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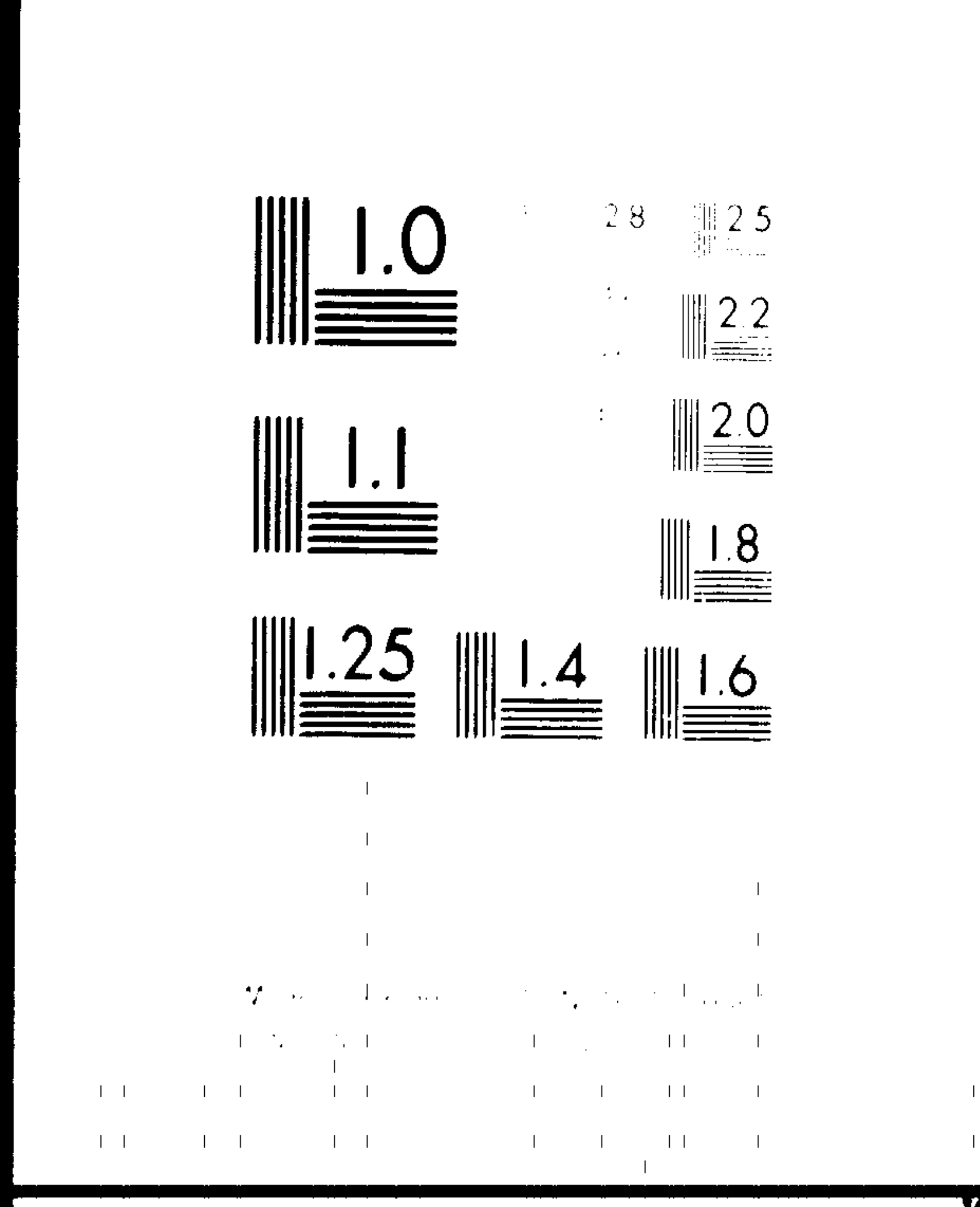
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PROSPECTS OF PRODUCTION AND PROSPECTING OF NON-FERROUS METALS

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PROSPECTS OF PRODUCTION AND TRANSFORMATION POSSIBILITIES OF NON-FERROUS METALS

INTRODUCTION

1. The Lima Declaration and Plan of Action recommended that the share of developing countries in world industrial output in the year 2,000 be raised to 25 percent through concerted action by the international community with the objective of identifying the forms and content of international co-operation which would supplement the national efforts of developing countries towards this objective.

2. The Lima Declaration and Plan of Action futher called for the establishment of a System of Consultations at the global, regional and inter-regional and sectoral levels within the UNIDO and within appropriate international bodies, between developed and developing countries, and among developing countries themselves in order to facilitate the achievement of the goals set forth in the field of industrialization as well as the redeployment of certain productive capabilities existing in developed countries and the creation of new industrial facilities in developing countries. In this context, the UNIDO Organization was assigned the role of a forum for consultations and the negotiations of agreements in the field of industry between developing and developed countries as well as amongst developing countries themselves.

3. The recommendation by the General Assembly in 1975 that UNIDO should "serve as a forum for negotiations of agreements in the field

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of industry" led to the establishment of a System of Consultations, on an experimental basis in 1976, which was later set on a permanent basis by the Industrial Development Board in 1980.

4. The 14 Consultations, covering 9 industrial sectors held so far, have enabled UNIDO to establish a new set of relations with the world of industry and have, on a continuing basis, progressively conceived the modalities of the operation of the System of Consultations.

5. The adoption of a sectoral approach to world industrial problems has permitted an understanding of the nature of the driving forces at the world level enabling the Secretariat to identify the strategies and motivations of the main actors in each sector, and to appreciate the nature of the underlying conflicts of interest and identify the opportunities for co-operation which will enable parties from all countries to discuss the future of a particular sector on the same footing and to elaborate a framework for increased industrial co-operation. The central co-ordinating role of UNIDO in the General Assembly and the evolution and adopting of a System of Consultations on a permanent basis have provided a multi-disciplinary and unified approach to the problems of industrial development and have the potential to transform general policies discussed at the political level into strategic action programmes for individual countries and into potential projects for implementation by UNIDO and the United Nations System.

6. The fact that the nine industrial sectors covered so far by the Consultations did not include the sector on non-ferrous metals is not an indication of a lack of interest of the countries concerned in its

evolution and development, but is rather a result of its complexity and the insufficiency of the information and data necessary to make a proper and detailed assessment of the sector in question. It is not difficult, however, to appreciate fully the importance of non-ferrous minerals to the economies of the developing countries, and the dominating share it occupies in the total economic activity of a large number of them. A recent World Bank study noted that minerals (non-fuel) contributed 25 percent or more to the GNP of six developing countries namely Bolivia, Gabon, Liberia, Mauritania, Suriname and Zambia and contributed 10 to 15 percent to the GNP of another eight developing countries, namely, Chili, Guinea, Guyana, Indonesia, Jamaica, Mexico, Sierra Leone and Zaire. Though the figures quoted are rough approximations, they can be safely regarded as indicative of the importance of the non-fuel minerals to the economies of these countries.

7. Although the sectoral approach to the question of the non-fuel metals is complicated by a number of factors (such as the inclusion of a number of developed countries is the list of producers, the different levels of economic development among the developing countries concerned, and the high mineral dependence in terms of income levels and export shares), these complications should not obscure the fact that the governments of mineral-exporting developing countries attach the highest importance to the development of this sector and have repeatedly expressed a strong desire to expand mineral processing activities in their own territories. It can safely be stated that their ambitions in this respect are wholly in

line with the resolutions of the New International Economic Order. It may not be, therefore, too presumptive to conclude that an "agreement in principle" can eventually be reached between the parties concerned relative to the share of the developing countries in the processing activities. The translation of these agreements in specific action-oriented measures which recognize, reconcile and balance divergent interests through consensus decisions is, however, another matter requiring a political will to match the complexity of the sector in questions, a full appreciation of the magnitude of the issues involved, and a full committment to the successful resolution of the long and arduous negotiations required.

8. Perhaps the best inducement to the developing countries concerned expanding mineral processing is the additional generation of export revenues which may ensue from such expansion. The gross increase in the foreign sales of mineral ores (including iron ore and nickel) would be more than fivefold or from $10 to $54 billion. The impact on the GNP of the developing countries concerned may be smaller than the potential increase in export revenue due to the substantial foreign inputs required in the form of technology, capital and energy. Another reason for the developing countries show of interest on what has come to be knows as "Resource-Based Industrialization", is the disappointment they encoutered when many of them chose to base their economies upon a high rate of growth of manufactures exports in the late 1960's and 1970's and were faced with protectionist policies by the developing countries and the volatility in real prices of their commodities

leading to sharp falls in the real prices of their commodities from 1977 levels. They are, therefore, turning back from the policies they have been pursuing to a policy of basing their industrial development on mineral processing in which they believe they have a competitive edge.

9. The narrowing of the size of processing capacity gaps - in other words, the expansion of processing operations in the developing countries - for each metal and country, and the identification of the issues and problems involved both on the individual and sectoral scales, would make it imperative to assess and analyse each and every one of the non-ferrous metals i.e. bauxite, copper, lead, tin and zinc. In this connection, it may be necessary to discuss briefly the costs and benefits of additional mineral processing in developing, including an analysis of investment requirements to create processing capacity, of the operating costs in mining, smelting and refining, of expected prices for the metals under scrutiny, and the additional export values created at each processing stage.

10. The policy options open or contemplated by mineral producing countries with gaps in their processing capacity, can be realistically assessed only if their objectives in mineral processing can be contrasted with the objectives of the other parties involved such as the multinational mining companies, the international financial institutions, and the governments of the industrialized importing countries.

11. The convening of Consultations on non-ferrous metals involving the participation of a large number of officials, industrialists, experts and others, the preparation in advance of the convening of the Consultations of issues and studies by UNIDO and other interested parties, the discussion in depth and on a continuing basis undertaken by the participants who may hopefully become decision-makers, may eventually lead to a ventilation and clarification of the problems and issues in question and help resolve in a reasonable period of time the issue of redeployment of processing operations in the developing countries and implement the objectives of the Lima Declaration and Plan of Action in raising the share of the developing countries in the world industrial output in the year 2000 by 25 per cent.

A SURVEY OF NON-FERROUS METALS ON AN INDIVIDUAL BASIS:

BAUXITE

1. Aluminium, the metal produced from bauxite, is well-known for its low density, great ductability and ease of fabrication. It can be cast into accurate shapes and is widely used in the transport industries, building and construction, and the electrical engineering industries. With the world demand for aluminium expanding by an average of 7.5 percent per annum, and where favourable conditions exist, notably the availability of power and access to markets, the developing countries have participated greatly in the expansion of primary ore supplies and in the extraction of alumina therefrom. Although the TNC's have undertaken and continue to undertake a major role in the extraction of the ore, the preparation of alumina and the smelting and refining of the metal, nevertheless a number of developing countries have been able, through the participation of local private investors or appropriate government departments, to install and operate processing activities, reaching vertically in some instances, to the fabrication of aluminium to meet local needs.

2. High-quality bauxite (containing more than 40 percent aluminum oxide) is heavily concentrated in tropical locations; however, 62 percent of current bauxite mining capacity and 77 percent of reserves are located in developing countries. The remaining 38 percent and 23 percent respectively are located in developed market economy countries such as

Table II.2: BAUXITE /a - WORLD PRODUCTION BY MAIN COUNTRIES AND ECONOMIC REGIONS

	Volume							Growth Rate		Share of World Total		
	1960	1965	1970	1975	1977	1978	1979	1960-77	1977-79	1960	1970	1979
	('000 tons)							(% per annum)				
Industrialized Countries	4,513	5,779	14,650	25,353	30,176	27,965	31,332	14.9	1.9	16.3	24.1	35.7
of which: Australia	70	1,186	9,256	21,034	26,086	24,293	27,584	41.6	2.8	0.2	15.2	31.4
Developing Countries	17,979	24,828	36,178	40,623	43,355	44,344	44,960	5.8	1.8	65.1	59.0	51.1
Africa, South of Sahara	1,579	2,134	3,285	9,455	12,322	12,694	13,130	12.6	3.2	5.7	5.4	14.9
of which: Guinea	1,378	1,600	2,490	8,406	11,300	11,648	12,199	12.9	3.9	5.0	4.1	13.9
South Africa	0	0	0	0	0	0	0	/c	/c	0	0	0
North Africa & Middle East	0	0	0	0	0	0	0	/c	/c	0	0	0
Asia & Pacific	1,532	2,389	3,743	2,791	3,430	3,285	3,415	5.5	0.0	5.5	6.2	3.9
of which: India	387	707	1,374	1,094	1,512	1,663	1,934	7.9	13.1	1.4	2.3	2.2
Latin America & Caribbean	12,959	17,442	24,702	22,426	22,082	22,676	22,323	4.0	0.5	46.9	40.7	25.4
of which: Jamaica	5,837	8,651	12,010	11,570	11,433	11,736	11,505	4.4	0.3	21.1	19.8	13.1
Suriname	3,455	4,360	6,022	4,751	4,856	5,113	4,741	3.4	-0.1	12.5	9.9	5.4
Guyana	2,511	2,919	4,417	3,828	3,344	3,479	3,354	2.7	0.1	9.1	7.3	3.8
Brazil	121	188	510	969	1,035	1,131	1,642	15.8	26.0	0.4	0.8	1.9
Southern Europe	1,911	2,863	4,448	5,951	5,521	5,689	6,092	6.7	5.0	6.9	7.3	6.9
Centrally Planned Economies	5,128	6,686	9,898	11,269	11,557	11,650	11,626	4.9	0.3	18.6	16.3	13.2
WORLD TOTAL	27,620	37,293	60,726	77,245	85,088	83,959	87,918	7.7	1.6	100.0	100.0	100.0
MARKET ECONOMIES	22,492	30,607	50,828	65,976	73,531	72,309	76,292	8.2	1.9	81.4	83.7	86.8

/a Gross Weight.
/b Preliminary
/c Incomputable

Source: Metallgesellschaft, Metal Statistics and World Bureau of Mines, World Metal Statistics (actual); World Bank, Economic Analysis and Projections Department (projected).

as Australia and Greece. In the last two decades, however, Australia accounted for 31 per cent in 1979 of the 76.3 million metric tons produced then globally. On the other hand, only 26 per cent of current alumina capacity and 13 per cent of smelting capacity are presently located in developing countries, eventually increasing to 36 per cent and 21 per cent in 1983 through expansion and new projects. The major bauxite producers from the developing countries are Jamaica, Guinea, Brazil and Surinam. World production of alumina has grown at 7.4 per cent annually from 1966 to 1977, decreasing to 3.1 per cent annually from 1977 to 1979 due mainly to the slow-down of the world economy. In 1979, Australia accounted for 23 per cent of the world alumina output, followed by the United States (20 per cent), Jamaica (6.4 per cent), and Japan (5.6 per cent). As for primary aluminium, it grew at 6.9 per cent annually from 1960 to 1977, and at 2.8 per cent annually from 1977 to 1979 totalling 15.2 million metric tons in 1979. The share of developing countries in aluminium output has increased from 3.2 per cent in 1960 to 13.7 per cent in 1979 reflecting the availability of hydroelectric potential and other types of cheap energy in these countries. Aluminium recovered from scrap increased from 2.18 million metric tons in 1970 to 3.75 million metric tons in 1979; this expansion is due mainly to the fact that scrap requires significantly less energy than alumina to be processed into aluminium.

3. The world market in aluminium metal is effectively dominated by six TNCs, namely ALCAN, ALCOA, ALUSUISSE, KAISER, PECHINEY, UGINE KUHLMANN, and REYNOLDS. They account for 60 per cent of bauxite production in the market economy countries and about 55 per cent of primary aluminium production. These major bauxite-aluminium corporations produce alumina and aluminium in joint operations with other corporations and with government agencies. They extracted more than half of their total production of bauxite in developing countries but only processed about one-third of their total alumina production there and had less than 10 per cent of their aluminium production capacity in the developing countries. They are mainly concerned with the production of aluminium, its semi-manufactures and manufactures, and connected activities such as the generation of energy for aluminium production and the operation of shipping firms for the transportation of bauxite/alumina/aluminium. New entrants in the industry and state-owned enterprises in

Table III.1: COMPANY CONCENTRATION IN BAUXITE MINING, 1977

Company	Capacity[a, b] (Mt/a)	Share (%)	Cumulative share (%)
Alcoa	20.8	22.0	22.0
Kaiser	12.5	13.2	35.2
Alcan	6.4	6.8	42.0
Rio Tinto Zinc	6.2	6.6	48.6
Reynolds	5.7	6.0	54.6
Alusuisse	4.6	4.9	59.5
Pechiney	4.6	4.9	64.4
Guyana government interests	4.0	4.2	68.6
Ergoinvest (Yugoslavia)	3.5	3.7	72.3
PT Timah (Government of Indonesia)	1.3	1.4	73.7
Noranda	1.2	1.3	75.0
Martin Marietta	1.2	1.3	76.3

/a Including proportionate share of capacity in joint-venture projects.

/b Capacity figures reflect equity ownership or control; actual disposal of bauxite may differ.

Source: UNIDO, Mineral Processing in Developing Countries.

Table III.2: COMPANY CONCENTRATION IN ALUMINA REFINING, 1977

Company	Capacity[a] (Mt/a)	Share (%)	Cumulative share (%)
Alcoa	6.8	22.4	22.4
Alcan	3.0	9.9	32.3
Reynolds	2.9	9.6	41.9
Kaiser	2.9	9.6	51.5
Pechiney	2.6	8.6	60.1
Alusuisse	1.6	5.3	65.4
VAW (Germany, Federal Republic of)	1.0	3.3	68.7
EFIM (Italy)	0.9	3.0	71.7
Nippon Light Metal	0.9	3.0	74.7
Sumitomo	0.8	2.6	77.3
Rio Tinto Zinc	0.6	2.0	79.3
Ergoinvest (Yugoslavia)	0.6	2.0	81.3

/a Including proportionate share of joint-venture projects.

Source: UNIDO, Mineral Processing in Developing Countries.

Table III.3: COMPANY CONCENTRATION IN PRIMARY ALUMINUM SMELTING, 1977

Company	*Capacity (Mt/a)*	*Share (%)*	*Cumulative share (%)*
Alcan	1 766	13.1	13.1
Alcoa	1 752	13.0	26.1
Reynolds	1 262	9.4	35.5
Kaiser	1 056	7.8	43.3
Pechiney	914	6.8	50.1
Alusuisse	704	5.2	55.3
VAW (Germany, Federal Republic of)	450	3.3	58.6
Sumitomo	439	3.3	61.9
Nippon Light Metal	400	3.0	64.9
Mitsubishi	358	2.7	67.6
Anaconda (Arco)	328	2.4	70.0
Rio Tinto Zinc	282	2.1	72.1

Source: UNIDO, Mineral Processing in Developing Countries.

some developing countries account for the rest and are putting up an increasingly effective competition to the TNCs. In fact, there are about 40 other firms which account for 25 per cent of world production capacity. Most of them are non-integrated and some are state-owned companies.

4. Although most bauxite is traded internally within the six TNCs, including its subsidiaries and affiliated companies, in 1976 about 90 per cent of total trade in bauxite and 83 per cent of alumina occurred through intra-system transfer, the rest is generally marketed under long-term contracts to independant producers, thus making bauxite pricing less arbitrary than it was in the past. As for aluminium, it is estimated that even a higher percentage is traded through open markets. Transfer prices of bauxite are set by the companies as a function of their costs of production and taxes, and therefore vary widely within deposits. They presumably take into account long-term market conditions as well as production costs. The most significant quotations are ALCAN's export prices and ALCOA producer prices. Since 1978 aluminium was introduced in the London Metal Market, reflecting more volatile nature because of short-term fluctuations in the industry. The increase of taxation in the 1970s by the bauxite-producing countries led by Jamaica, and the protective policies adopted by the consuming countries to protect their domestic production had their effect on the prevailing cost and pricing structures. Producers' prices are still the prevailing pricing system for alumina due to the high degree of integration in the aluminium industry. As for aluminium, there was an absence of market price fluctuations during the fifties and sixties due to the high degree of integration prevailing in the industry. In the seventies the situation changed on account of an excess producers' capacity in 1970-1972, forcing them to decrease their prices. Demand rose in the period 1972-1974 and prices increased. The depression of 1974 led to a cut in production rather than prices, and consumption recovered after 1976 leading to substantial price rise in spite of the recession of 1980-1981, but the rate of growth in prices in real terms remained less than that of the 1960s.

5. Since the demand for aluminium is generally expected to continue to grow at fairly high levels (averaging 7.6 per cent per annum for the period to 1985[1/], there seems to be reasonable market prospects which could encourage developing countries to become larger producers of primary aluminium. There are, at present, plans for additional smelting capacity. Nevertheless, there will be a shortage of smelting capacity for the mid-1980s. As a result, there exists substantial opportunity for the creation of additional refining and smelting faciltiies located closer to the sources of raw materials, especially in the developing countries.

6. The six traditional transnational corporations own 60 per cent of bauxite capacity, 51 per cent of world refining capacity and 42 per cent of world smelting capacity. In fact it is believed that effective control may exceed above levels - this is due to the emergence in the last decade of joint ventures in which the TNC is a technological contributor, or maintains lower equity participation plus the management rights; or in any case, control the market for the output. The remaining refinery and smelter ownership is divided among other TNCs, totalling some 51 organizations, in joint ventures with private investors or governments of developed and developing countries. Capacity at the mine and refinery stages appears to be well in excess of the requirements at the refinery and smelting stages. The latter stage is capital-intensive, hence the tendency to instal more than sufficient capacity at the earlier stage to ensure adequate and reliable supplies of feedstock. This means that bauxite and lumina output is eternally competing in a surplus market. The tightly integrated nature of the involvement of TNCs in the industry highlights what is essentially a captive market for a majority of the world output from bauxite to end-product. Industrial concentration in the aluminium industry remains high, but it seems to be decreasing slowly over time. Production by independent aluminium smelters, at present about 4 per cent, may perhaps double in the next four years. The growing use of scrap also provides a sources of metal which is not tied to vertically integrated systems.

7. The narrowing or the ultimate closure of the national processing gaps in aluminium will depend on the magnitude of primary production and the availability of the respective minimum economic plant sizes based on the standard technology of the late 1970s, et.c. the minimum economic plant

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1/ World Bank, Price Prospects for Major Primary Commodities, June 1977.

sizes for alumina has been established at 400,000 mtpy and for aluminium at 80,000 - 100,000 mtpy respectively. Thus there are at least seven countries where the development of an integrated aluminium industry could be contemplated based on existing bauxite mines, i.e. Guinea, Jamaica, Guyana, Indonesia, Brazil, Malaysia and India.

8. Closing the current processing gap in aluminium is estimated to cost some $38.8 billion, thus creating employment potential for 137.000 jobs and generating export revenue valued at $12,600 billion. The investment requirements and costs of running mineral processing operations are estimated at $1,035 and $ 3,500 capital costs per ton annual capacity for alumina refining and aluminium smelg, respectively, for additional capacity in developing countries, and $900 and $2,900, respectively, in industrial countries, as well as $159 and $958 annual capacity charge and operating costs per ton, respectively. These costs should, of course, be compared with the difference in market price between the unprocessed and processed product over an extended period of time in order to assess whether the price difference exceeds sufficiently the developing countries' cost levels to make the new processing operations worthwhile. World mineral demand and prices are naturally an important factor to take into consideration as well as the ability to the countries concerned to influence them is very limited indeed. Other factors which have an important bearing on the expansion of the processing operations are connected with the need to establish the required infrastructures - sometimes from scratch - the share of the overall inputs in the operating costs, the availability of the technology and the proper finance required for such ventures.

LEAD

1. Lead is largely used in the electric and oil industries as in gasoline additives, in batteries and in cable sheathing. The development of new technologies has resulted in new applications such as electric vehicles and lead-acid batteries for electric utilities. These applications, however, are at present rather limited, though they may be regarded as pointers to higher consumption of lead in the long run.

2. About 88 per cent of world consumption of lead is concentrated in industrialized countries, while about 72 per cent of world mine production also comes from developed countries. Major importers of lead are industrialized countries such as Japan, EEC member countries and the United States. Developing countries are very small importers - with Brazil and India having imports of some significance. Over 70 per cent of world exports come from developed countries, major exporters being Canada, Australia, Ireland and South Africa; the major exporters among the developing countries are Peru, Mexico, Iran and Morocco.

3. The developing countries play a relatively minor role in world lead industry, especially if secondary lead is taken into accounty. They account for one-third of the lead mine capacity, and one-fourth of the processing capacity, excluding the centrally-planned economies. The largest lead reserves are found in Algeria and Bolivia. On the whole, the share developing countries in lead mine capacity and world reserves is definitely smaller than that of the developed countries. These proportions are likely to remain the same in the foreseeable future. Lead production in developing countries - especially in Peru, India and Iran - will increase in the coming few years. Likewise, expansion in production will be effected in South Africa, Ireland, Spain and Canada. Parallel expansion in processing facilities will be undertaken in Peru and the Republic of Korea on the one hand, and in Ireland and South Africa on the other.

4. For the world exports as a whole the relative shares of ore/concentrates, bullion and refined metal in the total were 38 per cent, 15 per cent and 47 per cent, respectively, in 1976. The share of metal (bullion and refined lead together) in total exports in 1976 was 67.6 per cent for the developed

exporters as a whole (down from 70.6 per cent in 1965) and 50 per cent for the developing countries as a whole (up from 57 per cent in 1965). Major developing exporters of ores and concentrates in 1976 were Peru, Morocco and Iran while major exporters of lead metal were Mexico, Morocco and Peru, except for Mexico, Most of the developing country exporters export more lead in ore and concentrates than in metal form. As for developed exporters all except Canada export lead mainly in metal form.

5. In the developing countries, Mexico has adequate smelting facilities for its mine production. Peru processes one-third of its mine output; Morocco processes about one-half of its output; while Brazil and the Republic of Korea process excess smelting and refining capacity. In fact, among the developing countries, there are only a few countries with mine output greater than 50,000 tons annually - currently only Mexico, Peru and Morocco - which qualify for economies of scale. In Japan, Belgium, France and the Federal Republic of Germany, the processing capacity is in excess of domestic mine production, while in the United States, capacity for mine production and primary refining capacity are roughly in balance. However, since the outlook is for surplus mine capacity in the next few years, there are opportunities for additional smelting-refining capacity in some developing countries which are having processing plants under construction such as Peru, Mexico, and Iran, or are planning further expansions such as Bolivia. Of ten developing countries producing lead, in fact all, except for Bolivia and Iran, have their own smelters and refineries and refined 67 per cent of their total mine output in 1967. Taking into account the current imports of lead for domestic consumption by some of these countries, it appears that six countries, i.e. Argentina, Brazil, Iran, Mexico, Morocco and Peru may be said to have prima facie justification for local smelting and refining of lead from the scale economies' point of view.

6. The lead industry is not dominated by a single firm or groups of firms, but is rather a mixture of small and large producers. Large firms account only for 8 per cent of the total industry and 50 per cent of the metal capacity. Current prices are relatively high reflecting a balanced supply/demand position along with mining and processing costs that have been rising in real terms. The prediction is, however, for a slow rise through the 1980s just keeping pace with production costs. The long-term outlook for lead metal is influenced by the rising real cost of production and the uncertain long-term demand prospects for lead brought about by the development of substitutes replacing the metal in a number of traditional uses,

shifts to new technologies that replace or diminish the amoung of lead used, and pressures from environmental groups.

7. Lead smelting and refining are capital-intensive subject to scale economies. They are not technologically complicated; so technology is not a major problem. The major obstacle is the relatively large capital requirements for a plant of minimum economic size necessary fo; an economic operation and associated infrastructure. The optimum size for a lead smelting plant is estimated at 100,000 mtpy, and the capital cost per annual ton capacity is in the order of $2,300 for additional capacity in developing countries, and $2,100 in industrial countries. This cost estimate is for a conventional facility. The estimate will be considerably more if it is for a facility designed to treat more complex lead concentrates. The new plants based on the new Imperial Smelting Furnace technology are smaller than the optimum facility and treat lead and zinc together. As for the operating costs, they are, however, dependent on the nature of the concentrate being processed and whether they are concentrates with high impurity levels, or dirty concentrates, or concentrates with low-lead complex. Costs are also influenced by increases in the cost of energy, by the relatively high labour costs, and the high levels of environmental control costs, especially in the United States. Taking all these elements into consideration, the operating cost for smelting and refining is estimated at $132 per ton annual capacity; and the annualized capital charge is estimated at $245 per ton.

ZINC

1. Zinc is a metal which is largely located in developed countries, which accounts for 72 per cent of the world mine capacity. The most important mine producers among the developed countries are Canada, Sweden, Ireland, Spain and South Africa. The developing countries account for 28 per cent, and this share will actually decrease to 27 per cent by 1983 principally reflecting planned expansions in Canada, Ireland, South Africa and Spain. Among the developing countries, major producers are Peru, Mexico, Argentina, Bolivia, Brazil, Iran, Zaire, Zambia and South Africa; these nine countries accounted for 82 per cent of developing countries exports in 1976. As for processing, the developing countries at present account for 15 per cent of world slab zinc plants while the share of plant capacity in the developed countries will rise to nearly 20 per cent thus bringing the processing situation closer to a balanced position from the point of view of developing countries. Among the developing countries, Peru and Mexico are by far the largest sources of mine production accounting for 8 per cent and 5 per cent, respectively. Peru has expansion projects for domestic processing underway and will be able to process half of its mine output by 1983. Mexico processes 66 per cent of its ore production, and its current expansion plans will further reduce its concentrate surplus export to about one-sixth of its total mine output or some 50,000 mtpy by 1983. Other developing countries such as Brazil, Zaire, Zambia, and Algeria have processing capacities equal to the recent levels of mine production. Bolivia, Iran and Thailand export concentrates, although processing plants are being contemplated. India and the Republic of Korea have smelting capacity greater than domestic mine capacity. As for the developed countries, the major mine producers are the United States, Canada, Japan, South Africa, Australia, and Ireland. Most of the processing capacity, however, is located - some 25 per cent of world plant capacity - in four European countries, i.e. Belgium, France, the Federal Republic of Germany and Italy. Japan has processing capacity well in excess of its potential mine output while mine and plant production in the United States are roughly in balance. Substantial increases are planned in plant capacity in Canada and Ireland which, at present, export most of their mine production in the form of concentrates. The

industrialized countries, however, will continue to import substantial amounts of concentrates from developing countries and from the Democratic Republic of Korea so as to be able to continue to operate their processing plants at reasonable capacity utilization rates. Since 1960, the total concentrate deficit for zinc plants in Japan, the United States and Western Europe filled by developing countries has increased from around 8,000 per annum to 2 million tons.

2. The factors responsible for the rather sluggish growth in zinc smelting capacity in ore-producing developing countries are: (a) tariff barriers in the major consuming countries, (b) well-entrenched long-term arrangements between smelters and mining companies, and (c) economies of scale in mining and consequent need for sizable capital investment.

3. Economies of scale are an important factor in zinc smelting. The optimum size for a zinc smelter is estimated at 50,000 tons per year while the total capacity investments reuqired for zinc smelting and processing is in the range of $2,860 for additional capacity in developing countries and $2,500 in industrialized countries per annual ton capacity. As for the operating costs, the figure is estimated roughly at $150 per annual ton capacity; thus the total processing cost is about $410 per ton for new zinc smelters in developing countries. There are two factors which would favour the establishment of zinc smelting capacity in mine-producing countries: (a) the saving in transport cost (the zinc content of concentrates averages about 45 to 55 per cent); in fact, transportation cost from major mining countries to major consuming countries is a fairly important element of C/F price of zinc in concentrates, there could be some asving in transport cost by increasing trade in metal at the expense of concentrates; (b) the high cost of pollution control in zinc smelting. As a result of sharply tightened pollution control standards in most of the industrialized countries the cost of zinc smelting in industrialized consuming countries has increased significantly. Since 1973, about two-thirds of zinc smelting capacity in the United States has been closed down mainly because of prohibitive costs of adequate pollution control required in old facilities. Also, no new zinc facilities are likely to be built in Japan. In fact, building of new smelters in Japan would be limited to replacement of old facilities. Consequently,

even if the developing countries insist on stringent pollution control standards, this factor is likely to affect favourably the establishment of smelting capacity in these countries.

3. The forecasts for zinc prices foresee a relatively strong market through the 1980s, and the World Bank long-range projections foresee real prices increasing by roughly 25 per cent between 1980 and 1985. At present, the severe depression in the industry has resulted in an over-supply situation with competitive pressures and weak demands leading to heavy discounting from list prices by most metal producers and sellers.

4. A very substantial proportion of the zinc industry is owned or controlled by integrated producer groups, with some 40 integrated firms accounting for 85 per cent of zinc mine production and for 95 per cent of zinc processing capacity. In Europe, five groups account for 80 per cent of reduction capacity, i.e. Société Générale de Belgique (with interest in Europe, Brazil and the United States), Rio Tinto Zinc, Metallgesellschaft, Preussaz and Imetal-Pennaroya. The total excess capacity of these five groups is approximately equivalent to half the total amount of zinc concentrate that is treated outside it country of origin.

TIN

1. Tin is a mineral with a low melting point. It is a metallic chemical element of extraordinary malleability and ductability at low temperatures, it is soft, light and resistent to corrosion, and has a capacity for use in alloys. Tin is mainly used in tinplate, tinning, alloys (white metal, bronze and gunmetal), wrought products, chemicals and others. It is produced in upwards of 30 countries, the bulk of them are developing countries, particularly Malaysia, Bolivia, Thailand, Indonesia and Nigeria. The developing countries account for 88 per cent of the mine capacity and 72 of smelting capacity, rising to 90 per cent and 76 per cent, respectively, in 1983. Malaysia, the world's largest producer, accounts for 36 per cent of mine capacity and 38 per cent of smelter capacity, and treats tin concentrates from other countries in Southeast Asia in its own plants. Bolivia, the next largest mine producer will be capable of producing locally all its mines production by the early 1980s. Most of the other developing countries have adequate smelting capacity to treat the bulk of their domestic mine output. The present production of tin ore is about 190,000 mtpy and is expected to rise to 257,000 mtpy by 1983, while the tin smelting capacity is about 184,100 mtpy and 278,000 mtpy resepctively.

2. Unlike the other non-ferrous metals, developing countries are close to self-sufficiency in tin production. This situation will be consolidated when Bolivia completes its current processing expansion plans thus removing Bolivian concentrates from the market leading to an excess processing capacity in the industrialized countries, especially the United Kingdom and the United States. There are new projects underway in Brazil, Indonesia and others for expanding the processing facilities, and Malaysia and Thailand are planning further expansions. As a matter of fact, developing countries possess processing capacity estimated at 92 per cent of its recoverable mine production, and this capacity is expected to rise to 94 per cent in 1983.

3. The minimum economic smelter plant for tin is established at 15,000 mtpy and the developing countries have managed to acquire owenrship of tin mining and production facilities in the form of state-owned enterprises. There are 43 primary tin smelters in the world, located in 24 countries; they range from a 150 to 60,000 tons annual capacity. Excluding the centrally

planned economies, the 13 largest smelters account for over 85 per cent of the total estimated capacity of over 300,000 tons of refined tin. Indonesia now has the capability to smelt 33,000 tons of tin. It nationalized the Billiton tin operations in 1957 and set up its first integrated state enterprise. Bolivia nationalized its tin industry as early as 1952, and Malaysia acquired control of the major British tin operations through a take-over on the English Stock Exchange. There are, however, still a number of multinational corporations operating at the processing and marketing stages of the industry such as the Patino Group (in Malaysia, Nigeria, Australia and Brazil), the Rio Tinto Ainc-Copper Pass (in the U.K.), and the Metallurgic Hoboken-Overpelt (in Belgium). There are also some joint ventures and mixed operations with significant host-government control in Thailand and Zaire.

4. Most production and marketing of tin is still in private hands, even if government intervention in production is considerable in Indonesia and Bolivia. Direct government role in marketing is only a relatively recent phenomenum. The two largest tin-mining companies of the world are the state mining companies, P.M. Timah in Indonesia, and Corporation Mineral de Bolivia (COMIBOL) in Bolivia. The London Tin Corp. Ltd., the largest privately funded tin mining group, has interests in Malaysia, Nigeria and Thailand. In 1976/1977 a general organization of the management of the Malaysian tin industry took place, which resulted in the setting up of the Malaysian Mining Corporation, comprising under its management 13 major tin mining companies, and accounting for 27 per cent of total Malaysian production. In Indonesia, there are four companies engaged in tin mining, with a governmentçowned corporation P.T. Timah accounting for 90 per cent of current production. In Bolivia the industry is owned by three sectors: public sector accounting for 70 per cent of current production, a private sector (21 per cent), and small mines anc co-operatives (9 per cent). World tin production has fluctuated widely. In 1961 a large surplus situation materialized, forcing tin producers to cut back mine production sharply. As a result, mine production lagged behind current consumption when the USSR stopped its sales of tin in the early 1960s. The US alleviated the ensuing shortage of tin through sales from its stockpile. It was not until the 1960s that the balance between production and consumption was restored.

Table II-4: PRIMARY TIN METAL, PRODUCTION AND SMELTER CAPACITY, 1977

Country	Production of Primary tin Metal, 1977	Annual Primary Tin Smelter Capacity 1/
	('000 tons)	
AFRICA		
Nigeria	3.3	13.5
Rwanda	-	2.5 2/
South Africa	1.5	5.5 3/
Zaire	0.7	7.0
Zimbabwe-Rhodesia	0.9	1.2
AMERICA		
Argentina	0.1	2.0
Bolivia	13.0	21.5
Brazil	7.4	17.4
Mexico	1.0	5.0
USA	6.7	8.0
ASIA		
China, P.R.	23.0 e/	40.0
Indonesia	24.0	33.0
Japan	1.3	1.8
Korea, Rep. of	0.5	0.6 3/
Malaysia	68.3	130.0
Singapore	-	5.0
Thailand	23.1	25.0
EUROPE		
Belgium	3.5	8.0
German Democratic Republic	1.1 e/	1.5 3/
Germany, Federal Republic	2.9	3.6
Netherlands	2.1	2.5
Portugal	0.6	0.8
Spain	5.3	9.7 3/
United Kingdom	10.1	26.0
U.S.S.R.	25.0 e/	40.0
Australia	5.6	6.5
TOTAL	229.0	417.6

1/ Theoretical capacity for production of primary tin metal; smelter capacity is frequently expressed as maximum tonnage of concentrates treatable per annum - the metal capacity is then calculated based on the rated capacity of concentrates of average grade treated by that smelter.

2/ Under construction.

3/ Under expansion.

e/ Estimated.

Source: International Tin Council, Monthly Statistical Bulletin, December 1980

From then on, total production has grown at a very modest rate. The failure of the mine production to adjust quickly to changes in market demand was the main determinant of the relatively large price fluctuations experienced by tin. Consequently, in an attempt to dampen these fluctuations and to ensure a smoother demand - supply adjustment, tin producers and consumers entered into various market price stabilization agreements in the 1950s and since.

5. The first five-year International Tin Agreement (ITA) became operational in 1956, the fifth Agreement came into force for five years in July 1976, expired in June 1981 and was extended for one year pending the conclusions of the negotiations for a sixth Agreement - which is still pending the resolution of differences between the United States and the producers. The main objectives of all agreements were stabilization of prices, fostering the growth of the tin industry, further expansion in the use of tin, expansion of indigenous processing of tin and the development of the tin market in the developing countries. The agreements were adminsitered by an International Tin Council (ITC) which also managed the buffer stock set up to stabilize market prices within a predetermined but flexible band. When funds for protecting the floor price are deemed insufficient, the Council has the authority to introduce export controls to restric supplies. The Council also determines the quantities of tin that may be exported from producing countries during an export control period. The Council comprises six producing countries and sixteen consuming countries.

6. The processing smelting capacity gap in tin is due to be substantially narrowed by 1983 when the smelting capacity in the developing countries will rise from 44 per cent to 84 per cent. Actual consumption is expected to increase by 1 1/2 per annum in the period to 1983 according to World Bank estimates, and the price will increase by 1 per cent per year in real terms, over the same period based on the levels of 1967-1977. The International Tin Agreements have succeeded in maintaining a floor price for tin for more than 20 years. This indicates an element of stability in production and processing (also in prices and markets) which may help to some extent to balance the high cost of investment requirements ($ 3,000 per ton annual capacity for capital cost), and of operational costs ($1,710 per ton annual capacity for annual capital and operating costs). The investment requirements estimated to close the current tin processing gap in developing

countries is estimated at $100 million leading to the creation of 1,000 new jobs and a pctential annual export value of $30 million. Estimates of tin world reserves have avried with time and are generally valid for the economic conditions of cost and price at the precise time the ore reserve calculations are made. Malaysia, Thailand and Indonesia account for 41 per cent, Bolivia 10 per cant, Australia 3 per cent, China and USSSR for 27 per cent of total world tin reserves. On-shore reserves of high-grade ore in the traditional tin mining areas of Southeast Asia are declining rapidly, and the prospects of locating new deposits appear to be slim. High tin prices have stimulated intensive search for off-shore deposits of Thailand, Malaysia and Indonesia. A major step forward in international co-operation in this field has been the setting up of the South-East Asian Research and Development Center in Malaysia, partly financed by the UNDP and partly by the Governments of Indonesia, Malaysia and Thailand. The Center will assess regional tin potential and help in both carrying out exploration and promoting industries using tin.

COPPER

1. Copper is an ore with high conductivity, good tensile strength and ductility, is resistant to corrosion, easy to join by soldering and brazing, and gives rise to a range of useful alloys widely employed in wrought and cast forms. Copper is largely used in the production of a) wire, b) rods, bars and sections, c) sheet, strip and plate, and d)tubes. Copper is in demand by the engineering, construction and electrical industries, as well as in railway, automotive, and ship-building products. It is also in need by the ammunition and precision instrunments industries. The fabricators of copper semis products are comparatively small independent companies and are geographically widely dispersed. The larger companies engaged in the mining, smelting and refining of copper, in their effort to improve efficiency and effect a degree of rationalization, projected their processes vertically to the fabrication state. Such was the case in the U.S., the U.K., France and the F.R.G. This was certainly the case with extruded brass rods and copper tubes, but the multiplicity of size combinations and alloy compositions is a handicap towards rationalization and mass production.

2. Developing countries account for 53.5 percent of world copper mine capacity (excluding the centrally planned economies), 39 percent of smelter capacity and 27 percent of refining capacity. These figures are expected to increase by 1983 to 58.8 percent for mine production, 43.9 percent for smelters and 30.7 percent for refineries. The world copper reserves (excluding centrally-planned economies) are estimated at 437 million metric tons of which the developing countries account for

67 per cent, while the reserves and the resources are together estimated at 1,437 million metric tons with the developing countries accounting for 55.8 per cent. The largest amount of proven reserves are in Chile (20 per cent of total world reserves), while Peru, Zambia, Zaire and the Philippines possess significant, proven reserves. The interesting point to note in this respect is that some industrialized countries possess important proven reserves. The United States, for instance, has proven reserves roughly equal to those of Chile while Canada's reserves are of the same order of magnitude as those of Peru and Zambia.

3. As for smelting and refining, the sahre of the developing countries in market smelter output appears to have remained fairly constant at least over the last fifteen years or so. As for the world production of refined copper, the share of developing countries rose from 19 per cent to 26 per cent between 1960 and 1979, while the share of industrialized countries declined from 65 per cent to 49 per cent. Chile and Zambia possess a substantially integrated industry with Zambia refining all its mine production. Chile smelts all its ore and refines 70 per cent of it locally. Peru and the Philippines are evolving plans for increasing their smelting and refining capacities, but financing appears to be still a limiting factor in view of the substantial amounts required for such ventures. The optimum size for a copper smelter is estimated at 100,000 mtpy and for a primary smelter at 60,000 mtpy. The capital cost for a ton annual capacity is $2,000 for copper smelting and $500 for copper refining, while the annual capital charge and operating cost per ton is $545 for smelting and $213 for refining. The investment requirements estimated to close the current processing gap are estimated at $1.7 billion and the potential export value generated therefrom is estimated at $550 million.

4. Some developed countries such as Japan and Belgium and the FRG still account for some 30 per cent of the world smelting and refining capacity while they practically have no mining output. Blister and copper concentrates for these developed countries come basically from Zaire and Papua New Guinea. Some developing countries like Brazil are net importers of copper concentrate because they possess smelting and refining capacity far in excess of their domestic market production. Other countries like Canada and the United States appear to be self-sufficient while Taiwan and the Republic of Korea,

Table 5: COPPER - MINE PRODUCTION, BY ECONOMIC REGIONS AND MAIN COUNTRIES

	Actual							Growth Rate	Shares			
	1960	1965	1970	1975	1977	1978	1979	1960-77	1960	1970	1979 (A)	1979 (B)
	('000 tons)											
Developing Countries	1,949	2,192	2,605	3,279	3,730	3,655	3,620	4.1	46.0	41.1	45.6	59.1
Latin American & Caribbean	784	840	974	1,100	1,495	1,498	1,576	3.1	18.5	15.4	19.8	25.7
Chili	532	585	686	828	1,056	1,036	1,061	3.5	12.6	10.8	13.4	17.3
Mexico	60	55	61	78	90	87	110	3.6	1.4	1.0	1.4	1.8
Peru	182	177	206	181	341	366	397	2.0	4.3	3.2	5.0	6.5
Other	10	23	21	13	8	9	8	e -1.1	0.2	0.3	0.1	0.1
Africa	985	1,123	1,283	1,464	1,456	1,372	1,286	2.9	23.2	20.2	16.2	21.0
Zaire	302	289	387	495	482	424	400	3.9	7.1	6.1	5.0	6.5
Zambia	576	696	684	677	656	643	588	1.2	13.6	10.8	7.4	9.6
South Africa	48	61	144	179	205	209	203	9.9	1.1	2.3	2.6	3.3
Other	59	77	68	113	113	96	95	e 3.9	1.4	1.1	1.2	1.6
Asia and Africa	60	76	174	499	576	585	587	13.2	1.4	2.7	7.4	9.6
Indonesia	0	0	0	64	57	58	56	n.a.	-	-	0.7	0.9
Iran	0	0	0	4	6	6	3	n.a.	-	-	-	-
Philippines	44	63	160	226	273	263	297	12.4	1.0	2.5	3.7	4.8
Papua New Guinea	0	0	0	173	182	199	171	n.a.	-	-	2.2	2.8
Other	15	13	14	32	58	59	60	e 8.3	0.4	0.2	0.8	1.0
Southern Europe	121	154	174	217	203	200	171	2.2	2.9	2.7	2.2	2.8
Industrialized Countries	1,652	1,949	2,536	2,443	2,555	2,441	2,504	3.2	39.0	40.0	31.5	40.9
Western Europe	73	64	88	123	128	130	122	4.5	1.7	1.4	1.5	2.0
United States	980	1,226	1,560	1,282	1,364	1,358	1,444	2.3	23.1	24.6	18.2	23.6
Canada	399	461	610	734	759	659	644	4.8	9.4	9.6	8.1	10.5
Australia	111	92	158	219	222	222	235	6.1	2.6	2.5	3.0	3.8
Japan	89	107	120	85	81	72	59	-1.0	2.1	1.9	0.7	1.0
Market Economies	3,601	4,141	5,140	5,722	6,285	6,096	6,124	3.7	85.0	81.0	77.1	100.0
Centrally Planned Economies	637	924	1,205	1,626	1,696	1,778	1,818	6.2	15.0	19.0	22.9	
WORLD TOTAL	4,238	5,065	6,345	7,348	7,981	7,874	7,942	4.1	100.0	100.0	100.0	

/a All growth rates in this column are based on least-squares trend-fitting, except for those marked 'e', which are based on end-points.

Source: World Bureau of Metal Statistics.

though not mine producers, will have significant smelting and refining capacity by 1983 and are already competing for copper concentrate feed. On the whole, it can be stated that there is a substantial excess of smelter and refinery capacity over mine capacity which, in effect, gives the primary producer more freedom in selling their produce.

5. The copper industry is dominated by a combination of TNCs such as Anacondo, Rio Tinto Zinc, Mitsubishi, Kennecott, Phelps, Dodge and others as well as by large state enterprises such as NCCM-RCM in Zambia, Codelco and Enami in Chile, Centromin and Mineroperu in Peru and Gecamines in Zaire. The large U.S. firms, Kennecott, Phelps, Anacondo and Dodge, have now limited interests in the developing countries. In fact, the TNCs are important agents in the copper market. In mining, the top 13 firms control 73 per cent of capacity; in smelting, the top 15 control 73 per cent of capacity; and in primary refining, the top 14 control 63 per cent of capacity. However, some of those concerns are government enterprises such as Cadelco in Chile, and Centromin in Peru. In fact, three of the eight largest copper corporations are government-owned; they controlled about 30 per cent of world output in the early seventies but eventually reduced the share of the TNCs to about 54 per cent by 1966 and it further decreased to 23 per cent by 1978. The following factors were considered responsible for the erosion of the industry concentration:

(a) A series of discoveries of new sources of copper;

(b) The diffusion of the large-scale technology required to work large low-grade ore-bodies;

(c) The availability of financing from the smelters, refiners and fabricators which desired to secure raw material supplies;

(d) The growing desires of natural reosurce companies involved in other minerals to deversify into copper mining;

(e) The emergence and growth of state-owned enterprises in several major copper-producing developing countries.

Still concentration at the smelting and refining stages of the copper industry is high; at least it is greater than at the mining stage. Twelve large companies together accounted for 51 per cent and 40 per cent of market economies smelting and refining capacities, respectively. Taking into account the interlocking owenrship relationships among the companies, it is fair to say that there is a significant degree of concentration in the copper refining and smelting sectors. However, the degree of ownership

Table III.1: COPPER PRODUCTION OF LEADING COMPANIES

(thousand short tons)

	1948	1960	1966	1978
Kennecott	514	571	699	376
Anaconda	362	476	597	193
Phelps Dodge	247	234	284	346
Roan-AMC Group	134	241	368	-
Anglo-American Group	118	392	426	168
Union Minière	171	331	399	-
International Nickel	118	155	110	166
Total "The Seven"	1664	2400	2883	1730*
Percentage of World Production	70%	60%	54%	23%

*For 1978 the Roan-AMC Group and Union Minière have been replaced by Newmont (329,000 tons) and Asarco (359,000 tons).

Source: Moran, Theodore H. and D.H. Maddox, Structure and Strategy in the International Copper Industry (prepared for UNCTC, mimeographed preliminary draft, 1980), p. 74.

Table III.3: CONCENTRATION IN SMELTER AND REFINERY CAPACITY 1979

(Thousand metric tons, beginning of year)

		Smelter	Capacity (%)	Refinery	Capacity (%)
1.	Codelco	765	8.7	486	5.3
2.	Gecamines	536	6.1	230	2.5
3.	Zimco	444	5.0	380	4.2
4.	Kennecott	463	5.3	525	5.8
5.	Asarco	628	7.2	606	6.6
6.	Phelps Dodge	521	5.9	404	4.4
7.	Newmont	245	2.8	217	2.4
8.	Anaconda /a	258	2.9	261	2.9
9.	Anglo-American	155	1.8	115	1.3
10.	Inco	170	1.9	182	2.0
11.	RTB Bor	190	2.2	190	2.1
12.	RTZ	75	0.9	75	0.8
	Subtotal	4,450	50.7	3,671	40.2
	Others	4,321	49.3	5,453	59.8
	Total Industry (market economies)	8,771	100.0	9,124	100.0

/a In 1980, Anaconda decided to close its smelter.

Source: Copper Studies, Commodities Research Unit International Metals Databank, December 15, 1978.

Note: There are crossholdings between Anglo-American and RTZ.

Reproduced from: Moran, T.H., and D.H. Maddox, Structure and Strategy in the International Copper Industry (mimeographed preliminary draft prepared for UNCTC, 1980), p. 79.

concentration is lower at the semi-fabricating stage than at the copper ore production or refining stage. The 22 largest copper semi-fabricating firms in market economies accounted for half of total capacity by the mid-1970s.

6. The question of industry concentration takes on a far more serious complexion when vertical integration through the stages of mining, smelting, refining and semi-fabricating is considered. Many of the large companies owning refineries have their own mines and smelting facilities and some of them own semi-fabricating facilities as well. Consequently, independent smaller producers at each stage of copper production tend to depend on the large integrated producers for either supplies of raw materials or marketing outlets, or both. Thus the "presence of vertical concentration in the copper industry does militate against effective competition".

7. According to World Bank estimates, prices are expected to rise substantially in real terms until 1982 to justify the construction of new capacity after the slow-down of investments since the mid-seventies. Thereafter, they will increase by one per cent in real terms. Prices are an important element in justifying the increase in production capacity and the construction of integrated copper projects. Recent estimates of capital costs range between $6,000 and $8,000 per annual ton capacity, of which only one third is for smelter-refinery components. In some recent constructions, the figures range between $11,000 and $14,000 per annual ton. This is due to the size of the projects deemed essential to produce economic scale and the cost of the necessary infrastructure requirements.

ECONOMIC AND POLITICAL ASPECTS OF REDEPLOYMENT OF PROCESSING CAPACITY

1. The economic determinants of the processing of natural resources in developing countries are basically input availability and, in sufficient quantities, conditions of processing and characteristics of output.

2. The input availability, its quantities, the availability of other complementary inputs and whether they can be imported at advantageous prices are measured by what is known as comparative advantage criteria. Since these criterion are usually discussed in terms of the relative intensities of two factors of production, labour and capital, it is interesting to note that in the case of non-ferrous metals, data on labour coefficients have shown that they rank amongst the least labour intensive industries. Studies have shown that labour as a share of total cost is, by far, the smallest of the cost components. This may reflect relatively low labour costs per unit of sufficient output to influence comparative advantage. Since the developing countries, on the whole, still lack technical and managerial skills, the cost of these two elements of labour costs is likely to account for a higher share, especially since skilled manpower is largely drawn from expatriates. Capital costs still account for a major part of the total costs in most industries thus making it imperative in developing countries to seek cheaper sources of finance for the future expansion of their processing industries in order to make savings on capital charges. Capital charges per annual ton capacity as compared to operating charges in aluminium processing is $440 to $518; in copper smelting is $325 to $220; in lead smelting

and refining is $113 to $132; in tin smelting is $1300 to $410; in zinc smelting is $260 to $150. Therefore, the need to ensure a steady return from the very substantial sums committed to processing plants has been the dominant factor behind the vertical integration that now characterizes several processing industries. The processing of mineral ores requires raw material inputs as well as the presence of certain infrastructural facilites. If the processing requires other inputs, then the relative importance of the various inputs must be appraised to establish whether they represent a major share of the inputs to later phases of processing or whether they are costly to transport. In the case of infrastructural requirements, they could be decisive in deciding the location of the various processing stages as, for instance, in the case of aluminium smelting where considerable amounts of electricity are required; and aluminium has to be moved to smelters situated near suitable sources of power. Processing bauxite into alumina, on the other hand, requires less energy and the problem of transportation in this case does not arise.

2. The conditions of processing are determined by the technologies used inthe processing of the raw material such as the extent to which economies of scale may impede or encourage the siting of the processing capacity in the developing countries concerned, or the range of technologies choice in the industry and whether they may prove more advantageous in the developing countries. All natural resource-based industries exhibit economies of scale; consequently, most developing countries may face difficulties in this respect arising from the limitation of the

domestic markets for the processed product and the need to export the product of the excess capacity to markets which may be hedged by trade barriers or high transport costs or are dominated by marketing schemes of the existing dominant corporations. The need to import one or more complementary inputs to service the raw material in question may also present the developing countries with a difficulty which may prove insurmountable and may result, therefore, in the installing of the appropriate technology, but to operate it at less than the minimum efficient scale of output. In many industries of scale, by-products may be created when the raw material is under manipulation e.g. a zinc or copper smelter creates sulphuric acid, a product which is both difficult and expensive to transport and requires, in effect, proximity to markets which in their turn may not be accessible to the by-product. These markets are generally located in the developed countries and may tend to pull the whole processing operation towards established locations in their territories. The provision of complementary inputs has had an important influence on the location of the respective processing operations. However, studies have tentatively established that linkage effects initiated by certain processing plants have given a high rank to basic metals in the developing countries. Moreover, the growing stringent laws and regulations generated by environmental pressures have tended to favour sitings in developing countries. Certain interested parties in the developed countries often converge although other factors may weight in the final decision to locate the processing operations in question. Changes in mineral processing technology may

affect the location of plants in the future. The most obvious technological improvement in this respect has been the continuous casting in the metal industries taking the molten metal from the final reduction phase of processing and casting it directly into shapes for final use or for subsequent manufacture. In the case of copper, this new technology results in better quality wire bars. It has, therefore, been predicted that continuous casting will take up 70 to 80 percent of the new mill capacity. The location in this respect does not have to be entirely in the developing countries concerned since some of them i.e. Chile and Zambia, have bought into processing plants in Europe. Such acquisitions were motived by three factors: closeness to markets for end products, reduction in transport costs, and the fact that technology can be more easily bought and adapted. In the case of aluminium, continuous casting has made it possible to recover aluminium from the abundant clays found in the developed countries to eliminate the alumina processing phase and, therefore, make it less costly to reduce the ore into metal, and to resort increasingly to the recycling of aluminium. On the whole, the discovery of new techniques raises the possibility that new processing capacity could be deployed in the developing countries provided that the integrated companies and the TNC's, having the interest and capability in developing technologies that are necessary, can overcome some of the inhibitions they amy have acquired from their unfamiliarity with the social and economic environment of developing countries.

3. The characteristics of output relate to difficulties

that may be encountered in supplying the end-products to the customers, involving the difficulties of marketing and distribution in commodity processing markets often characterized by integrated conditions, or the costs and problems of transportation, or the tariff and non-tariff barriers levied on processed or semi-processed items as they move to markets of developed countries. The processing of ores does not yield comparable gains in value-to-weight ratios. Moreover, in the case of powder ores, handling by automatic devices has proven more practical than in the case of ingots; and consequently, shipping conferences have tended to charge higher rates proportionally for processed goods rather than for unprocessed goods. This, in effect, tended to protect processing industries in the importing countries. In the case of tariff, the rounds of negotiations under GATT and the Kennedy Round did nothing to assist exporters based in developing countries; Unprocessed raw materials often get duty-free or nearly duty-free entry into developed country markets while significantly higher tariffs confront those same materials once they have been transformed into semi-processed goods. Non-tariff barriers in the various Generalized System of Preferences, country schemes, ceilings, tariff-quotas, maximum country amounts, and rules of origin and other measures have acted together to make a formidable barrier to the selling by developing countries of more processed items on developed country markets. On the other hand, many of the markets for mined, semi-processed and processed raw materials are dominated by TNC's. These multinationals are well-established in most of the minerals; and they are also important in exporting unprocessed raw materials to developed

country trading partners or subsidiaries. It may, however, be difficult to generalize in this respect as the degree of TNC involvement at various stages of processing may vary from one mineral to another. The degree of integration from mining through refining may indicate the extent to which trade is undertaken within the firms. Hence, the decisive importance of ownership ties in determining the pattern of trade in a given commodity. Ownership is, however, more dispersed at the latest stage of semi-fabrication and fabrication. The value added at the fabrication stage is fairly small. Eighty to 90 percent of the value of fabricated products is represented by the refined mineral itself. This is especially so in the case of copper whose growing scarcity has encouraged the substitution of aluminium in many electrical uses, the entry of the TNC's into the aluminium industry and a shift in processing technology. Integrated companies have shown a strong preference to build smelters and refineries in their home countries in order to ensure supplies of their raw materials and also in view of the heavy capital investments needed for processing plants especially in the cases of copper and aluminium. This trend is strongest in Western Europe, although in other respects, the desire of the governments of the developed countries concerned with securing raw material supplies has tended to reverse the trend. However, the importance of the TNC's in the marketing of the processed products has tended to encourage many developing countries in involving them in their processing activities in order to secure the necessary finances for the new plants, and in

order to reduce the market risk involved in the setting-up of new plants by obliging them to purchase a proportion of the output of the plant it is involved in setting up. As most TNC's possess their wholesale or retail outlets, their involvement in marketing the processed products can help the producing developing countries mitigate the difficulties encountered in trying to break into new markets. In fact, the relationship between the developing countries and TNC's has undergone a marked change in the past two decades due to the fact that the developing countries have reached political independence during this period which, in turn, gave rise to their awareness of the possibilities of developing their countries through their own resources, and the possibilities of doing so with the improvements they achieved in their economic and political infrastructures. Moreover, as the cost of expanding or setting up new processing facilities increased, the TNC's were no longer the sole suppliers of equity or risk capital. In fact, they tended to resort increasingly to loan capital. However, since new sources of finance became available in the form of international and indigenous capital markets as well as international and regional finance agencies and sources which, in effect, have improved the bargaining power of the developing countries in their dealings with the TNC's and enabled them to increase their participation in the extraction and processing stages. The TNC's are, however, still important in respect of supplying the developing countries with know-how market. The TNC's market and product outlets still has an obvious complementary interest in the producing developing countries; and so long as the latter

continue to be largely dependent on the integrated corporations to reach markets abroad, the TNC's -- at least with respect to some minerals which require economies of scale-- will continue to exert a significant commercial control of the raw and processed mineral activities in the developing countries concerned. On the whole, it can be stated that the reluctance of the TNC's to extend their processing operations to the ore producing developing countries stems from the vertically integrated structure of the mineral industry which enables them to take advantage of the economics of scale available in raw materials processing in developed countries of a relatively well-developed infrastructure, and the ability to secure raw materials including complementary inputs from different sources. Their reluctance also stems from their aversion to risk--real or imaginery--which may arise from political conflict with the host developing countries in their pursuit of their social and political objectives. An increasing resort to a policy of inducement by ore-producing developing countries in the past few years, apart from outright nationalization and expropriation, has had a significant impact in increasing the extent of processing activities in the developing countries. These inducements took the shape of equity and contractual arrangements, and the policy instruments used were of legislative as well as of a contractual and administrative nature. The primary legislative instrument used by developing countries to promote local processing is the taxation of the mining industry in the form of special allowance, tax rate reductions, extended loss carry-forward,accelerated depreciation and other methods. The contractual instruments arrangement, as compared

to the general legislation referred to, has the advantage that the individual investment project in question may be shaped in a specific ways so as to develop the project's potential for maximum downstream integration. The agreements contain obligations to process minerals, to renegotiate in the light of the performance of the investing corporations, and to grant financial incentives conditional upon the establishment of the processing capacities desired. Examples of increased processing capacities in developing countries as a result of these measures abound; however, some basic problems still remain largely because of the information gaps which still hinder the assessment of the economic feasibility of many projects. In fact, an energetic policy of downstream integration requires precise information about the cost and benefits of such integration for the host country, the technical and economic elements influencing feasibility, and the potential and willingness of various TNC's to engage in such downstream investments. Generally speaking, it can be assumed that the trend now is for integrated corporations to seek establishing co-operative ventures with developing countries. Partnerships and long-term purchasing contracts with developing country, state or private firms enable corporations to channel mineral output into their own market networks. With the cost advantages in favour of increased processing operations in developing countries, such operations would enable national companies or joint ventures to participate with increasing effectiveness in competition with TNC's.

The trend towards greater processing of downstream activities appears

to be inevitable for the following factors:

-Developing countries are concerned with establishing sovereignty over their mineral resources

-Developing countries are pursuing policies for increasing the degree of local processing

-Technology and capital are increasingly available outside TNC's

-Some cost advantages exist for processing in the developing countries

-Ore bodies of relatively high-grade in developing countries are relatively unexploited

The move by developing countries to secure more processing activities led to counter strategies by the TNC's based on differentiation of goods produced or stressing the later stages of the chain of production or the diversification among competitive and substitute metals (aluminium and copper, for instance) in what has become known as horizontal integration* or the diversification of the regional location of their sources of raw materials leaving those geographical regions where the risks of their activities are relatively high.

The policies of the developed countries have also their bearing on the efforts of the developing countries to expand their processing activities. Trade barriers in the form of tariffs and NTB's on processed minerals from developing countries, restrictive business practices by TNC's, and restrictions in the flow of technology and capital to the

*Atlantic Richfield Oil Company purchased Anaconda (the largest of the transnational copper groups, thus acquiring interest in copper, aluminium, uranium, and other activities carried out in Brazil, Jamaica, Mexico, Iran, Saudi Arabia, Australia, Canada and the Netherlands.

developing countries, have acted as a hindrance to the aspirations of the developing countries, and will have to be dealt with in the context of international co-operation on non-ferrous metals.

Aluminium prospects

1. Is a metal which acquired general commercial use during the last three decades. It has become in many respects a substitute for steel, copper, lead wood and plastics. The properties that enable aluminium and its alloys to displace traditional materials are: its low density, high electrical and thermal conductivity, resistance to corrosion, non-toxicity, malleability, reflectivity, high strength to weight ratio, and the abundant availability of its raw materials.

2. Aluminium consumption has gone primarily to the electrical, transport, packaging, mechanical and construction industries. Diversification in aluminium utilization is encouraged by the fact that the metal exhibits unusual combinations of characteristics for which there are many markets. Its use has spread to many other areas of consumption, such as, the manufacture of household goods, utensils, packages and decorative trim; the manufactures of radiators, engine blocks and trim for the automotive industry; and various other applications in the construction industry. In many of these new uses, aluminium has posed a serious challenge to cast iron, steel, and copper, but the principal impact has been on steel, because of weight consideration (in the auto industry), a general tendency to pre-fabrication (in construction and building), and a trend to higher transport costs (shipping and container uses).

3. Aluminium maintained a consumption growth rate of 8% from 1960 to 1977, and 5.8% from 1977 to 1979; the projection for the period 1980-1995 is estimated at about 3.9%, a growth rate still higher than that projected for other non-fuel minerals (doubles that for copper and more than doubles that of tin). The growth of aluminium consumption has been due to the substitution of aluminium for other materials in a wide range of end uses due to its favourable price levels as well as physical properties.

4. Most of the bauxite is used for the production of alumina. The remainder is used for the abrasive refractory, chemical and paper industries. Alumina, in its turn is used mainly to produce aluminium, while other uses cover the abrasive, glass, chemical, ceramic, and petroleum industries. As for aluminium, a quarter of its output is used in the transportation industries in the production of motors, vehicle parts, for electric end uses and in paints. Machinery and equipment account for 6% of the output; and electrical engineering and communications use another 10%. Building and construction account for another quarter of the aluminium produced. The packaging industry consumption of aluminium vary from 6.8% in Japan to 22% in the U.S. Consumer durables such as refrigerators, air conditioners, washing machines and other account for 7.5%.

Table I.2: CONSUMPTION OF ALUMINUM BY END USES, 1978

	W. Europe /1	Japan	U.S.	World Average
	(%)			
Transport	29.5	23.1	23.6	24.9
Mechanical Engineering	6.8	4.5	6.1	5.9
Electrical Engineering	9.7	10.5	10.2	10.1
Building and Construction	16.7	34.4	23.8	24.2
Packaging	10.4	6.8	22.0	16.2
Domestic and Office Appliances	9.3	6.2	7.2	7.5
Metal Industries and Miscellaneous	17.6	14.5	7.1	11.2
	100.0	100.0	100.0	100.0

/1 Germany, France, United Kingdom, Italy

Source: Computed from Metal Statistics, Metallgesellschaft, 66th Edition, 1979.

Table II.5: PRIMARY ALUMINUM - WORLD CONSUMPTION BY MAIN COUNTRIES AND ECONOMIC REGIONS

	Volume							Growth Rates		Share of World Total		
	1960	1965	1970	1975	1977	1978	1979	1960-77	1977-79	1960	1970	1979
	('000 tons)							(% per annum)		(%)		
Industrialized Countries	3,047	4,845	7,104	7,310	9,728	10,221	10,725	7.3	5.0	74.3	71.4	67.0
of which: United States	1,541	2,852	3,488	3,265	4,756	4,978	5,009	6.1	2.6	37.6	35.1	31.3
European Economic Community	1,065	1,264	2,008	2,039	2,598	2,654	2,888	6.2	5.4	26.0	20.2	18.0
Japan	151	298	911	1,171	1,422	1,656	1,802	16.3	12.6	3.7	9.2	11.2
Developing Countries	141	394	796	1,292	1,565	1,853	1,921	14.9	10.8	3.4	8.0	12.0
Africa, South of Sahara	11	20	60	95	78	81	80	15.4	1.3	0.3	0.6	0.5
of which: South Africa	11	20	49	68	53	51	55	12.3	1.9	0.3	0.5	0.3
North Africa & Middle East	0	11	18	70	99	136	121	/a	10.6	0	0.2	0.8
Asia & Pacific	25	103	246	283	394	553	561	15.0	19.3	0.6	2.5	3.5
Latin America & Caribbean	44	117	186	382	407	480	563	14.0	17.6	1.1	1.9	3.5
Southern Europe	61	143	286	462	587	552	541	15.0	-4.0	1.4	2.9	3.4
Centrally Planned Economies	912	1,392	2,046	2,686	2,984	3,312	3,371	7.4	6.3	22.2	20.6	21.0
WORLD TOTAL	4,100	6,631	9,946	11,288	14,277	15,386	16,017	7.9	5.9	100.0	100.0	100.0
MARKET ECONOMIES	3,188	5,239	7,900	8,602	11,293	12,074	12,646	8.0	5.8	77.8	79.4	79.0

/a Incomputable.

Source: Metallgesellschaft, Metal Statistics and World Bureau of Mines, World Metal Statistics (actual).

5. World exports of bauxite have grown at 5.3% per annum between 1960 and 1977, lower than that of bauxite production (7.7% annually) reflecting more processing in bauxite producing countries. The market economy industrialized countries accounted for 83% of world bauxite imports in 1978, and the centrally planned economies for 10.2%. Meanwhile, the industrialized countries are becoming net importers of primary aluminium (the U.S. importing 7% of its consumption, Japan 41% and the EEC 24%). These ratios are expected to increase because of the lack of cheap electrical energy for new aluminium projects, and the setting up of new plants in the Middle East (Bahrein and Egypt), the Caribbean and Latin America.

6. Bauxite and aluminium producers are actively involved in several international organizations at both government and non-government levels. Eleven bauxite producing countries are members of the International Bauxite Association (IBA), established in 1974, in Kingston Jamaica, and now accounts for 74% of world production of bauxite and 90% of world trade. The IBA holds meetings regularly to discuss issues on bauxite pricing and control of production facilities. Most of the aluminium producting companies are members of the International Primary Aluminium Institute (IPAI) which aims at the promotion of understanding the aluminium industry. The OECD has an ad hoc committee on aluminium which studies the industry prospects.

7. The shipping of aluminium raw materials is an important issue which affects considerably bauxite and alumina prices. Ocean freight, as well as shipping and cargo handling charges account for as much as 50% of the delivered cost of bauxite. The level of freight charges depends on shipment distance, the size of the shipment and the type of transport arrangements. The size of the ship, for instance, exerts considerable influence on shipping costs. Bulk materials, however such as bauxite and alumina can be handled more cheaply per ton than aluminium and its fabricated products - the higher costs reflecting the greater diversity of destinations of the metal as compared with the raw materials. Steamship rates for ingot, therefore, tend to the 2-5 times the rate for bauxite/alumina.

Table II.4: PRIMARY ALUMINUM - WORLD PRODUCTION BY MAIN COUNTRIES AND ECONOMIC REGIONS

	Volume							Growth Rates 1960-77/1977-79		Share of World Output		
	1960	1965	1970	1975	1977	1978	1979			1960	1970	1979
	(million tons)							(% per annum)		(%)		
Industrialized Countries	3,475	4,818	7,263	8,441	9,626	9,869	9,878	6.2	1.3	76.7	70.5	64.9
of which:												
United States	1,828	2,499	3,607	3,519	4,118	4,358	4,557	4.9	5.2	40.4	35.0	29.9
European Economic Community	517	735	952	1,816	1,987	2,007	2,021	8.2	0.9	11.4	9.2	13.3
Japan	133	292	728	1,013	1,188	1,058	1,010	13.7	-8.8	2.9	7.1	6.6
Canada	691	753	962	878	973	1,048	864	2.0	-6.7	15.2	9.3	5.7
Norway	171	276	522	595	637	657	674	8.0	2.9	3.8	5.1	4.4
Developing Countries	143	273	792	1,453	1,687	1,729	2,092	15.6	11.4	3.2	7.7	13.7
Africa, South of Sahara	44	51	165	271	278	236	300	11.4	3.9	1.0	1.6	2.0
of which:												
Ghana	0	0	113	143	154	114	169	/a	4.8	0	1.1	1.1
South Africa	0	0	0	76	78	81	86	/a	5.0	0	0	0.5
North Africa & Middle East	0	0	0	164	233	249	238	/a	1.1	0	0	1.6
Asia & Pacific	27	83	205	213	231	273	286	13.4	11.3	0.6	2.0	1.9
of which India	18	64	161	167	184	205	212	14.6	7.3	0.4	1.6	1.4
Latin America & Caribbean	18	53	167	275	360	407	667	19.3	36.1	0.4	1.6	4.4
of which:												
Brazil	18	30	56	121	168	186	238	14.0	19.0	0.4	0.5	1.6
Venezuela	0	0	22	50	43	71	207	/a	119.4	0	0.2	1.4
Southern Europe	54	91	255	530	586	564	601	15.0	1.3	1.2	2.5	3.9
Centrally Planned Economies	911	1,491	2,246	2,941	3,046	3,156	3,247	7.4	3.2	20.1	21.8	21.3
WORLD TOTAL	4,529	6,587	10,301	12,835	14,360	14,754	15,217	7.0	2.9	100.0	100.0	100.0
MARKET ECONOMIES	3,618	5,096	8,055	9,894	11,314	11,598	11,970	6.9	2.8	79.9	78.2	78.7

/a Incomputable.

Source: Metallgesellschaft, Metal Statistics and World Bureau of Mines, World Metal Statistics (actual); World Bank, Economic Analysis and Projections Department

Smelting and Refining

1. In industrial operations the underlying technology produces patterns of freedoms and constraints. As technology is extended and developed, vertical integration and economies of scale are applied. At the same time, management and process decisions become increasingly related to economic factors that reflect geographic dependencies. In an expanding and interrelated world system, technologies tend to change, and in so doing prepare the way for potentially fundamental alterations of established locational patterns. Such a situation is pertinent to the aluminium industry both globally and in the developing countries.

2. The processing of bauxite into aluminium undergoes two processes: alumina extraction or the reduction of the bauxite into aluminium oxide, and the smelting of the alumina to produce aluminium The Boyer process applied for extracting alumina, requires very large amounts of fresh water, a factor which poses a serious problem for countries suffering from persistent or fresh water shortages e.g. like in some Caribbean Islands. The impact on overall extraction efficiency, on the other hand, is accounted for by differences in the quality of the ore employed, and the recovery rate achieved, depending on the input requirements, eventually permits less mining practice. Capital costs of alumina plants vary widely depending on the nature of the bauxite ore to be treated, the availability of the essential infrastructure, and the scale of the plant. Economies of scale, however, appear to fix plant-capacities at 300,000 tons annually, although in some remote locations plants of 1.2 million tons capacity have been built. Transport costs are an important factor, especially when we recall, that it takes two tons of bauxite to produce one ton of alumina. The different ore qualities such as bauxite type, alumina content, and influence the processing conditions and production costs.

3. Almost all of world's primary aluminium production is carried out by electrolytic reduction. The importance, therefore of power costs is such, that aluminium reduction has historically tended to locationally towards cheap sources of electric power, initially hydroelectric power. Investment costs for electrolytic reduction plants vary depending on, whether the plant includes power generating facilities, town sites, and other infrastructure. These costs decline significantly for projects of larger size, where significant scale economies are possible. The heavy cost of capital costs at the smelting end of the aluminium industry has exercised a powerful pressure towards vertical integration which characterizes the international sector.

Trade policy, has also played an impcrtant role in determining the locational economies of the primary aluminium industry. As for semis fabrication, the installation required are not prohibitive except for the largest projects utilizing continous facilities; that is whay, there are now, many semi-fabricating plants in many developing countries. Although semi-fabrication, on the whole, is highly market oriented locationally, because aluminium shapes and forms are subject to damage in transit, still the feasibility of establishing new capacity depends to a large extent on the trade policies devised to stimulate domestic investment in final finishing capacity. The existence of excess capacity in most product lines maintained by major aluminium companies, may on the other hand, act as a constraint on capacity expansion in the developing countries. Secondary aluminium recovery scrap is an important factor to be taken into consideration as to the future consumption of aluminium in the markets of the industrialized countries, especially the United States and Western Europe.

4. There is no large and reliable open market for alumina, consequently alumina plants are either controlled directly by fully-integrated firms, or jointly financed by two or more such firms with established agreements covering the division of capacity. Therefore, bauxite-mining countries, can achieve the alumina stage of production through their ability to negotiate mutually satisfactory relationships with an integrated aluminium producers. Ability to raise the finance for an optimum scale alumina plant, the prevalence of political stability, and the rising ocean transport cost, are generating enough incentives for location in developing countries with large bauxite reserves. As for integration through alumina smelting to produce primary aluminium, the basic problem involves capital cost and access to reliable markets. In this respect, the heavy capital outlay necessary to set up the integrated smelting facility, could be spread over a period of several years, by phasing the smelting capacity into the project over a period of time, thus permitting a closer correspondence between initial primary metal capacity and the size of the domestic and regional market: In other words, output at the outset should be proportional to the domestic market plus what regional markets may be available. Developing countries with small domestic markets but sizeable bauxite reserves, should therefore, proceed cautiously into primary metal production.

Table II.3: ALUMINA - WORLD PRODUCTION BY MAIN COUNTRIES AND ECONOMIC REGIONS

	Volume						Growth Rates		Share of World Total		
	1966	1970	1975	1977	1978	1979	1966-77	1977-79	1966	1970	1979
	('000 tons)						(% per annum)		(%)		
Industrialized Countries	9,054	12,774	16,077	19,219	19,246	20,231	7.1	2.6	61.2	60.3	62.6
of which:											
United States	5,338	6,051	5,135	6,033	5,960	6,450	1.1	3.4	36.0	28.5	20.0
European Economic Community	1,717	2,074	3,114	3,421	3,689	3,720	6.5	4.3	11.6	9.8	11.5
Japan	662	1,285	1,565	2,045	1,767	1,822	10.8	-5.7	4.5	6.1	5.6
Australia	307	2,152	5,129	6,659	6,776	7,415	32.3	5.5	2.1	10.2	23.0
Developing Countries	2,479	4,609	5,831	6,031	6,219	6,624	8.4	4.8	16.7	21.7	20.5
Africa, South of Sahara	525	610	639	562	622	662	0.6	8.5	3.5	2.9	2.0
of which: Guinea	525	610	639	562	622	662	0.6	8.5	3.5	2.9	2.0
North Africa & Middle East	0	0	0	0	0	0	/a	/a	0	0	0
Asia and Pacific	205	369	383	438	531	551	7.1	12.2	1.3	1.7	1.7
Latin American & Caribbean	1,581	3,191	3,969	3,888	4,017	4,002	8.5	1.5	10.7	15.1	12.4
of which:											
Jamaica	804	1,719	2,259	2,047	2,141	2,074	8.9	0.6	5.4	8.1	6.4
Suriname	407	1,036	1,148	1,215	1,261	1,199	10.4	0.0	2.7	4.9	3.7
Guyana	302	317	294	277	250	280	-1.0	0.0	2.0	1.5	0.9
Brazil	68	119	268	349	365	449	16.0	13.4	0.5	0.6	1.4
Southern Europe	168	438	840	1,143	1,049	1,409	19.0	11.0	1.1	2.1	4.4
Centrally Planned Economies	3,275	3,816	4,772	5,262	5,362	5,444	4.4	1.7	22.1	18.0	16.9
WORLD TOTAL	14,808	21,198	26,680	30,512	30,827	32,299	6.8	2.9	100.0	100.0	100.0
MARKET ECONOMIES	11,533	17,382	21,908	25,250	25,465	26,855	7.4	3.1	77.9	82.0	83.1

/a Incomputable.

Source: Metallgesellschaft, Metal Statistics and World Bureau of Mines, World Metal Statistics (actual); World Bank, Economic Analysis and Projections Department.

5. Energy, in any case, will continue to be a major factor in the locational criteria, since of the total cost of energy consumed in transforming bauxite ore into aluminium ingot, 0.5% is attributable to the mining stage, 24.5% to the refining stage and 75% to the smelting stage. The pattern of development tending to emerge is one of refining at or near the mine site. In fact new investments in smelting ore being undertaken in developing countries, are based upon hydro-power in South America, natural gas in the Middle East, and black and brown coal in Australia. The rising energy costs are an inducing factor, in installing semi-fabrication facilities alongside new and existing facilities to avoid cost of resmelting, while fabrication plants continue to be located as close as possible to the consuming markets.

6. Since energy resources are unevenly distributed, this factor has acted as a constraint on some producing countries from entering smelting. International action to promote regional co-operation among producing countries, could remove the constraint and enable them to get involved in smelting. In this connection producers and consumers could collaborate in joint approaches to the World Bank for financing of energy resources development for agreed regional projects in downstream development of the industry in producing countries. Since the financial resources required for the projected investments, in the case of some mineral, could be very large, the World Bank could act as a catalyst, and in co-operation with other regional financial institutions.

Copper prospects

1. The average growth rate for copper consumption from 1950 through 1979, was 4.6* for thw rold and 4% for the market economy countries. The leading consumers of refined copper have been the United States (22% of the 1979 world total), followed by the U.S.S.R. (14%), Japan (14%), the Federal Republic of Germany (8%) and the United Kingdom (5%). The market economy countries of Europe collectively account for 28% of world refined copper consumption. Over the last decade the growth rate of consumption for the industrial countries has been on the decline, due mainly to a slower overall growth in market econcmies in the 1970's and a downward trend in intensity of use because of shifts in the types of final goods and services demanded, and increased efficiency and substitution in the use of materials. Other industrialized countries like Australia and Canada have attained a high per capita consumption, while some developing countries such as Brazil, Mexico, Republic of Korea and Taiwan have exhibited higher growth rates based on the development of their infrastructure and the export of manufactured copper products. However, the consumption share of these countries is realtively small and therefore has impact on the overall growth of copper consumption than would increased consumption by the major consumers.

2. Factors in the market that cause fluctuation in the magnitude of copper consumption include general economic conditions, copper prices and the availability and price of substitute materials. There is considerable inelasticity in copper demand in the short-run, because of the direct relationship between the consumption of copper and the production of durable goods ana because of the fixed nature of equipment, plant, and production processes. Over the long run, however, the amount of copper consumed is much more responsive to changes in the relative prices of copper and aluminium, since consumers can modifay their processes or change their product designs to accomodate substitute materials, such as aluminium and plastics.

Table II.4: COPPER - CONSUMPTION BY ECONOMIC REGIONS AND MAIN COUNTRIES

	Actual							Shares		
	1960	1965	1970	1975	1977	1978	1979	1960	1970	1979
	('000 tons)							(%)		
Developing Countries	303	432	525	773	975	955	1,095	6.4	7.2	11.2
South Africa	26	32	35	65	52	60	69	0.5	0.5	0.7
Southern Europe	108	141	216	271	324	308	312	2.3	3.0	3.2
Other Developing	169	259	273	437	599	587	714	3.6	3.7	7.3
Industrialized Countries	3,527	4,620	5,279	4,682	5,895	6,262	6,414	74.4	72.4	65.4
United States	1,245	1,844	1,860	1,397	1,986	2,193	2,168	26.3	25.5	22.1
Western Europe	1,805	2,036	2,263	2,158	2,468	2,461	2,544	38.1	31.0	26.0
Japan	304	428	821	828	1,127	1,241	1,330	6.4	11.3	13.6
Other Industrialized	173	312	335	300	314	366	372	3.6	4.6	3.8
Market Economies	3,830	5,052	5,803	5,455	6,870	7,217	7,509	80.8	79.6	76.6
Centrally Planned Economies	912	1,166	1,486	2,018	2,160	2,232	2,291	19.2	20.4	23.4
WORLD TOTAL	4,742	6,217	7,289	7,473	9,030	9,449	9,800	100.0	100.0	100.0

Source: World Bureau of Metal Statistics.

3. Copper has a rather limited market in terms of the total tonnage of copper sold in the world resulting in price fluctuations which has posed a serious problem, and a rising concern with the threat of substitution by other metals, having a better record of price stability. These and other difficulties induced the major copper producers to set up an Intergovernmental Council of Copper Exporting Countries (CIPEC) to act as an advisory body,, especially with regard to determining the factors influencing the pricing of copper, and improving the methods of marketing it.

4. The principal end-use sectors of refined copper are electrical, construction, machinery, transportation, ordonance and others. Electrical and construction sectors, however, and still the most important consumers of refined copper. In developed countries, copper consumption in the electrical sector, has a tendency for lower growth rate, because of the inroads made by some substitutes. The initial major substitution has already occured in the shift from copper to steel cored aluminium wire in overhead power transmission lines which lowered costs by reducing the number of cable-supporting structures required. Copper is also being replaced by aluminium in underground power cables in low-voltage ranges (although copper should continue to be preferred for high voltage). Magnet wire, transformers and switchgears have partially gone over to aluminium and the use of silicon chips is increasing in electronic equipment. In the telecommunication field, there are various possibilities for reducing the usage of copper, such as the use of thinner gage wire in the subscriber loop and the junction cable, the introduction of the fully electronic digital exchanges, and fibre optic systems which use fibre glass as conductors of light pulses and capable of carrying far greater volumes of traffic than the same cross section of copper cable. Other alternative transmission media include micro-wave towers, satellites, and the waveguide system. Even in undersea cables, aluminium and eventually fibre optics, will replace copper. It is in the less industrialized and developing countries, that the growth prospect for copper in telecommunication based on existing copper-based technology is likely to be on the increase, at least in the medium term. In the construction sector, copper remains the preferred material for most applications as substitution efforts within this sector have yielded only mixed results. It is, however, in the field of solar energy, that copper has developed some interesting possibilities, although the method of collection of energy and its specific application has to be still further developed and resolved.

Copper is well established in machinery, and its consumption is widely diversified in such components as values, pipe fittings, pumps and hearings, but substitutes such as stainless steel is making inroads. Copper alloys in power generating in marine-related applications, and water is maintaining its level of consumption. As for transportation, copper is used extensively in the automatic industry in radiators and wiring, but its consumption is declining on account of down-sizing and weight-saving efforts of automakers, and the competitition from aluminium and plastics in radiators - especially in Europe and Japan. Prospects of growth are possible in electrically-powered vehicles, in railways, in public transit systems, and in shipbuilding both in traditional applications such as electric equipment and propellers, and in new promising applications such as copper-nickel hulls and copper-nickel shelting over steel hulls for increased fuel economy and reduced maintenance (no painting of hulls is required). On the whole, copper consumption, is predicted to occur in the electrical end-use sector, and demand in the industrialized countries will continue to grow at moderate rates, taking into consideration substitution by other minerals and the rise in the rate of recycling. It is, however, in the developing countries that the rate of growth, is expected to be higher with their increased industrialization. To sustain the rate of growth in the consumption of refined copper, and to cope with competition, the industry is characterized by a strong co-operative technological development effort, directed at opening new markets to replace those cost to aluminium and other materials, and defend existing markets by improving copper alloy performance and reducing copper required for a given job, and improving the economies of copper extraction from areas. Developing countries account for almost two thirds of world copper exports. In fact their export dependence for the group as a whole is estimated at 90%. The major mine producers are usually the major exporters; namely, Chile, Peru, Zambia, Zaire, Philippines, Papua New Guinea and South Africa. Among the industrialized countries Canada is the major exporter followed by Australia.

5. In world copper market today, there is no effective market control arrangement in operation although the Intergovernmental Council of Copper Exporting Countries (CIPEC) was created in 1967, its direct influence on the market has been rather modest. Efforts to establish a formal international copper agreement involving major producing and consuming countries have been continued since 1976 under the auspices of UNCTAD, but so far no concensus has been reached on creating such an agreement. The International Wrought Copper

Table II.5: COPPER - WORLD EXPORTS BY ECONOMIC REGIONS AND MAIN COUNTRIES

	Actual							% Share in World Total		
	1960	1965	1970	1975	1977	1978	1979	1960	1970	1979
	('000 tons)							(percent)		
Developing Countries	1,748	1,941	2,383	2,825	3,393	3,198	3,228	59.1	60.9	64.4
Asia and Pacific	44	66	155	449	555	545	545	1.5	4.0	10.9
Papua New Guinea	-	-	-	170	182	195	172	-	-	3.4
Philippines	42	63	150	212	282	258	292	1.4	3.8	5.8
Indonesia	-	-	-	61	60	59	56	-	-	1.1
Other	2	4	4	5	31	33	25	-	0.1	0.5
Africa	930	1,087	1,244	1,312	1,414	1,218	1,213	31.4	31.8	24.2
Zaire	274	289	370	493	489	440	366	9.3	9.5	7.3
Zambia	560	683	689	635	655	576	647	18.9	17.6	12.9
South Africa	50	58	136	119	189	133	138	1.7	3.5	2.8
Other	46	58	50	65	81	69	62	1.6	1.3	1.2
Latin America and Caribbean	722	731	905	961	1,348	1,341	1,391	24.4	23.1	27.8
Chile	515	522	669	788	1,005	978	1,004	17.4	17.1	20.0
Peru	168	181	217	150	330	355	382	5.7	5.6	7.6
Mexico	35	9	6	14	10	5	4	1.2	0.2	0.1
Other	4	19	14	9	3	3	1	0.1	0.4	-
Southern Europe	51	57	80	104	76	94	79	1.7	2.0	1.6
Industrialized Countries	1,139	1,113	1,358	1,510	1,481	1,454	1,396	38.5	34.7	27.9
Canada	295	260	428	634	574	530	509	10.0	10.9	10.2
United States	409	314	264	167	96	123	127	13.8	6.8	2.5
Western Europe	384	500	548	540	643	648	593	13.0	14.0	11.8
Other Industrialized	52	39	118	168	168	153	167	1.8	3.0	3.3
Market Economies	2,887	3,055	3,741	4,335	4,874	4,652	4,624	97.5	95.7	92.3
Centrally Planned Economies	73	121	168	323	378	383	386	2.5	4.3	7.7
WORLD TOTAL	2,960	3,176	3,910	4,658	5,252	5,035	5,510	100.0	100.0	100.0

Source: World Bureau of Metal Statistics.

Council (IWCC), consisting of major copper producing, trading and fabricating companies, meets regularly to exchange information on market situation and discuss specifically demand and supply prospects. It appears to have a modest stabilizing influence through reducing information gaps on market countries and corporate plans for capacity additions.

Mining and Smelting

Most modern copper mines in developing countries are large open-pit mines, often inconveniently located with respect to population centres, transportation facilities and operating services. Infrastructure demands and overhead costs tend to be high and substantial annual capacities and reserves are necessary to justify commercial development. Because copper ores are lean in metal, the burden of transport costs dictates in most cases that the ores be concentrated and smelted to crude metal or blister or very near the mine site. In case of underground ores, which are usually high grade, concentrates are sent to custom smelters for reduction or to the smelters of the larger mining operations. Fuel and electric power requirements for smelting, their cost and availability, are important considerations in determining the feasibility and profitability of a given copper project, especially when connected with remote mines. The smelting process producers considerable by-product sulphuric acid which is in high demand in industrialized countries.

Refining

Copper refining is done by two major processes, fire refining and electrolytic refining. The latter is now more widely used because it produces copper pure enough for electrical applications, and is also more efficient and is also more efficient in recovering valuable by-product metals than fire refining. Refining is not necessarily tied locationally to mining and smelting phases, because there is some advantage in shipping blister rather than refined shapes, in that the surface quality of refined copper is often an important consideration at semi-fabricating stage; and consequently wire and slabs shipped long distances are likely to have surface checks and cracks which can be avoided by conducting the refining and casting operation close to the semis market. Power costs also tend to encourage the location of primary refining capacity in the consuming country where the power costs are likely to be lower.

As for the semi-fabricating stage, it is the market and not the capital costs which set the crucial limitations, and therefore, even small plants entail capacities appropriate only to the demands of the larger "industrialized" countries

Vertical integration between mine and smelter capacity already exist in most copper producing countries. As for refining there is still a potential for on-site copper processing in many developing countries, and an increase in on-site refining capacity presents the most effective target available, in the present circumstances, to the developing countries for greater participation in the copper industry.

Lead Zinc Prospects

The long term prospects for lead is influenced by a number of factors, ranging from the rising in the cost of production, to the development of substitutes, to the development of new techniquies which in effect diminished the amount of lead used. The total refined lead consumption in 1980 was 3,8 million metric tons - excluding the centrally - planned economies. The storage batteries accounted for some 40% of this consumption or some 1,5 million metric tons. Lead used as antiknock additive in gasoline, accounted for another 300.000 metric tons annually, while lead used in cable sheating is in the order of 205.000 metric lons per annum. Some of these uses of lead have been threatened by the contruction of new technology, while others actually suffered on account of the prolonged world recession, as in the case of the automobile industry, or on account of new environmental laws and regulations. Research activities were undertaken by the producers and conducted through the zinc and lead international service (ZALIS) financed jointly by the lead and zinc associates of U.S.A., U.K., Australia and Japan, was assigned the functions to stimulate domestic consumption in the developing countries by promoting use of there metals and by providing up-to-date technical information for manufacturers and prospective manufactures of lead and zinc. International lead zinc research organization, with the purpose of maintaining the levels of consumption of certain uses threatened by technological or environmental developments and developing new and uses for the metal. Efforts undertaken in this direction have, so far proved rewarding. The development of lead and batteries for electric vehicles and for load levelling represent new market potentials which could increase lead consumption by an estimated 850.000 metric tons annually. Organolead, or lead chemicals development may open a whole new vista for lead consumption, as for example in potable water piping, in antifouling paints, in compounds designed to reduce the rate of hardening and cracking of asphalt. These uses, however, may still have to obtain approval from the sanitation and enviromental agencies, and pass the toxity testing. World consumption of lead (including secondary metal has been growing at around 3,4% per annum since 1960. Despite the sharp decline in 1975, it has recovered significantly in the following three years. World consumption is projected to increase from 3-5 million tons in 1976 to 5,5 millions tons in 1990 at the implied growth rate of 3,2% a year. World exports of lead (lead in one / concentrates and metal combined), which increased at 2,9% per annum, are expected to rise to about 3-4% a year in 1976 - 1990.

Developed countries exports, which rose at 4,8% per annum in 1965 - 1976, are projected to grow slightly less than 4% a year, while developing countries exports are expected to grow at the moderate rate of 2% per annum in 1976 - 1990 reversing the decline trend in the past.

Zinc is a mineral with several end uses, and has not, therefore, suffered from any decline in its consumption. It is used in many industries particularly construction including highways, building and bridges, automobiles, coil coating and process industries among others. Zinc's largest market, however, is the galvanizing of steel and discasting significant technological improvements, and the introduction of a comparatively new galvanizing alloy (GALFAN), has helped maintain the level of consumption, which was threatened by another galvanizing alloy (GALVALUME) based mainly on aluminium. There are new uses, some of them still under development, which offer attractive potentials for expanding consumption of zinc. These uses include the use of galvanized steel for low cost housing by using zinc sheet for flat roofing; for zinc chemicals for plastics, paints and ceramics; and for zinc oxide applications. Although zinc alloys used for dry cells continues to constitute some 4% of the 4,5 millions metric tons of zinc consumed annually, efforts are still undertaken to developed new technologies directed to energy related projects, such as zinc phosphide solar cells and nickel zinc secondary battery, to further expand the consumption of zinc.

Zinc is traded in concentrates and slab zinc (refined). Trade in zinc fabricates is insignificant. Most importers of zinc are Europe, the United States and Japan. About 59% of zinc imports by developed countries are in the form of concentrates. Most of the zinc imported by the EEC and Japan are in unrefined form while the zinc imported by the United States and developing countries are in refined form. Major exporters of zinc are Canada, Australia, Sweden, Peru and Mexico. Demand for zinc is expected to sustain a fairly healthy groth in 1976 - 1990 period (about 4 - 4,5% per annum), because of the continued dominance of Canada and Australia in the export market. The share of the developing countries in world zinc exports is not likely to increase by 1990.

As for the future period up to 1990, the developing countries are likely to increase their smelting refining capacity substantially by 1990, especially in major ore-producing countries, such as Bolivia, Mexico, Peru, Iran, South Korea and Marocco. Exports of zinc metal from developing countries in 1990 are projected to be 550.000 tons higher than in 1976. Assuming that the smelting

refining charge per ton of zinc metal in 1990 is $ 300 (in 1976 constant dollars), the additional tonnage implies extra export earnings of $ 165 million (in 1976 constant-dollars) in 1990. In addition, annual savings in the value of the imported zinc metal which are projected to result from import substitution are estimated to amount to $ 80 million (in 1976 constant dollars). To sum up, the projected progress in zinc smelting/refining in developing countries would result in an increase in the gross export earnings from zinc of some $ 250 million (in 1976 constant dollars) in 1990, notwithstanding the substantial expenditures needed for imported inputs and capital goods.

PROSPECTS AND ISSUES

Prospects for Tin:

Tin is used in many various ways. The use of tin as a coating on steel sheets to form tinplate accounts for 40%, solder 28%, white metal and pewter 70%, chemicals 7%, bronze 6%, tinning 4% and others 8%.

Since the developing countries are close to self-sufficiency in tin processing, especially when Bolivia completes its processing expansion plans, further development of the tin industry, with a view to augment the export earnings of the developing countries, will depend largely on maintaining the level of consumption of tin and eventually increasing it to cope with the expected increase in production. The recession which started in the second half of 1980, adversely affected the production of tin, at a time when the brunt of competition from other products was increasingly felt, especially in the packaging industry. The ability of tin to resist attack by air and by many of the organic acids often present in food has results in the metal being used in the farm of tinplate for making containers of food. Tinplate is, in fact, steel sheets plated with a thin layer of corrosion resistant tin.

This particular industry uses 90% of the tinplate, which in its turn consumes 40% of the tin production. Since tinplace is a steel product, tinplate producers are usually fully integrated with the steel industry. In the packaging industry tinplate is used to make cans and other containers, and closures. The main products packaged are food, beer and soft drinks, and a limited range of non-edible products, mainly oils, paints, varnishes, solvents, antifreeze and waxes. It is, however, in the can-making industry, that most of the tinplate produced, is being consumed, and it is this industry, which faces stiff competition from other tin mill products, aluminium and other materials such as glass, plastic, paper and composites, in a continuing search for more cost effective materials and fabrication techniques. Steelmakers have developed thinner, stronger materials, and have found ways of reducing the thickness of the tin coating - tin constitutes less than 0.5% of the weight of the tinplate, and it is a continuing feature of tinplate production and usage that this figure is falling. In 1980 tinplate consumption was approximately 13.6 million tons and this used 72000 tons of tin. It is this amount of tin which is adversely affected by any reduction in the thickness of the, tin coating, and the situation can only

Table II-5: TIN - WORLD CONSUMPTION OF PRIMARY TIN, BY MAIN COUNTRIES AND ECONOMIC REGIONS

	Actual							Shares			Growth Rates
	1960	1965	1970	1975	1977	1978	1979	1960	1970	1979	1960-79
	('000 tons)							(%)			(% per annum)
Industrialized Countries	146.2	143.4	148.2	131.8	140.8	135.8	140.0	71.2	68.0	61.9	-0.2
US	52.4	59.5	53.8	43.6	47.6	48.4	49.5	25.5	24.7	21.9	-0.3
Japan	13.1	17.4	24.7	28.1	29.7	29.4	31.2	6.4	11.3	13.8	4.7
Western Europe	72.3	56.9	60.8	51.5	54.2	51.9	50.3	35.2	27.9	22.3	-1.9
Other Developed	8.4	9.6	8.9	7.9	9.3	8.8	9.0	4.1	4.1	4.0	0.4
Developing Countries	18.4	20.6	25.1	29.9	31.4	32.9	32.0	9.0	11.5	14.2	2.9
South Africa	2.0	1.3	2.1	2.3	2.1	1.9	2.0	1.0	1.0	0.9	0.0
Southern Europe	3.4	4.8	6.3	8.3	7.3	7.8	6.8	1.7	2.9	3.0	3.8
Market Economies	164.6	164.0	173.3	161.0	172.2	171.4	172.0	80.2	79.5	76.1	0.2
Centrally Planned Economies	40.6	40.3	44.7	53.3	54.6	56.2	54.0	19.8	20.5	23.9	1.5
WORLD TOTAL	205.2	204.3	218.0	218.7	226.8	227.6	226.0	100.0	100.0	100.0	0.5

Sources: International Tin Council, Monthly Statistical Bulletin and Metallgesellschaft, A.G., Metal Statistics.

be alleviated by increasing the demand for tinplate. Competition from aluminium cans in beverages, and of other products such as plastics and glass, can only be met by developing new fabrication techniques such as the three-piece soldered can, leading later on to the welded cans and the redrown cans. The continuing tinc coating weight reducations resulting from more cost effective techniques, apparently have a a negative effect on tin consumption, but have, at the same time helped tinplate maintain its competitveness with other products, and an increase in the consumption of cans and containers, may eventually help redress the present adverse trend. On the other hand, pressure from environmental groups, to reduce the risk of exposure of the population to lead migration in canned foodstuffs, have resulted in more stringent national and international regulations. Consequently tin coating in conjunction with lacquering, still offer the best method available to reduce lead migration and offer an effective protection against internal and external corrosion. The high feasibility of tin has produced the tin-lead alloy know as solder, which is used to join the edges of less feasible metals. The addition of lead lowers the melting point of the solder while increasing its strength considerably.

Soldering is the second largest and use for primary tin, consuming some 50000 tons per annum of the total tin production representing about 24%. World-wide demand for tin in this application has been stable in recent years. Tin used in soldering is alloyed with lead, zinc, silver or antinony for different applications such as body-fill in vehicle manufacturing, heat exchangers, sheet metal work, plumbing and general engineering. However, the tin content in these solders is low. Solders used in electrical and electronic assemblies, hand soldering, machine soldering, high and low-temperature soldering (used for cans for milk and baby food), contain a high tin content. Tin uses in this respect, is expected to grow slowly in the medium-term, and has excellect growth prospects world-wide and in the longrun. The ease with which tin can be alloyed with other metals and the desirable properties that such mixing produces have given rise to the important tin alloys industry. Today tin alloys such as bronze, gunmetal and brass are used for coinage, bearings, high-pressure steam plants and miltary hardware. The anti-friction property of tin has produced a whole group of bearing metals such as babbitt, while metal alloys, where tin is alloyed with varying amount of antimony, copper and lead.

It is in the manufacture of chemicals, that the prospects for tin consumption was around 13000 tons of primary tin, rising to 16000 tons (or 10% of world tin production) in 1979. Organotins is a complex technology, and its uses cover a wide range from agricultural insecticides to ceramics, plastics and glass. Organotins is a promising field, but pressure from environmental groups, may make it imperative to undertake more research undertakings to alloy the fears raised by such groups; and in this respect perhaps more international co-operation may be enlisted to finance projects jointly undertaken by the respective international organizations, and some of the specialized bodies and institutes, such as, the International Tin Research Institute. The same can be said about marine paints using tin, which is considered a promising field of consumption, but which again are raising an outcry amongst the environmentalists.

The consumption, in the canning industry is facing a growing competition from the promotional activities for other minerals, and which are generously financed by the concerned companies and NTC's. This promotional activities are not being matched by similar activities on behalf of tin because of lack of finance. Perhaps more can be done in this respect by joint action both from producing and consuming countries, to undertake research in the present uses of tin, and exploring its possible uses and application in new areas. Developed countries consume about 61% of world tin production, as compared with 71% in 1960; centrally planned economies account for about 24% of the total, as compared with 19.8% in 1960 and the remainder is consumed in developing countries. The US is the single most important tin consuming country with a share of about 21% of total world consumption followed by Japan with 14%, the Federal Republic of Germany and the UK, each with about 6%, their consumption has grown more slowly than that of other metals: at 1.7% per annum from 1955-74, compared to 4.8% per annum for copper, 8.3% per annum for aluminium and 4.6% for zinc. Their demand further declined between 1977 and 1979. The main reason for this slow growth was the increasingly substitution of tin-free steel and aluminium for tinplate in can manufacturing. In addition, technical innovation has reduced the quantity of tin needed in tinplate.

There is a growing conviction that industrial countries are gradually contracting their consumption of some strategic minerals, including tin; and are earnestly trying to develop substitutes which can be developed locally.

Table II-6: TIN - WORLD EXPORTS (VOLUME), BY MAIN COUNTRIES AND ECONOMIC REGIONS

	Actual							Shares			Growth Rates 1960-79
	1960	1965	1970	1975	1977	1978	1979	1960	1970	1979	
	('000 tons)							(%)			(% per annum)
Industrialized Countries	30.5	32.2	32.5	20.8	27.9	29.4	27.1	13.7	14.6	12.6	-0.6
Australia	-	0.6	4.8	6.9	7.5	9.1	8.1	-	2.2	3.8	6.0*
United Kingdom	7.9	6.8	12.9	6.4	6.8	7.0	6.2	3.5	5.8	2.9	-1.3
Other Industrialized	22.6	24.8	14.8	7.5	13.6	13.3	12.8	10.1	6.6	5.9	-2.9
Developing Countries	157.7	149.7	184.3	163.6	171.3	182.2	186.4	70.8	82.6	86.5	0.9
Malaysia	77.6	74.6	91.9	77.6	63.2	70.1	72.1	34.8	41.2	33.5	-0.4
Indonesia	27.1	14.3	17.8	21.8	24.9	23.1	27.5	12.2	8.0	12.8	0.1
Thailand	12.8	15.9	21.8	16.6	23.3	28.9	32.5	5.7	9.8	15.1	5.0
Bolivia	19.7	27.7	29.6	26.5	30.9	29.3	25.7	8.8	13.3	11.9	1.4
Brazil	-	-	-	2.8	2.1	4.3	4.7	-	-	2.2	13.7**
Nigeria	8.0	10.8	10.9	4.7	3.0	3.1	2.6	3.6	4.9	1.2	-5.7
Zaire	8.4	1.3	6.3	4.6	4.2	3.9	2.2	3.8	2.8	1.0	-6.8
South Africa	0.8	0.7	0.9	2.3	2.4	2.2	1.5	0.4	0.4	0.7	3.4
Southern Europe	0.3	0.4	1.7	1.6	1.6	0.2	0.4	0.1	0.8	0.2	1.5
Other Developing	3.0	4.0	3.4	5.1	15.7	17.1	17.2	1.3	1.5	8.0	9.6
Market Economies	188.2	181.9	216.8	184.4	199.2	211.6	213.5	84.5	97.2	99.1	0.6
Centrally Planned Economies	34.5	7.1	6.2	12.9	3.7	5.5	2.0	15.5	2.8	0.9	-13.9
WORLD TOTAL	222.7	189.0	223.0	197.3	202.9	217.1	215.5	100.0	100.0	100.0	0.2

* 1970-79 growth rate
** 1975-79 growth rate

Sources: International Tin Council, Monthly Statistical Bulletin.

This trend may perhaps be arrested within the context of international co-operation, which could be encouraged and evolved in any forthcoming consultation between all concerned including UNIDO. The structure of the International Tin Agreement appears to be well suited for such discussions as might be required, and for any long-term arrangements to expand the developing countries capacity for processing.

Developing countries dominate the tin trade: they account for 92% of total world exports of tin-in-concentrates and for almost 80% of world exports of tin metal. Historically the flow of trade has been in the form of export tin-in-concentrates from producing developing countries to consuming developed countries. In recent years, the direction of trade has remained the same, but tin metal has substituted for tin-in-concentrates. The importance of the trade-in-concentrates has in fact decreased drastically over the last 20 years as developing producing countries have expanded their smelting capacity. Developed countries absorb 85% of world tin metal imports, centrally planned economies about 10% and developing countries the remaining 5%. Centrally planned economy countries have been self-sufficient in tin, however, the USSR and China on occasions exported significant amounts of metal to developed countries.

Investment requirements in the non-fuel mineral industry - a prospect for 1980 - 1995

The capital investments needed to ensure a growth of production capacity in the mineral ores sector is likely to be very large, given the continuous rise in the costs of capital goods and the neces sary infrastructure. Production of minerals is capital intensive, and therefore, the developing countries are likely to face critical investment decision in this sector during the next decade or so. In fact, the heavy investment outlay required for maintaining and expanding the processing capacity, has acted as an inducement on foreign investors, in particular the integrated corporations, to seek agreement with developing countries on joint ventures, an attitude which constitutes a major departure from normal practice by these companies in the past.

Capital investments required, cover new mining and processing capacity, as well as, financial resources needed for maintaining or replacing existing levels of capacity, such as replacing depleted mines, depreciated or economically outdated equipment and other fixed assets on ongoing operations. The estimates for capital investment include requirements for primary investment covering the direct cost of plant and equipment and the labour and technical inputs required for mines, smelters and refineries. They also include requirements for infrastructure and exploration expenditures (estimated at 5 per cent of primary investment). Total requirements for mining and processing for the period 1980 - 1995 for the eight non-fuel mineral products, including the five non-ferrous metals - is estimated at $151 billion, 63 per cent of which is for processing and 37 per cent for mining proper including initial treatment of ore. The total is about equally divided between industrial and developing countries, and the annual investment requirement during this period is about $5.05 billion for developed countries (as indicated in Tables No. 38 and 39).

The products requiring the largest investments in mining during the above period, are in the following order: copper, iron ore, bauxite, lead and zinc. With respect to processing, the largest investment requirements are in bauxite, for alumina refining and aluminium smelting. These investments account for 70 per cent of the processing requirements of industrial countries. These estimates, however, do not cover the cost of electricity generating facilities, otherwise the actual capital investment needs would be even higher than estimated here.

TABLE 38: INVESTMENT REQUIREMENTS FOR MINING AND PROCESSING IN DEVELOPING COUNTRIES, BY REGION, 1981-95

	INVESTMENT REQUIREMENTS			PERCENTAGE SHARE OF EACH REGION IN TOTAL INVESTMENT		
	MINING	PROCESSING	TOTAL	MINING	PROCESSING	TOTAL
	(BILLION 1981 $)			%		
ASIA	10	14	24	27	37	32
AFRICA	6	3	9	16	8	12
AMERICA	17	16	33	46	42	44
OCEANIA /A	1	1	2	3	3	3
S. EUROPE	3	4	7	8	10	9
ALL REGIONS	37	38	75	100	100	100

/A DOES NOT INCLUDE AUSTRALIA AND NEW ZEALAND WHICH ARE AMONG THE INDUSTRIAL COUNTRIES.

SOURCE: WORLD BANK, ECONOMIC ANALYSIS AND PROJECTIONS DEPARTMENT, COMMODITIES AND EXPORT PROJECTIONS DIVISION.

TABLE 39: ESTIMATES OF INVESTMENT REQUIREMENTS FOR MINING AND PROCESSING OF EIGHT MAJOR NON-FUEL MINERALS IN INDUSTRIAL AND DEVELOPING COUNTRIES, 1981-1995

(BILLION 1981 CONSTANT $)

	MINING		PROCESSING		TOTAL	
	INDUSTRIAL COUNTRIES	DEVELOPING COUNTRIES	INDUSTRIAL COUNTRIES	DEVELOPING COUNTRIES	INDUSTRIAL COUNTRIES	DEVELOPING COUNTRIES
COPPER	8.40	13.50	3.20	6.50	11.60	20.00
TIN	0.03	0.25	0.0	0.03	0.03	0.28
NICKEL	0.40	0.85	1.40	2.52	1.80	3.37
LEAD	1.80	1.60	6.25	2.40	8.05	4.00
ZINC	2.65	4.20	5.00	4.50	7.65	8.70
BAUXITE /A	1.50	3.15	39.75	20.25	41.25	23.40
IRON ORE	4.00	13.55	0.65	0.75	4.65	14.30
MANGANESE ORE	0.12	0.40	0.35	0.75	0.47	1.15
TOTAL	18.90	37.50	56.60	37.70	75.50	75.20
TOTAL PER ANNUM	1.25	2.50	3.80	2.50	5.05	5.00

/A INCLUDES ALUMINA AND ALUMINUM.

SOURCE: WORLD BANK, ECONOMIC ANALYSIS AND PROJECTIONS DEPARTMENT, COMMODITIES AND EXPORT PROJECTIONS DIVISION.

Although the total investments are equally divided between developing and industrial countries, the share of capital expenditures necessary to maintain current levels of output in industrial countries is twice as much as that of developing countries, due largely to the fact that the existing capacity in industrial countries is generally much older and due for faster replacement than in developing countries (as indicated in Table No. 40 attached).

Perhaps this factor may prove of interest to those who advocate expansion of the processing facilities in the developing countries. There is an increasing interest in exploration and processing in developing countries as evidenced by the slow flow of financial resources in these directions, and in complete contrast to the situation that prevailed in the second half of the 1970's, when there was hardly any flow, following a decade of requisitions and increasing control by the developing countries of their natural resources. A sense of realism based on mutuality of interests and benefits, and a tendency on the part of foreign investors to participate in joint ventures, and enter into agreements, and mutually beneficial arrangements, have resulted in some significant investments in a number of developing countries, chosen perhaps on political risk minimization grounds, and reasonable economic potential. Political and economic environment and conditions, however, vary from one region to another, and in most instances, from one country to another, and there is still wide scope for co-ordination and co-operation at the regional, interregional and global levels.

TABLE 40: INVESTMENT REQUIREMENTS IN THE NON-FUEL MINERAL SECTOR IN INDUSTRIAL AND DEVELOPING COUNTRIES, FOR MAINTAINING EXISTING LEVEL OF CAPACITY AND INCREASING LEVEL OF CAPACITY, 1981-1995

(BILLION 1981 CONSTANT $)

	INVESTMENT REQUIREMENTS FOR		
	MAINTAINING EXISTING LEVEL OF CAPACITY	INCREASING CAPACITY LEVEL	TOTAL
INDUSTRIAL COUNTRIES			
MINING	5	14	19
PROCESSING	10	47	57
TOTAL	15	61	76
DEVELOPING COUNTRIES			
MINING	5	32	37
PROCESSING	3	35	38
TOTAL	8	67	75
INDUSTRIAL & DEVELOPING			
MINING	10	46	56
PROCESSING	13	82	95
TOTAL	23	128	151

SOURCE: WORLD BANK, ECONOMIC ANALYSIS AND PROJECTIONS DEPARTMENT, COMMODITIES AND EXPORT PROJECTIONS DIVISION.

Gaps in Information:

1. Selection of a location for a natural resource processing activity will depend on the availability of information, for a comprehensive evaluation. Such information may not be available or is expensive to locate.

2. There is an information gap on the availability of the natural resource and other inputs, in terms of their prices, quality and quantities.

3. There is an information gap concerning the existence, operating costs and input requirements of the technology to be used in the processing activity. There may be newer techniques, than those known to government officials or entrepreneurs, that are more appropriate to local conditions and offer increased efficiency over the techniques allowed for in the evaluation processes.

4. Market potential to be taken into consideration for evaluation exercises, have to be evaluated on the basis of likely demand, prices and destinations, because there are very few projected activities established under contracts, which involve guaranteed markets.

5. Data on values of variables such as prices of existing inputs, capital equipment and outputs, usually correspond to market values and incorporate the effects of market imperfections and policy-caused distortions; and since it is not possible to determine whether or not apparent market prices are really actual market prices, it is difficult to estimate the effects on those prices of the introduction of the projected activity, or to assess with any degree of confidence the economic or commercial viability of the projected activity.

6. Information may not be available about the commercial possibilities in a certain location, that there is a total lack of awareness of the existence of the economic and commercial potential for an industrial processing activity.

7. A study of available sources of finance for mineral processing, the terms on which finance is made available (including repayment periods, interest rates, guarantee provision and grace periods), and the varying implications for the use of the different types of finance, could enable the developing countries to select the most attractive means of securing the necessary funds for processing projects.

8. A comprehensive study of the entire minerals-shipping industry is required, focusing in particular on opportunities for shipping lines owned by individual developing nations or group of nations; on technological advances in the handling of processed minerals that could reduce shipping charges; and on the use of non-conference shipping for mineral products.

9. A study of the role of producers' associations could indicate the extent to which these groups could exert market power or could organize collectively so as to improve their members ability to establish processing facilities. The study could also cover the usefulness of these associations in co-ordinating sales contract terms, avoiding destructive competition among member countries, and identifying possible sources of finance for processing projects.

10. A study of corporate priorities could indicate which potential developing country policies and incentives would be most likely to attract transnational investments in processing activities in developing countries, given the wide variety and diversity of investment decisions, styles and motivations of the TNC's.

11. A study of national mining corporations, often state-owned, focussing on their sources of finance, management and organization, sales policies, and other aspects, so as to indicate the approaches most likely to be successful and capable of emulation by similar enterprises in other developing countries.

12. Information on prices of products, inputs, energy, with an analysis of the relative cost. Maps outlining the flow of supply of products, and the sources from which the Integrated Corporations draw their materials, could fill an important gap in the information available to the developing countries.

13. Studies are needed in market development and the promotion of mineral consumption in developing host countries or regions, along with the relevant feasibility studies. These studies could be undertaken and financed by the relevant international bodies including UNIDO, UNDP, UNCTAD and others.

Issues to be considered in the consultation

A number of studies have already been prepared on minerals and mineral processing in developing countries - including non-ferrous metals. The relevant studies and data available will have to be updated for the purposes of the forthcoming consultations. A study has to be undertaken offering a global survey of worldwide non-ferrous metals supply and demand, including an assessment of non-ferrous metals production and processing, covering feedstocks, infrastructure, energy needs, transportation, costs, investment worldwide, integration, marketing, policy factors offering inducements and posing constraints, consumption and end uses, technology and development. The survey should cover existing capacity and forecasts for the medium and long-term. Problems relating to upstream and downstream integration must be taken into consideration within the prevailing global conditions, and in the context of deploying processing facilities in the developing countries producing the non-ferrous metals.

The following are the issues recommended for consideration:

A quantitative survey of world mineral resources:

1. Existing production capacity of non-ferrous metals and the global potential reserves.

   Trade and marketing.

   The elasticity of supply and demand.

   The growth in consumption, and the problem of substitutes and the development of new uses for the mineral ores. The long-term trends.

   Long-term security of supply of raw materials.

   Marketing - within integrated firms and under medium and long-term contracts.

   Price trends.

2. Processing activities in developing countries.

   Existing processing activities in the developing countries, a comparative analysis.

   The economic and technical viability of processing, and the conditions prevailing in the input and output markets.

The input requirement for processing, their identification and availability.

Access to export markets for processed products by means of bilateral agreements, participation in multilateral negotiations aiming at liberalizing trade arrangements in specific or general trade arrangements in specific or general trade areas, group marketing arrangements and product cartels.

The role played by Trade Policy in determining the locational economics.

The effect of the efforts undertaken by developing countries to improve their control over their natural resources, and benefit from the mineral-related activities on their soil, on the location of mineral processing.

3. Prospects for and implications for further mineral processing in developing countries.

Location decision as affected by technological change and product substitution.

Policy options to encourage more processing activities in developing countries, by means of general legislation and contractual instruments.

Policy instruments as a means of removing or compensating for the effects of market imperfections or policy distortions.

The problem of technology transfer, its availability and suitability and the possibility of developing duplicate or alternate technology. The extent to which the adaptability, or otherwise of the known available technology can affect projections of operating costs, variations in the quality of output, variations in capacity utilization and economics of scale.

Marketing and the effect of tarrif - rates and NTB's on processed and fabricated mineral products.

The trend to develop substitutes in industrial countries.

The impact of more stringent environmental laws and regulations.

Problems relating to unfamiliarity of investors with social and political circumstances obtaining in in developing countries.

Problems relating to financing, and the setting up of joint ventures mutually beneficial to all parties.

The adoption and publicizing by developing countries of their established and mineral processing policies and codifying them into laws and regulations, as an inducement to investors to increase their investment in processing activities in developing countries.

4. Measures designed to encourage international co-operation.

The establishment of producers associations as an instrument of strenghtening the bargaining power of the developing countries and harmonizing decisions and policies related to the same mineral industry.

The possibility of establishing regional processing facilities to overcome some of the economic disadvantages of processing within a single producing country. Prossible assistance from the World Bank and regional development banks in putting together regional processing projects by providing planning assistance and financing feasibility studies.

Possible participation by governments of producing and consuming countries in the UNIDO scheme for sharing of contract information on a reciprocal basis, by having participating governments undertaking to deposit relevant contracts with the UNIDO Secretariat.

The feasibility of establishing a programme for the collection and analysis of statistical information from governments and international organizations in order to arrive at a greater understanding of the world market for non-ferrous metals.

Discuss the feasibility of sponsoring investment seminars by UNIDO and international and regional financial institutions, in which ore-producing developing countries and potential investors could exchange information and views on conditions of investment, potential opportunities and terms of participation, with a view to identify projects for joint venture, and the provision of soft-loans for required investments by host countries in infrastructure.

Consider the establishment of a system whereby governments of producing and consuming countries could provide one another with information on projected supplies and demand, undertaken within the framework of a producer/consumer agreement, to make it possible to forecast the demand for a given mineral in the short run.

The active participation of international and regional financial institutions in projects endorsed by both producers and consumers and whose technical and economic feasibility has been established.

International action by producers and consumers to identify appropriate technology and to secure the conditions for the effective transfer to producing countries on reasonable terms, including the drafting of suitable national legislation for the protection of intellectual property and for the establishment and operation of relevant registration systems; and the training of producing countries nationals in the negotiation of relevant technology transfer agreements and in providing relevant technological information relating to patents, processes, suppliers and conditions of transfer.

The promotion of training of nationals of producing countries in tax administration, and the provision by governments of consuming countries of consultancy services to assist producing countries in strengthening their tax structures, in order to enable them to check taxation minimization and transfer pricing, which in effect lower the returns to producing countries from the development of their natural resources.

APPENDIX

Since it was not possible to cover the whole range of non-ferrous metals in the period of time assigned to this consultation, i.e. 10 August to 24 September 1982, of which the period 21 August to 17 September 1982 was actually assigned to the contacts - and in view of the fact that bodies, institutions and associations concerned are widely scattered geographically, consultations were held with the following:

1. The International Tin Council
   28 Haymarket
   1 Oxendon Street
   London S.W. 1
   (i) Mr. Peter Lai
   Chairman, International Tin Council
   (ii) Mr. Malcolm H. Farrow
   Director, Policy and Research
   (iii) Mr. Omar Yahya
   Tin Industry Officer

2. The International Tin Research Institute

3. H.E. Ambassador Herbert Walker
   Jamaican High Commissioner
   50 St. James'
   London S.W. 1

4. UNIDO Liaison Office to the United Nations, New York
   UNIDO Investment Promotion Service
   Dr. Adly Abdel-Meguid, UNIDO representative
   Mr. H. Bahlouli

5. The United Nations Natural Resources and Energy Division, New York
   (i) Mr. Vladimir Baum, Director of Division
   (ii) Mr. G. Robson, Chief or Mineral Exploration and Geology Section
   (iii) Mr. J. Harris, Special Technical Adviser,
   Mineral Economics and Engineering Section
   (iv) Mr. W. Glushke, Officer-in-Charge,
   Mineral Economics and Engineering Section

6. A meeting with businessmen and representatives of companies and research institutes in the field of non-ferrous metals, and attended by representatives from the U.N. Natural Resources and Energy Division. The meeting was attended by:

(i) Mr. H. Bahlouli, UNIDO representative

(ii) Mr. G. Robson and Mr. J. Harris,
U.N. Natural Resources and Energy Division

(iii) Mr. Simon Strauss
Behre Dolbear and Company Inc.
230 Park Avenue
New York, N.Y. 10169

(iv) Mr. Derek J. Ottley
Vice-President, Process Technology
Mineral Systems Inc.
P.O. Box 10745
Stamford CT 06904

(v) Mr. C.F. Barber
ASARCO Inc.
120 Broadway
New York, N.Y. 10271

(vi) Mr. W. Dresher
International Copper Research Association
708 Third Avenue
New York, N.Y. 10017

(vii) Mr. Gonzales Tufino
Texasgulf Inc.
High Ridge Park
Stamford, CT 06904

7. The International Copper Research Association
708 Third Avenue
New York, N.Y. 10017

Mr. W. Dresher, Director of the Association

8. The International Lead Zinc Research Organization, Inc.
292 Madison Avenue
New York, N.Y. 10017

Mr. Schrade F. Radtke, President

9. The United States Department of State
C Street
Washington D.C. 20520

Mr. Robert C. Mackler, UNIDO Desk Officer

10. The International Bank for Reconstruction and Development (IBRD)
1818 H. Street, N.W.
Washington D.C. 20433

(i) Dr. Marianne Haug
Chief, Mining and Non-Ferrous Metals Division
Industrial Projects Department

(ii) Mr. Alfredo Dammert

(iii) Mr. Kenji Takeuchi

(iv) Mr. Hideo Hashimoto

11. The International Bauxite Association
67 Knutsford Boulevard
P.O. Box 551
Kingston, Jamaica

(i) Dr. Alfred Francis
Director of Economics

(ii) Mr. Slavko Ostojic
Director of Technical Information

12. BATCO
9 Barbados Avenue
Kingston, Jamaica

Mr. Hugh Hart

13. Jamaica Bauxite Institute
Kingston, Jamaica

Mr. Carlton Davis

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