi-fabricated items (strips, slugs and drawn wires).

The total number of workers employed at the smelters is 2,100; of which 17% are engineers, technicians and clerks, and 83% mannual workers.

## 5. Semi-manufacturing

By 1944 semi-manufacturing output amounted to 5,000 tons. In the post-World War II period, production has been as follows:

1950 = 12,000 tons
1960 = 33,000 tons
1970 = 80,000 tons
1980 = 150,000 tons
1985 = 180,000 tons (preliminary).

The selection of available semi-fabricated products is wide, encompassing the following items: rolled plate, sheet, strip and disc; extruded rods, sections, tubes; continuous cast and drawn wire; forged pieces; a variety of high finish foils - laminated, painted, printed, etc.; anodized products.

The minimum thickness of rolled products is 0.2 mm and their maximum width 1,500 mm. Plates and sheets may be cut to maximum lengths of 4,000 mm. Using modern technologies rolled products are available in the soft, quarter-hard, half-hard, three-quarter hard and hard state. Deep-drawing properties of discs are fully up to demand by the holloware industry. The uniformly even lay of sheet and strip surfaces is further improved by using stretch-dressers.

Foils are made from a 1,235 AA material in up to 1,400 mm maximum width. Their minimum gauge is 9 microns.

Most extruded products are made from materials of the 6,000 AA series. Principal end-users of such items are the building trade, transport vehicle manufacturing and other industries.

Some 30% of production is exported, meeting the requirements of well-known foreign standards. The light metal works employ a workforce of 5,000. Of these 5% are graduates of higher technical education, 13% of medium-grade technical education and 28% are skilled workers. At present no expansion of available facilities is being implemented.

## 6. Research and development in the aluminium industry

The Research Institute for Non-Ferrous Metals, FKI, was founded in 1948, and Aluterv was established in 1955. In 1976 the two of them were amalgamated. The aluminium industry's design programmes were implemented by specialized design institutes even before 1955. Research and design institutes have always had an important role to play in developing the Hungarian aluminium industry.

It is a characteristic feature of R+D that it is being carried out in co-operation with plant engineers, and that it covers all activities of the integrated Hungarian aluminium industry. This is the key to several important results, e.g.:

- lowering the level of the Karstic-water;
- digestion additives for alumina production;
- technology for processing bauxites, containing goethite;
- energy consumption in the alumina plants;
- intensification in metallurgy;
- organization of labour in semi-finished production:
- development of new alloys;
- elaboration of welding and surface treatment technologies;
- construction of slab-casting machines for foundries;
- design of aluminium structures and elaboration of the technology of manufacturing;
- design of new measuring methods and measuring instruments.

It must be pointed out that the development of the aluminium industry also had an impact on the development of the machine industry which had to develop with in order to meet the growing investment demands of the aluminium industry.

Due to R+D and design activities in the aluminium industry a remarkable amount of research, development and design experience accumulated especially in alumina production. That provided the basis for building workshops and factories abroad.

## 7. The structure of aluminium consumption

Table 7 shows the structure of aluminium consumption in Hungary.

It is a characteristic that it differs from that of the industrialized countries, which are leaders in aluminium consumption. Consumption figures in electrical engineering - 35% - are higher than those of the leading market economy countries, which is usually within 10%. The main reason is the big cable-export, which appears as domestic consumption in international statistics. At the same time the amount used in transportation is rather modest. It is many times higher in the industrialized nations - 18 to 30% - because of their vehicle and aircraft industry. Similarly, the building industry uses less aluminium (11%) than the leading consumers - between 17 and 31%.

Table 7. The structure of Hungarian aluminium consumption (%) (1955 - 1980)

| Denomination | 1955 | 1960 | 1965 | 1970 | 1975 | 1980 |
|---|---|---|---|---|---|---|
| Means of transport | 19.8 | 19.74 | 18.87 | 12.33 | 11.61 | 8.6 |
| General mechanical industry | 9.8 | 2.75 | 4.00 | 3.95 | 3.52 | 7.4 |
| Electrical engineering industry | 29.3 | 42.32 | 38.52 | 30.20 | 27.86 | 30.8 |
| Building industry and structures | 3.1 | 2.80 | 4.14 | 8.53 | 14.91 | 13.0 |
| Chemical and food industry agricultural industry, packaging | 4.6 | 7.14 | 10.07 | 10.89 | 12.11 | 9.5 |
| Household and office equipment | 9.8 | 12.76 | 13.34 | 16.19 | 16.35 | 21.1 |
| Mass products | 4.9 | 3.38 | 3.63 | 5.43 | 2.93 | 3.1 |
| Others and losses | 18.7 | 9.11 | 7.43 | 12.43 | 10.70 | 6.5 |

8. Government strategy

Aluminium consumption before the Second World War was independent of the country's bauxite deposits and dates further back than the beginning of aluminium production. After the Second World War that industry was nationalized and organized in accordance with the well-tested international experience, that is, the branch was merged into one corporation. It was thus possible to shape the demands for aluminium and the metal base needed to meet them, which in turn led to various international co-operation agreements, which ensured the amount of metal needed, provided for appropriate government support, central development programme, preferential credits, domestic R+D activity, and an advisory service for customers.

It is beyond any doubt that the Hungarian bauxite deposits largely contributed to the development of the aluminium industry, because the authorities realized the importance of aluminium and the possibilities of utilizing this material. However, consumption demand had to be generated and a production pattern required by the characteristics of the country had to be provided along with the necessary financial resources.

# THE NON-FERROUS METALS INDUSTRY IN YUGOSLAVIA

## INTRODUCTION

Yugoslavia is a country which has progressed since the Second World War, from a state of total undeveloped industry to one with very modern technology, especially in the non-ferrous metals. The aluminium industry is particularly characteristic, having developed to greater detail at this phase.

With the majority of investments coming from foreign sources and despite lack of experience, industrial complexes composed of vertically integrated industries have been developed - from mines and metal production to the most refined processing, with very modern technical and technological solutions.

Table 8 illustrates the results achieved in the production of non-ferrous ores, concentrates and metals during the period 1976-1984.

Table 8. Production of ores, concentrates and metals
(in 1,000 t)

| | 1976 | 1977 | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984* |
|---|---|---|---|---|---|---|---|---|---|
| 1) bauxite | 2,033 | 2,044 | 2,565 | 3,012 | 3,138 | 3,149 | 3,433 | 3,516 | 3,300 |
| 2) alumina | 456 | 500 | 496 | 838 | 1,059 | 1,053 | 1,015 | 1,019 | 1,158 |
| 3) aluminium | 183 | 185.5 | 187 | 185 | 201 | 219 | 258 | 293 | 320 |
| 4) copper ore | 17,377 | 17,533 | 17,098 | 16,466 | 19,559 | 18,377 | 19,733 | 23,443 | 25,300 |
| 5) copper concentrate | 471 | 457 | 508 | 478 | 496 | 478 | 514 | 543 | n.a. |
| 6) copper | 136 | 93 | 151 | 129 | 135 | 133 | 127 | 124 | 127.6 |
| 7) lead and zinc ore | 3,805 | 3,130 | 4,051 | 4,125 | 4,308 | 4,365 | 4,268 | 4,215 | 4,634 |
| 8) lead concentrate | 136 | 170 | 164 | 169 | 158 | 156 | 148 | 144 | 148 |
| 9) lead | 114 | 133 | 121 | 115 | 108 | 107 | 99 | 114 | 112 |
| 10) zinc concentrate | 172 | 184 | 174 | 168 | 155 | 150 | 149 | 144 | 149 |
| 11) zinc | n.a. | 95 | 95 | 99 | 84 | 90 | 78 | 93 | 92 |

* preliminary data.

# I. NON-FERROUS ORES

## 1. Bauxite production

In the five-year plan period (1976-1980) production grew at a relatively high average rate of 6.9 per cent, while in the period 1981-1983 production growth considerably diminished, with an average of 3.8 per cent.

Due to the rapidly developed alumina capacities in the country and the existing high amount of exports which consume practically the entire quantity of newly determined bauxite reserves, the increase in ore reserves in Yugoslavia virtually stagnates. For a more stable increase in domestic ore reserves a considerable increase in funds is necessary for exploration than hitherto available.

Yugoslav bauxites are basicelly of the mono-hydrate type, which require greater quantities of caustic soda, as well as a higher temperature and pressure for their treatment than the tri-hydrate bauxites.

Notwithstanding the difficulties caused by increasing skip ratio, which reaches 5 in some operations, open-pit mining will prevail in the future because of the possibility of erecting larger production facilities and making better utilisation of the available ore reserves, in comparison to underground mining.

The trends of bauxite marketing and consumption during the period 1971-1983 were the following:

Table 9. Import, export and domestic bauxite consumption, 1971-1983
(1,000 t)

| | 1971 | 1972 | 1973 | 1974 | 1975 | 1976 | 1977 | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Production | 1955 | 2197 | 2167 | 2370 | 2306 | 2033 | 2044 | 2565 | 3012 | 3138 | 3249 | 3432 | 3516 |
| Imports | 238 | 166 | 170 | 220 | 109 | 41 | 51 | 44 | 64 | 218 | 394 | 176 | 159 |
| Exports | 1859 | 1813 | 1707 | 1611 | 1283 | 1024 | 909 | 676 | 525 | 247 | 266 | 600 | 549 |
| Total Domestic Consumption | 338 | 550 | 630 | 979 | 1132 | 1020 | 1186 | 1933 | 2551 | 3109 | 3377 | 3244 | 3126 |
| Domestic Bauxite Consumption | 100 | 384 | 460 | 759 | 1173 | 1009 | 1135 | 1889 | 2487 | 2891 | 2993 | 2832 | 2967 |

During the past 13 years, the domestic bauxite consumption increased almost 30-fold, while exports dropped by over 300 per cent; today 85 per cent of the bauxite production is consumed in domestic alumina factories.

The developed capacities for alumina production in Yugoslavia will demand constant supply from the domestic mines of 3.5 million tons of bauxite annually. Besides these quantities, the bauxite mines are obliged to export part of their production in order to obtain foreign exchange for the purchase of imported spare parts, equipment and diesel fuel.

## 2. Copper ore production

The production of copper ore (Table 8) has shown a growth tendency throughout the whole period under review. Production grew faster during the period 1981-1983 (6.2 per cent annually) than in the previous five-year period (with an average of 4.0 per cent annually).

Table 8 also reflects considerable increase in the production of copper concentrates.

## 3. Lead and zinc ore production

Production trends (Table 8) were more favourable during the period 1976-1980, when it grew (at an annual rate of 3.6 per cent), than during the period 1981-1983, when it started to decrease. In 1984, the production of lead and zinc ore increased considerably compared with 1983 and reached an output of 4,634 thousand tons.

According to the indication in Table 8, a slight decrease in the yearly production of lead and zinc concentrates occurred in the period 1976-1984.

The most dis-balance in the development of Yugoslav non-ferrous metallurgy is in the exploratory work and mine capacity. The unsatisfactory production of ore causes the biggest bottleneck in non-ferrous metallurgy. The reasons for this are: the years of insufficient investment in exploratory and preparatory mining work; the diminishing metal content in the ore; the worsening of the mining conditions; technological problems related to the usage of geological reserves and the diminishing degree of the usage of metal contained in the ore; the unfavourable economic position of mining; and the lack of specialized personnel.

## II. PROCESSING OPERATIONS

### 1. Aluminium

#### A. Alumina production

During the period 1976-1983 the average annual growth rate of alumina production was 17.3% (Table 8). From 1976 to 1980, alumina production increased more than 370%, that is from some 283 thousand tons in 1975, to around 1,058 thousand tons in 1980. Thereafter a slight decrease in production due to the problems and closing of the Obrovac Alumina Plant could be observed. An increase again appeared in 1984.

Due to the above explaination of the development of alumina production, Yugoslavia's share in the world's alumina production reached 3.3% in 1983.

Technological solutions and engineering in domestic alumina factories were obtained from well-known foreign companies. Domestic alumina plants, using up to date Bayer process technology and modern equipment, therefore obtain very good consumption figures for material and energy, i.e. at the level of world factories, which use bauxite of a similar quality to that of Yugoslavia.

The successful absorption of alumina technology by the Yugoslav plants was also demonstrated by the fact that applied research was engaged in several of them with a view to finding new solutions in all phases of the technological process, e.g.: in washing, filtering and stocking red mud, the use of lime to diminish the consumption of caustic soda, energy saving as the result of better cleansing of the settlers, the elimination of bottle-necks in white filtration, the transition to the production of surface, active alumina (Sandy), etc.

Due to those achievements, the utilization of production capacity (Table 10) in the period under review was on average 80%, and in 1984, when production was anticipated to be 1,190,000 tons of alumina, increased to 93%, which was a world average.

## Table 10. Dynamical development and alumina capacity use by producers for the period 1971-1983

| Alumina Factory | Technical capacity of factory / Attained production in thousand tons in the years: 1971 | 1972 | 1973 | 1974 | 1975 | 1976 | 1977 | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Mostar | - | - | - | - | - | 280 | 280 | 280 | 280 | 280 | 280 | 280 | 280 |
| | - | - | - | - | - | 163 | 178 | 200 | 115 | 202 | 195 | 206 | 250 |
| Birac | - | - | - | - | - | - | - | - | 600 | 600 | 600 | 600 | 600 |
| | - | - | - | - | - | - | - | - | 300 | 428 | 521 | 533 | 484 |
| KAT | - | - | 200 | 200 | 200 | 200 | 200 | 200 | 200 | 200 | 220 | 280 | 280 |
| | - | - | 153 | 149 | 157 | 182 | 205 | 173 | 166 | 170 | 183 | 169 | 179 |
| TGA | 130 | 130 | 130 | 130 | 130 | 130 | 130 | 130 | 130 | 130 | 120 | 120 | 120 |
| | 118 | 126 | 122 | 124 | 126 | 111 | 117 | 123 | 124 | 118 | 111 | 107 | 106 |
| Obrovac | - | - | - | - | - | - | - | - | 300 | 300 | 300 | (300)[+] | (300)[+] |
| | - | - | - | - | - | - | - | - | 133 | 141 | 43 | - | - |
| TOTAL | 130 | 130 | 330 | 330 | 330 | 610 | 610 | 610 | 1,510 | 1,510 | 1,520 | 1,280[+] | 1,280[+] |
| SFRY | 118 | 126 | 275 | 273 | 283 | 456 | 500 | 496 | 838 | 1,059 | 1,053 | 1,015 | 1,019 |
| Capacity Usage in SFRY (in %) | 90.8 | 96.9 | 83.2 | 82.6 | 85.8 | 74.8 | 82.0 | 81.3 | 55.6 | 70.1 | 69.3 | 79.3 | 79.6 |

[+] The capacities of Obrovac which are now preserved are not calculated.

Notwithstanding the above impressive achievements, the Yugoslav alumina plants also face serious difficulties, the most important of them being the following:

- utilisation in selected cases of heavy oil or gas for the production of technological steam, increasing energy costs;

- irregularities in the bauxite supply emerging from mining or transport operations;

- irregularities in the supply of auxiliary materials, mainly caustic soda and particularly of those imported;

- irregularities in the supply of spare parts and accessories.

Alumina marketing and consumption in Yugoslavia over the past 13 years showed the tendencies reflected in Table 11.

An important part of the alumina is consumed by domestic non-ferrous metal and chemical industries. The export of calcined alumina and hydrates takes place generally within the scope of long-term contracts with the USSR, CSSR and Poland, while the importation of this raw material comes basically from Guinea.

The price of alumina on the domestic market barely covers the cost of its production. From the point of view of world export prices, the situation is even worse. In most cases it covers only 70-80% of the production costs of domestic alumina. It is worth mentioning here that the closure of the production operations in the alumina plant at Obrovac was due to the high cost of obtaining alumina owing to the fact of the high bauxite specific consumption (2.9 tons); of the high caustic soda consumption (190 kg/t); and it consumed only expensive, imported heavy oil for the production of steam and for calcination.

## B. Aluminium smelting

During the period from 1976 to 1980, the production of primary aluminium grew at a relatively slow rate (averaging 2.3% annually), while over the period 1981-1983 it grew considerably, with an average growth rate for the three-year period of approximately 13%. The high rate of production growth of 6.4% over practically the whole period, was the result of installing new capacities. In 1975, production of primary aluminium was 178,000 tons, while in 1984 it was 320,000 tons (Table 8).

Table 11. Import, export and domestic alumina consumption 1971-1983

(in thousand tons)

| | 1971 | 1972 | 1973 | 1974 | 1975 | 1976 | 1977 | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Production | 123.4 | 126.0 | 274.4 | 272.7 | 287.1 | 455.3 | 499.4 | 496.5 | 838.2 | 1,059 | 1,053 | 1,015 | 1,019 |
| Imports | 8.3 | 40.2 | 45.2 | 33.7 | 153.0 | 48.6 | - | - | 1.3 | - | 55 | 34 | 101 |
| Exports | 23.7 | 23.2 | 73.4 | 76.3 | 73.8 | 91.7 | 111.1 | 80.4 | 395.4 | 622 | 633 | 528 | 497 |
| Domestic Consumption | 108.0 | 142.0 | 241.0 | ....1 | 366.3 | 412.2 | 388.3 | 416.1 | 144.1 | 437 | 475 | 521 | 623 |

The trend of the balance of brutto and netto primary aluminium consumption in Yugoslavia for the period 1971-1983 is shown in Table 12. From 1971 until the beginning of the eighties, the brutto and netto consumption of aluminium in Yugoslavia increased by approximately 300%. In 1982 and 1983, the netto consumption of aluminium in the country diminished despite the increased production of that metal. The reason was the considerable increase of primary aluminium exports due to matured installments of foreign investment credits and the increased needs of the electrolysis for foreign exchange for the acquisition of basic raw materials through import, as well as the perceptible increase in aluminium semis exports, creating in turn a shortage on the domestic market.

## C. Fabrication of aluminium semis

The structure of the production of semi-products over the past eight years is shown in Table 13.

From Table 13 it may be concluded that during the period 1976-1983 the total production of aluminium, Al-alloy rolled, extruded and drawn products in Yugoslavia had a growth index of 148.4. In other words it grew at an annual rate of 5.8%. The production of Al-alloy semi-products grew somewhat faster, i.e. at the rate of 6.8%, which changed the relationship between aluminium and Al-alloy products, i.e.:

| | in 1976 | in 1983 |
|---|---|---|
| Aluminium semi-products | 60.54% | 57.83% |
| Al-alloy semi-products | 39.46% | 42.12% |
| | 100.00% | 100.00% |

In Yugoslavia today, factories producing aluminium and Al-alloy semis are able to provide the broadest assortment of rolled, extruded and drawn semi-products, in accordance with world standards.

Table 12. Import, export and domestic aluminium consumption 1971-1983

| In SFRY (in 1,000 tons) | 1971 | 1972 | 1973 | 1974 | 1975 | 1976 | 1977 | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Production of primary Al | 46.5 | 72.8 | 90.8 | - | 168.3 | 182.9 | 185.5 | 187.1 | 185.0 | 201.1 | 218.8 | 257.9 | 292.9 |
| Primary Al import | 39.0 | 46.0 | 57.0 | - | 32.0 | 33.7 | 43.7 | 41.6 | 42.3 | 58.6 | 51.8 | 31.0 | 37.5 |
| Import of Al semis | 16.4 | 14.1 | 20.0 | - | 16.2 | 11.9 | 12.5 | 8.8 | 8.5 | 10.5 | 16.4 | 16.2 | 11.7 |
| Export of primary Al | 13.0 | 31.0 | 42.0 | - | 67.0 | 81.3 | 63.2 | 55.6 | 46.2 | 54.1 | 58.5 | 91.0 | 143.6 |
| Export of Al semis | 32.7 | 37.5 | 41.8 | - | 51.7 | 61.5 | 49.4 | 54.8 | 50.0 | 59.8 | 48.2 | 50.0 | 68.5 |
| Brutto consumption of Al in SFRY | 72.5 | 87.8 | 105.8 | - | 133.3 | 135.3 | 166.0 | 173.1 | 180.1 | 205.6 | 212.1 | 197.9 | 186.9 |
| Netto consumption of Al in SFRY | 56.2 | 64.4 | 84.0 | - | 97.8 | 85.7 | 129.1 | 127.1 | 138.6 | 156.3 | 180.3 | 164.1 | 130.0 |

Note: The export and import of cable industry, Al-constructions, containers and tubes, as well as castings are not included in the balance for they are considered final products.

Table 13. The structure and capacities of aluminium and aluminium alloy semi-products
(in tons)

| A) Aluminium semis | 1976 | 1977 | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 |
|---|---|---|---|---|---|---|---|---|
| 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| Pressed and extruded wire (without Properzi rods)+ | 4119 | 11116 | 11953 | 9237 | 4176 | 3331 | 2938 | 1028 |
| Rods | 376 | 277 | 368 | 247 | 209 | 378 | 407 | 206 |
| Profiles | 300 | 41 | 120 | 13 | 24 | 19 | 21 | 12 |
| Pipes | 896 | 303 | 627 | 558 | 533 | 508 | 490 | 376 |
| Sheets | 25127 | 24605 | 27169 | 27101 | 28610 | 32346 | 29691 | 29101 |
| Strips | 24806 | 33593 | 33844 | 23927 | 28862 | 28774 | 36281 | 43660 |
| Rondels and discs | 3933 | 2966 | 3255 | 3150 | 3898 | 4198 | 5190 | 4780 |
| Bare foils | 960 | 2674 | 2332 | 4701 | 4332 | 3699 | 3203 | 2941 |
| Laminated foils | 2522 | 3996 | 3784 | 5083 | 5957 | 7442 | 6589 | 7384 |
| B) Aluminium alloy semis | 41078 | 49017 | 57773 | 64596 | 65702 | 63181 | 62612 | 65132 |
| Pressed and extracted wire | 579 | 847 | 857 | 751 | 784 | 1095 | 773 | 827 |
| Rods | 7447 | 7222 | 8011 | 7996 | 8468 | 8473 | 8152 | 9249 |
| Profiles | 9243 | 13404 | 17039 | 20181 | 24068 | 21883 | 21947 | 21575 |
| Pipes | 2137 | 2627 | 2718 | 2675 | 2938 | 3073 | 2833 | 2210 |
| Sheets | 12185 | 13766 | 13711 | 14619 | 13097 | 13877 | 14196 | 16613 |
| Strips | 8239 | 9634 | 14702 | 17389 | 15126 | 13608 | 13716 | 14465 |
| Discs | 1091 | 1174 | 565 | 673 | 602 | 675 | 612 | 73 |
| Rondelles | 157 | 343 | 170 | 312 | 619 | 497 | 383 | 120 |
| Total A+B | 104175 | 128588 | 141225 | 133702 | 142303 | 143847 | 147422 | 154620 |

+ Here is not included cast and rolled Al rods (Properzi) of which 19,060 tons were produced in 1983.

During the past 6 years, the members of the Association of Yugoslav Bauxite, Alumina and Aluminium Producers and Processors alone produced the following quantities of final products of aluminium and Al-alloys:

Table 14. Dynamics of final product production, 1978-1983

(in tons)

| Type of aluminium and Al-alloy final products | Production by years | | | | | |
|---|---|---|---|---|---|---|
| | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 |
| Al-constructions | 2,989 | 4,150 | 4,400 | 4,100 | 4,550 | 4,980 |
| Tubes and containers | 1,551 | 1,540 | 1,500 | 1,610 | 1,658 | 1,543 |
| Conductors (AL and Al/Fe) | 2,801 | 3,493 | 3,656 | 3,845 | 4,265 | 1,905 |
| Welded Al-pipes | - | 365 | 580 | 631 | 753 | 1,245 |
| Castings, moulds, etc. | 905 | 2,728 | 3,118 | 3,735 | 4,567 | 2,572 |

Yugoslavia is among the biggest exporters of aluminium and Al-alloy semi-products in Europe. In 1983 exports reached a record of 68,700 tons, i.e. 44% of the total domestic production, of which 48,000 tons were sold on the convertible market (69%).

Export, import and consumption in the country of rolled, pressed and extruded semi-products during the period 1971-1983 had the following trends (Table 15):

Table 15. Export, import and consumption of rolled, pressed and extruded semi-products in SFRJ
(in thousand tons)

| | 1971 | 1972 | 1973 | 1974 | 1975 | 1976 | 1977 | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Production | 71.0 | 77.3 | 85.1 | 95.9 | 119.2 | 104.2 | 128.6 | 141.2 | 133.7 | 142.3 | 143.8 | 147.4 | 154.5 |
| Import | 16.4 | 14.1 | 20.0 | 26.2 | 16.2 | 11.9 | 12.5 | 8.8 | 8.5 | 10.5 | 16.2 | 12.4 | 11.7 |
| Export | 32.7 | 37.5 | 41.8 | 51.0 | 51.7 | 61.5 | 49.4 | 54.8 | 50.0 | 59.8 | 48.1 | 49.6 | 68.7 |
| Domestic consumption of semis | 54.7 | 53.9 | 63.3 | 71.1 | 83.7 | 54.6 | 91.7 | 95.2 | 92.2 | 93.0 | 111.9 | 110.2 | 97.5 |

Exportation grew by over two times, at the yearly rate of 6.4%. Importation diminished by 40%. The consumption of semi-products in the country was almost doubled.

## 2. Copper production

After a relatively high increase in 1978, with the output level reaching 151 thousand tons, copper production began to decline (Table 8). In 1983, it was down to about 124 thousand tons. However, in 1984 it increased somewhat in comparison with 1983 and was 127.6 thousand tons.

## 3. Lead and zinc production

According to the data included in Table 1, no important changes can be identified in the production of lead and zinc in the 1976-1984 period. The trend is rather negative.

## 4. Employment, productivity

At the end of the first half of 1984, according to official data, 60,148 workers were employed in the non-ferrous metallurgical industries.

With the largest number of employees in the production of non-ferrous metal ores (28,397 or 47.2%), followed by those in the production of non-ferrous metals (16,553 or 27.5%), and thirdly by those in the processing of metals (15,198 or 25.3%). In the first half of 1984, in comparison to 1976, the labour force in non-ferrous metallurgy increased by approximately 22%.

The most outstanding fall in productivity of in the first half of 1984, in comparison to 1976, occurred in the production of lead and zinc ore (-3.2%), in the metallurgical part of copper production (-25.9%), lead (-17.9%), and zinc production (-26.5%). A notable rise in productivity in the period 1976-1984 was recorded in the production of bauxite (26.5%), alumina and aluminium (31.7%), in the field of non-ferrous metal processing, in aluminium processing (38.9%) and copper processing (25.9%).

## 5. Exports, imports

Table 16 shows the export and import figures of the most important products of the non-ferrous metallurgy for the period 1976-1984.

Table 16. Export and import of the most important non-ferrous metal ores and non-ferrous metals
(in thousand tons)

| | | 1976 | 1977 | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 |
|---|---|---|---|---|---|---|---|---|---|---|
| Copper concentrates and ores | Export | - | - | - | - | 16.1 | - | - | 61.4 | - |
| | Import | 30.7 | 20.1 | 23.9 | 7.7 | 47.8 | 11.5 | 9.6 | - | - |
| Bauxite | Export | 1,023.9 | 908.8 | 676.1 | 524.9 | 248.8 | 266.0 | 599.6 | 552.0 | 651.9 |
| | Import | 41.3 | 51.4 | 43.6 | 63.8 | 217.5 | 394.1 | 175.6 | 158.7 | 185.8 |
| Alumina | Export | 91.6 | 111.0 | 79.0 | 395.3 | 622.0 | 633.0 | 510.0 | 519.0 | 402.6 |
| | Import | - | - | 3.7 | - | - | - | 1.8 | 101.1 | 113.2 |
| Lead concentrates | Export | 11.3 | 5.4 | 39.8 | 13.4 | 10.0 | 12.8 | 9.1 | 4.2 | 5.9 |
| | Import | 8.1 | - | 1.9 | 1.9 | 2.7 | 1.0 | - | 6.5 | 0.6 |
| Zinc concentrates | Export | 0.6 | - | 2.2 | 6.6 | 8.8 | 6.0 | 1.1 | 3.4 | 5.5 |
| | Import | 67.8 | 33.4 | 33.4 | 55.7 | 65.2 | 56.3 | 58.5 | 29.3 | 26.9 |
| Electrolytic copper | Export | 1.1 | 1.1 | - | - | - | - | - | - | - |
| | Import | 5.4 | 0.9 | - | - | - | - | - | 8.0 | 7.3 |
| Primary aluminium | Export | 81.3 | 63.2 | 55.6 | 41.6 | 50.5 | 58.1 | 96.1 | 134.9 | 134.0 |
| | Import | 32.2 | 43.0 | 40.7 | 40.6 | 58.3 | 50.5 | 31.0 | 37.6 | 33.6 |
| Refined lead | Export | 23.2 | 33.7 | 40.9 | 33.5 | 24.2 | 13.5 | 17.7 | 17.6 | 13.9 |
| | Import | 3.7 | 5.2 | 8.1 | 9.5 | 10.0 | 12.1 | 15.6 | 10.7 | 3.9 |
| Electrolytic and refined zinc | Export | 33.6 | 25.3 | 32.5 | 31.5 | 19.1 | 21.6 | 22.4 | 24.9 | 23.8 |
| | Import | 5.5 | 5.6 | 0.5 | - | 2.9 | 9.1 | 9.4 | 25.0 | 19.8 |

Source: Foreign Trade Statistics, SZI, Nos. 1 and 2.

## 6. Investments and financial sources

### 6.1. Investments in non-ferrous metallurgy

Investment activity during the five-year period 1976-1980, in the non-ferrous metallurgical complex was very dynamic. The average yearly growth rate of investments in assets was 46.4%. In the period 1981-1983 investments in the non-ferrous metallurgy as a whole continuously declined. The average yearly growth rate in the period under review was negative and amounted to -3.7%.

The level of investments in the non-ferrous metallurgical complex was very high. This is confirmed by data on implemented investments in the social product. The average yearly participation of implemented investments in the social product of non-ferrous metallurgy in the period 1976-1980 was 90.1%.

In the period 1981-1983, the participation of investments in the social product was considerably less than in the previous five-year period, but was still very high. The average yearly rate of investment over the period 1976-1983 was 46.5%.

Table 17. Financial sources of investments made in non-ferrous metallurgical assets

| | Year | Structure (in %)[1/] | | | |
|---|---|---|---|---|---|
| | | Is | Iu | Ik | Io |
| Non-ferrous Metallurgy Total | 1976 | 41.0 | 2.5 | 55.5 | 1.0 |
| | 1977 | 29.7 | 0.9 | 67.3 | 2.1 |
| | 1980 | 18.4 | 0.6 | 80.2 | 0.8 |
| | 1976-1980 | 21.6 | 1.5 | 74.6 | 2.3 |
| | 1981 | 14.0 | 2.0 | 81.3 | 2.7 |
| | 1982 | 19.6 | 4.3 | 73.0 | 3.1 |
| | 1983 | 27.7 | 2.2 | 63.3 | 6.8 |
| | 1981-1983 | 20.3 | 2.9 | 72.7 | 4.1 |

[1/] The abbreviations used have the following meaning: Is - own funds; Iu - associated funds; Ik - loans; Io - other sources.

The diminished investments in the period from 1981 to mid-1984, in respect to the previous planning period, were mainly due to restrictive investment activities and the worsening conditions of credit, as well as to the need to repay foreign debts.

## 6.2. Total credit obligations of the non-ferrous metallurgical complex

The total debts of the non-ferrous metallurgical complex amounted to 83.7 billion dinars at the end of 1982, while at the end of 1983 it was 128.9 billion dinars. In the first six months of 1984, the loans taken had already reached the total amount of 1983's.

A more detailed analysis of the structure of those credits shows: (1) the considerable participation of metal production in the total debts of the complex. Almost 60% of all credits fall in this branch, about one third on the ore producers, and about 10% on the processors; (2) a major portion of the non-ferrous metallurgical debts (about 85%) are long-term credits; about 15% of all obligations are short-term. In metal processing, the participation of short-term credits is somewhat greater (26.3% in 1983), in the ore production very little (about 10%), however for the complex, viewed as a whole, it amounts to 15%;
(3) throughout the whole period from 1981 to 1984, the debts of non-ferrous metallurgy grew much faster than in other industrial branches. In 1982 this growth amounted to 36.8% in comparison to 26.8 in industry, while in 1983 it was 53.9% compared to 47.4% in industry.

## 6.3. Obligations abroad

The value in dinars of the total foreign credits for the non-ferrous metallurgical industry amounted to 78 billion dinars in 1983, or 61.2% of the total debt of non-ferrous metallurgy. The structure of this debt, according to years and fields of activity, is as follows:

| | 1981 | 1982 | 1983 |
|---|---|---|---|
| Non-ferrous metal mines | 32.0 | 28.6 | 30.6 |
| Non-ferrous metal production | 60.2 | 63.9 | 62.2 |
| Non-ferrous metal processing | 7.8 | 10.5 | 7.2 |
| TOTAL | 100.0 | 100.0 | 100.0 |

The highest rate of foreign indebtedness, i.e. the biggest participation of foreign debts in the total debts, was held in 1983 by the copper producers (76.5%), alumina producers (74.8%), aluminium producers (70.3%).

## III. LINKAGES BETWEEN THE NON-FERROUS METALS INDUSTRY AND THE REST OF THE ECONOMY

### 1. Analysis of main flows between sectors

Table 18 illustrates the consumption of the most important non-ferrous metals in Yugoslavia compared with those of developed countries. It can be seen that the level achieved in Yugoslavia corresponds to the use of those metals in other developed countries.

### 2. Technical and socio-economic relationships between the non-ferrous metals industries and the other sectors of the economy

The highest technical coefficient multiplier is in the non-ferrous metals industry itself, showing significant vertical integration. Vertical integration into manufacturing is most apparent in the fabrication of aluminium. There are high technical coefficient multipliers with several industrial branches.

There are nevertheless several problems:

- the local market is under-supplied with non-ferrous metallurgy products due to commitments;
- difficulties are caused to the enterprises of the non-ferrous metallurgy by irregularities in power supply, delivery of auxiliary materials and spare parts.

### 3. Degree of integrated development, development of related companies and technological innovations

These industries in Yugoslavia serve the export as well as the domestic market. Growth might stimulate downstream activities particularly through the creation of possibilities for wider utilisation of the available metallurgical and semi-fabrication facilities. Technology employed in the newly erected aluminium industry is close to the "state of the art". However it was purchased from foreign companies. Recently, with a UNDP contribution, the "Aluminium Institute for Research and Development" was established in Titograd with a view to carrying out R and D activities.

Table 18. Consumption of non-ferrous metals

(in developed countries and Yugoslavia for 1983, in kg. per 1,000 inhabitants+)

| COUNTRY | ALUMINIUM | COPPER | LEAD | ZINC | NICKEL | CADMIUM |
|---|---|---|---|---|---|---|
| CANADA | 11 824 | 7 823 | 3 793 | 5 796 | 193 | 4 |
| FRANCE | 11 224 | 7 136 | 3 588 | 4 950 | 595 | 15 |
| WEST GERMANY | 17 665 | 11 098 | 5 182 | 6 608 | 1 026 | 24 |
| ITALY | 7 566 | 5 718 | 4 029 | 3 660 | 396 | 6 |
| JAPAN | 15 098 | 10 197 | 3 015 | 6 462 | 962 | 12 |
| USA | 18 052 | 7 597 | 4 856 | 3 290 | 596 | 18 |
| YUGOSLAVIA (+) | 6 710 | 5 894 | 5 885 | - | 110 | 4 |
| (++) | 8 697 | 6 490 | 4 018 | 4 018 | - | - |

(+) World Metal Statistics, World Bureau of Metal Statistics, November 1984.

(++) Institute of Social Sciences, Belgrade, Unpublished Data.

## IV. GOVERNMENT LONG-TERM FORECASTS

In compliance with the "Long-Term Program of Economic Stabilization", the Chamber of Commerce, the general association and the organizations of associated labour are supposed to organize work and activities in the planning phase in order to coordinate individual, joint and general social interests. Of these activities, the most important is certainly the association for the coordination of interests of advancing and development of:

- capacities and production;
- technology; and
- economic relations abroad.

## V. LONG-TERM FORECASTS

Long-term forecasts by the enterprises operating in the country indicate the following target figures for the possible production of the non-ferrous metals: aluminium: 414,000 tons; copper: 180-207,000 tons; lead: 210-226,000 tons; zinc: 180-190,000 tons.

These projections mention an additional possibility for the creation of 100,000 tons of aluminium production capacity provided further power generation facilities are installed. Without considering the additional aluminium production, the realization of the programme would require investments amounting to US dollars 3038.5 million in the period 1984-2000.

One of the basic tasks in the following planning period is to solve the problem of the unbalanced development created to date. This unbalanced development is not only reflected in the slow production of non-ferrous metal ores, but also in the disproportions in the successive phases of reproductive entities. Over-dimensioned capacities are present in one portion of metallurgy processing of non-ferrous metals.

There are two basic options for the better utilisation of the available metallurgical capacities:

- to increase the domestic ore production
- to import additional quantities of ores or concentrates.

Regarding the available excess capacities for the production of semis, revision of the policy of ingot exportation might be undertaken, particularly considering the loan agreements through which delivery of equipment has to be paid by ingot exportation.

In the Yugoslavian non-ferrous metals industry several problems require solutions within the framework of any of the main possible options:

- increase the volume of geological research;

- intensify the R and D activities with a view to continuously adapt the technological process to the available raw material; increase the efficiency of the processes; extract the useful components of the ores; provide the customers with higher quality products;

- improve the supply of the enterprises of non-ferrous metallurgy as far as possible with machinery, equipment and auxiliary materials from domestic origin;

- stabilize the energy supply of the subsector particularly that of the smelters.

# THE NON-FERROUS METALS INDUSTRY OF SWEDEN

## I. INTRODUCTION

The history of the Swedish non-ferrous metals industry dates back to the early Middle Ages. Stora Kopparberget (in English Big Copper Mountain) is probably the oldest mining company in the world and its Falu mine has been operating continuously for at least 900 years. The oldest extant certificates and charters of Stora Kopparberget are from 1288 and 1347. In the middle of the 17th century two-thirds of the total European copper production came from the Falu mine and the yearly output was around 2000 tons of copper.

The second most important mine was the Sala silver mine which reached its peak of production in the late 16th and early 17th century. During the 16th and 17th centuries these two mines played a central role in Swedish economy and politics. State revenue came primarily from these two operations and they were the foundations for an expansive and aggressive Swedish foreign policy at that time.

During the 19th century the iron and steel industry became the backbone of the Swedish industry and the importance of the non-ferrous metals industry diminished.

The decline of international trade in metals due to of the First World War gave impetus to a renewed interest in non-ferrous metals mining.

In 1986 the international crisis in the non-ferrous metals industry also hit the Swedish mines hard and the industry is now in the middle of an important restructuring process, which will most certainly radically change the present structure of the Swedish non-ferrous metals industry.

## II. RESERVES

A survey of known reserves of non-ferrous metals at various price levels was made in 1975 (see Table 19). Only a brief description of the most important deposits currently being mined will be made here.

### Copper

Copper is produced mainly from complex sulphide deposits with varying contents of pyrite, zinc, lead and precious metals. Only Viscaria, close to the Kiruna iron ore, is exclusively mined for its copper content.

### Zinc, lead

Zinc, together with silver, is the main constitution of the active mines in middle Sweden. It is also a major component of the Laisvall lead-producing mine at the border of the Caledonides. The largest reserves of zinc in Sweden are presently within the Zinkgruvan Mine at Ammeberg.

### Silver

Silver is recovered as a main constituent of the ore deposits in middle Sweden with contents varying from some tens of grams up to several hundreds of grams per ton.

### Gold

Although present in very small amounts (0.2 g/t), gold is chiefly produced from the open cast mine at Aitik in northern Sweden. It is also a vital component of all the ore deposits within the Skellefte field.

### Chrome

No mineable deposit of chrome is so far known in Sweden although several low grade deposits have been thoroughly investigated.

### Tungsten

Tungsten present as scheelite is still mined from the Yxsjöberg deposit although the present price level does not allow profitable operation. The metal is, however, vital for the Swedish manufacturing industry and mining is subsidized. A promising new deposit has recently been found in Arjeplog in northern Sweden.

### Manganese

Many of the iron ores in middle Sweden contain substantial amounts of manganese. The mining of manganese in Sweden was stopped in the 1970s.

### Nickel

Only minor deposits of sulphide type have been found and mined in Sweden, mainly during periods of shortage in foreign supply such as the world wars. In the caledonides of north-western Sweden low grade deposits (0.2 per cent) of peridotites are known.

Cobalt

The metal cobalt was first discovered from a deposit in middle Sweden in the 18th century. No economic occurencies are known at present. However no exploration has been made.

Table 19. Swedish known mineable reserves 1975, Metal content

| | | Known mineable reserves at various metal price levels | | | | Lifetime, years | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | At 1974 level of production | | At 3% annual increase of prod. | |
| | | Base price[a] | Base price[a] +25% | Base price[a] +50% | Base price[a] -20% | Base price | Base price +50% | Base price | Base price +50% |
| Copper | (Mt) | 2.1 | 2.3 | 2.4 | 1.9 | 52 | 59 | 32 | 35 |
| Zinc | (Mt) | 4.4 | 4.9 | 5.2 | 4.2 | 39 | 46 | 26 | 29 |
| Lead | (Mt) | 2.4 | 2.5 | 3.0 | 2.0 | 32 | 40 | 23 | 27 |
| Tungsten | (kt) | 5.9 | 5.9 | 5.9 | 4.5 | 22 | 22 | 17 | 17 |
| Manganese | (kt) | - | - | 220 | - | - | 5[b] | - | - |
| Vanadium | (kt) | 300 | 300 | 300 | 300 | 307[b] | 307[b] | 70[b] | 70[b] |
| Silver | (kt) | 7.1 | - | - | - | (50)[c] | - | (31)[c] | - |
| Gold | (t) | 139 | - | - | - | (66)[c] | | - | - |

Note:

[a] Base prices (SEK/t metal content in ore):

| | | |
|---|---|---|
| Copper | 6 800 | (8 500 SEK/t metal) |
| Zinc | 1 150 | (3 300 SEK/t metal) |
| Lead | 1 550 | (2 000 SEK/t metal) |
| Tungsten | 40 000 | |
| Manganese | 340 | |

[b] Reserves compared with 1975 Swedish consumption

[c] Silver and gold are only obtained as by-products and it is not relevant to calculate lifetime.

## III. MINING

Deposits of zinc, lead, copper, silver, gold and tungsten are currently being mined. Production in recent years is shown in Table 20.

The ownership structure of the Swedish mining sector is highly concentrated.

Boliden is the dominating producer of copper, zinc, lead, silver and gold containing mineral concentrates, and the only producer of copper, lead, silver and gold metals in the country. In addition to Boliden there are four minor mining companies operating in Sweden:

- Vieille Montagne, a Belgian company in the Union Miniere group, produces zinc and lead concentrates.

- LKAB Viscaria produces copper concentrates. It is a wholly owned subsidiary of the State-owned iron ore company LKAB. Negotiations, however, are currently under way to sell the Viscaria mine to the Finnish mining and smelting group Outokumpu (also State-owned). The deal is to be finalized in the autumn of 1986.

- Statsgruvor, another LKAB subsidiary, is the only producer of tungsten concentrates.

- Stora Kopparberget still produces some amounts of copper, lead and zinc concentrates in the ancient mine at Falun.

Of the approximately 20 mines producing non-ferrous ores in Sweden most are comparatively small and the ore grades are low. The Aitik open cast copper mine produces approximately 11 Mt ore per annum. It is the biggest copper mine in Europe and operates with a copper content of 0.4 per cent.

Most of the lead ore, 1.5 Mt/year, is mined at the Laisvall underground mine, which is the biggest lead mine in Europe. The other mines produce complex sulphide ores and the production levels vary from 70 to 600 kt ore/year. Out of the total production of 19 mt ore in 1984 60 per cent was mined in 2 open cast mines and the rest in 18 underground mines. There were 21 mines and 12 concentrators in operation in early 1986.

Boliden ranks number 10 in Western World mine production of both lead and zinc, while its rank in silver, gold and copper is 15, 16 and 24 respectively.

## IV. SMELTING AND REFINING

The following metals are produced: copper, lead, silver, gold, aluminium, silicon and ferro alloys. Production is given in Table 21. The last three metals are produced from imported raw materials.

The production of copper, lead and precious metals from ores is concentrated at the Rönnskär works near Skelleftea and controlled by Boliden.

An aluminium smelter owned by the Gränges group is situated in Sundsvall.

A plant producing silicon products is located to Ljungaverk west of Sundsvall. It belongs to the Nobel Industries group.

Table 20. Mine production, metal content (kt) [1]

| Year | 1965 | 1970 | 1975 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 |
|---|---|---|---|---|---|---|---|---|---|
| Copper | 14.1 | 24.3 | 37.9 | 42.4 | 50.7 | 55.4 | 63.9 | 87.1 | 91.5 |
| Lead | 68.9 | 78.3 | 70.3 | 72.8 | 85.7 | 81.7 | 79.5 | 80.9 | 76.6 |
| Zinc | 84.2 | 103.3 | 111.3 | 168.9 | 182.4 | 187.2 | 204.2 | 207.2 | 212.7 |
| Tungsten[2] | 0 | 0 | 143.0 | na | na | na | 441.0 | 462.0 | 489.0 |
| Gold[3] | 3.7 | 2.0 | 2.0 | 2.0 | 2.0 | 2.4 | 3.2 | 3.8 | 4.3 |
| Silver[3] | 106.0 | 123.0 | 124.0 | 146.0 | 161.0 | 168.0 | 171.0 | 211.0 | 218.0 |

Note:

1 Figures for 1965-1983 from SOS Industri, 1984 and 1985 from RMG Data

2 $tWO_3$

3 t

na: not available

Table 21. Metal production

| Year | 1965 | 1970 | 1975 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 |
|---|---|---|---|---|---|---|---|---|---|
| Copper (kt) | | | | | | | | | |
| Blister | 0 | 0.5 | 0.8 | 0.7 | 12.0 | 28.1 | 39.0 | 39.0 | 36.9[e] |
| Refined | 50.5 | 51.2 | 56.2 | 55.7 | 65.0 | 61.8 | 62.8 | 63.7 | 63.2[e] |
| Total | 50.5 | 51.7 | 57.0 | 56.4 | 77.0 | 89.9 | 101.8 | 102.7 | 100.1 |
| Lead (kt) | | | | | | | | | |
| Crude | 0 | 2.1 | 16.9 | 26.8 | 14.8 | 34.1 | 26.0 | 15.9 | 13.7 |
| Refined | 40.4 | 41.4 | 21.7 | 20.3 | 7.0 | 29.6 | 34.8 | 49.8 | 43.2 |
| From scrap | na | na | na | 20.0 | 20.2 | 21.2 | 18.8 | 23.4 | 27.4 |
| Total | 40.4 | 43.5 | 38.6 | 67.1 | 42.0 | 84.9 | 79.6 | 89.1 | 84.3 |
| Silver (t) | 129.0 | 190.0 | 219.0 | 239.0 | 213.0 | 249.0 | 318.0 | 305.0 | 288.0 |
| Gold (t) | 4.8 | 4.2 | 3.4 | 4.5 | 4.6 | 4.6 | 6.4 | 7.6 | 8.8 |

Note:

na: not available

e: estimate

Ferro alloys are already produced in two plants, Vargon Alloy and Ferrolegeringar, and a third, Swed Chrome, is under construction.

Sandvik and Seco Rock produce tungsten carbide mainly from imported ores but also from the ores mined by Statsgruvor.

In addition to these plants based on domestic or imported ores, there are a few scrapbased smelters and refineries. Boliden Bergsoe in Helsingborg is the most important one producing non-ferrous metals.

Boliden has a monopoly position in the Swedish non-ferrous metals industry. However, the structure of the international industry crosses the national borders. The concentrates not treated at Rönnskär are sent abroad to plants in the Federal Republic of Germany (Preussag Boliden Blei), and to Norway (Norzink). These plants are only 50 per cent owned by Boliden; the rest is owned by Preussag and BP Minerals respectively.

## V. CONSUMPTION

The Swedish consumption pattern is similar to the pattern found in other industrialized countries such as the United States. Compare Table 22. The consumption of alloying metals is among the highest in the world due to the highly developed special steel industry.

Some specific characteristics of Swedish non-ferrous metals consumption should be noted.

### Lead

Production of batteries accounts for 70 per cent and a growing part of the lead consumption. The comparable international figure is 55 per cent. The Swedish consumption of lead for cables is higher than the present international average figure 7 per cent (in 1975 the Swedish figure was 28 per cent).

### Zinc

A larger part than the international average consumption (50 per cent in 1975) goes into anti-trust treatment of steel. This is due primarily to the wide spread use of galvanized steel in the construction industry. Brass accounted for 40 per cent of the consumption in 1975.

### Copper

The consumption pattern is fairly similar to the international one. A slightly higher part is used for cables.

### Tungsten

No tungsten produced from ores is used in the steel industry. The hard metal industry accounts for all consumption.

Table 22. Per capita consumption of metals in the US and Sweden 1974 (kg/person)

| | USA | Sweden | |
|---|---|---|---|
| | | Gross | Net |
| Aluminium | 25,2 | 15,1 | 18,2 |
| Lead | 4,0 | 5,0 | 5,0 |
| Steel | 605,0 | 500,0 | 520,0 |
| Silicon | 3,0 | 3,8 | na |
| Cobolt | 0,05 | 0,06 | 0,009 |
| Copper | 10,3 | 15,7 | 13,2 |
| Chromium | 2,4 | 8,4 | 3,8 |
| Magnesium | 0,5 | 0,15 | 0,16 |
| Manganese | 6,4 | 12,0 | 7,3 |
| Molybdenum | 0,2 | 0,7 | 0,2 |
| Nickel | 1,0 | 28,6 | 1,3 |
| Silver | 0,02 | 0,008 | 0,04 |
| Tin | 0,23 | 0,07 | 0,16 |
| Titanium | 0,1 | 0,2 | 0,08 |
| Vanadium | 0,05 | 0,12 | na |
| Tungsten | 0,05 | 0,25 | na |
| Zinc | 6,2 | 5,7 | 7,3 |

Note

na: not available
Gross: metals used for production of semifabricated goods (sheets, ingots, etc.)
Net: metals used for production of finished goods.

## VI. TRADE

Minerals and metals account for approximately 15 per cent of the Swedish foreign trade. The share is declining slowly. Most of the trade consists of semifinished products of various types. Zinc, lead and copper concentrates with some precious metals content are exported to Norway, Finland, Federal Republic of Germany and Belgium.

Imports of ores and concentrates are dominated by chromium, molybdenum and tungsten in terms of value. Most important countries of origin are USSR, USA, The Netherlands, Norway, Turkey, Brazil, Canada and China.

It is difficult to find correct figures in available official statistics, on trade balances for ores and concentrates. Tables 23 and 24 give some figures from 1975, 1980 and 1985. In spite of these difficulties it is clear that the total trade with non-ferrous metals in ores and concentrates shows a deficit in 1975 and a surplus in 1985. This is due primarily to growing exports of zinc and copper.

The import dependence for certain metals in 1975 and some of the companies supplying these metals are given in Table 25.

Table 23. Net export, ores and concentrates

| Year | 1975 | | 1980 | | 1985 | |
|---|---|---|---|---|---|---|
| | Metal content (kt) | MSEK | Metal content (kt) | MSEK | Metal content (kt) | MSEK |
| Copper | -3.6 | -30 | -7.8 | -104 | 0.4 | 6 |
| Lead | 27.5 | 55 | 32.4 | 169 | 20.7 | 118 |
| Zinc | 107.2 | 198 | 172.4 | 278 | 210.4 | 831 |

Table 24. Net imports, ores and concentrates (MSEK)

| | 1975 | 1980 | 1985 |
|---|---|---|---|
| Chromium | 169 | 111 | 230 |
| Tungsten | 115 | 169 | 61 |
| Molybdenum | 88 | 350 | 242 |

Table 25. Swedish import dependence for certain metals 1975

| Metal | Dependence | Supplier |
|---|---|---|
| Alumina | 100% | Alcan |
| Silicon | 100% | Norway [1] |
| Cobalt | 100% | Hoboken Overpelt (Gécamines), Outokumpu |
| Chromium | 100% | Soviet Union, Outokumpu, South Africa, Metallurg |
| Magnesium | 100% | Norsk Hydro |
| Manganese | 100% | Union Carbide, South Africa, Gabon |
| Molybdenum | 100% | AMAX |
| Nickel | 100% | INCO, Falconbridge, Western Mining, Soc. Le Nickel |
| Tin | 100% | Great Britain, Malaysia, FRG |
| Titanium | 100% | Soviet Union, FRG |
| Vanadium | 100% | Rautaruukkii, Elkem-Spigerverk, Austria, Union Carbide |
| Tungsten | 85% | not available |
| Gold | 75% | not available |
| Copper | 30% | Hoboken Overpelt (Gécamines), Mindeco, Codelco, Canada |

Note

[1] When the companies are not known, country of origin is indicated.

## VII. MINING EQUIPMENT INDUSTRY AND CONSULTING

In addition to the mining and metals industry as such, Sweden has a large and growing mining equipment industry. The sales value of the mining equipment industry exceeds that of the mining industry. Internationally well-known companies in this branch are: Atlas Copco, Sandvik (drill bits, mining drills), Skega, Trelleborg (rubber linings), NitroNobel (explosives), Morgardshammar (crushers), ASEA (lifts, transport equipment, furnaces), Kockum, Mining Transportation, Volvo BM (dumpers). Hägglunds (drills), Linden Alimak (lifts), Svedala, Sala International (ore treatment equipment). The last two companies are owned by the US Allis-Chalmers group.

The mining equipment industry represents by far the most important linkage with the Swedish non-ferrous mining industry. Most of the mining equipment industry is owned and controlled by the most important Swedish capital groups such as the Wallenberg or the Volvo groups. Svedala and Sala were bought by the US Allis-Chalmers group in the late 1970s and NitroNobel was sold to the Norwegian company Dyno in 1986.

The close ties between the Swedish mining equipment manufacturers are also illustrated by their joint international marketing efforts under the auspices of the so-called Swedish Mining Group.

The mining equipment industry has grown on a parallel with the mining industry but the domestic market has gradually lost its importance to the equipment producers. The export as part of total production exceeds 90 per cent for several of the international mining equipment companies. This means that at present the possibility of a total collapse of the Swedish non-ferrous mining industry will probably not overly affect the mining equipment industry.

A number of consulting groups are specialized in mining projects. The direct macro economic importance of these consulting companies is negligible but if one considers the significant mining equipment industry, the role of the consultants becomes more important.

Boliden has a consulting subsidiary, Boliden WP Contech, which is active around the world in the fields of exploration, mining and metallurgy. Two examples of recent important projects are:

The Portuguese Neves Corvo copper mine which is to be enlarged at a total cost of 250-300 MUSD. Boliden WP Contech has been awarded responsibility for underground facilities.

Soviet exploitation of the Kola peninsula. This deal is not yet finalized but could give both export possibilities for Swedish mining equipment industry and imports of raw materials (apatite) to the Swedish fertilizer industry.

LKAB used to have a similar subsidiary, LKAB International, but this was divested in 1985 and taken over by Scandiaconsult, which is a leading Swedish consulting group.

SWECO, a Swedish consulting group, is a group of general consulting companies which has been involved in several large international constructing projects including mines and metallurgical plants.

SGAB, Swedish Geological, is a state owned exploration organization, which is engaged both in domestic exploration and in the international market.

## VIII. LEGISLATION

The present Swedish mining legislation was adopted in 1974 (SFS 1973:342) but has its roots in different periods of the history of the Swedish mining industry. Three different systems are used:

- A mining claim covers most metals, gold, silver, copper, lead, zinc, iron, nickel, etc. Anyone who finds an ore deposit has the right to develop and exploit it. The right is granted for a period of three years within which development must take place. The system was originally introduced in the 18th century to support and encourage investments in the mining industry. Today there are examples of how this system, which does not make any difference between for example a mining company and a private person trying to make a mineral find, makes it difficult to organize a cost effective large scale mining operation.

- A concession is given only after special consideration by the state. This system covers all energy minerals, oil, coal, uranium, natural gas, peat and oil shales. It was introduced in the early 20th century to protect Swedish energy reserves from foreign ownership.

- The land owner system. This system gives the right to the land owner to mine all minerals which are not covered by the two other systems, mainly the industrial minerals. The system is a remnant from medieval times when most Swedish mining was carried out by landowning peasants mainly in winter time.

In all mining claims the State has the option to participate in the operation on a 50/50 basis. The State also has the possibility to start mining even on privately held claims. This system of State participation was introduced in 1938 and was part of a series of laws aimed at protecting Swedish minerals from foreign ownership. This process was started in the early 20th century when the important iron ore mines in Kiruna and Gällivare were about to be sold to foreign investors. The series of laws was completed only after the Second World War. In the early 1980s, however, the economic integration of the Western World and the subsequent demand for reciprocity in investment codes forced the Swedish Government to allow foreign ownership of Swedish mineral resources. The new law (SFS 1982:617) gives the Government the right to allow foreign ownership of Swedish mineral deposits and land. This is a very important change in policy considering that it comes closely after 50 years' struggle to enforce a system of laws necessary to guarantee national control of the subsoil. In particular the Miners' Union has opposed the new law. At present a committee, set up by Parliament, is working to review the mineral law of 1974. One of the main problems is the old mining claim system as mentioned above. There are suggestions that a single

concession system should replace all three earlier systems. A report from the committee is expected in late 1986.

In practice the Swedish State has not actively exercised the possibilities which the existing laws give to direct and influence the activities of the mining industry. Twelve of the Swedish non-ferrous metals mines are wholly or partially owned by the State but the State today leases its mineral rights to public companies such as Boliden. Three of the mines operated by Boliden are wholly State-owned (Stekenjokk, Rävliden and Hornträskviken) and others, in principle all new mines such as Aitik, Enasen, Garpenberg, Laisvall, Saxberget, Udden and Släppen, are jointly owned on a 50/50 basis. For all the State-owned mining rights Boliden and LKAB (Viscaria, Yxsjöberg) paid 27 MSEK in 1984, Aitik alone accounting for 14 MSEK.

## 1. Environment

The present system of laws, regulations and authorities set up to protect the environment in Sweden was introduced in the end of the 1960s. However, laws regulating the uses of water have been in force since 1941. The Environment Protection Act (SFS 1969:387) deals primarily with emissions of water to the atmosphere and noise from industrial, agricultural and other activities as e.g. waste water treatment and energy production. Important areas such as emissions from vehicles are not regulated by this act.

The Environment Protection Act defines a number of industries for which an advance permission is mandatory. The authorities granting these permissions are organized at three levels: local, regional and national. At the national level there is the National Swedish Franchise Board for Environment Protection (Koncessionsnämnden for miljoskydd) which checks all industrial activities that have an influence on the environment at a national scale. Mining and metallurgy are examples of industries scrutinized by this Board. There is also a central authority, the Swedish National Environment Protection Board (SNV) which primarily sets the long-term goals and controls the activities of the local, regional and national authorities giving permission for industries to make environmentally harmful emissions.

In cases of large and important industries, the Government has the responsibility to scrutinize the pollution problems. According to the Building Act paragraph 136, a localization or introduction of industrial activities which are of crucial importance to economizing on energy, wood fibres and the Swedish land and water resources, requires Government permission. When the Government has given its preliminary permission, the case should be tried by the appropriate authority as described above. According to this law the local communities have the right to veto all applications.

A case of interest to the mining industry was the veto of the Skövde community in the early 1980s, which stopped a project to utilize uranium containing shales.

In the 1970s, 8 billion SEK were invested in measures to protect the Swedish environment. The annual investment and operating costs for the 1980s have been estimated at 2.5 billion SEK.

During the last decade, the Swedish mining industry has invested heavily in pollution control. By international standards the situation in the Swedish industry as far as the environment is concerned is quite good. However, the mining and in particular the metals refining industry are still among the heaviest polluters.

In the mining industry the main problem is water pollution. Leaching processes caused by acid waste water release heavy metals, which poison the surroundings of both existing mines and ancient waste rock heaps. Mining in general is not a problem with regard to pollution of the atmosphere. Besides water pollution, the most serious problem to the mining industry is damage to the landscape caused by open pit mining methods and by large waste rock heaps.

## IX. DEVELOPMENT STRATEGIES

Swedish industrial growth, which began in the middle of the 19th century, was for a long period, based on domestic resources: iron ore, timber and hydro electric power. In the aftermath of the Second World War and during the Korean war boom, the Swedish export industry flourished. As has been described above, the mining industry actively tried to internationalize its operations. There was little need for a State minerals policy trying to secure a stable supply of strategic raw materials, However, only the LAMCO iron ore venture in Liberia was put into operation and it slowly became obvious that direct investment in foreign mines and co-operation with mining companies abroad were difficult ways to obtain a steady flow of raw materials.

It was only after the first oil price shock in 1973/74 and the publishing of the Club of Rome report, that the Swedish Government finally started to formulate a carefully prepared minerals policy. An important reason why this decision was delayed so long was the fact that the Swedish mining and metals industry parallel to its efforts to make direct investments abroad, opted for a second way to obtain the raw materials it needed: minerals in exchange for mining technology and know-how. This second strategy was more successful. By combining the long experience of the mining companies, particularly from underground mining, with the skills of the Swedish machine industry, several important mining equipment manufacturers have emerged. This process was facilitated by the close ties between several of these companies, belonging to the biggest Swedish industrial group, the Wallenberg empire. But not even this line could be successful in the late 1970s without a comprehensive State minerals policy.

A Minerals Policy Commission (MPU) was appointed in 1974. Its task was to make forecasts of Swedish production and consumption of mineral raw materials up to the year 2000. The Commission should also consider whether changes in the minerals policy were called for with regard to the long range needs of society. MPU had members from parliament, industry and trade unions. The work of the Committee was extended over a longer period than that which probably was anticipated by the Government from the start. This was partly due to the opposite opinions taken by the industry and the unions. The Miners' Union presented its own minerals policy programme in the late 1970s. MPU presented several reports at the end of the 1970s, and a Government minerals policy bill including several new measures was accepted by parliament in 1982, 8 years after the start of the Committee's work.

## 1. Government policy

The metals report of the MPU (published in 1979) presented three main forecasts, mine production and production of refined metals up to the year 2000 and gross consumption of metals for the same period. See Tables 26 and 27, where the actual values for 1985 have now been added, and Table 28.

It should be noted that in spite of the huge efforts underpinning these forecasts, the figures are based on a series of a decade. The mine production figures are generally too low while the figures for the metals production are fairly accurate even if also on the low side. The consumption forecast indicates a continuing growth of the special steel-industry and a concomitant consumption of alloying metals. Looking back it could very briefly be said that the development of the Swedish mining and metallurgical industry has been much more rapid than anticipated by the MPU.

Table 26. Swedish mine production forecast, metal content (kt)

| | 1975 actual | 1985 forecast | 1985 actual | 2000 |
|---|---|---|---|---|
| Tungsten (t) | 150 | 575 | 489 | 575 |
| Copper | 38 | 76 | 92 | 74 |
| Zinc | 107 | 154 | 213 | 154 |
| Lead | 69 | 85 | 77 | 85 |
| Gold (t) | 2 | 3 | 4 | 3 |
| Silver (t) | 140 | 160 | 218 | 160 |

Table 27. Swedish production of refined metals and of ferro-alloys for sale, forecast (kt)

| | 1975 actual | 1985 forecast | 1985 actual | 2000 |
|---|---|---|---|---|
| Silicon manganese [ab] | 8,6 | 0 | | 0 |
| Ferro-chrome and silicon chrome[b] | 108 | 276 | 134 | 276 |
| Ferro-molybdenum[b] | 1,7 | 3,5 | | 3,5 |
| Ferro-tungsten[b] | 0,7 | 0,7 | | 0,7 |
| Ferro-vanadium[b] | 0,4 | 0,8 | | 0,8 |
| Ferro-silicon[bc] | 52,1 | 0 | | 0 |
| Silicon metal | 16,4 | 13-19 | 22 | 13-19 |
| Copper | 60 | 90 | 100 | 90 |
| Lead | 37 | 70 | 57 | 70 |
| Aluminium | 78 | 83 | 83 | 83 |
| Gold (t) | 3,4 | 4-6 | 9 | 4-6 |
| Silver (t) | 219 | 200-300 | 288 | 200-300 |

Note

[a] Production discontinued in 1976
[b] Kt ferro-alloys
[c] Production discontinued in 1977

Table 28. Gross consumption of metals in Sweden, forecast, metal content (kt)[h]

| | 1975 actual | 1985 | 2000 |
|---|---|---|---|
| Non-alloy steel[g] | 2677,00[a] | 3175,00 | 3175,00 |
| Special steels[g] | 1122,00 | 1175,00-1765,00 | 1225,00-2460,00 |
| Manganese | 61,00 | 71,10- 78,60 | 70,20- 83,90 |
| Chromium | 68,00 | 85,40- 117,20 | 89,50- 147,00 |
| Nickel | 28,5 | 26,00- 33,6 | 27,30- 37,60 |
| Molybdenum | 5 | 5,41- 8,96 | 5,88- 10,93 |
| Tungsten | 1,7 | 2,26- 2,74 | 3,56- 5,79 |
| Cobalt | 0,58 | 0,89- 1,00 | 1,05- 1,59 |
| Vanadium | 0,86 | 1,01- 1,30 | 1,00- 1,84 |
| Silicon[b] | 35 | 31,10- 35,70 | 33,30- 42,10 |
| Copper | 126,10 | 147,00- 159,00 | 176,00- 204,00 |
| Zinc | 47,00 | 62,00 | 62,00 |
| Lead | 38,80 | 35,00 | 35,00- 40,00 |
| Tin | 0,60 | 0,35 | 0,20 |
| Aluminium | 120,00 | 143,00- 161,00 | 261,00- 292,00 |
| Titanium | 1,10[d] | 1,34- 1,57 | 1,36- 1,61 |
| Magnesium | 0,92[e] | 2,21- 2,45 | 3,37- 4,06 |
| Gold[f] | 0,0034 | 0,0035 | 0,0035 |
| Silver | 0,07 | 0,05- 0,10 | 0,05- 0,10 |

Note

a 1973-1975 average
b Silicon content in ferro-silicon and silicon metal
c 1974
d 1976
e 1977
f Final consumption
g Total weight
h Gross: metals used for production of semifabricated goods (sheets, ingots, etc)

In 1982 the following guidelines for the Swedish minerals policy were adopted:

- Secure a stable supply of mineral raw materials for the Swedish industry
- promote the usage of Swedish mineral resources and at the same time fully consider the environmental demands
- promote an effective use of all mineral raw materials.

The close connection between the mining and the mining equipment industry is still considered to be the most important linkage between the mining industry and other sectors of industry. In this perspective the mining industry is primarily seen as a home market and a place to develop new products for world leading capital goods export industry such as: Sandvik and Atlas Copco drill bits and mining drills, Skega and Trelleborg rubber linings.

The chemical industry is also to some extent, particularly within Boliden itself, linked by its flow of raw materials to the mining industry. It is the sulphur content of the pyrite which is used for production of basic inorganic chemicals such as sulphuric and phosphoric acid. This linkage could be expected to further develop but mainly in the field of industrial minerals rather than in the field of traditional non-ferrous metals. If new by-products could be recovered from the non-ferrous mines, e.g. Aitik, this linkage effect could grow in importance.

The government elected in autumn 1982 continued the policy outlined by the previous government. In addition to earlier measures a more extensive exploration support was introduced and most important, in 1983 foreign investment in the minerals industry was allowed. The same year BP Minerals started exploration in co-operation with LKAB.

During the end of the 1970s when the non-ferrous price levels reached a trough, Boliden demanded that the Swedish State should take over several of the non-ferrous mines which at that time were unprofitable to the company. It was also suggested by the Miners' Union that a concentration of the industry with active State participation should take place. The founding of a new mining and metallurgical group, Swedish Non-ferrous Metals, comparable to the partially State-owned Swedish Steel was envisaged. After the rehabilitation of Boliden in 1980 these two suggestions were forgotten. However, new demands for an active structural change, if necessary with State support, have been raised by the trade unions once again during the present crisis.

## 2. Policy of the industry

When the limits to foreign expansion were introduced in the 1970s, State activities that could support further growth were coordinated under the new policy guidelines adopted in the early 1980s. This made it possible for Boliden to actively and with some success, look for alternative sources of supply for its Ronnskar smelter. The way which Boliden has chosen to get out of the present crisis is to close down the unprofitable Swedish mines and to rely to a higher extent on imported ores and concentrates. The bulk

of Boliden's investments has been made in the smelter. It is considered to operate at a cost advantage compared to other competing non-ferrous smelters because of the capability to cope with complex ores. The treatment of these ores is made with high yields and low emissions of environmentally dangerous substances.

The ownership concentration process within the Scandinavian non-ferrous metals industry is mainly directed by two companies: Norsk Hydro and Outokumpu. Both companies are State-controlled and both have acquired companies in Sweden and in other Scandinavian countries in recent years.

Norsk Hydro is a diversified originally chemical group which has been actively involved in the North Sea oil. It has a fertilizer division and is an important producer of light metals both aluminium and magnesium. Norsk Hydro has already made a big intrance into the Swedish chemical industry and its interest in its chemical operations, one of the important forward links of Boliden, is obvious. Norsk Hydro had been negotiating to take over the Granges aluminium smelter in Sundsvall. However, this deal did not materialize. Instead Hydro succeeded in merging its aluminium division with ASV, the second biggest aluminium producer in Norway. The new group will be one of the leading aluminium suppliers in Europe. The interest in exploration in Sweden could well grow into taking over parts of Boliden's mining business. Hydro has been mentioned as a potential partner of Boliden in Norzink. The declining oil prices and the poor economic results of Norsk Hydro during the first half of 1986 could possible make it a little less aggressive in the near future. In a long-term perspective, further acquisitions are highly probable.

Outukumpu has already established itself as an important force in the Swedish non-ferrous metals industry through two major acquisitions, the Viscaria mine and the copper manufacturing company Metallverken formerly owned by Granges. Outokumpu has also been part of a negotiating team regarding restructuring of the Swedish special steel industry.

The group has for some time been the leading Finnish non-ferrous metals company and has also made a series of foreign investments to secure a stable supply of ores and concentrates for its smelter in Finland and also to ease the sale of its proprietary smelting technology. One future possibility is a split of production lines between Outokumpu's smelters in Finland and Boliden's Ronnskar works. Outokumpu has also recently taken over some minor Norwegian copper deposits.

It is difficult to assess the capital needs of the Swedish non-ferrous metals industry for the next decade. The environment investments in Rönnskär demanded by the national authorities and the Skellefte field which will be depleted in the early 1990s and hence must be replaced, are but two examples of heavy investments which must be started in this period. Boliden does not possess the capability of raising the necessary capital on its own and the capital shortage is another reason to expect an interscandinavian or international solution to the crisis. LKAB when in a similar situation in the early 1980s applied for financial support from the EEC. At present with the iron ore industry flourishing, LKAB still wants to pursue this loan of 165 MSEK in order to establish closer ties with the European markets. The same arguments are valid for foreign capital in the non-ferrous industry.

# THE NON-FERROUS METALS INDUSTRY IN PORTUGAL

## I. INTRODUCTION

Portugal is almost entirely dependent on supplies of non-ferrous minerals. This situation can only change if exploitation of domestic mining reserves and appropriate processing facilities are improved.

## II. SUPPLY-DEMAND

The production of non-ferrous metals/ores in Portugal is shown in Table 29.

Considering that the 1982 consumption of the main non-ferrous metals was approximately as follows: copper: 30,000 tons; lead: 18,000 tons; zinc: 17,000 tons; tin: 900 tons; aluminium: 30,000 tons. The import of non-ferrous metals represented a heavy burden for the trade balance of the country (see Table 30).

Table 29. Production of non-ferrous metals/ores, in tonnes ($10^6$ PTE)
Portugal, 1974 and 1979 to 1982

| | 1974 | | 1979 | | 1980 | | 1981 | | 1982 | |
|---|---|---|---|---|---|---|---|---|---|---|
| Berilium | 15 | (0.12) | 12 | (0.15) | 20 | (0.32) | 18 | (0.33) | 12 | (0.87) |
| Copper | 2,460 | (19.9) | 2,103 | (48.8) | 3,807 | (24.7) | 2,437 | (33.1) | 2,802 | (45.2) |
| Tin | 606 | (85.5) | 346 | (173.2) | 421 | (229.3) | 506 | (299.3) | 585 | (403.6) |
| Manganese | 21 | (0.11) | - | | - | | - | | - | |
| Molybdenium | 0.4 | (0.02) | 0.4 | (0.20) | - | | - | | - | |
| Tantalum and niobium | 9 | (1.74) | 3 | (6.78) | 4 | (11.27) | 9 | (14.60) | 6 | (10.95) |
| Gold and silver | 2,266 | (51.6) | 1,751 | (301.7) | 1,134 | (294.1) | 1,123 | (232.1) | 1,058 | (274.9) |
| Titanium | 274 | (0.04) | 390 | (0.06) | 384 | (0.06) | 400 | (0.06) | 585 | (0.09) |
| Tungsten | 2,483 | (354.0) | 2,348 | (1,158.4) | 2,670 | (1,416.1) | 2,385 | (1,502.6) | 2,300 | (1,498.2) |
| Production of Pyrites: | 510,573 | (182.7) | 349,172 | (277.6) | 382,171 | (355.5) | 286,622 | (307.3) | 262,142 | (404.6) |

Table 30. Portuguese trade balance for non-ferrous metals
(1980 to 1983)

| | 1980 | | | 1981 | | | 1982 | | | 1983 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | I | E | B | I | E | B | I | E | B | I | E | B |
| Aluminium | -4,631 | + 342 | -4,289 | -6,120 | + 297 | - 5,823 | -6,982 | + 443 | - 6,539 | -9,727 | + 849 | -8,878 |
| Copper | -3,534 | + 173 | -3,361 | -3,582 | + 182 | - 3,400 | -4,027 | + 345 | - 3,682 | -5,632 | + 259 | -5,373 |
| Lead | - 959 | + 5 | - 954 | - 942 | + 26 | - 916 | | | n.a. | | | n.a. |
| Zinc | - 822 | + 1 | - 821 | - 796 | + 7 | - 789 | - 942 | + 12 | - 930 | -1,116 | + 3 | -1,113 |
| Tin | - 524 | + 9 | - 515 | - 397 | + - | - 459 | | | n.a. | | | n.a. |
| | | | -8,940 | | | -11,387 | | | -11,151[2] | | | -15,364[2] |
| Tungsten [1] | - 3 | +1,632 | +1,629 | - 11 | +1,827 | + 1,816 | | | n.a. | - 342 | +1,689 | + 1,327 |
| Silicium | - | +1,204 | +1,204 | - | + 644 | + 644 | - | + 790 | + 790 | | + 943 | + 943 |
| | | | +2,833 | | | + 2,460 | | | + 790[3] | | | + 2,270 |
| Total | | | -7,107 | | | -8,927 | | | -10,361[4] | | | -13,094[2] |

E = export (positive sign)
I = import (negative sign)
B = balance (+ = surplus; - = deficit)
Value in $10^6$ PTE

1/ including concentrates
2/ not including lead and tin
3/ not including tungsten
4/ not including lead, tin and tungsten

Bearing in mind the possible consequences of Portugal's recent entry into the E.E.C, a considerable increase in the consumption of non-ferrous metals is estimated for the year 2000, as follows: copper - 50,000 t; lead - 25,000 t; zinc - 25,000 t; tin - 1,100 t; aluminium - 100,000 t.

## III. MINING

### 1. Copper

#### 1.1. Copper concentrates production in Portugal outside the "Pyrite Belt"

The low production of this metal is restricted to copper-containing by-products of tin and tungsten mining and confined to the mining centres of Borralha and Panasqueira, which in the years 1975-1984 produced an annual amount of a few thousand tonnes of copper concentrates, which were mainly consumed at the Barreiro smelter.

#### 1.2. Mining activities near the Portuguese part of the Iberian Pyrite Belt: smaller copper mines

Several smaller copper enriched mines have been worked for many years along the Iberian Pyrite Belt. These are either non-deep sulphide deposits or oxydized material with unknown reserves. Copper from sulphide ores is obtained as copper concentrates, after suitable mineralurgical treatment; from oxydized ores, copper is generally leached by an acid (sulphuric acid) and then precipited as copper cement by reduction with iron scrap.

Available statistics combine the copper cement output of Miguel-Vacas with the cement produced in Aljustrel, the relatively small quantity of concentrates or cement copper was either smelted in Barreiro or exported.

#### 1.3. Complex pyrite mining

The Iberian Pyrite Belt contains considerable reserves of massive polymetallic sulphides concentrated in ore bodies with generally big dimensions. Pyrite is the most dominant in these formations, which also show variable amounts of i.a. copper, zinc, lead, gold and silver. The best known deposits in Portugal are S. Domingos, considered as exhausted, Neves-Corvo, Aljustrel area, Lousal and Serra da Coveira.

There is strong evidence of an overall decline in pyrite production. In the 1960's and 1970's it was about 1 million tons/year. Its present level is indicated in Table 31.

Table 31. Pyrite production in Portugal (years 1982, 1983, 1984)

| | 1982 | 1983 | 1984 |
|---|---|---|---|
| Aljustrel, 103 tonnes | 216.5 | 245.8 | 291.7 |
| Lousal | 45.6 | 34.2 | 42.7 |
| Total | 262.1 | 280.0 | 334.4 |
| Overall value 103c=106PTE | 404.6 | 544.1 | 847.4 |
| Average value PTE/tonne | 1544 | 1943 | 2534 |

Table 31 also shows a decline in Lousal production; this decline is combined with low sulphur (35-42) and iron contents and most probably shows a certain state of depletion in the mine.

The evolution of prices shows a continuous increase between 1982 and 1984, the price of 1983 being 25.8 per cent above that of 1982, and the price of 1984 30.8 per cent above that of 1983.

1.3.1. The Aljustrel project

Complex pyrite ore reserves are very considerable in the Aljustrel area, representing about 200 million tons. The production is tailored to satisfy Portuguese domestic demand. The mining operations are directed by Pirites Alentejanas, SARL, holder of the Aljustrel concession, in which the participation of the state-owned Empresa de Desenvolvimento Mineira do Alentejo E.P. (EDMA) is of approximately 95%, the difference representing Belgian interests.

The situation of this company which employs about 680 persons, cannot be regarded as stable in the medium term: with the availability of "floated pyrite" in Spain (by the flotation of complex pyrites for non-ferrous metals recovery) and soon to be in Portugal (by the treatment of cupriferous ore of Neves Corvo with pyrite matrix), low value pyritic residues will be made available at much cheaper prices for the production of sulphuric acid; sulphuric acid producers will therefore be forced to employ fine raw material, in adapted units, instead of the present coarse pyrite. In addition, the planned erection in Portugal of a reasonably sized copper metallurgy industry may well provide enough sulphuric acid for domestic needs as well as for the more important export markets.

Recently, tests were carried out in the Aljustrel ore dressing pilot-plant on the possibility of differential flotation of the Aljustrel complex pyrites.

The results of extensive pilot plant testing, carried out for Pirites Alentejanas with Aljustrel complex pyrites in the above-mentioned pilot plant, have already brought about some decisions on its differential floatability to launch an independent Aljustrel project (see Table 32).

The Aljustrel ore could therefore be considered as suitable for the differential (or selective) flotation route as has been proposed and put in practice for other ores in the Pyrite Belt (Sotiel, Aznalcollar), and hence not restricted to the limitations of bulk flotation and semi-bulk flotation which laboratory tests performed before the operation of the pilot plant had proposed.

Table 32. Results obtained in Aljustrel ore dressing pilot plant for the differential flotation of Aljustrel complex pyrites

| | Weights (pct) | Contents, pct | | | | Yelds, pct | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Cu | Pb | Zn | Ag | Cu | Pb | Zn | Ag |
| Pyrite fed | 100 | 1.19 | 1.33 | 4.10 | 43 | 100 | 100 | 100 | 100 |
| Cu concentrates | 4.15 | 20.88 | 3.58 | 2.80 | 130 | 72.8 | 11.2 | 2.8 | 12.5 |
| Pb concentrates | 1.94 | 1.40 | 30.14 | 5.44 | 750 | 2.3 | 44.0 | 2.6 | 33.8 |
| Zn concentrates | 6.88 | 2.12 | 1.35 | 48.00 | 63 | 12.3 | 7.0 | 80.6 | 10.9 |
| Pyritic residues | 87.03 | 0.17 | 0.59 | 0.66 | 22 | 12.4 | 38.6 | 14.0 | 44.5 |

Minor elements:

| | Contents (%) | | | | | | |
|---|---|---|---|---|---|---|---|
| | Sb | As | Ni | Co | Bi | Cd | Hg |
| Cu concentrates | 0.37 | 0.18 | 70 | 140 | 410 | 51 | 60 |
| Pb concentrates | 0.05 | 0.40 | 18 | 100 | 1200 | 110 | 140 |
| Zn concentrates | 0.03 | 0.20 | 15 | 60-19 | 170 | 900 | 770 |

A first evaluation of the Aljustrel project is at present being submitted to a techno-economical audit by a well-known mining engineering company.

The following contours for the Aljustrel project were recently disclosed by Pirites Alentejanas:

I. pyrite extraction: 1 million tonnes/year from the Moinho mine.

II. products:

| | quantity tonnes/year | contents |
|---|---|---|
| copper concentrates | 26,000 | 20% Cu; 150 g/t Ag |
| zinc concentrates | 55,000 | 45% Zn |
| lead concentrates | 20,000 | 25% Pb; 500 g/t Ag |

and also 900,000 tonnes/year of residual (floated) pyrite, from which 600,000 tonnes/year will be in condition of direct supply to sulphuric acid/fertilizers producers.

III. starting-up date: foreseen for 1989-90;

IV. investment: 5,800 $10^6$ PTE (1985);

V. expected sales value for produced concentrates: 3,000 $10^6$ PTE/year to be increased by 900.$10^6$ PTE/year from the supply of 300,000 tonnes of coarse pyrite to Quimigal and Sapec.

1.3.2. The Neves-Corvo mining project

In 1972, active exploration was started in the Alentejo region (Beja district), within the Pyrite Belt, by an association formed by the Portuguese corporation Sociedade Mineira de Santiago (SMS), originally part of the CUF group, and the French companies Societe d'Etudes, Recherches et d'Exploitations Minières (SEREM) of the BRGM Entrepreneurial Group, and Sociedade Mineira e Metalurgica de Penarroya Portuguesa (SMMPP), which is directly attached to the Societe Minière et Metallurgique de Penarroya and therefore to the IMETAL Group.

Data collected up to the end of 1979 proved, from the first feasibility assessment, that the Neves-Corvo finding had a great potential, and hence a "Preliminary study on the Neves-Corvo Exploitability" was forwarded to the Portuguese Government by the Association in February 1980. This opened the negotiations for the incorporation of Somincor - Sociedade Mineira de Neves-Corvo, SARL.

SOMINCOR was incorporated in 1980, after negotiations between EMMA (which replaced in the Association SMS after its nationalization in 1975) and its French partners, in the presence of representatives of the Portuguese Ministry of Industry and the Institute of Foreign Investment.

Geological reserves disclosed at the end of 1984 were the following:

| | | |
|---|---|---|
| copper containing ores | 26.8 million tons with | 8.64% Cu |
| complex copper/zinc ores | 8.3 million tons with | 4.87% Cu |
| | | 2.33% Zn |
| complex zinc ores | 32.9 million tons with | .48% Cu |
| | | 5.71% Zn |
| | | 1.49% Pb |

as well as about 50 million tons of crude pyrite (under 3.5% total NFM, about 48% S).

In October 1984 the French partners in SOMINCOR entered into an agreement with RTZ Metals Ltd., from the RTZ Group, establishing the terms of transmission of their entire participation in Somincor, with approval of the relevant Portuguese authorities. Protocol was established between the partners to cover the following new share-capital distribution of Somincor:

| | |
|---|---|
| 51% Edma | |
| 49% RTZ Group, | represented by Tinto Investments Bristol Ltd and with a representative participation RTZ (Metals) Limited. |

In the newly agreed contractual terms of August 1985, the schedule proposed for the mining project is as follows:

- copper containing ores: ore dressing start-up with production of concentrates commercially saleable in the 4th quarter of 1988, and attaining a treatment level of not under 1 million tons of extracted ore in the 4th quarter of 1990;

- complex pyrite ores: depending on the studies undertaken on the technical, economic and financial feasibility of this exploitation, Somincor will start the treatment of such ores 30 months after decision, and attempt to attain maximum level production within 48 months.

## 2. Lead/Zinc

No production of lead and zinc ores have been reported since 1973, Complex pyrites can be regarded as the main potential sources of these metals in Portugal. Should the Aljustrel and Somincor projects be realized, substantial amounts of lead and zinc concentrates would be available.

## 3. Tin

The production of cassi' rite concentrates in Portugal has shown a decline during the 10-years period 1975-1984:

Table 33. Cassiterite production in Portugal

Cassiterite concentrate
(about 69-71% Sn)

| | tonnes | value $10^6$ PTE |
|---|---|---|
| 1975 | 529 | 62 |
| 1976 | 974 | 73 |
| 1977 | 379 | 108 |
| 1978 | 403 | 153 |
| 1979 | 346 | 173 |
| 1980 | 421 | 229 |
| 1981 | 506 | 299 |
| 1982 | 585 | 403 |
| 1983 | 495 | 454 |
| 1984 | 453 | 558 |
| average | 459 | |

These figures are well below the yearly averages recorded for previous decades. However tin mining in Portugal still maintains a small but steady production level, about 10 per cent of the value of total mining output in 1983 was related to tin production (8 per cent in 1984).

The economy of tin mining in Portugal is largely dependent on its industrial structure (small mines, requiring the revision of extraction processes) and on the output of other substances generally present (tungsten, titanium, etc.). Overall employment related to tin and tungsten mining in Portugal is approximately 2500 people.

One should also note that there are substantial tin ore reserves in Argimela, with a production possibility of 200-300 tons of cassiterite concentrate per month, i.e. 2000-2800 tons of tin metal/year.

The association of tin to the complex pyrites merits special attention. The importance of this problem is easily apparent: with 1 million tons Corvo copper ore, (assuming that the average content is 5200 g tin/t), the quantity of tin present is in the range of 5000 tons/year equivalent to about 7,150 tons of cassiterite concentrate,

i.e. more than 15 times that of Portuguese production from tin mining in 1984; which means that with a tin recovery of no more than 10 per cent, a production figure equal to that of 1984 could only be obtained from Corvo. The recovery of tin from these ores represents a serious challenge to mineralogy and metallurgy.

## IV. EXISTING PROCESSING OPERATIONS

### 1. Aluminium

The absence of a primary aluminium production in Portugal necessitates important amounts of imports.

Table 34. External trade of aluminium, all forms, 1983

| | | |
|---|---|---|
| Total imports | 58,000 tonnes | $10,300 \times 10^6$ PTE |
| including: | | |
| bulk metal | 19,300 tonnes | $2,900 \times 10^6$ PTE |
| aluminium alloys | 23,000 tonnes | $3,600 \times 10^6$ PTE |
| aluminium plates and foil | | |
| thick, above 0.20mm | 11,200 tonnes | $2,340 \times 10^6$ PTE |
| below 0.20mm | 920 tonnes | $460 \times 10^6$ PTE |
| aluminium tubes | 650 tonnes | $140 \times 10^6$ PTE |
| Total exports | 15,230 tonnes | $2,390 \times 10^6$ PTE |
| including: | | |
| bars and shapes | | $800 \times 10^6$ PTE |
| cuttings | | $440 \times 10^6$ PTE |
| scrap | | $270 \times 10^6$ PTE |

These figures demonstrate the relative weight of aluminium in Portuguese imports, with a marked dependence on foreign supplies and a distribution by categories reflecting the demand by downstream activities.

Domestic activities in aluminium semis fabrication are the most important in extrusion. Wire and cable production is significant in the country, and facilities for the production of foil and castings have been installed. Remelted metal is also produced.

## 2. Copper

### 2.1. General features

The present dependence of Portugal on external copper supplies is well demonstrated in Table 35.

The following may be considered:

i) Portugal is dependent on basic raw materials for copper domestic primary production;

ii) this dependence is even more accute for wrought copper metal, which suggests a certain imbalance between domestic primary production and secondary copper processing industries;

iii) if the domestic demand for copper wire is almost covered by Portuguese production (with substantial capacity for exports), significant dependence still exists in copper shapes and tubes;

iv) the non-metallurgical demand for copper (in chemical compounds) is practically covered by domestic production;

v) the potential interest of Portuguese copper processing operations may be significantly enchanced by an increase in the production of domestic primary copper.

The establishment of a domestic primary processing of copper concentrates may also potentialize current (as well as other) copper uses just starting-up or yet uncommon in Portugal (vg. copper tubing in houses, copper-roofing), increasing the demand of this metal.

Table 35. Portuguese imports and exports for copper raw materials and copper alloys

| | Imports | | | | | | | | Exports | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | tonnes | | | | value, $10^6$ PTE | | | | tonnes | | | | value, $10^6$ PTE | | | |
| | 1980 | 1981 | 1982 | 1983 | 1980 | 1981 | 1982 | 1983 | 1980 | 1981 | 1982 | 1983 | 1980 | 1981 | 1982 | 1983 |
| 1. Raw materials | | | | | | | | | | | | | | | | |
| Scrap | 233 | 221 | 276 | 188 | 10 | 7 | 12 | 16 | 60 | 17 | 104 | 1200 | 7 | 1 | 9 | 48 |
| 2. Wrought copper metal | 11190 | 9576 | 11310 | 13947 | 1310 | 1086 | 1339 | 2621 | - | - | 2108 | 152 | - | - | 218 | 22 |
| 3. First processing | | | | | | | | | | | | | | | | |
| L[illegible] | 8030 | 10966 | 10379 | 6347 | 1227 | 1547 | 1543 | 1478 | 1084 | 882 | 730 | 1293 | 140 | 128 | 113 | 232 |
| F[illegible] (plates) | 6726 | 6136 | 6160 | 6050 | 1071 | 994 | 1145 | 1533 | 25 | 48 | 54 | 22 | 6 | 7 | 14 | 5 |

## 2.2. The processing of complex pyrites for sulphuric acid production

Complex pyrites as a source of sulphur for the production of sulphuric acid have been processed in Portugal since the second half of the last century. However, only after the development of the Barreiro works by Companhia Uniao Fabril (CUF) in 1908, have they been widely used and marked the definitive ingress of Portugal in full-scale processing of pyrites in coastal areas relatively distant to the mine, that characterized what was called hereabove the "sulphur/iron/copper cycle".

The recovery of other important products from such domestic raw material, soon made Barreiro an example of "integrated utilization" of pyrites, today with copper, zinc, lead, precious metals and hematitic iron ore also being added to its productions. The overall situation in Portugal with regard to the production of sulphuric acid from pyrites can be described as follows:

- about 89 per cent of listed capacity for sulphuric acid production representing about 700,000 t/year is operated by QUIMIGAL, a state-owned chemical, fertilizer and metallurgical company already mentioned; 87 per cent of this capacity are located in the Barreiro complex;

- pyrite remains a representative raw material for the Portuguese production of sulphuric acid;

- the Portuguese sulphuric acid industry still using coarse pyrite has been directed towards dearsenifying roasting processes, due to the interest of recovering dearsenified hematitic purified cinders (purple ore) as a raw material for iron-making;

- the incorporation in the Barreiro complex, downstream of the sulphuric acid units, of treatment units for pyrite cinders resulted in Barreiro becoming a traditional "collector" of available Portuguese cinders as well as a non-ferrous metallurgical centre.

- if the pyrites are to be used for the separation of non-ferrous containing minerals (see "Aljustrel Project") or if sufficient quantities of floated pyrite are to be available from the flotation of copper minerals from rich copper ores with pyritic-matrix, then sulphuric acid producers may shift from the use of coarse pyrites towards the easier roasting of cheaper flotation pyrites in adequate new plants;

- the traditional role of the sulphuric acid industry as the first stage for the production of non-ferrous metals from pyrites will take on secondary importance, according to the new specifications for raw materials.

Table 36. Products obtained at Quimigal from pyrite processing

| | yearly production |
|---|---|
| Sulphuric acid | 390,000 tonnes |
| Iron (contained in hematitic pellets) | 205,000 tonnes (b) |
| Zinc (electrolytic grade) | 11,000 tonnes (a) |
| Copper (electrolytically refined) | 700 tonnes (c) |
| Copper sulphate | 7,000 tonnes |
| Gold | 90 kg |
| Silver | 8,700 kg |
| Sodium sulphate | 12,000 tonnes |
| Steam (45 bars, 425 C) | 300,000 tonnes |

(a) installed capacity
(b) potential production
(c) not mentioning copper from non-pyrite sources.

Barreiro is an integrated complex and the sequence of its interlinked industrial operations in relation to complex pyrites is sensitive to major operational changes; one change - the refusal by Portuguese steel producers at the beginning of the 1970's to receive purple ore resulted in the pelletizing option.

Efforts and studies carried out since 1980 to change the situation have resulted in the expected zinc recovery being reduced.

The alternatives for complex pyrite flotation as well as for copper ore dressing and processing operations demand careful assessment in an integrated complex such as Barreiro, and indicate the need for an effort to be made towards the development of new products.

2.3. Copper smelter and refinery project

Quimigal was committed under Ministerial Order No. 88/82, of 16 December 1982 (28), to prepare final feasibility and implementation studies for this project, as well as evaluating the participation of potential private Portuguese or foreign companies.

Following these studies and further Ministerial Orders, Quimigal issued an invitation for tenders for the services of a general contractor.

The project considers a copper capacity (cathodes "higher grade") of 100,000 tonnes/year (the range 80,000 to 100,000 tonnes/year was investigated; partial blister production with a corresponding decrease in cathodes output also under study, as an alternative).

Sulphuric acid: 400,000 tonnes yearly $H_2SO_4$ 98.4%

Anodic slimes: for the full load of electrolysis, about 600 tonnes/year, containing precious metals.

The economic indicators of the project are the following:

| | |
|---|---|
| Investment | $56.1 \times 10^9$ PTE including working capital |
| Sales value | approx. $37 \times 10^6$ PTE/year |
| Ratio operating costs/sales value | 11% * |
| Ratio gross added value/sales value | 27% * |
| Economical project life | 15 years |

* in a year of stabilized operation.

2.4. Secondary copper processing industries

The output of this secondary sector is almost entirely produced by Companhia Portuguesa do Cobre SARL (CPC), which manufactures copper wire rod, copper and brass sections and shapes and cold-laminated plates.

CPC semis output for the period 1980/82 were reported to be in the range of 21,000 to 22,000 tonnes/year, corresponding to gross production values well above $3,0 \times 10^9$PTE, with a certain equilibrium between supply and demand. Table 37 shows the operation of CPC in 1982 and 1983.

Table 37. CPC operations (1982 and 1983)

| Operating year | 1982 | 1983 |
|---|---|---|
| Production, tonnes | 22,637 | 21,603 |
| Sales, tonnes | 22,896 | 22,303 |
| domestic market, tonnes | 22,280 | 21,564 |
| export, tonnes | 616 | 739 |
| Production value, $10^6$PTE | 3,373 | 4,612 |
| Gross added value, $10^6$PTE | 776 | 1,312 |
| Investments, tangible assets, $10^6$PTE | 430 | 79 |
| Employment (at 31 Dec.) | 827 | 803 |

CPC is joint-owned by the following:

- Trefimetaux, from France (with 25 per cent);
- IPE-Instituto de Participacoes do Estado, SARL, keeping the shares of the Portuguese public participation to approximately 34 per cent;
- private shareholders (Portuguese), with about 41 for a share capital of $1,0 \times 10^9$PTE.

There are several other small producers of semis in copper and copper alloys in Portugal, generally recycling available scrap and residues.

## 3. Nickel

No relevant processing operations are reported for nickel in Portugal.

It was estimated in 1981 that by the year 2000 the Portuguese nickel primary consumption would reach up to 5,500 tonnes total maximum consumption.

## 4. Lead

Portugal is dependent on foreign supplies to cover its lead demand, with imports of lead ingot at the beginning of the 1980's in the range of the 18,000 tonnes/year. A domestic secondary production of lead recycling by Metal Portuguesa SARL, with a total capacity of up to 7,000 tonnes/year (produced 5,000 tonnes). Total lead consumption in Portugal is therefore in the range of 23,000 tonnes/year.

The new concept of differential flotation of complex sulphides will provide in the medium term about 13,500 tonnes of lead in lead concentrates (specially interesting because of their precious metals content) and possibly lead thereby to reconsideration of the use of primary lead from domestic resources.

## 5. Zinc

Zinc ingot, which before 1980 was not produced in Portugal, is now processed by Quimigal with an installed capacity of about 11,000 tonnes. However, the shut down of the pelletizing process deprived Quimigal's zinc unit from a relevant part of its supply, about 60 per cent of total, thereby lowering its possible output. The following figures reflect the operation of this unit:

Table 38. Barreiro zinc operations (1982 and 1983)

| | 1982 | 1983 |
|---|---|---|
| Production, tonnes | 4,214 | 4,427 |
| Sales, tonnes (totally in domestic market) | 4,536 | 3,905 |
| Production value, $10^6$PTE | 193 | 220 |
| Gross added value, $10^6$PTE | 88 | 103 |
| Employment (at 31 Dec.) | 37 | 34 |

The balance of imports and exports of zinc and zinc alloys for these same years also demonstrates dominant import situation (Table 39).

Table 39. Portuguese zinc balance (1982 and 1983)

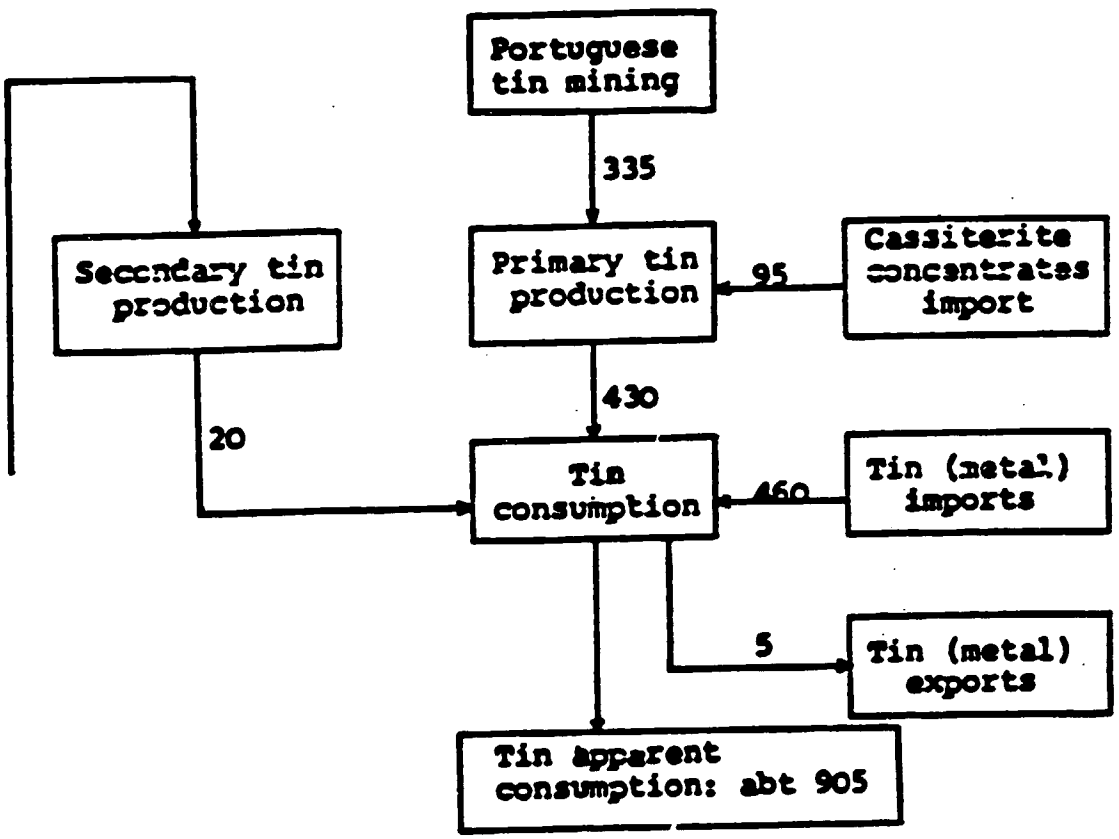
| | 1982 | | 1983 | |
|---|---|---|---|---|
| | Import | Export | Import | Export |
| Raw materials | | | | |
| scrap and residues, tonnes | 174 | 98 | 381 | - |
| ($10^6$ PTE) | (6) | (5) | (17) | (-) |
| Zinc metal, tonnes | 10,774 | 1 | 10,642 | 1 |
| ($10^6$ PTE) | (762) | (-) | (922) | (-) |
| 1st processing, semis | | | | |
| long products, tonnes | 1,634 | 213 | 1,306 | 313 |
| ($10^6$ PTE) | 178 | (12) | (193) | (3) |
| Plates, tonnes | 21 | 1 | 6 | 1 |
| ($10^6$ PTE) | (2) | (-) | (1) | (-) |

## 6. Tin

Portuguese tin processing operations show a characteristic feature not found to date for the metals previously studied. The capacity of the tin smelters is well above Portugal's ore production, which obliges the country to import cassiterite concentrates in order to continue the operations of some of its primary metallurgical units.

The following chart shows the tin balance for the 5-year period 1979/1983:

Figure 1. Portuguese tin balance (average 1979/1983)



## V. LEGAL AND INSTITUTIONAL ASPECTS

### 1. Governmental entities

The main Governmental entities connected with the non-ferrous metals sector are as follows:

- Direccao-Geral de Geologia e Minas (DGGM)
- Direccao-Geral da Indùstria (DGI)
- Instituto do Investimento Estrangeiro (IIE).

A) Direccao-Geral de Geologia e Minas (DGGM) (General Directorate of Mining and Geology), covers the following activities:

- geological services;
- mining promotion and development services;
- laboratory;
- technical support;
- administrative and technical organization and fiscalization in the mining sector;
- publications (including the "Boletim de Minas" and the "Guide to the Citizen").

Mining activities under the authority of DGGM include exploration, concessions, exploitation, ore dressing as well as plant-connected activities such as exporting (terminals) and integrated smelters - entitled in mining law "mining annexes".

At present, DGGM is establishing a "National Mining Plan", and revising the Portuguese Mining Law, both of which should contribute to greater development and better organization of the mining activities in Portugal.

B) Direccao-Geral da Indùstria (DGI) (General Directorate of Industry), covers all activities related to manufacturing industries, including smelters and downstream plants.

C) Instituto de Investimento Estrangeiro (IIE) (Foreign Investment Institute), attached to the Ministry of Finance, has direct intervention in the establishment of agreements and incentives for direct foreign investment in Portugal.

## 2. Mining laws

Portuguese mining law is still based on Decrees 18.713 (dated 1 August 1930) and 29.725 (1939), and their modifications necessitated by nearly half a century of continuous application. Decree-Law No. 46.312 (April 1965) ordered that there must be a Portuguese majority in mine exploitation, and set out rules for the access of foreign capital to exploration works.

The modifications in mining activities as well as Portugal's membership of the EEC, activated the interest in a more modern and adequate mining law, which has since been approved by the Parliament.

A new regulation for occupational hygiene and safety in mining works was recently issued (Decree-Law No. 18/85 of 15 January 1985).

In very general terms, the access to mining of non-ferrous metals follows the requirements of "concessible substances", i.e. "first class" metal-containing substances.

With proper legislation, the Government may define "captive areas", i.e. areas where interesting mineral resources may exist and where both exploration and/or concession rights may be subjected to the formulation of a contract. The definition of "captive areas" should take due consideration of the rights already established for interest locations prior to the legislation.

## 3. Access to the processing industries

In principle, full access is granted to the processing industries, following formal registration.

An "authorization" request for "industrial installation" must be submitted to the pertinent authorities with a description, details and other data, assuring the observance of the "Regulation for Industrial Activities (RILEI)" and of the respective environmental obligations.

After erection, and before start-up of the plant, approval of operative conditions is required: this is obtained following inspection by the relevant authorities.

## 4. Direct foreign investment

Direct foreign investment in Portugal can be covered by:

- general regime, or
- contractual regime.

The contractual regime covers those projects having special value for the Portuguese economy. In such cases, negociations take place between IIE who acts on behalf of the Portuguese Government, and the interested corporation. The final agreement is then subject to formal governmental approval.

## VI. ENVISAGED OR FEASIBLE PROJECTS

### 1. Mining

Specific reference has already been made to those main mining projects for non-ferrous metals, that are already being developed or planned for the near future. They are:

- for copper and complex ores:
  Somincor project is in full scale progress;

- for basic non-ferrous metals (copper, zinc and lead) from complex pyrites:
  Aljustrel project in the feasibility after-pilot testing;

- for tin:
  Argimela project, pre-feasibility stage;
  Somincor project, at preliminary research stage.

As a consequence of pyrite flotation required by the first two projects listed above, large quantities of rich pyrite tailings may be available as potential sources of sulphur (vg. as sulphuric acid); this could change the pattern of sulphuric acid production in Portugal (whether combined or not with the acid from the Copper Smelter Project).

### 2. Primary processing

For copper smelting and refining: the copper smelter and refining project: this unit, within the Neves-Corvo mining project, may collect all other copper fractions (primary and/or secondary) available in Portugal. Its production, in terms of sulphuric acid, is also very important.

For tin smelting: a certain rationalization of surplus smelting capacity is to be expected in relation to the respective mining evolution.

## OCEANIA: The case of Australia

# THE NON-FERROUS METALS INDUSTRY IN AUSTRALIA

## I. NON-FERROUS ORES

### 1. Reserves and mining facilities

Australia has an important and wide range of economic reserves of non-ferrous ores. In 1983 it had 13.02 per cent of the world demonstrated reserves in bauxite, 2.67 per cent (of the reserves) in copper, 9.29 per cent (of the reserves) in lead, 1.83 per cent in nickel, 2.27 per cent in tin and 6.76 per cent in zinc. Australia also has important reserves of zircon (26.09%) and silver (10.46%). The participation of Australia in the production of non-ferrous ores was even higher. In 1983 Australia contributed with 35.21 per cent of the world production of bauxite, and with 3.19 per cent in copper, 14.33 per cent in lead, 12.31 per cent in nickel, 5.38 per cent in tin, and 11.20 per cent in zinc. For major details see table 1.

### 2. Evolutions of the non-ferrous ores

The bauxite production showed a steady growth between 1983 and 1984. Production increased from 24.5 million tons to 32.2 million tons. In relation to investment, most non-ferrous ores experienced increased investment in the early 1980 "resources boom" period. For further details see tables 2 and 3.

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NOTE: All figures in value are in Australian dollars, unless otherwise stated.

Table 1. Economic reserves of non-ferrous ores
Australia as at 31 December 1983

| ORE (MEASURE) | RESOURCE | | | PRODUCTION 1983 | | |
|---|---|---|---|---|---|---|
| | Demonstrated | Inferred | Total | % World Demonstrated | Aust. | % World |
| Bauxite ('000 Mt) | 2.93 | 1.39 | 4.32 | 13.02 | 0.025 | 35.21 |
| Copper (Mt, Cu) | 13.63 | 9.45 | 23.08 | 2.67 | 0.261 | 3.19 |
| Gold (t, Au) | 728.00 | 555.00 | 1283.00 | 1.81 | 30.59 | 2.30 |
| Lead (Mt, Pb) | 12.64 | - | 12.64 | 9.29 | 0.48 | 14.33 |
| Ilmenite (Mt) | 39.81 | 0.59 | 40.40 | 5.13 | 0.91 | 22.20 |
| Monazite ('000t) | 216.70 | 2.30 | 219.00 | 3.10 | 15.14 | 79.68 |
| Rutile (Mt) | 7.90 | 0.23 | 8.13 | 6.08 | 0.16 | 47.06 |
| Zircon (Mt) | 11.48 | 0.22 | 11.70 | 26.09 | 0.38 | 55.88 |
| Nickel (Mt, Ni) | 1.92 | - | 1.92 | 1.83 | 0.08 | 12.31 |
| Silver ('000t, Ag) | 28.30 | - | 28.30 | 10.46 | 1.03 | 8.49 |
| Tin ('000t, Sn) | 227.00 | 2.00 | 229.00 | 2.27 | 9.30 | 5.38 |
| Zinc (Mt, Zn) | 18.24 | - | 18.24 | 6.76 | 0.69 | 11.20 |

Source: Australian Mineral Industry Quarterly, 37(4), 1984.

Table 2. Production of non-ferrous ores
(tonnes)

| ORE | 1975 | 1976 | 1977 | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 |
|---|---|---|---|---|---|---|---|---|---|---|
| Bauxite | 21,003,000 | 24,084,000 | 26,086,000 | 24,293,000 | 27,583,000 | 27,179,000 | 25,441,000 | 23,625,000 | 25,540,000 | 32,181,000 |
| Copper | 218,961 | 218,480 | 221,579 | 222,111 | 237,610 | 243,540 | 231,339 | 245,319 | 260,373 | 239,584 |
| Gold | 16 | 16 | 19 | 20 | 19 | 17 | 18 | 27 | 31 | 39 |
| Lead | 407,801 | 397,403 | 432,204 | 400,291 | 421,158 | 389,556 | 388,122 | 455,338 | 484,356 | 443,311 |
| Nickel | 75,825 | 82,532 | 85,868 | 82,359 | 69,709 | 74,323 | 74,355 | 87,552 | 79,021 | 76,748 |
| Silver | 726 | 779 | 856 | 813 | 832 | 767 | 744 | 907 | 1,043 | 970 |
| Tin | 9,507 | 10,531 | 10,577 | 11,817 | 12,524 | 11,531 | 12,233 | 12,093 | 9,037 | 7,488 |
| Ilmenite concentrate | 991,433 | 969,20[illegible] | 1,033,000 | 1,255,000 | 1,181,000 | 1,385,000 | 1,321,000 | 1,149,000 | 896,209 | 1,097,831 |
| Rutile concentrate | 348,350 | 389,750 | 325,281 | 257,075 | 274,533 | 311,744 | 230,817 | 220,697 | 158,217 | 181,805 |
| Zinc | 510,035 | 461,931 | 491,608 | 473,293 | 529,157 | 496,312 | 518,297 | 664,800 | 703,252 | 664,657 |

Source: Australian Mineral Industry Quarterly.

Table 3. Capital expenditure less disposals 1975/76 - 1983/84 ($'000)

| INDUSTRY CLASS | 1974/75 | 1975/76 | 1976/77 | 1977/78 | 1978/79 | 1979/80 | 1980/81 | 1981/82 | 1982/83 | 1983/84 |
|---|---|---|---|---|---|---|---|---|---|---|
| Bauxite | 16,232 | 26,857 | 16,349 | 33,008 | 47,166 | 34,347 | 29,340 | 46,359 | 31,790 | 19,624 |
| Copper | 44,103 | 27,185 | 13,806 | 8,742 | 9,773 | 16,501 | 61,166 | 22,502 | 27,897 | 48,009 |
| Gold | 12,332 | 9,651 | 17,155 | 11,815 | 13,352 | 35,514 | 74,080 | 73,133 | 115,291 | 177,906 |
| Mineral sands | 43,800 | 34,671 | 11,513 | 13,989 | 4,158 | 6,140 | 7,609 | 10,970 | 5,281 | 15,466 |
| Nickel | - | 31,910 | 32,131 | 67,663 | 29,684 | 30,903 | 50,172 | 73,104 | 66,583 | NA |
| Silver,lead,zinc | 21,536 | 22,813 | 24,320 | 74,118 | 60,356 | 43,921 | 91,048 | 170,632 | 92,932 | 48,692 |
| Tin | 9,600 | 4,742 | 8,506 | 8,795 | 10,546 | 25,451 | 21,857 | 22,648 | 12,358 | 10,347 |
| Uranium ) | | | | | | NA | 173,119 | 56,533 | NA | NA |
| ) | NA | 25,459 | 14,632 | 23,457 | 28,311 | | | | | |
| Other ) | | | | | | 10,749 [a] | 104,016 | NA | 3,711 | NA |

[a] Excludes uranium

Source: ABS, Areas of Mining Establishment, Details of Operations.

3. Intermediary consumption in non-ferrous mining

Major purchases by the non-ferrous mining in 1974/75 and 1978/79 were:

| | 1974/75 $ M | TOTAL % | 1978/79 $ M | TOTAL % |
|---|---|---|---|---|
| Electricity | 29.4 | 10.6 | 48.3 | 10.3 |
| Construction of machinery | 15.1 | 5.5 | 31.1 | 6.7 |
| Other machinery | 27.3 | 9.9 | 37.0 | 7.9 |
| Wholesale purchases | 20.8 | 7.5 | 33.3 | 7.1 |
| Petroleum, coal products | 12.1 | 7.6 | 32.4 | 6.9 |
| Business seminars | 8.7 | 3.1 | 24.3 | 5.2 |
| Mining services | 14.3 | 5.2 | 18.3 | 3.9 |
| Basic chemicals | 10.2 | 3.7 | 23.5 | 5.0 |
| Road transport | 16.6 | 6.0 | 22.2 | 4.7 |
| Iron and steel | 10.8 | 3.9 | 11.2 | 2.4 |
| Welfare services | 4.7 | 1.7 | 10.5 | 2.2 |

Major purchases, transfers in, and selected expenses for, non-ferrous ore mining industries are listed in table 4.

Table 4. Intermediary consumption in non-ferrous mining 1983-84 ($'000)

| Description | Electricity and fuels purchased | Purchases and Transfers in (a) | | Commission Work Expenses and Payments to Mining Contractors (c) | Repair and Maintenance Expenses | Outward Freight and Cartage (d) | Motor Vehicle Running Expenses | Sales Commission Payments | RENT, LEASING AND HIRING EXPENSES | | | Total Purchases Transfers in and Selected Expenses |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Stores Materials etc. (b) | Minerals and Other Goods for Resale | | | | | | Land Building and Other Structures | Motor Vehicles | Plant Machinery and Other Equipment | |
| Bauxite | 17,600 | 27,941 | - | 6,214 | 12,179 | 8,839 | 1,084 | 996 | 379 | 5 | 345 | 76,580 |
| Copper | 6,942 | 88,777 | - | 9,748 | 13,227 | 7,100 | 510 | 100 | 223 | 254 | 4 | 126,884 |
| Gold | 37,982 | 83,733 | 2 | 52,959 | 17,778 | 5,301 | 2,601 | 35 | 691 | 507 | 5,396 | 206,986 |
| Mineral sands | 18,410 | 13,921 | 4,438 | 12,679 | 11,427 | 10,557 | 1,387 | 1,063 | 641 | 199 | 2,982 | 77,703 |
| Nickel | NP | NP | NP | NP | NP | NP | NP | NP | NP | NP | NP | NP |
| Silver, lead, zinc | 34,292 | 155,517 | 2,066 | 27,735 | 20,112 | 45,875 | 1,212 | 12 | 223 | 459 | 2,839 | 290,341 |
| Tin | 11,559 | 17,457 | 1,354 | 6,347 | 19,035 | 2,239 | 1,453 | 435 | 686 | 273 | 4,369 | 65,198 |
| Uranium | NP | NP | NP | NP | NP | NP | NP | NP | NP | NP | NP | NP |
| Non-ferrous metals ores n.e.c. | NP | NP | NP | NP | NP | NP | NP | NP | NP | NP | NP | NP |

Source: ABC Census of Mining Establishments, Details of Operations

Notes: (a) Transfers in from other establishments of the same enterprise
(b) Includes minerals for further processing
(c) Includes imputed commission charges for work done by other establishments of the same enterprise
(d) Includes imputed charges for freight carried out by other establishments of the same enterprise.

## 4. Royalties and taxation

Royalties vary between $0.20 per ton in Western Australia to not less than $1.00 per ton in Queensland for exported bauxite, and not less than $0.50 per ton for domestically consumed bauxite.

Companies are subjected to Commonwealth company tax of 46 per cent of profits.

Non-residents are subject to withholding tax on dividends at the rate of 30 per cent; this is reduced to 15 per cent where double tax agreements operate as in the USA, Canada, France and Switzerland. Withholding tax on interest payments to a non-resident company is equal to 10 per cent of interest paid. An Australian branch of a non-resident company is subject to an additional branch profits tax of 5 per cent. Royalty payments vary between 3 and 5 per cent of turnover. For further details see table 5.

## Table 5. Mineral royalties paid ($'000) 1974/75 - 1983/84

| ORE | 1974/75 | 1975/76 | 1976/77 | 1977/78 | 1978/79 | 1979/80 | 1980/81 | 1981/82 | 1982/83 | 1983/84 |
|---|---|---|---|---|---|---|---|---|---|---|
| Bauxite | 8,749 | 7,969 | 9,004 | 8,990 | 9,337 | 12,287 | 16,853 | 17,119 | 16,105 | 18,076 |
| Copper | 6,399 | 6,866 | 8,723 | 8,093 | 10,726 | 13,910 | 10,309 | 10,329 | 11,425 | 11,631 |
| Gold | 176 | 110 | 265 | 214 | 343 | 578 | 975 | 519 | 1,301 | 1,125 |
| Mineral sands | 4,266 | 5,527 | 4,423 | 3,228 | 3,636 | 4,373 | 4,710 | 4,512 | 4,265 | 4,478 |
| Nickel | - | 5,289 | 6,066 | 4,055 | 4,290 | 6,727 | 5,371 | 6,012 | 6,689 | NA |
| Silver,lead,zinc | 32,602 | 16,540 | 22,893 | 25,054 | 30,449 | 82,892 | 52,481 | 18,453 | 20,812 | 19,876 |
| Tin | 206 | 398 | 1,062 | 1,500 | 2,788 | 3,913 | 3,243 | 2,379 | 2,179 | 1,606 |
| Uranium ) | | | | | | NA | 6,483 | 10,803 | | |
| ) | NA | 1,530 | 3,291 | 2.189 | 2,219 | | | | NA | NA |
| Other ) | | | | | | 2,246 * | 2,100 | 1.706 | | |

* Excludes Uranium.

## II. PROCESSING OPERATIONS

### 1. Evolution of the value added, turnover and employment

Between the traditional non-ferrous industries, the ones that experienced the higher levels of growth were aluminium smelting and refining. They had in the period 1972-1984 an average annual growth of the value added of 4.7 per cent, of the turnover of 6.5 per cent and of the employment of 5.4 per cent. The aluminium semi-fabrication experienced significant growth in the period under analysis with value added growing by 3.8 per cent per annum and turnover by 5.6 per cent per annum. 1/ The industries of copper smelting and refining in the period 1971-1983 had a decrease of their value added at an average annual growth of 5.2 per cent, a decrease of the turnover at an average annual growth of 7 per cent and a decline in fixed capital expenditure at an annual rate of 27.2 per cent. The silver, lead and zinc refining and smelting industries had a declining trend in the value added, turnover and employment in the period 1979-1984. The evolution of silver, lead and zinc refining and smelting showed a declining trend in value added, turnover, fixed capital expenditure and employment in the period 1979-1984. For further details see tables 6, 7, 8 and 9.

### 2. Productivity

The higher level of productivity of the non-ferrous industries in Australia is in the alumina and aluminium industries. These industries had a level of 32.9 thousand Australian dollars per worker in 1982. 2/ The industry of copper in that same year had a level of productivity of 21.0 thousand Australian dollars per worker, and the other metals experienced a lower level of productivity.

The level of productivity in the alumina and aluminium industries had its peak in 1973 with 44.3 thousand Australian dollars per worker falling marginally over the decade. New facilities coming on stream should increase the productivity of these industries. In the copper industry there was a noticeable decrease in the levels of productivity.

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1/ Semi-fabrication of other metal products showed a slight negative growth trend in the period 1972-1984.

2/ The aluminium semi-fabrication had a level of productivity in 1982 of 21.0 thousand Australian dollars per worker.

Table 6. Alumina and aluminium smelting and refining

| YEAR | Number of Establishments | Employment '000 | VALUE ADDED Current prices $m | VALUE ADDED 1974/75 prices $m | TURNOVER Current prices $m | TURNOVER 1974/75 prices $m | FIXED CAPITAL EXP. Current prices $m | FIXED CAPITAL EXP. 1974/75 prices $m | WAGES AND SALARIES Current prices $m | WAGES AND SALARIES 1974/75 prices $m |
|---|---|---|---|---|---|---|---|---|---|---|
| 1972-73 | 10 | 5.8 | 108.1 | 156.8 | 245.8 | 356.6 | 56.9 | 82.5 | 40.3 | 58.5 |
| 1973-74 | 10 | 4.8 | 171.2 | 212.5 | 338.1 | 419.6 | 45.9 | 60.0 | 54.2 | 67.3 |
| 1974-75 | 9 | 6.6 | 235.3 | 235.3 | 487.9 | 487.9 | 53.6 | 53.6 | 67.1 | 67.1 |
| 1975-76 | 9 | 6.6 | 249.9 | 232.9 | 578.9 | 539.5 | 88.0 | 82.0 | 75.7 | 70.5 |
| 1976-77 | 9 | 6.8 | 313.3 | 233.8 | 752.7 | 571.7 | 24.4 | 18.2 | 88.5 | 66.0 |
| 1977-78 | 9 | 7.1 | 335.3 | 238.2 | 821.8 | 583.8 | 59.9 | 42.6 | 102.3 | 72.7 |
| 1978-79 | 9 | 7.4 | 339.3 | 207.1 | 896.8 | 547.4 | 62.2 | 38.0 | 117.2 | 71.5 |
| 1979-80 | 9 | 7.8 | 556.8 | 258.0 | 1,222.2 | 566.2 | 127.0 | 58.8 | 135.2 | 62.6 |
| 1980-81 | 9 | 8.0 | 569.2 | 268.4 | 1,329.0 | 626.6 | 195.6 | 92.2 | 155.7 | 73.4 |
| 1981-82 | 10 | 9.1 | 646.3 | 299.2 | 1,595.2 | 738.4 | 1,216.5 | 563.1 | 195.7 | 90.6 |
| 1982-83 | 10 | 9.3 | 646.4 | 302.8 | 1,715.6 | 803.7 | 1,149.5 | 538.5 | 229.1 | 107.3 |
| 1983-84 | 12 | 11.0 | 805.2 | 330.9 | 2,112.2 | 868.2 | 692.3 | 284.6 | 274.3 | 112.8 |
| Average annual Growth (%) | | 5.4 | | 4.7 | | 6.5 | | | 16.2 | 3.5 |
| Total Manufacturing | | -1.6 | 11.3 | -0.1 | 11.3 | 1.0 | 12.4 | | 10.7 | |

Source: Ibid.

Table 7. Aluminium rolling, drawing, extruding

| YEAR | Number of Establishments | Employment '000 | VALUE ADDED Current prices $m | VALUE ADDED 1974/75 prices $m | TURNOVER Current prices $m | TURNOVER 1974/75 prices $m | FIXED CAPITAL EXP. Current prices $m | FIXED CAPITAL EXP. 1974/75 prices $m | WAGES AND SALARIES Current prices $m | WAGES AND SALARIES 1974/75 prices $m |
|---|---|---|---|---|---|---|---|---|---|---|
| 1972-73 | 21 | 3.7 | 47.9 | 57.4 | 145.3 | 174.1 | 8.6 | 10.1 | 21.4 | 25.6 |
| 1973-74 | 24 | 4.0 | 61.6 | 71.6 | 176.7 | 205.4 | 5.8 | 6.7 | 28.6 | 33.2 |
| 1974-75 | 24 | 4.0 | 76.3 | 76.3 | 195.8 | 195.8 | 10.0 | 10.0 | 33.9 | 33.9 |
| 1975-76 | 22 | 3.8 | 69.8 | 61.4 | 212.4 | 186.8 | 7.2 | 6.3 | 35.9 | 31.6 |
| 1976-77 | 23 | 4.0 | 85.9 | 68.4 | 262.4 | 209.1 | 14.5 | 11.6 | 44.2 | 35.2 |
| 1977-78 | 24 | 3.9 | 96.2 | 69.3 | 306.7 | 223.2 | 13.0 | 9.5 | 49.2 | 22.0 |
| 1978-79 | 23 | 3.8 | 130.3 | 88.5 | 346.2 | 235.1 | 13.2 | 9.0 | 50.1 | 34.0 |
| 1979-80 | 26 | 4.3 | 173.2 | 98.3 | 483.1 | 275.7 | 17.0 | 9.7 | 59.5 | 34.0 |
| 1980-81 | 29 | 4.9 | 187.6 | 94.0 | 563.3 | 282.3 | 20.3 | 10.2 | 72.3 | 36.2 |
| 1981-82 | 27 | 4.7 | 206.7 | 98.5 | 651.3 | 310.5 | 31.9 | 15.2 | 84.3 | 40.2 |
| 1982-83 | 6 | 4.2 | 161.4 | 71.1 | 657.6 | 289.3 | 36.4 | 16.0 | 87.2 | 38.4 |
| 1983-84 | 30 | 4.4 | 220.9 | 90.8 | 763.1 | 313.7 | 43.1 | 17.7 | 89.2 | 36.7 |
| Average annual Growth (%) | | 1.9 | 14.4 | 3.8 | 16.2 | 5.6 | 16.2 | 5.0 | 13.4 | 2.5 |
| Total Manufacturing | | -1.6 | 11.3 | -0.1 | 11.3 | 1.0 | 12.4 | | 10.7 | |

Source: Basic Metals Industry Council for Australian Manufacturing Council.

Table 8. Copper smelting, refining

| YEAR | Number of Establishments | Employment '000 | VALUE ADDED Current prices $m | VALUE ADDED 1974/75 prices $m | TURNOVER Current prices $m | TURNOVER 1974/75 prices $m | FIXED CAPITAL EXP. Current prices $m | FIXED CAPITAL EXP. 1974/75 prices $m | WAGES AND SALARIES Current prices $m | WAGES AND SALARIES 1974/75 prices $m |
|---|---|---|---|---|---|---|---|---|---|---|
| 1972-73 | 3 | 708 | 25.7 | 37.3 | 167.0 | 242.3 | 18.6 | 27.0 | 4.8 | 7.0 |
| 1973-74 | 5 | 929 | 29.6 | 36.7 | 242.9 | 301.5 | 11.6 | 14.4 | 7.1 | 8.8 |
| 1974-75 | 4 | 992 | 31.9 | 31.9 | 201.7 | 201.7 | -16.3 | -16.3 | 10.1 | 10.1 |
| 1975-76 | 3 | 847 | 32.1 | 29.9 | 191.1 | 178.1 | 9.2 | 8.6 | 9.3 | 8.7 |
| 1976-77 | 3 | 774 | 32.2 | 24.0 | 224.5 | 167.5 | 10.4 | 7.8 | 9.7 | 7.2 |
| 1977-78 | 3 | 1,035 | 34.1 | 24.2 | 202.5 | 143.9 | 0.6 | 0.4 | 12.9 | 9.2 |
| 1978-79 | 3 | 998 | 50.8 | 31.0 | 305.0 | 186.2 | 4.0 | 2.4 | 13.7 | 8.4 |
| 1979-80 | 3 | 1,040 (e) | 50.9 | 23.6 | 309.9 | 143.6 | 4.2(e) | 1.9 | 16.7 | 7.7 |
| 1980-81 | 4 | 1,084 (e) | 51.0 | 24.0 | 314.9 | 148.5 | 4.4(e) | 2.1 | 20.4 | 9.6 |
| 1981-82 | 3 | 1,125 | 51.1 | 23.7 | 319.6 | 147.9 | 4.6 | 2.1 | 22.7 | 10.5 |
| 1982-83 | 4 | NA | NA | | NA | | NA | | NA | |
| Average annual Growth (%) | | 4.3 | | -5.2 | | -7.0 | | -27.2 | | 2.3 |
| Total Manufacturing | | -1.6 | 11.3 | -0.1 | 11.3 | 1.0 | 12.4 | | 10.7 | |

(e) Estimate

Source: Basic Metals Industry Council for Australian Manufacturing Council, June 1985.

Table 9. Silver, lead and zinc refining and smelting

| YEAR | Number of Establishments | Employment '000 | VALUE ADDED Current prices $m | VALUE ADDED 1974/75 prices $m | TURNOVER Current prices $m | TURNOVER 1974/75 prices $m | FIXED CAPITAL EXP. Current prices $m | FIXED CAPITAL EXP. 1974/75 prices $m | WAGES AND SALARIES Current prices $m | WAGES AND SALARIES 1974/75 prices $m |
|---|---|---|---|---|---|---|---|---|---|---|
| 1979-80 | 6 | 4,683 | 192.9 | 114.6 | 956.8 | 568.4 | 20.2 | 12.0 | 60.6 | 36.0 |
| 1980-81 | 6 | 4,747 | 157.2 | 86.4 | 903.1 | 490.4 | 13.3 | 7.2 | 71.3 | 38.7 |
| 1981-82 | 6 | 4,791 | 113.7 | 55.9 | 716.4 | 352.4 | 10.0 | 4.9 | 83.9 | 41.3 |
| 1982-83 | 6 | 4,417 | 181.3 | 80.2 | 750.5 | 331.9 | 11.5 | 5.1 | 87.8 | 38.8 |
| 1983-84 | 7 | 4,300 | 134.9 | 55.5 | 774.3 | 318.3 | 19.3 | 7.9 | 92.2 | 37.9 |

Source: ABS: Manufacturing Establishments, Details of Operations by Industry Class, Australia.

It descended from 52.7 thousand Australian dollars per worker in 1972 to 32.6 thousand Australian dollars in 1983. The other metals industries showed mainly no growth in the period 1971-1982. In the aluminium semi-fabrication industry the value added per employee rose substantially until 1979/80 but then declined. The industry is currently restructuring its facilities to improve efficiency. Value added per employee in other metal semi-fabrication rose steadily throughout the decade. For further details see table 10.

## 3. Exports and imports

The non-ferrous metals industry in Australia is export-oriented. Agricultural products and mineral ores and concentrates have been the main commodities historically exported.

In 1983/84 the non-ferrous metals industry provided a favourable trade balance of Australian $1,437,492,000 for metal products and $3,362,915,000 for ores and concentrates. There is only limited trade in semi-fabricated and fabricated metal products. Exports and imports of non-ferrous metals and non-ferrous ores and concentrates over the past decade are shown in tables 11 and 12.

Exports of non-ferrous metal products by country are compared for 1975/76 and 1983/84 in table 13. The United Kingdom is the major market although Japan has increased significantly as a major customer over the decade. Trade to the USA has declined in relative importance. Although trading patterns have been relatively stable with smaller customers over the decade, some evidence of a shift to a "Pacific Basin Region" strategy is in evidence.

The relative value of metal products in trade is expected to increase in the near future as three new large-scale aluminium smelters begin production. All their production in the form of ingots is destined for export, mainly to Japan.

Table 10. Value added per employee in non-ferrous metals - 1974/75 prices ($'000)

| METAL | 1972/73 | 1973/74 | 1974/75 | 1975/76 | 1976/77 | 1977/78 | 1978/79 | 1979/80 | 1980/81 | 1981/82 | 1982/83 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Copper | 52.7 | 39.6 | 32.2 | 35.3 | 31.1 | 23.4 | 31.1 | 22.7 | 22.2 | 21.0 | NA |
| Alumina & aluminium | 27.0 | 44.3 | 35.7 | 35.3 | 34.4 | 33.5 | 28.0 | 33.1 | 33.5 | 32.9 | 32.6 |
| Silver, lead, zinc, nickel and other | 18.2 | 20.2 | 17.9 | 20.8 | 20.4 | 20.8 | 19.9 | 18.6 | 20.3 | 17.3 | NA |
| Secondary Recovery | | | | | | | | | | | |
| Other metals -semi-fabrication | 10.9 | 11.3 | 13.6 | 10.4 | 11.7 | 13.9 | 12.2 | 13.6 | 15.9 | 15.3 | 18.7 |
| Aluminium semi-fabrication | 15.5 | 17.9 | 19.1 | 16.2 | 17.1 | 17.8 | 23.3 | 23.0 | 19.2 | 21.0 | 16.9 |

Source: AB S 8203.0 Manufacturing Establishments, Details of Operations by Industry Class.

Table 11. Imports and Exports of non-ferrous metal products

| Year | EXPORTS $'000 | EXPORTS % of total | IMPORTS $'000 | IMPORTS % of total |
|---|---|---|---|---|
| 1975/76 | 439,762 | 4.56 | 32,558 | 0.40 |
| 1976/77 | 595,361 | 5.11 | 47,221 | 0.45 |
| 1977/78 | 578,177 | 4.71 | 51,229 | 0.46 |
| 1978/79 | 792,622 | 5.57 | 67,461 | 0.49 |
| 1979/80 | 1,258,694 | 6.67 | 95,587 | 0.59 |
| 1980/81 | 984,129 | 5.13 | 109,535 | 0.58 |
| 1981/82 | 994,490 | 4.82 | 136,768 | 0.59 |
| 1982/83 | 1,251,504 | 5.67 | 93,370 | 0.29 |
| 1983/84 | 1,535,653 | 6.53 | 96,161 | 0.41 |

Source: ABS 5411.0 Australian Exports and 5414.0 Australian Imports.

Table 12. Imports and exports of non-ferrous ores and concentrates

| Year | EXPORTS Quantity* tonnes | EXPORTS f.o.b. $'000 | IMPORTS Quantity tonnes | IMPORTS f.o.b. $'000 |
|---|---|---|---|---|
| 1975 | 1,735,968 | 354,395 | 182 | 10,032 |
| 1976 | 2,303,496 | 424,724 | 1,123 | 9,013 |
| 1977 | 2,242,073 | 462,432 | 2,423 | 6,919 |
| 1978 | 2,504,595 | 496,970 | 2,963 | 3,260 |
| 1979 | 2,347,209 | 596,906 | 120 | 4,031 |
| 1980 | 2,673,316 | 766,318 | 2,423 | 15,213 |
| 1981 | 2,250,621 | 716,255 | 2,139 | 6,034 |
| 1982 | 2,278,426 | 979,002 | 452 | 5,556 |
| 1983 | 2,346,386 | 764,228* | 1,007 | 27,364 |
| 1984 (e) | 2,833,006 | 922,511* | 1,185 | 31,615 |

(e) Estimate
* Excludes bauxite

Source: Australian Mineral Industry Quarterly and Year Books.

Table 13. Exports of non-ferrous metal products by country

| Region and Country | 1975-1976 Value $'000 | 1975-1976 % of total exports | 1983-1984 Value $'000 | 1983-1984 % of total exports |
|---|---|---|---|---|
| ASEAN | | | | |
| Indonesia | 15,313 | 3.48 | 54,472 | 3.55 |
| Malaysia | 6,570 | 1.49 | 27,783 | 1.81 |
| Philippines | 7,170 | 1.63 | 13,093 | 0.85 |
| Singapore | 4,793 | 1.09 | 27,984 | 1.82 |
| Thailand | 12,707 | 2.89 | 43,055 | 2.80 |
| EEC | | | | |
| Belgium/Luxembourg | 8,159 | 1.86 | 14,077 | 0.92 |
| Denmark | 40 | 0.00 | 38 | 0.00 |
| France | 12,976 | 2.95 | 37,545 | 2.44 |
| Germany | 34,122 | 7.76 | 28,657 | 1.87 |
| Greece | 500 | 0.11 | 2,681 | 0.17 |
| Italy | 9,029 | 2.05 | 1,096 | 0.01 |
| Netherlands | 33,481 | 7.61 | 12,546 | 0.82 |
| United Kingdom | 113,561 | 25.82 | 309,984 | 20.19 |
| AMERICAS | | | | |
| Canada | 4,676 | 1.06 | 60 | 0.00 |
| USA | 34,186 | 7.77 | 48,408 | 3.15 |
| ASIA | | | | |
| China | 4,549 | 1.03 | 39,326 | 2.56 |
| Taiwan | 10,359 | 2.35 | 66,007 | 4.30 |
| Hong Kong | 7,565 | 1.72 | 33,906 | 2.21 |
| India | 12,161 | 2.76 | 22,454 | 1.46 |
| Japan | 53,482 | 12.16 | 295,293 | 19.23 |
| Korea | 622 | 0.14 | 15,082 | 0.98 |
| Saudi Arabia | 45 | 0.00 | 16,976 | 1.11 |
| USSR | 0 | 0.00 | 181 | 0.01 |
| OCEANIA | | | | |
| Fiji | 209 | 0.00 | 484 | 0.03 |
| New Zealand | 30,066 | 6.84 | 62,499 | 4.07 |
| Papua-New Guinea | 1,032 | 0.23 | 1,602 | 0.10 |

Source: ABS 5411.0 Australian Exports.

These new smelters have a high level of foreign ownership and a large proportion of the investment funds were borrowed overseas. Thus, while the value of exports will rise, outflows related to loan repayments, interest and dividends paid overseas will also increase. These payments, plus payments for imported inputs (e.g. pitch), will be about equivalent to 50 per cent of export earnings. Thus, although representing higher value added export earnings, the net gain to balance of payments will be lower than anticipated.

4. Investment

Capital expenditure grew dramatically in alumina and aluminium over the past decade and accounted for a substantial proportion of new investment in manufacturing. The new plants are Comalco-Gladstone, Alcoa-Portland and Pechiney-Tomago with a total annual capacity of 558,000 tons. They are proposals for new expansion in the future for approximately 2 million tons. 3/ The capital expenditure in copper has been low in recent years after major investment in the early and mid-1970s. In the other non-ferrous metals the capital expenditure has been very variable from year to year but shows a negative average of -5.2 per cent per annum over the past decade.

The capital expenditure grew by 5 per cent per annum in real terms in the aluminium semi-fabrication industry over the past decade while other semi-fabrication had a negative trend of -11.4 per cent per annum.

The foreign ownership or control is relatively high in the non-ferrous metals industries mainly in alumina, aluminium smelting and copper smelting. However, the naturalization process is lowering foreign ownership in these industries. In the other non-ferrous metals there is a higher degree of Australian ownership. For further details see table 14.

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3/ Australian Parliamentary Library Service, Some implications for Australia of Rapid Development of the Aluminium Industry, 1979-12-05, updated from press reports.

Table 14. Ownership and control of non-ferrous basic metal products 1982-83

| Industry | No. of Estabs. | % Foreign Control | % Joint Control | % Natural-izing | % Austr. Control |
|---|---|---|---|---|---|
| Copper smelting | 4 | 25.0 | - | 50.0 | 25.0 |
| Silver, lead and zinc | 6 | 33.0 | - | - | 67.0 |
| Alumina | 4 | 100.0 | - | - | - |
| Aluminium smelting | 6 | 50.0 | - | 16.7 | 33.3 |
| Nickel smelting | 3 | 33.0 | - | - | 67.0 |
| Other non-ferrous | 5 | 20.0 | 20.0 | - | 60.0 |
| Secondary | 39 | 20.5 | - | - | 79.5 |
| Total Basic | 67 | 29.9 | 1.5 | 6.0 | 62.4 |
| Aluminium rolling, drawing, Extruding | 26 | 30.8 | 3.8 | 15.4 | 50.0 |
| Other rolling, drawing, extruding | 21 | 23.8 | - | - | 76.2 |
| Metal casting | 103 | 1.9 | 1.0 | - | 97.1 |
| Total Products | 150 | 10.0 | 1.3 | 2.7 | 86.0 |

% under foreign ownership or control of

| 1982-83 | Employment | Wages and Salaries | Turnover | Value Added | Final Capital Exp. |
|---|---|---|---|---|---|
| Basic non-ferrous metals | 82.1 | 85.9 | 80.9 | 88.7 | 99.1 |
| Non-ferrous products | 55.8 | 61.3 | 71.0 | 63.2 | 79.3 |

Source: ABS 5322.0 Foreign Ownership and Control of the Manufacturing Industry.

## 5. Consumption of energy

Non-ferrous basic metals are extremely high consumers of energy. On average energy costs were 16 per cent of turnover for this industry, but only 2.8 per cent of turnover for Australian manufacturing as a whole. Semi-fabrication of non-ferrous products was very similar to the manufacturing average.

Electricity was the main energy cost in the industry. Alumina refining was the highest consumer of energy, but a large proportion of this consisted of furnace or fuel oils. The Nabalco refinery at Gove, Northern Territory, is run entirely on fuel oils. The aluminium industry was the largest consumer of electricity. An analysis of the consumption of energy by the different non-ferrous metals is shown in table 15.

Table 15. Consumption of energy by non-ferrous industries ($'000)

| | 1974/75 | 1975/76 | 1976/77 | 1977/78 | 1978/79 | 1979/80 | 1980/81 | 1981/82 | 1982/83 | 1983/84 |
|---|---|---|---|---|---|---|---|---|---|---|
| **COPPER** | | | | | | | | | | |
| Electricity | 931 | 952 | 1,253 | 1,528 | 1,684 | [$]included | NP | | 7,129 | NP |
| Total | 4,750 | 5,426 | 6,186 | 7,576 | 8,097 | in Other | NP | | NP | NP |
| % Turnover | 2.35 | 2.84 | 2.75 | 3.74 | 2.65 | | NP | | NP | NP |
| **SILVER, LEAD, ZINC** | | | | | | | | | | |
| Electricity | 6,604 | 9,194 | 11,228 | 10,117 | 15,445 | 13,766 | 14,080 | | 20,722 | 27,592 |
| Total | 17,770 | 44,115 | 53,927 | 53,826 | 71,002 | 35,836 | 39,954 | | 54,934 | 62,389 |
| % Turnover | 5.50 | 7.70 | 7.39 | 7.58 | 6.94 | 3.75 | 4.42 | | 7.32 | 8.06 |
| **ALUMINA** | | | | | | | | | | |
| Electricity | 33,052) | 35,909) | 43,165) | 48,335) | 19,607 | 61,021) | NP | | NP | 49,731 |
| Furnace Oil | 33,858) | 47,508) | 66,411) | 76,212) | 75,590 | 110,821) | NP | | 167,892 | 179,813 |
| Total | 88,936) | 109,197) | 143,027) | 161,896) | 135,564 | 219,609) | NP | | 291,762 | 342,681 |
| % Turnover | 18.23) | 18.86) | 19.00) | 19.70) | 21.61 | 17.97) | | | 25.06 | 25.20 |
| **ALUMINIUM** | | | | | | | | | | |
| Electricity | | | | | 37,806 | | 60,173 | | 84,274 | 120,194 |
| Total | | | | | 40,209 | | 67,092 | | 94,673 | 134,580 |
| % Turnover | | | | | 14.92 | | 15.15 | | 17.17 | 17.89 |
| | | | | | | | | DATA NOT PUBLISHED | | |
| **NON-FERROUS NEC** | | | | | | | | | | |
| Electricity | 1,447 | [$]Included | | | | 5,618 | 254 | | NP | 364 |
| Total | 9,339 | in Silver, | | | | 78,408 | 874 | | 689 | 884 |
| % Turnover | | Lead, Zinc | | | | 8.42 | 0.95 | | 1.00 | 1.36 |
| **SECONDARY RECOVERY** | | | | | | | | | | |
| Electricity | 815 | 823 | 967 | 768 | 893 | 1,109 | 1,194 | | 2,067 | 3,924 |
| Total | 2,354 | 2,689 | 3,233 | 2,069 | 2,327 | 3,136 | 3,329 | | 4,286 | 10,958 |
| % Turnover | 1.77 | 2.00 | 2.10 | 1.43 | 1.20 | 1.00 | 1.10 | | 1.72 | 2.98 |
| **TOTAL NON-FERROUS METALS** | | | | | | | | | | |
| Electricity | 110,593 | 46,878 | 56,613 | 60,747 | 75,435 | 81,514 | 113,357 | | 161,334 | 213,280 |
| Black coal | 12,580 | 15,334 | 18,663 | 20,056 | 22,869 | 26,120 | 29,545 | | | 60,561 |
| Coke | 9,713 | 9,134 | 13,221 | 15,547 | 17,481 | 18,969 | 21,230 | | | 28,496 |
| Light oils | 1,122 | 735 | 735 | 2,263 | 2,882 | 161 | 2,978 | | 9,098 | 5,309 |
| Industrial diesel | 2,653 | 3,482 | 4,230 | 4,554 | 7,217 | 13,126 | 19,158 | | 17,303 | 13,585 |
| Furnace oils | 44,199 | 69,420 | 92,205 | 97,564 | 104,962 | 165,786 | 240,343 | | 213,516 | 216,510 |
| Mains gas | 7,847 | 8,279 | 12,620 | 16,157 | 17,797 | 20,620 | 25,901 | | 46,248 | 80,815 |
| LPG | NP | NP | NP | 254 | 330 | 501 | 530 | | 729 | 1,008 |
| Other gases | NP | NP | NP | 193 | 55 | 96 | 638 | | NP | 243 |
| All other fuels | 5,461 | 8,165 | 8,086 | 8,033 | 8,172 | 10,097 | 11,704 | | 104,884 | 21,506 |
| Total | 126,211 | 161,427 | 206,373 | 225,368 | 257,198 | 336,989 | 470,883 | | 553,112 | 641,312 |
| % Turnover | 9.52 | 10.93 | 11.09 | 11.99 | 10.64 | 9.84 | 13.08 | | 15.56 | 15.91 |
| **ALUMINIUM SEMI-FABRICATION** | | | | | | | | | | |
| Electricity | 3,156 | 3,137 | 3,775 | 4,820 | 5,064 | 5,988 | 6,925 | | 9,893 | 15,754 |
| Total | 5,111 | 5,502 | 6,443 | 7,692 | 7,604 | 9,360 | 11,417 | | 15,044 | 21,331 |
| % Turnover | 2.61 | 2.59 | 2.46 | 2.51 | 2.20 | 1.94 | 2.03 | | 2.29 | 2.80 |
| **OTHER SEMI-FABRICATION** | | | | | | | | | | |
| Electricity | 2,987 | 3,059 | 3,477 | 3,680 | 4,396 | 4,913 | 5,553 | | 4,914 | 6,186 |
| Total | 5,642 | 5,908 | 6,622 | 6,969 | 7,811 | 9,447 | 10,532 | | 6,408 | 8,011 |
| % Turnover | 2.00 | 3.07 | 2.78 | 2.71 | 2.88 | 2.63 | 2.76 | | 1.83 | 2.15 |
| | | | | | | | | DATA NOT PUBLISHED | | |
| **METAL CASTING** | | | | | | | | | | |
| Electricity | 370 | 520 | 624 | 626 | 722 | 835 | 963 | | 1,834 | 2,424 |
| Total | 958 | 1,276 | 1,524 | 1,460 | 1,741 | 2,432 | 2,499 | | 3,587 | 4,567 |
| % Turnover | 2.56 | 2.99 | 2.82 | 2.71 | 2.79 | 3.04 | 2.79 | | 3.10 | 3.60 |
| **TOTAL SEMI-FABRICATION** | | | | | | | | | | |
| Electricity | 6,513 | 6,716 | 7,876 | 9,126 | 10,182 | 11,735 | 13,441 | | 16,641 | 24,363 |
| Light oils | 39 | 550 | 498 | 63 | 49 | 66 | 104 | | 90 | 95 |
| Industrial diesel | 822 | 696 | 604 | 583 | 591 | 628 | 1,006 | | 317 | 396 |
| Furnace oil | 2,757 | 2,866 | 2,927 | 4,037 | 3,767 | 4,912 | 4,554 | | 947 | 586 |
| Mains gas | 509 | 828 | 964 | 1,117 | 1,436 | 2,579 | 3,771 | | 6,725 | 8,278 |
| LPG | NP | NP | NP | 1,055 | 956 | 1,210 | 1,503 | | 282 | 120 |
| Other gases | NP | NP | NP | 5 | 9 | 20 | 56 | | NP | 33 |
| Other fuels | 801 | 1,022 | 1,598 | 111 | 150 | 68 | 8 | | 37 | 28 |
| Total | 11,611 | 12,686 | 14,589 | 16,121 | 17,156 | 21,239 | 24,447 | | 25,039 | 33,909 |
| % Turnover | 2.28 | 2.83 | 2.63 | 2.61 | 2.52 | 2.30 | 2.36 | | 3.61 | 2.89 |

Source: ABS: Manufacturing Establishment; Details of Operations by Industry Class.

## III. LINKAGES BETWEEN NON-FERROUS METALS INDUSTRIES AND THE REST OF THE ECONOMY

### 1. Analysis of main flows between sectors

In the Australian economy the main users of non-ferrous metal products are the non-ferrous industries themselves, reflecting in this way the degree of further processing (refining or smelting) in Australia. Other important consumers of non-ferrous metals are the capital goods, the iron and steel and the construction industries. In 1978/79, of a total of intermediate sales of 2,068.7 million of Australian dollars, 376.2 were sales inside the non-ferrous sector, 208.9 to the electrical machinery industry, 169 to the iron and steel, 257.8 to the industries producing structural metal products and other metal products, and 87.9 to the construction sector. See table 16.

The domestic consumption of aluminium was 197,000 tons of primary metal and 49,000 tons of secondary metal in 1979 and it is still increasing. The main users are the building and construction sector, packaging, electrical and transport industries. In copper the domestic consumption was about 140,000 tons of refined copper in 1981. The main users of copper products are building and construction (35 to 40 per cent); tele-communications and electrical machinery and equipment industry (13 to 17 per cent); and the motor vehicle industry (6 to 8 per cent). The domestic consumption of nickel, in 1979, was only 4,000 tons. It was used mainly in the steel industry (stainless steel, construction steel and non-ferrous alloys), electroplating, catalyst and electronics and ceramic industries. In zinc the main user was also the iron and steel industry and its domestic consumption in 1979 was 99,000 tons. Lead was used mainly in the motor vehicle industry and in the case of tin approximately 60 per cent of the production was used in the iron and steel industry. 4/

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4/ The domestic consumption of lead in 1979 was 71,000 tons, and in tin was 2,700 tons in 1982 plus 4,000 tons of secondary tin, but it is declining over time.

Table 16. Non-ferrous metals products
Sales to other sectors - Australian production

$A Millions

| Industry | 1974/75 | 1978/79 |
|---|---|---|
| Joinery, wood products | 9.5 | 13.8 |
| Commercial and job printing | 13.1 | 2.8 |
| Industrial chemicals | 4.0 | 20.7 |
| Petroleum and coal products | 5.0 | 2.3 |
| Basic iron and steel | 57.0 | 169.0 |
| Non-ferrous metal products | 287.0 | 376.2 |
| Structural metal products | 61.5 | 144.3 |
| Sheet metal products | 34.8 | 61.4 |
| Metal products, n.e.c. | 71.9 | 113.5 |
| Motor vehicles and parts | 47.3 | 81.8 |
| Scientific equipment | 9.0 | 32.7 |
| Electronic equipment | 18.1 | 25.5 |
| Household appliances | 33.0 | 33.3 |
| Electrical machinery | 153.0 | 208.9 |
| Other machinery and equipment | 48.7 | 71.1 |
| Plastic and related products | 11.3 | 10.2 |
| Other manufacturing | 10.4 | 1.3 |
| Residential building | 15.9 | 31.5 |
| Building n.e.c. construction | 78.2 | 87.9 |
| TOTAL INTERMEDIATE SALES | $ 1,007.0 | $ 2,068.7 |

## 2. Technical and socio-economic relationships between non-ferrous metals industries and the other sectors of the economy

The highest technical coefficient multiplier is in the non-ferrous industries themselves, showing significant vertical integration through the mining, refining, smelting and semi-fabrication stages. Vertical integration into manufacturing is less common but does occur with some aluminium fabrication. Also high technical coefficient multipliers are in relation with the electrical machinery, structural metal products and scientific instruments. The expansion in these industries will have the largest impact on the non-ferrous metals industries. The different technical coefficients are shown in table 17.

Table 17. Technical co-efficients by main users of non-ferrous metals

| Industry | Non-ferrous Metals Products Co-efficient 1974/75 | 1978/79 |
|---|---|---|
| Non-ferrous metal products | 119.093 | 115.280 |
| Electrical machinery | 23.122 | 22.317 |
| Structural metal products | 11.800 | 16.564 |
| Scientific instruments | 7.461 | 13.062 |
| Other metal products | 10.819 | 10.755 |
| Household appliances | 10.758 | 9.283 |
| Sheet metal products | 8.467 | 9.723 |
| Other machinery and equipment | 6.903 | 7.214 |
| Electronic equipment | 6.299 | 6.923 |
| Basic iron and steel | 4.483 | 8.326 |
| Paints, varnishes, lacquers | 3.807 | 6.284 |
| Motor vehicles and parts | 5.609 | 5.467 |
| Agricultural machinery | 3.679 | 5.972 |
| Other building and construction | 3.900 | 4.178 |
| Ship and boat building | 4.184 | 3.757 |
| Construction - machinery | 4.061 | 3.963 |
| Other chemical products | 3.225 | 3.729 |
| Joinery, wood products | 3.230 | 3.251 |
| Locomotives, rolling stock | 2.077 | 3.082 |
| Signs, writing equipment | 2.984 | 3.076 |

3. Effects of national economy

(a) Degree of integrated development, development of related companies and technological innovation

These industries in Australia consist of large mining and refining operations serving the international market and small fabricating and manufacturing operations servicing the domestic market. Growth will stimulate downstream activities, however little evidence of domestic structural change exists.

Current structural changes in the Australian economy favour mainly export development and specialized growth rather than integrated development. Technology being employed in new aluminium smelters is close to "state of the art". However, it is being imported under license from parent companies or being purchased overseas and little technological development is occurring within this country beyond certain adaptations for local conditions.

(b) Employment, training and balance of payment

The direct employment in mining in 1983/84 was 19,536 persons; in processing facilities it increased to 28,200 persons. That means that the non-ferrous activities gave a total direct employment of 47,736 persons in 1983/84. In addition to this direct employment in non-ferrous refinery, smelting and semi-fabricating facilities, multiplier coefficients for new aluminium smelters have been estimated. The accepted calculations for Australia are: Type I (direct plus indirect) employment, 3.286; Type II (including induced) employment, 6.714. Such figures would imply the 5,200 jobs in aluminium smelting are ultimately responsible for approximately 35,000 jobs throughout the economy.

Non-ferrous metal production and mining do not require skills beyond the level usually available in the Australian workforce. All facilities provide apprenticeship training in relevant trades and on-the-job training for process operatives. Opportunities exist for study towards further qualification for administrative, technical and professional staff in line with most large corporations in Australia.

With respect to the balance of payments, as already mentioned, treating the aspects of exports and imports, the non-ferrous metals industry in Australia makes a significant contribution towards the debit side of the Nation's balance of payments.

IV. ANALYSIS OF THE GOVERNMENT STRATEGY

1. Federal Government

(a) Foreign investment

In general, Australian governments encourage foreign investment as a means of augmenting capital resources in order to increase the rate of growth and employment. All major proposals involving foreign investment must be submitted to the Foreign Investment Review Board.

Specific guidelines apply to new mining projects. To proceed, Australian interests must have a minimum of 50 per cent of equity and of Board control. Mineral processing projects are subjected to consultation to ensure that an appropriate level of Australian equity is achieved. However, no specific percentages are specified. Manufacturing projects are encouraged to contain adequate Australian equity unless considerable offsetting advantages to the national economy can be demonstrated.

Foreign companies may acquire naturalisation status by progressively increasing the level of Australian participation in their Australian operations. This allows them credit as Australian equity in new projects. CRA, a major company involved in the non-ferrous metals industry, has acquired naturalisation status. Its Australian equity increased from 27.4 per cent in 1978 to 47.67 per cent in 1985.

(b) Trade policy

In the post-war period, the Federal Government actively used tariff protection to encourage local manufacturing. This resulted in small-scale establishments oriented to the small domestic market. Many operated as branch plants of multinational corporations. The degree of local design and technological innovation declined over this period.

The increasing internationalisation of world production in the 1970s and 1980s has led to Australian manufacturing facing increasing import competition. Local plants have had limited success in exporting beyond the basic metals stage. Current trade policy now takes a much stronger stand towards "free trade" and favours export expansion rather than import substitution.

Basic products have very limited protection while manufacturers have between 20-25 per cent tariffs. The non-ferrous industries are predominantly exporters and the extent of imports is quite low. Thus changes in trade policy are unlikely to effect the basic industry. A number of the metal fabrication industries face severe import competition, where imports now cover 40 to 50 per cent of the market. Little exporting occurs. Fabricated metals receive a higher than average effective rate of tariff protection, especially sheet metal products and metal containers.

(c) Industry policy

Until recently, the Australian Government has not played an active role in industry development aside from the provision of tariff protection to encourage domestic manufacturing. The current Government has established a Prices and Income Accord which recognises the need for a more interventionalist role.

Industry development at the federal level is now conducted through tripartite industry councils in order to achieve the objectives of industry modernization, import replacement and export expansion in selected industries. The established industry councils are:

- Basic metals
- Chemicals and plastics
- Forestry and forest products
- Metal fabrication
- Processed foods
- Paper conversion, printing and publishing
- Textiles, clothing and footwear
- Machinery and metal engineering
- Electrical, electronics and information
- Aerospace.

Non-ferrous metal products are covered by the basic metals and the metal fabrication councils. The only activity to date by these councils has involved the steel and automotive industries. However, all councils are in the process of developing industrial strategies. The "stocktake" prepared for the non-ferrous metals industries suggests the Australian operations are export-oriented and technically modern. Fabrication, however, is limited to the small domestic market. Australia was rated as among the most efficient world producers of basic metals.

## 2. State Government

The State Governments are the legal owners of natural resources within the Australian constitutional system. Thus they are the level of government most directly involved in negotiations with the corporations in the non-ferrous metals industries.

Mines are leased to companies on long-term lease. The level of royalties is generally low to encourage development, and few other charges are made directly against mining operations. In isolated areas the companies must provide their own infrastructure. In sites closer to development the State will frequently provide rail and road access and port facilities.

States have utilized their control of leases to influence the location decisions of processing plants as illustrated above. Non-ferrous metals processing is energy-intensive and States are the electricity supply authorities in Australia. Current strategy is to use cheap electricity as an inducement to plant location.

Until very recently, Australian Governments have not taken public equity in mineral processing facilities. The Portland Aluminium Smelter Joint Venture between the Victorian Government (30 per cent), Alcoa of Australia (50 per cent) and other interests is the first departure from this purely free enterprise approach. Alcoa of Australia was caught financially with the collapse of the "resources boom" in 1982 with a new "mothballed" refinery at Wagerup in Western Australia and the partially completed smelter at Portland when the world market collapsed. It suspended construction and was unable to find new partners for the smelter among the Japanese or Koreans. To revive the project, the State Government took equity and developed a flexible electricity tariff.

Industry policy for Australian State Governments has revolved around location policy. The Victorian Government has recently introduced a series of industry policies of a more interventionist stance which in fact preceded the federal development. Although metal fabrication is potentially an area which might be encouraged through these policies, little success in changing these from a domestic to an export market has been achieved to date. A strategy for the development of an alumina ceramics industry in Australia has been produced.

## V. THE ECONOMICS OF NON-FERROUS METALS

### 1. Mining

The Australian mining industry is highly integrated with the world market and exposed to overseas developments. Control over prices by Australian based companies is minimal. Overall the industry is internationally competitive due to national comparative advantages in the extraction of minerals and the high quality of deposits.

Profitability in mining varies significantly with world economic conditions as shown on the following table. Low returns in the 1980s related to low world prices and rising input and wages costs.

Table 18. Returns in the Australian mining industry

| | 1979/80 | 1980/81 | 1981/82 | 1982/83 | 1983/84 | 1984/85 |
|---|---|---|---|---|---|---|
| Net profit return on average shareholders funds (%) | 21.5 | 10.9 | 2.2 | 4.1 | 4.4 | 5.7 |
| Effective after tax return on funds employed (%) | 13.3 | 8.5 | 3.4 | 4.3 | 4.4 | 5.5 |

SOURCE: Australian Mining Industry Council - Minerals Industry Survey.

### 2. Metals

Australia is internationally competitive in most non-ferrous metals produced due to natural advantages from the availability of raw materials and abundant and relatively low cost energy. Australia only supplies a small percentage of total world output of processed raw materials. In recent years, more processing has been occurring locally although the bulk of new investment has been in aluminium smelting.

In terms of output per employee, Australia has ranked amongst the highest in the world although this productivity has been affected by recent falls in world demand and metal prices. Limited investment in transformation projects has been planned and the majority of this was in the aluminium industry. A number of the proposed projects in other non-ferrous areas have been deferred due to the market downturn.

### 3. Semi-fabrication

The majority of semi-fabrication occurs in aluminium and copper products and is for the domestic market. The lack of economies of scale particularly in the copper and tin semi-fabrication facilities due to the small domestic market has led to unit production costs being above that of overseas competition.

Technology in aluminium semi-fabrication is of world standard although productivity per employee is a little below world standards. However, energy efficiency is equal to best available standards. Technology and productivity in other semi-fabrication is below world standard although recent plant modernization has occurred at some sites. Improved markets are likely to induce further modernization in the future.

### 4. Metal fabrication

Metal fabrication in Australia is predominantly dependent on the domestic market where a variety of products is produced by small-scale jobbing and batch work production lines. Most sectors are experiencing competition from imports which often have 40-50 per cent of the market. Little exporting is occurring.

Profitability is generally quite low although marginally above the manufacturing average. Little productivity increases have been achieved and cost structures are generally above those of overseas competitors. Little capital investment has occurred over the past decade although new technology is now being introduced in some firms.

## VI. ALTERNATIVE STRATEGIES

### 1. Basic metals industry strategy

The large amount of capital required to establish new facilities is an important constraint to the development of the non-ferrous industries. To reduce capital costs and achieve a coherent productive system, linkages were recommended between the basic metals industry and the Australian heavy engineering industry to increase the potential for "offsite fabrication". This may also necessitate improvements to transport infrastructure. Changes to depreciation allowances were also recommended to allow taxation concession to commence at the time of installation rather than at completion of the project.

Improvements in research and development were recommended through the establishment of an industry research database and an improvement in management attitudes. These are to form the basis of a research and development strategy.

A number of measures was recommended to improve the skills of the workforce, to improve workforce flexibility, productivity and job satisfaction. Improvements in the working environment were recommended to mitigate the effects of repetitious work and the hazardous environment. Improved industrial relations through more effective employer/employee communication and consultative processes are also recommended.

More small and medium-sized firms need to develop their export awareness and to improve the standard of their product to export standard production of basic metals in the United States of America, the European Economic Community and Japan which are becoming markets for Australian exports.

2. Metal fabrication industry strategy

Metal fabrication in Australia is fragmented and dependent on the domestic market. It is facing increasing pressure from imports and there is urgent need for revitalization in order to increase competitiveness and thus market size. The major elements of the strategy include:

(a) market identification and market plans on behalf of individual firms and co-operative industry plans in relation to market penetration strategies, quality standards, productive differentiation, innovative products. Industry associations may need consolidating before effective self-help programmes can be developed;

(b) management performance improvements through education and skills training covering areas such as operational efficiency, corporate strategic planning, market development, product development, etc. Innovative education programmes to meet the needs of small businesses need to be developed;

(c) industrial relations at the individual firm and industry level to cover issues such as changing work practices, redeployment of labour, union demarcation disputes, industrial democracy;

(d) industry co-operation to overcome the effects of fragmentation by increasing intra-industry, self-help and co-operation. This could include merger or cross-supply arrangements, joint export marketing arrangements, joint research activities. Basic metals account for half of production costs and co-operation is required to reduce domestic prices for metals closer to export prices;

(e) improve the domestic business climate to encourage investment and product development through Government policies on depreciation allowances, regulation, and anti-dumping provisions. The Government will also consider levels of tariff protection (currently relatively high) and nationalizing developing country preferences;

(f) technology and research and development need to be encouraged to increase firms' awareness of available technology, the benefits of products and process innovation, methods of introducing new technology and access to government assistance programmes. Greater co-operation between research agencies and industry is required;

(g) training and retraining in order to overcome the high level of wastage of trade skills and to improve skill levels in conjunction with new technology Professional and technical skills education need to include the specific characteristics of these industries. Much of this needs to be supplemented by improved "in-house" training.