Distri.
RESTRICTED

E/CEPAL/R.265
7 July 1981

ENGLISH
ORIGINAL: SPANISH

---

C E P A L

Economic Commission for Latin America

# EVOLUTION OF, AND PROSPECTS FOR, THE MINING SEC IN LATIN AMERICA */

*/ This document was prepared by the Natural Resources Division. It is a preliminary version, subject to revision both in form and content, and the purpose of distributing it to authorities and technical experts in the mining sectors of the countries and bodies of the region is to obtain comments, observations and contributions of an informational and statistical nature.

81-6-1209

CONTENTS



/Introduction

## Introduction

1. The industrialized countries per capita output of minerals and fuels is two and a half times greater than that of the developing countries, while the consumption of the former is sixteen times greater, with the result that they require a considerable amount of raw materials from the developing countries. In fact, 70% of world exports come from developing countries. However, the income of those countries normally represents less than 25% of the final price to the consumer. This situation highlights the opportunity that the developing countries have of increasing the returns on exportation of their mining resources through enhancement of their bargaining positions and advances in industrial processing, thus generating substantial financial resources for developing the countries in question.

2. Latin America not only has this position in common with the other developing regions, its share in world trade in the products in question and of world investment in mining prospection and exploration is decreasing. At the same time, its requirements for engineering products are growing steadily, which means that an adequate pattern of local inputs must be developed in the sector in question. If the above-mentioned trend is to be reversed and a contribution is to be made to stepping-up development of engineering on a metallurgical basis, it would be necessary to redefine the strategic value of the mining and metallurgical extraction industry through analysis of its possibilities and implementation of a programme of co-operative action leading to greater knowledge of the region's mining potential and improved organization of its output and marketing.

3. The present study forms part of a series of four documents, the purpose of which is to promote more in-depth analysis of the possibilities of the mining and metallurgical sector and to provide one of the frameworks for formulation of programmes and projects concerning horizontal co-operation in developing the region's mineral resources.

4. Inadequate statistical information has meant that it has not been possible to give concepts the same treatment, since in a number of cases the data concerns all forms of mining and in other cases it concerns only mining of metals, with an indication of the concepts in question being given in each case. At the same time, analysis is generally focused on the characteristics of large and medium-scale mining, and those of small-scale mining, which deserve more specific treatment, are not covered.

## Summary

Summary

5. Assuming that the economic and social development of countries depends on growth in the productivity of their sectors and the increased availability of strategic factors relating to production, mining, owing to its greater potential for generating financial surpluses, is one of the sectors whose expansion can help to generate and maintain such development. Specifically, the mining sector could make a contribution to:1/

(a) Net generation of foreign currency,

(b) Increased government revenue; the resources in question are generally publicly owned, which gives the government the necessary basis for having a greater share in the surplus generated;

(c) Development of the pattern of production in the context of a strategy for integrating the industrial sector;

(d) Local or regional expansion of the industrial sector's areas of influence, a process whose centre or focus could be constituted by mining;

(e) Generation of high-productivity employment.

6. The producing countries' experience has so far not been at all favourable in fact, in many cases the contribution made by mining to national development has been minimal, as it was based on external dependence, which had a number of negative effects. Despite the progress made over the past fifteen years in a number of the region's producing countries, the mining sector has not had the necessary support where investment is concerned, owing to the high degree of uncertainty relating to such investment. Substantial fluctuations in international prices, expectations that there will be slower expansion of demand in the major consumer centres, lack of financial resources for prospection and exploration of new deposits are not only working against the implementation of development plans, but are also forming an obstacle to expectations relating to future world supply. Despite these considerations, the region must not fail to exploit the advantages arising from possession of the resources in question. If that goal is to be attained, it will be necessary to solve not only problems relating to financing and international trade but also those resulting from the very nature of the sector itself.

1/ See United Nations, E/C.7/97.

/Basically, it

Basically, it is necessary to identify and measure the proportions of mining revenue that are to be distributed among the producing countries, the institutions that contribute capital and technology and those that play a role in the marketing process. Secondly, in view of the fact that mineral deposits are a non-renewable resource, the producing country must transform that resource into other forms of reproductive capital and use the surplus generated by mining for financing further projects.

7. The following characteristics constitute the basic aspects of world output and marketing of minerals:

(a) Prices are chiefly determined by the evolution of, and fluctuations in, demand, which is shaped by immediate utilization of the product in question and the establishment of commercial stocks and strategic reserves. The fact that there is no open market for a number of minerals is one of the factors responsible for the high level of uncertainty with regard to estimates concerning future revenue and investment decisions.

(b) The activities of the mining and metallurgical sector call for extremely high levels of capital density and, therefore, high levels of investment. It is estimated that in the year 2000 investment on the part of the developing countries could reach the approximate level of US$ 70 000 million in terms of 1980 prices. The average for the past decade fluctuated at around US$ 15 000 million.2/ In such circumstances it is possible that domestic saving and traditional sources of financing will not be sufficient to meet such investment requirements and will have to be supplemented by credits from the consumer countries, suppliers of machinery, transnational corporations and other institutions involved in the production and marketing process.

(c) Studies indicate that over 75% of current world mineral reserves are concentrated in only fourteen countries, among which are Bolivia, Brazil, Chile, Mexico and Peru.3/ However, it must be

---

2/ See Mikesell.

3/ See Nankani.

borne in mind that the assessment of "economically exploitable" reserves is to a great extent influenced by price fluctuations, since it is related to the cost of mining and obtaining the fine metal. Although in absolute terms existing reserves are sufficient to meet the demand of the coming decades, there are two problems relating to the supply of minerals; one of these problems is that of finding the funds to meet the high investment requirements and the other is the gradual rise in the cost of exploiting known deposits. It would be possible to reduce that cost, if prospection and exploration work to identify and evaluate new, higher-yield deposits were stepped up or if the technologies for mining and obtaining the metal were improved. In the specific case of Latin America, if this investment is not rechannelled to such activities soon, the low levels of investment of the 1970s could result in a drop in the rate of output in the course of the current decade.

(d) Projections concerning the demand for minerals 4/ suggest that the long-term prospects for the mining sector are relatively favourable, a situation that will to a great extent depend on the goals, policies, institutions and instruments selected by each of the producing countries for developing the sector in question. In Latin America these prospects will have the following characteristics:

(i) As in the case of all developing economies, the region needs to increase its foreign currency reserves and its internal saving in order to reduce the trade deficit and the deficit in investment financing. For the following reasons, mining may have a high potential for generating foreign currency and revenue for the public sector; throughout the world metal ingots are a homogeneous product and are therefore equally competitive on the international market. In general, mining legislation stipulates that the resources of the subsoil are public property, which can make it easier for the State to obtain a major proportion of the income generated by mining.

---

4/ See Leontief.

/(ii) Metal

(ii) Metal and engineering products originating from mining and metallurgical production account for about 40% of Latin American imports. Such products,have a higher income elasticity of demand than that of other industrial products, which means that their import volume will rise, if a large-scale production process is not stepped up at the regional level. However, one of the basic prerequisites for such a process is industrial complementation and integration, in view of the relatively small size of domestic markets compared with the scale and degrees of diversification of the output in question and the uneven growth of demand in the various lines of business. In this connexion, joint action could be undertaken, from preparation of studies and mining prospection to agreements on industrial complementation and co-production.

8. The various chapters would seem to establish the need to bring about joint action on the part of the countries of the region with a view to achieving the following major goals:

(a) Enhanced bargaining power in order to obtain a greater share of world trade and revenue from mining.

(b) Securing financial resources in order to expand prospection and exploration for, and process of minerals.

(c) Vertical integration of the production process in order to make rapid progress in industrializing products resulting from the mining industry.

## I. ROLE AND IMPORTANCE OF THE MINING SECTOR IN THE LATIN AMERICAN ECONOMY

9. In the context of the development theories of the classical and neoclassical schools, which were based on production functions, natural resources were one of the chief strategic factors in development. Practical application of such models encountered the difficulty of measuring adequately the wealth represented by such resources, which is subject to constant reassessment. Subsequently, Keynesian theory and models centered on global demand focused analysis of the evolution of its components and on capital formation, with the result that natural resources to a greater extent lost their characteristics as a strategic variable. Modern theory is once again according a relative degree of importance to the role of natural resources in the development process, attributing, for example, to mining a strategic value in expanding exports and, consequently, in generating foreign currency (Perloff and Dodds in 1963); and in increasing public sector income as a primary formation of an exhaustable resource that can be transformed into other forms of reproductive capital (Solow and Schulze in 1974, Pearce and Rose in 1975).

10. However, the chief characteristics of the actual evolution of the mining and metallurgical sector at the international level were as follows:

(a) Growth of the product was lower than that of the overall product, despite the high income elasticity of demand for metals (see table 1).

(b) In a number of developed regions growth of the mining and metallurgical sector exceeded that of the developing regions,5/ which is precisely where approximately 50% of world mineral reserves are located.6/

### 1. Contribution to the formation of gross domestic product

11. Extractive activities relating to mining, quarrying and hydrocarbons accounted for over 4% of the region's gross domestic product in the period 1950-1979 (see table 2). At the international level the corresponding share was 1% in the developed and centrally planned economies and 2% of the gross

---

5/ See ESCAP, E/ESCAP/NR.6/6, 1979.

6/ See Nikesell.

/Table 1

Table 1

EVOLUTION OF THE MINING SECTOR 1960-1979 a/

| Regions | Rate of growth of per capita mining GDP as a percentage of the rate of growth of overall per capita GDP | Comparative index of the rate of growth of per capita mining GDP b/ |
|---|---|---|
| A. Developed regions | | |
| 1. Australia, Japan and New Zealand | 80 | 100 |
| 2. Western Europe | 51 | 48 |
| 3. United States of America and Canada | 12 | 8 |
| B. Developing regions | | |
| 1. Latin America | 60 | 41 |
| 2. Rest of Asia and the Pacific | 91 | 46 |

Source: See ESCAP, E/ESCAP/NR.6/6.

a/ Only covers the stage of mining minerals, excluding that of hydrocarbons.

b/ Rate of growth of mining GDP of Australia, Japan and New Zealand = 100.

/Table 2

Table 2

LATIN AMERICA: EVOLUTION OF THE SHARE OF MINING GROSS DOMESTIC PRODUCTa/ IN OVERALL GROSS DOMESTIC PRODUCT

(Percentages)

| | 1950 | 1960 | 1979 | Annual rate of growth of mining GDP, 1950-1979 (at constant prices) |
|---|---|---|---|---|
| Countries with mining economies | | | | |
| Bolivia | 19.7 | 6.4 | 5.5 | 4.42 |
| Chile | 12.5 | 11.1 | 12.2 | 4.18 |
| Ecuador | 1.2 | 1.3 | 6.6 | 15.64 |
| Guyana | - | - | 13.0 | - |
| Jamaica | - | - | 8.7 | - |
| Mexico | 4.0 | 4.2 | 5.1 | 7.34 |
| Peru | 7.0 | 7.9 | 8.7 | 4.69 |
| Dominican Republic | 0.3 | 1.9 | 5.9 | 12.60 |
| Venezuela | 22.7 | 27.5 | 8.0 | -0.95 |
| Countries with semi-mining economies | | | | |
| Argentina | 0.6 | 1.3 | 1.9 | 5.63 |
| Brazil | 0.4 | 0.5 | 0.9 | 10.50 |
| Colombia | 2.5 | 2.7 | 1.0 | 0.52 |
| El Salvador | 1.0 | 0.2 | 0.1 | 1.35 |
| Guatemala | 0.2 | 0.2 | 0.2 | 7.18 |
| Haiti | 3.4 | 5.0 | 1.3 | -4.98 |
| Honduras | 1.9 | 1.7 | 1.8 | 4.69 |
| Nicaragua | 1.5 | 1.1 | 0.3 | -2.65 |
| Panama | 0.3 | 0.3 | 0.2 | 5.30 |
| Paraguay | - | 0.2 | 0.6 | 13.62 |
| Latin America | 4.1 | 4.3 | 4.3b/ | 5.70b/ |

Source: See table 1 of the statistical annex and CEPAL, E/CEPAL/1061.

a/ Including extraction of hydrocarbons.
b/ Provisional figures.

/domestic product

domestic product of the developing countries as a whole, thus demonstrating the greater relative importance of such activities in the Latin American economy. These figures are not altogether representative, since they do not include the mining and metallurgical activities' value added, which is considerably higher than that of the purely mining stage. For example, the value added through the manufacture of copper wires is nine times greater than that of the metal mined from a porphyry deposit.7/

12. If the countries in which the value added of such extractive activities accounts for over 5% of the overall product are classified as countries with mining economies, in 1979 the following Latin American countries fell within that category: Bolivia, Chile, Dominican Republic, Ecuador, Guyana, Jamaica, Mexico, Peru and Venezuela.8/ (See table 1 of the statistical annex.) Similarly, countries with semi-mining economies would be those whose mining contribution was below 5%. (See table 2 once again.)

13. In the new group of countries with mining and semi-mining economies in 1979 the contribution made by the product of extractive activities to overall gross domestic product was between 0.1% in the case of El Salvador to 13% in the case of Guyana.

14. In the period 1950-1979 the share of gross domestic product of extractive activities in the overall product grew in a number of countries and decreased in another group of countries. Argentina, Brazil, the Dominican Republic, Mexico, Paraguay, and Peru were in the first group, and Bolivia, Colombia, El Salvador, Haiti, Nicaragua and Venezuela were in the second.

15. In the period 1950-1979 the highest annual growth rates in the product of extractive activities were attained by Brazil (10.50), the Dominican Republic (12.60), Ecuador (15.64), Guatemala (7.18), Mexico (7.34) and Paraguay (13.62). On the other hand, Haiti, Nicaragua and Venezuela had negative rates, estimated in terms of 1970 prices (see table 2 once again).

16. According to a number of studies, over coming decades Latin American gross domestic product could grow at a cumulative annual rate of approximately 7%.9/ According to this growth hypothesis and historical industrialization

---

7/ See United Nations, E/C.7/97.

8/ See Mamalakis and ESCAP, E/ESCAP/NR.6/20.

9/ See CEPAL, E/CEPAL/R.237. Normative scenario.

patterns, between 1970 and the year 2000 the mining sector's share will rise from 24.5% to 32.3% and the annual growth rate of industrial gross domestic product should reach approximately 8%.10/ Similarly, it is estimated that the basic metals and engineering subsectors should grow at a rate of 9.5%, which is slightly higher than that projected for expansion of metallic mineral exports in the above-mentioned period.11/ This projection establishes that the mining sector product will grow at a rate similar to that referred to above (9.5%), with the result that its share of overall Latin American product will rise from 4.3% in 1979 to 8.2% in the year 2000 (table 3). If this goal is achieved, and taking into account the fact that mining projects take four to seven years to achieve results, it is necessary to make an immediate and large-scale effort to channel investments towards the mining sector, since otherwise serious obstacles to the process of industrialization and development of the region could arise. Given the scale of the investment in question, the greatest difficulties could occur in the relatively less developed countries, since such investment would represent a high percentage of overall investment and public revenue and would divert resources from more balanced development of the other sectors.

## 2. Share of exports

17. Only seven products account for close to 60% of the value of Latin American metal output: iron ore 23%, copper 17%, nickel and zinc 5% each, tin 3%, lead 3% and bauxite 2%. Latin American mining potential could permit exploitation of over 50 minerals, thus resulting in the diversification of the production and exportation pattern in accordance with the requirements of the region's future industrialization and of the international markets for minerals. In 1977 the relative shares of metal exports were as follows: iron ore 32%, copper 31%, bauxite 13%, zinc 6%, silver 6%, tin 6%, lead 4%, and nickel 2%. However, this pattern could change quite rapidly, if the differences in growth rates for the period 1970-1977 are maintained. The highest annual growth rates were attained by exported silver, zinc and tin, whereas the lowest expansion rates were those of lead and copper (see tables 4 and 5).

10/ Also see Chenery.

11/ See Leontief.

/Table 3

Table 3

PROSPECTS FOR THE MINING SECTOR UNTIL THE YEAR 2000

(Billions of dollars, at 1970 prices)

| | Base year 1970 | | Projection to the year 2000 | | Growth rates, 1970-2000 |
|---|---|---|---|---|---|
| | Gross domestic product | Percentage | Gross domestic product | Percentage | |
| 1. World gross domestic product | 3 220.0a/ | | 11 072.0a/ | | 4.2 |
| 2. Overall Latin American gross domestic product | 154.0a/ | | 1 217.0a/ | | 7.1a/ |
| Share of world gross domestic product (percentage) | | 4.8b/ | | 11.0b/ | - |
| 3. Industrial gross domestic product of Latin America | 38.0c/ | | 393.0c/ | | 8.1 |
| Share of the overall Latin American gross domestic product (percentage) | | 24.5c/ | | 32.3c/ | - |
| 4. Engineering gross domestic product of Latin America | 7.0b/ | | 107.0b/ | | 9.5 |
| Share of industrial gross domestic product of Latin America (percentage) | | 18.4a/ | | 27.2a/ | - |
| 5. Mining gross domestic product of Latin America | 6.6d/ | | 100.0e/ | | 9.5e/ |
| Net metallic mineral exports | 3.3a/ | | 49.4a/ | | 9.4 |
| Internal consumption of metals in relation to the engineering gross domestic product of Latin America (percentage) | | 47.1a/ | | 47.3b/ | - |
| Share of overall gross domestic product of Latin America (percentage) | | 4.3d/ | | 8.2b/ | - |

a/ See Carter. CEPAL estimates a rate of 6.2% according to the trends scenario and 5.9% in the moderate acceleration scenario.

b/ Estimates on the basis of footnote a/.

c/ See CEPAL, E/CEPAL/R.237.

d/ Table 1 for the year 1970.

e/ CEPAL estimates a rate of 5.4% in the moderate accelaration scenario.

/Table 4

Table 4

LATIN AMERICA: BREAKDOWN AND GROWTH OF EXPORTED ORES

| Product | Exported ores 1977 | | Annual growth rate, 1970-1977 (current prices) |
|---|---|---|---|
| | Value in millions of dollars | Breakdown by percentage | |
| Iron ore | 1 756.2 | 31.8 | 14.0 |
| Copper | 1 733.8 | 31.4 | 4.3 |
| Bauxite | 709.5 | 12.9 | 12.3 |
| Tin | 352.4 | 6.4 | 17.5 |
| Silver | 347.3 | 6.3 | 23.7 |
| Zinc | 319.1 | 5.8 | 18.2 |
| Lead | 202.1 | 3.7 | 10.6 |
| Nickel | 91.4 | 1.7 | 129.2 a/ |
| Total | 5 511.8 | 100.0 | 10.8 |

Source: See table 2 of the statistical annex.

a/ 1971-1977.

/Table 5

Table 5

LATIN AMERICA: CHIEF COUNTRIES EXPORTING ORES, 1977

| Product | Countries | Percentages | Subtotal by ore |
|---|---|---|---|
| Iron ore | Brazil | 63.7 | |
| | Venezuela | 17.3 | |
| | Chile | 5.9 | 86.9 |
| Copper | Chile | 76.0 | |
| | Peru | 22.0 | |
| | Mexico | 1.5 | 99.5 |
| Bauxite a/ | Jamaica | 75.8 | |
| | Guyana | 18.3 | |
| | Dominican Republic | 3.1 | 97.2 |
| Tin | Bolivia | 92.7 | |
| | Brazil | 6.3 | |
| | Peru | 0.9 | 99.9 |
| Silver | Mexico | 34.6 | |
| | Peru | 33.1 | |
| | Dominican Republic | 15.9 | 83.6 |
| Zinc | Peru | 44.1 | |
| | Mexico | 36.7 | |
| | Bolivia | 14.0 | 94.8 |
| Lead | Peru | 62.2 | |
| | Mexico | 26.1 | |
| | Bolivia | 6.1 | 94.4 |
| Nickel b/ | Dominican Republic | 99.6 | |
| | Brazil | 0.3 | 99.9 |

Source: See table 2 of the statistical annex.

a/ No information available on Suriname.

b/ No information available on Cuba.

/18. Relatively

18. Relatively speaking, mining is one of the most important export areas for a number of countries of the region. If hydrocarbons are excluded, minerals fluctuated from 0.1% of Ecuador's total export volume to 65% of that of Chile. Other countries in which exported minerals are of relatively great importance are: Bolivia, the Dominican Republic, Jamaica, Guyana and Peru (see table 6). The share of exported minerals in relation to overall exports rose in the period 1970-1977 in the cases of Colombia, the Dominican Republic, Honduras and Jamaica. In contrast, their share dropped in the remaining countries, with the exception of Mexico and Peru, whose share remained constant (see once again table 6 and table 4 of the statistical annex).

19. In absolute terms the chief countries exporting ores are Chile and Brazil, with amounts exceeding one billion dollars. Those two countries are followed, in order of importance, by Peru, Jamaica, Bolivia, Mexico and Venezuela, with amounts exceeding US$ 300 million (see table 7).

20. One of the most outstanding characteristics of the region's metal mineral exports is their high level of specialization in one single product. Bauxite and aluminium accounted for 99.7% of exports of the chief metal mineral products of Guyana and Jamaica; iron and steel 97.5% of those of Brazil, 94.1% of those of Argentina and 94.3% of those of Venezuela; copper accounted for 87% of Chile's exports and 92.9% of those of Ecuador, and tin for 78% of those of Bolivia (see table 7). This level of concentration of mineral exports is rising in the cases of Argentina (steel), Bolivia (tin), Colombia (iron ore), the Dominican Republic (iron and nickel), Ecuador (copper), Mexico (silver), and Nicaragua (iron ore), since the rate of growth of these products is greater than that of overall metal mineral exports (see tables 5 and 6 once again). On the other hand, the exports of two or three countries accounted for a high percentage of the region's exports of each product, the share of such exports varying from 83.6% in the case of silver to over 99% in the case of copper, tin and nickel (see table 5 once again).

21. Another of the major characteristics of Latin American mineral exports is their low elasticity in relation to price fluctuations, giving rise to the need to establish regional trade reserves. In the period under consideration elasticity of exported tin, zinc and nickel was below unity, and the rise in the value of those exports was therefore influenced to a greater extent by higher prices than by the increase in the volume exported.

/Table 6

Table 6

LATIN AMERICA: SHARE OF EXPORTED MINERALS a/ IN OVERALL EXPORTS

| | Share | | Rate of growth of exports, 1970-1977 | |
|---|---|---|---|---|
| | Year | Percentage | Minerals | Percentage |
| Countries with mining economies | | | | |
| Bolivia | 1977 | 58.0 | 15.6 | 19.3 |
| Chile | 1975 | 64.8 | 5.1b/ | 7.8b/ |
| Ecuador | 1974 | 0.1 | 23.2c/ | 34.1c/ |
| Guyana | 1977 | 44.4 | 9.4 | 10.3 |
| Jamaica | 1977 | 50.0 | 13.3 | 10.9 |
| Mexico | 1976 | 5.0 | 13.1d/ | 13.3d/ |
| Peru | 1977 | 39.0 | 8.4 | 8.7 |
| Dominican Republic | 1977 | 18.6 | 41.1 | 19.7 |
| Venezuela | 1976 | 3.4 | 10.2d/ | 20.5d/ |
| Countries with semi-mining economies | | | | |
| Argentina | 1977 | 1.3 | 14.9 | 17.5 |
| Brazil | 1977 | 8.8 | 20.4 | 23.1 |
| Colombia | 1977 | 0.2 | 27.3 | 19.2 |
| Honduras | 1977 | 5.9 | 19.1 | 16.0 |
| Nicaragua | 1977 | 1.3 | 9.3 | 19.4 |

Source: See table 4 of the statistical annex.

a/ Calculated on the basis of current prices, including only major metals.

b/ 1968-1975

c/ 1968-1974.

d/ 1969-1976.

/Table 7

Table 7

LATIN AMERICA: CHIEF METALS EXPORTED

(Current prices)

| | Minerals exports | | Growth rates, 1970-1977 | Share of chief product | |
|---|---|---|---|---|---|
| | Year | Millions of dollars | | Product | Percentage |
| Argentina | 1977 | 86.3 | 16.4 | Iron ore | 94.1 |
| Bolivia | 1977 | 418.7 | 17.3 | Tin | 78.0 |
| Brazil | 1977 | 1 147.9 | 20.5 | Iron ore | 97.5 |
| Colombia | 1977 | 6.5 | 37.3 | Iron ore | 59.7 |
| Chile | 1975 | 1 132.7 | 4.4a/ | Copper | 87.0 |
| Ecuador | 1974 | 1.4 | 81.3b/ | Copper | 92.9 |
| Guyana | 1977 | 130.2 | 9.4 | Bauxite | 99.7 |
| Honduras | 1977 | 32.7 | 11.3c/ | Zinc | 39.2 |
| Jamaica | 1977 | 539.1 | 13.3 | Bauxite | 99.8 |
| Mexico | 1976 | 348.1 | 14.8d/ | Silver | 33.3 |
| Nicaragua | 1977 | 9.9 | 20.0 | Iron ore | 40.7 |
| Peru | 1977 | 852.8 | 4.7 | Copper | 44.7 |
| Dominican Republic | 1977 | 168.4 | 136.8e/ | Iron and nickel | 54.1 |
| Venezuela | 1976 | 344.1 | 10.0d/ | Iron ore | 95.3 |

Source: See table 3 of the statistical annex.

a/ 1968-1975.
b/ 1967-1974.
c/ 1973-1977.
d/ 1969-1976.
e/ 1971-1977.

/In the

In the cases of copper and lead elasticity was negative, but it had a different significance in each case. The price of lead rose by 104% during the period 1970-1977, and the volume exported dropped by 1%, whereas in the case of copper volume rose by 45% while the price dropped by 7% during the same period (see table 8).

22. The United States Department of the Interior 12/ estimates that in the period 1974-2000 world demand for metals will grow at the following cumulative annual rates: aluminium 5.4%, copper 4.4%, lead 3.1%, nickel, steel, zinc and silver between 2.3 and 2.8% and tin 1.6%. In view of the potential of regional reserves it may be anticipated that Latin American exports will grow at rates considerably higher than those mentioned above.

### 3. Generation of foreign currency and public revenue

23. Although there may be differences in the texture and quality of the ore mined, in international trade the fine content of metal, which does not vary, is taken as a basis. This is why quotations for the various metals are similar in the major marketing centres of the world. On the other hand, it has been estimated that the income elasticity of international demand for metal products is greater than that of agricultural products.13/ In theory, in international trade in minerals these considerations would result in:

(a) A better position on the world market than that of agricultural products - which have to compete from the point of view of quality and prices - and therefore better opportunities for generating foreign currency.

(b) A decrease in requirements regarding external resources and an improvement in the external debt situation.

(c) Improvement in the terms fof trade owing to greater income elasticity of demand for metal products.

24. However, this is not the actual situation; it must be borne in mind that demand for metals is basically a form of demand resulting from the industrial expansion of the developed countries, whose behaviour can cancel out or reduce the relative advantages mentioned above. The following figures give a picture of this situation:

---

12/ See United States Department of the Interior, 1975.

13/ See Nankani.

/Table 8

Table 8

LATIN AMERICA: PRICE ELASTICITY OF EXPORTED MINERALS, 1970-1977

| Product | Variation in the percentage of export volume | Variation in the percentage of prices | Elasticity |
|---|---|---|---|
| 1. Aluminium (bauxite) | 59 | 42 | 1.40 |
| 2. Copper | 45 | -7 | -6.42 |
| 3. Tin | 6 | 194 | 0.03 |
| 4. Lead | -1 | 104 | -0.01 |
| 5. Zinc | 61 | 100 | 0.61 |
| 6. Nickel | 10a/ | 76a/ | 0.13a/ |

Source: See tables 2 and 5 of the statistical annex.

a/ 1972-1977.

/(a) The

(a) The share of minerals and metals in international trade was 10% during the period 1972-1974. This percentage fluctuated in subsequent years, with a relatively greater reduction than that in the case of foodstuffs and manufactures (see table 9).

(b) During the period 1968-1976, in the mining economies the coefficient of generation of foreign currency in relation to gross domestic product was greater than in the non-mining economies; however, the relative growth of that coefficient in the latter economies was greater than that of the mining economies during the above-mentioned period (see table 10).

(c) The rate of expansion of the region's external debt was high both in countries with mining economies and in the countries belonging to the second group. Similarly, one of the two countries that managed to reduce their levels of external debt belongs to the one group and the other to the other group, thus proving that mining was not the factor responsible for the decrease in external debt requirements (see table 11).

(d) Nor was there a close relationship in the period 1972-1978 between mining economies and favourable terms of trade, although it is clear that low quotations for copper had an adverse effect on terms of trade in the case of Chile and Peru, while high quotations for tin had a positive effect on the terms of trade for Bolivia (see table 12).

25. Current Latin American legislation generally stipulates that the resources of the subsoil are publicly owned and that rights over them may be conceded to the private sector. In this case the government may, on the one hand, establish norms giving it a substantial share of the income generated by the mining sector and, on the other hand, use the surplus in question in a productive manner. It is therefore extremely important to prepare legislation that, in unstable conditions, permits both encouragement of the investor and achievement of high elasticity of the governments' share in relation to revenue fluctuations. In accordance with these goals, the legislation should fulfil the following basic requirements:14/

(a) The tax to be paid should be foreseeable before invesment in exploration is begun.

---

14/ See Palmer.

/Table 9

Table 9

BREAKDOWN OF INTERNATIONAL TRADE BY PERCENTAGES a/

| | 1972 | 1973 | 1974 | 1975 | 1976 |
|---|---|---|---|---|---|
| 1. Manufactured metal and engineering products | 36 | 34 | 29 | 33 | 33 |
| 2. Other manufactures | 26 | 26 | 24 | 22 | 23 |
| 3. Hydrocarbons | 11 | 12 | 21 | 20 | 21 |
| 4. Food products | 17 | 18 | 16 | 16 | 15 |
| 5. Minerals and metals | 10 | 10 | 10 | 9 | 8 |
| Total | 100 | 100 | 100 | 100 | 100 |

Source: See United Nations, Monthly Bulletin of Statistics.

a/ Calculated on the basis of current prices.

Table 10

COEFFICIENT OF GENERATION OF FOREIGN CURRENCY IN RELATION TO GROSS DOMESTIC PRODUCT

(Percentages)

| Developing countries | 1968-1970 | 1971-1973 | 1974-1976 |
|---|---|---|---|
| 1. Non-petroleum mining economies | 33.4 | 35.9 | 35.2 |
| 2. Petroleum economies | 32.6 | 27.4 | 47.5 |
| 3. Non-mining economies | 17.1 | 18.1 | 20.1 |

Source: See UNDP, DP/430.

/Table 11

Table 11

LATIN AMERICA: EVOLUTION OF EXTERNAL DEBT a/

| Countries | Rate of growth of foreign debt 1973-1979 | Foreign debt as a percentage of GDP | |
|---|---|---|---|
| | | 1973 | 1979 |
| Countries with mining economies | | | |
| Bolivia | 4.9 | 37 | 38 |
| Chile | -2.6b/ | 36 | 29 |
| Jamaica | 10.4b/ | - | - |
| Mexico | 14.9 | 11 | 18 |
| Peru | 10.9 | 16 | 25 |
| Dominican Republic | 5.8 | 20 | 21 |
| Venezuela | 18.7b/ | 8 | 15 |
| Countries with semi-mining economies | | | |
| Brazil | 9.4 | 14 | 16 |
| Colombia | -3.2 | 13 | 7 |
| Honduras | 12.1 | 19 | 30 |
| Nicaragua | 8.1 | 32 | 57 |

Source: See table 6 of the statistical annex.

a/ 1970 prices were taken as a basis for calculation, in the case of GDP and the unit value index of imported goods, as an external debt deflator.

b/ Period 1973-1978.

/Table 12

Table 12

LATIN AMERICA: TERMS OF TRADE

(Indices, 1970=100)

| Countries | 1972-1974 | 1975-1977 | 1978 |
|---|---|---|---|
| Countries with mining economies | | | |
| Bolivia | 102 | 115 | 121 |
| Chile | 81 | 54 | 49 |
| Ecuador | 131 | 145 | 142 |
| Guyana | 118 | 126 | 129 |
| Jamaica | 101 | 123 | 110 |
| Mexico | 107 | 114 | 118 |
| Peru | 114 | 100 | 83 |
| Dominican Republic | 100 | 118 | 88 |
| Venezuela | 190 | 279 | 253 |
| Countries with semi-mining economies | | | |
| Argentina | 132 | 91 | 83 |
| Brazil | 91 | 92 | 88 |
| Colombia | 106 | 136 | 147 |
| Honduras | 97 | 103 | 106 |
| Nicaragua | 100 | 102 | 111 |

Source: See table 7 of the statistical annex.

/(b) However,

(b) However, tax should be levied on actual income, estimated by calculating probable income, so as to reduce the level of uncertainty both for the public budget and for the investor.

(c) The tax structure should therefore minimize distorsions in the allocation of resources and maintain incentives that encourage efficient administration of projects.

26. There are various tax systems that can be applied to mining, among which the following may be mentioned: royalties on output that could also be at set or variable levels; taxes on the value of exports and taxes on profits. Even although all these systems have an adequate theoretical and legal basis and are relatively easy to administer, taken separately they could hardly meet all the requirements mentioned above, which means that it is necessary to achieve an appropriate combination of the systems in question. In this connexion, an effective system could contain the following elements:

(a) A low ad-valorem tax scale for imports.

(b) An accelerated depreciation scheme, for example, 15 to 20% in the first four years of the project's operation and the rest distributed over the project's life.

(c) Profits after depreciation would be the basis for initial income tax at a rate that could be around 50% of profits.

(d) A system for recovering and repatriating or reinvesting the capital invested within a period of five to ten years. An additional depreciation system could be applied in order to achieve this goal.

(e) Once the capital invested has been recovered a second tax of approximately 50% would be levied on the net flow of funds (financial surplus).

27. According to the figures in table 13, taxation is more onerous in countries with mining economies (17%) than in other countries (15%) During the period 1960-1973 this coefficient was 21 and 17% in the case of Guyana and Jamaica and 8 and 10% in the case of Guatemala and Paraguay, respectively. The figures would appear to show how much easier it is to levy taxes in mining economies, despite the instability of the prices of the products in question.

/Table 13

Table 13

TAX BURDEN a/

(Percentages)

| Developing countries | 1960-1970 | 1971-1973 |
|---|---|---|
| 1. Mining economies | 16.8 | 17.0 |
| 2. Petroleum economies | 19.8 | 22.8 |
| 3. Non-mining economies | 13.0 | 13.5 |

| Latin America | 1960-1973 |
|---|---|
| 1. Countries with mining economies | |
| Guyana | 21.0 |
| Jamaica | 17.5 |
| 2. Countries with semi-mining economies | |
| Colombia | 8.1 |
| Guatemala | 7.8 |
| Honduras | 10.6 |
| Nicaragua | 9.0 |
| Panama | 11.5 |
| Paraguay | 10.0 |

Source: See UNDP, DP/430.

a/ Total tax revenue in relation to overall GDP.

## 4. Impact on the development process

28. Assuming that development depends on capital formation and technical progress expressed in terms of labour productivity levels and growth, mining and metallurgical activities constitute one of the sectors that could potentially make a considerable contribution to the region's economic growth.

29. Mining resources are a form of "primary capital formation" that must be transformed into other forms of reproductive capital, a process that consists of the following stages:15/

(a) The securing by the producing country of a substantial share of mining revenue in the form of foreign currency and revenue for the public sector.

(b) Allocation of a considerable part of the surplus in question to formation of domestic saving.

(c) Use of this resource to finance other investment projects.

30. As already mentioned, Latin American mining is generating considerable financial flows in the form of foreign currency and revenue for the public sector, and on the other hand, there is no precise information on the extent to which such resources are used for the purpose of immediate improvement of the quality of life (consumption) or for the future development of countries (saving and investment). The figures in table 14 show that for the developing countries as a whole in the period 1968-1976 the average propensity to save dropped in the countries with mining economies, whereas it rose in the countries with non-mining economies. There are no greater differences in Latin America between the two groups, and the differences in question actually basically occur in the higher-income countries as compared with the lower-income ones. This situation would appear to indicate that the surpluses generated in the mining sector are not being used on a large scale to form other types of capital.

31. In view of their high capital requirements per worker and their potential for increasing the capacity to absorb investment in keeping with the potential of reserves, mining and metallurgical activities could become one of the most dynamic sectors of the region's economy. During the 1960s and 1970s their productivity was 10 to 20 times higher than average productivity in Ecuador, Honduras, the Dominican Republic, and Venezuela,

15/ See Mamalakis.

/Table 14

Table 14

AVERAGE PROPENSITY TO SAVE

(Percentages)

| Developing countries | 1968 | 1970 | 1976 |
|---|---|---|---|
| 1. Mining economies | 17.6 | 14.8 | 14.9 |
| 2. Non-mining economies | 13.5 | 15.2 | 16.2 |
| **Latin America** | | **1976-1978** | |
| 1. Countries with mining economies | | | |
| Bolivia | | 11 | |
| Chile | | 18 | |
| Ecuador | | 16 | |
| Guyana | | 17 | |
| Mexico | | 20 | |
| Peru | | 13 | |
| Dominican Republic | | 21 | |
| Venezuela | | 22 | |
| 2. Countries with semi-mining economies | | | |
| Argentina | | 24 | |
| Brazil | | 25 | |
| Colombia | | 21 | |
| Honduras | | 13 | |
| Nicaragua | | 16 | |

Sources: See UNDP, DP/430 and table 8 of the statistical annex.

/and 2

and 2 to 5 times in the cases of Argentina, Bolivia, Chile and Peru. In turn, the rate of growth was higher than that of average productivity in all cases, with the exception of Bolivia, Mexico and Nicaragua (see table 15). According to studies conducted, the productivity of mining projects basically depends on the following factors:

(a) The scale of the mining, which is associated with improved technological levels of production. For example, in Peru the four major mining enterprises generate two thirds of the product of the sector in question and employ only one third of its labour.16/

(b) The type of mining operation, since it is generally possible to mine a greater volume of mineral per worker at open-face mines than in the case of mining in shafts and galleries in the subsoil or by suction of marine nodules.17/

(c) The fine metal content of the ore or efficiency of processing.

(d) The grade or standard of metallurgical recovery, which depends on the quality of the ore and on the technology used in the process in question.

32. From the colonial era to the early decades of this century the mining sector's high productivity resulted in the existence of a dual or enclave economy in a number of countries of the region. Although in recent years an endeavour has been made to diversify such economies in an attempt to achieve more balanced growth, the high productivity of the mining sector and other modern subsectors continues to make the pattern of production uneven.18/ This situation may be observed in figure 1, in which the group of Latin American countries with mining economies displays a more uneven pattern than that displayed by the group of countries with semi-mining economies. In the former group 40% of the labour force, which is concentrated in the less productive sectors, accounts for approximately 11% of the total product, whereas in the more productive sectors 6% of the labour force contributes over 36% of the product. In the latter group 40 and

---

16/ See United Nations, E/C.7/97.

17/ Ibid.

18/ See Cosulich.

/Table 15

Table 15

LATIN AMERICA: EVOLUTION OF MINING AND OVERALL PRODUCTIVITY[a]

(Percentages)

| | Period | Growth rate | | Ratio between mining productivity and overall productivity, index [b] |
|---|---|---|---|---|
| | | Mining productivity | Overall Productivity | |
| **Countries with mining economies** | | | | |
| Bolivia | 1960-1976 | 1.1 | 3.3 | 184 |
| Chile | 1960-1970 | 6.2 | 3.1 | 371 |
| Ecuador | 1962-1974 | 17.8 | 3.9 | 1 941 |
| Mexico | 1960-1970 | 3.6[c] | 4.5 | 126 |
| Peru | 1961-1972 | 5.4 | 2.6 | 472 |
| Dominican Republic | 1960-1970 | 13.4 | 1.4 | 1 888 |
| Venezuela | 1961-1971 | 3.2 | 2.8 | 1 063 |
| **Countries with semi-mining economies** | | | | |
| Argentina | 1960-1970 | 8.6 | 2.5 | 392 |
| Brazil | 1960-1970 | 8.9 | 3.4 | 106 |
| Colombia | 1951-1964 | 2.2 | 2.3 | 152 |
| Honduras | 1961-1974 | 8.7 | 2.0 | 1 161 |
| Nicaragua | 1963-1971 | -0.5 | 4.6 | 100 |

Source: See table 9 of the statistical annex.

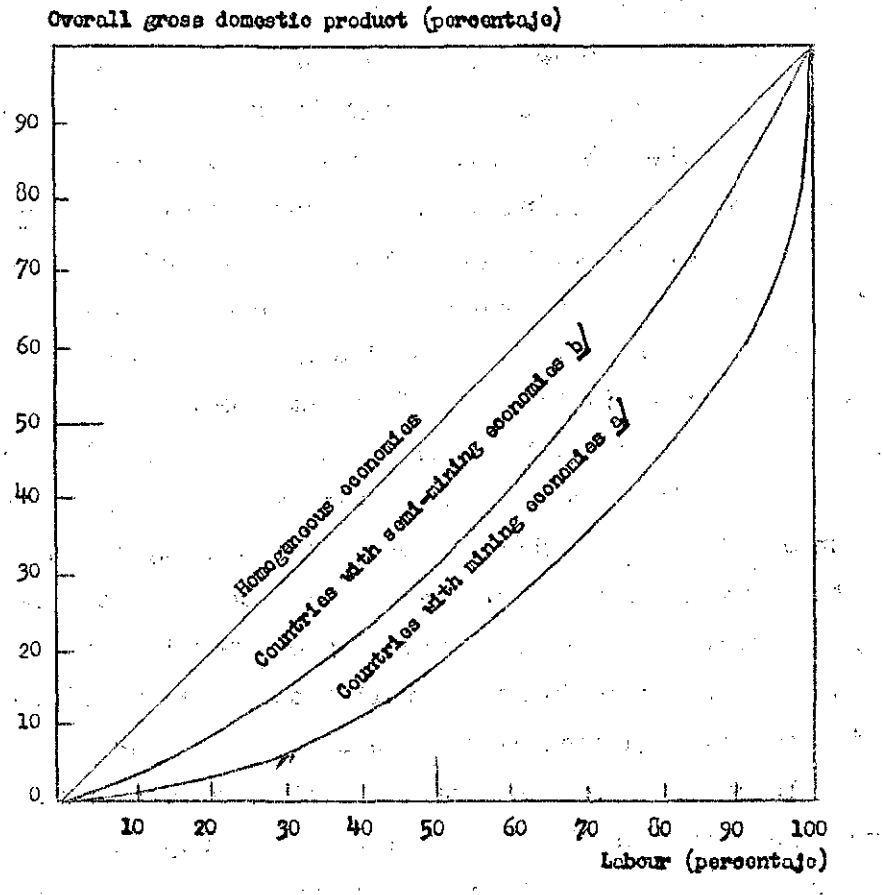
a/ Gross domestic product per person employed.
b/ Overall productivity of each country (in the last year indicated) = 100.
c/ Including industry.

/Figure 1

Figure 1

LATIN AMERICA : DISTRIBUTION OF PRODUCTIVITY

(Primary distribution of income)




Source: See table 9 of the statistical annex.

a/ Bolivia, Chile, the Dominican Republic, Ecuador, Mexico, Peru and Venezuela.

b/ Argentina, Brazil, Colombia, Honduras and Nicaragua.

/6% of

6% of the labour force contribute 23 and 12% of the product, respectively. The above situation means that expansion of mining activities and of other highly productive subsectors calls simultaneously for systematic action to raise the productivity of the most backward sectors and subsectors.

33. There are, in addition to productivity differences, other reasons, why the wages of mining workers are higher than average and industrial wages, including the harsh working conditions, particularly within mines, the remoteness and often the inhospitable environment of mining centres and the effectiveness and negotiating power of miners' unions.19/ 20/ However, the salary differential is not in proportion to the difference in productivity as compared with other sectors (see table 16), which could mean that a substantial proportion of the mining surplus goes to entrepreneurs and the State and is used by them in the form of consumption.

34. In a number of countries the mining sector employs a high proportion of unskilled labour. This fact, together with the wage differentials, attracts redundant labour in other sectors, particularly the agricultural sector, and the social cost of the transfer in question is close to zero,21/ thus placing the mining sector in an advantageous position in relation to other sectors with higher training, installation and adaptation costs. However, owing to its high capital requirements per worker, large-scale mining has little capacity to generate new employment directly. During the 1970s the percentage of the economically active population employed in the mining sector varied from 0.1% in the Dominican Republic to 3.9% in Bolivia, and in the period 1960-1972 in a number of countries, such as Chile, the Dominican Republic, Nicaragua, Peru and Venezuela, there was even a displacement of labour from the mining sector to other sectors (see table 17). Even although medium and small-scale mining have a greater capacity to absorb labour, it must be borne in mind that the drop in productivity may be proportionately greater. It is therefore necessary, for the purposes of planning in the mining sector, to strike a proper

---

19/ See United Nations, E/C.7/97.

20/ See Nankani.

21/ Ibid.

/Table 16

Table 16

LATIN AMERICA: MINING SECTOR WAGES, 1970-1975

(Coefficients)

| | Ratio between per capita mining GDP and overall per capita GDP | Ratio between industrial and mining wages and overall per capita GDP | Ratio between mining wages and overall per capita GDP |
|---|---|---|---|
| Countries with mining economies | | | |
| Bolivia | 1.84 | 0.93 | 0.95 |
| Chile | 3.71 | 0.45 | 0.80 |
| Ecuador | 19.41 | 1.77 | - |
| Jamaica | - | - | 1.60 |
| Peru | 4.72 | 1.84 | - |
| Dominican Republic | 18.88 | 1.30 | - |
| Venezuela | 10.63 | 1.67 | 3.82 |
| Countries with semi-mining economies | | | |
| Argentina | 3.92 | 0.90 | - |
| Colombia | 1.52 | 1.50 | - |
| Nicaragua | 1.00 | 1.90 | - |
| Panama | - | 1.50 | - |

Sources: See UNDP, DP/430, and table 15.

/Table 17

Table 17

LATIN AMERICA: DIRECT EMPLOYMENT OF LABOUR IN MINING ACTIVITIES a/

(Percentages)

| | Period | First year of the period | Final year of the period | Rate of growth of employment in labour |
|---|---|---|---|---|
| Countries with mining economies | | | | |
| Bolivia | 1960-1976 | 3.3 | 3.9 | 0.8 |
| Chile | 1960-1970 | 4.0 | 3.2 | -1.1 |
| Ecuador | 1962-1974 | 0.3 | 0.4 | 5.7 |
| Mexico | 1960-1970 | 17.2b/ | 21.8 | 4.8 |
| Peru | 1961-1972 | 2.3 | 1.5 | -1.9 |
| Dominican Republic | 1960-1970 | 0.3 | 0.1 | -8.2 |
| Venezuela | 1961-1971 | 2.6 | 1.7 | -1.3 |
| Countries with semi-mining economies | | | | |
| Argentina | 1960-1970 | 0.6 | 0.5 | 0.6 |
| Brazil | 1960-1970 | 0.8 | 0.8 | 2.6 |
| Colombia | 1951-1974 | 1.7 | 1.6 | 2.2 |
| Honduras | 1961-1974 | 0.3 | 0.3 | 1.9 |
| Nicaragua | 1963-1971 | 0.9 | 0.6 | -3.9 |

Source: See table 9 of the statistical annex.

a/ As a percentage of the overall economically active population.

b/ Including industry.

/balance among

balance among the growth rate of the product of that sector, higher labour productivity, and levels of employment. At the same time, account should be taken of the fact that the mining sector could generate more indirect employment than other sectors, since many of the new mining production centres could be located in areas far from urban centres that will therefore call for new economic, physical and social infrastructure works.22/

35. In view of the fact that a great part of Latin American mining output is destined for export there is an indirect transfer of resources to other sectors at times when local currencies are overvalued, and the mining sector receives resources when such currencies are undervalued. In this connexion, in some cases exchange rate fluctuations could give an impetus to mining activities or redistribute the mining sector's nominal surplus to the rest of the economy.

36. However, it should be borne in mind that an undervalued currency can exert considerable inflationary pressures, since the level of the prices of imports rises in the national currency. In the case of mining economies such pressures could be exacerbated by a marked drop in metal prices since, on the one hand, there would be a drop in government revenue and government spending would have to be maintained with the aid of credits from the central bank, and, on the other hand, foreign currency would become less readily available, thus causing a contraction in imports and, consequently, in overall supply. Currently, inflationary pressures are caused by a series of factors affecting both mining and non-mining economies, which means that this phenomenon cannot be attributed solely to fluctuations in the prices of metal products; it is for this reason that, taking the developing countries as a whole, in the period 1970-1976 the rate of growth of inflation was higher in non-mining economies than in mining economies. In Latin America the higher rates of inflation of 1978 were recorded both in countries with semi-mining economies (Argentina 170% and Brazil 38%) and in countries with mining economies (Peru 74% and Jamaica 48%) (see table 18).

37. In view of the foregoing, it could be concluded that a number of countries of the region can base their development and industrialization

---

22/ See United Nations, E/C.7/97.

/Table 18

Table 18

ANNUAL INFLATION RATES

(Percentages)

| | 1960-1970 | 1970-1976 |
|---|---|---|
| Mining economies | 8.3 | 12.2 |
| Non-mining economies | 5.5 | 13.6 |
| | 1970 | 1978 |
| Countries with mining economies | | |
| Bolivia | 3.8 | 13.5 |
| Chile | 34.9 | 30.3 |
| Ecuador | 8.0 | 11.7 |
| Guyana | 2.4 | 20.0 |
| Jamaica | 7.5 | 48.4 |
| Mexico | 7.8 | 16.2 |
| Peru | 5.7 | 73.7 |
| Dominican Republic | -1.3 | 1.8 |
| Venezuela | 3.4 | 7.0 |
| Countries with semi-mining economies | | |
| Argentina | 21.6 | 169.8 |
| Brazil | 17.7 | 38.1 |
| Colombia | 3.5 | 17.8 |
| Honduras | 1.4 | 5.2 |
| Nicaragua | 1.9 | 4.4 |
| Total Latin America | 12.2 | 30.9 |

Source: See UNDP, DP/430.

/strategy on

strategy on stepped-up expansion of mining and metallurgical output and that in that case the State could play a more important role in transforming such economies. In other countries, whose chief development options are not in the area of mining and engineering production, expansion of the mining and engineering sector could, in any event, be a strategic or dynamic factor in the process in question. However, as already pointed out, development of mineral resources is a complex process calling for systematic action in the long term. Such action could be systematized in the form of plans that could take into consideration the following stages:

(a) Establishment of long-term development policy with regard to mining and industry.

(b) Planning of long and medium-term investment in mining and metallurgy.

(c) Programming of utilization of the surplus generated by mining, which could be used to finance new investment projects that could be connected with mining as follows:

(i) Investment in infrastructure to reduce mining production and marketing costs.

(ii) Vertical integration of the production process through the establishment of industries to provide mining with inputs and of industries to process the output of metals.

(iii) Regional development of areas that have an influence on mining and metallurgical activities.

(iv) Projects that permit internal retention of the multiplier effects of investment in mining.

(d) A policy of change in accordance with the goals of promoting mining production or of distributing the mining surplus.

(e) A wage policy in accordance with objectives relating to employment of labour or productivity increases.23/

---

23/ Ibid.

## II. IMPORTANCE OF LATIN AMERICA WITH REGARD TO WORLD MINERAL RESOURCES AND TRADE IN MINERALS

38. A great part of the highest-quality deposits are located in developing countries, and Latin America is no exception in this respect, since, taken as a whole, it has approximately one-third of known mining reserves. On the other hand, the other basic inputs, capital and technology, as well as the chief centres of consumption, are concentrated in the developed countries. In accordance with this distribution of factors, an international division of labour has been established whereby the developing countries have generally focused their activities on the mining, processing, founding, refining and exportation of ores, while importing metal and engineering products at levels that, in the case of Latin America, represent approximately 40% of their total imports.

39. If mining resources are considered as a factor of production separately from capital and technology, it may be seen that there is a sufficient theoretic basis for concluding that the developing countries that have such resources should specialize solely in exporting raw material, in view of the constraints on availability of capital and technology and the small scale of their domestic markets. However, unlike agricultural production, in which the major complementary factors are land and unskilled labour, the exploitation of mineral resources needs to be complemented to a great extent by capital and technology, which are requirements that result in a high intensity of the factor in question per worker at all stages of the production process, including those of prospection and exploration for minerals. In view of this situation, the theories put forward do not appear to provide an adequate basis for establishing which countries should specialize in mining and industrial production - those with the raw materials, or those that have greater resources in terms of capital, technology and consumer markets. The following arguments may be used in favour of the first criterion:

(a) The income elasticity of metal products is increasing in the developing countries, whereas per capita consumption in the more developed countries displays very low growth rates, with the result that there will be a gradual transfer of the centres of consumption to the current developing areas.

/(b) In

(b) In the long term the relative availability of the factors of production will change, with the result that the pattern of agricultural exportation will change into a system of industrial exportation that will have to compete closely with that of the countries that are already industrialized, whereas the mining and industrial economies that have sufficient reserves will be able to maintain their comparative advantages.

(c) Transport costs for only the finished products will be lower than those for the current transport of raw materials and finished products.

(d) The least mobile factor is the unskilled labour required for maintaining the levels of mining and industrial operation costs, in contrast with a greater degree of mobility of capital.

40. Although the integration of mining and industrial activities that has frequently taken place as a result of action on the part of the transnational corporations, which are involved at the various stages of production and marketing, could be an important factor in the development of resources, it is not desirable for a substantial portion of the surplus generated in the process in question to be concentrated in the hands of such corporations.

41. The factors described above are giving rise to situations that could result in a change in the current focus of international trade in the products in question. On the one hand, the developing countries are gradually participating in the various stages of the production and marketing process, chiefly with a view to obtaining a greater proportion of the revenue from mining. On the other hand, the developed countries are moving towards a higher level of self-sufficiency in raw materials through:

(a) Concentration of investment in prospection and exploration in their own territories;

(b) Production of substitutes and secondary metal from scrap metal;

(c) Establishment of strategic stocks;

(d) Exploration for marine minerals.

42. Latin America has major comparative advantages over the other regions for the following reasons, which will be considered in the remainder of this chapter:

(a) It is a region with extensive, comparatively high-grade mineral resources, many of which have yet to be explored or exploited;

/(b) It

(b) It is undergoing a rapid industrialization process calling for large quantities of engineering products; and

(c) It has production patterns that are largely geared towards exporting.

### 1. The importance of Latin American reserves with regard to world mineral resources

43. Mineral resources are subject to constant appraisal in accordance with the level of knowledge there is of the size of deposits and with the economic value of such deposits, which in turn depends directly on the international prices quoted for metals and, conversely, on production and marketing costs. At the same time, it must be borne in mind that such resources are not constituted only by primary ores located in land-based deposits and in the form of marine nodules, but also by secondary metals that can be obtained from waste material (scrap). The difficulties involved in interpreting and evaluating information on mineral resources and the need for common classification criteria prompted the United Nations Economic and Social Council to adopt, in March 1979, a proposal concerning the international classification of mineral resources, prepared by a group of experts on definitions and terminology relating to such resources and which permits the following classification of resources:

Category R-1 covers resources in situ in deposits that have undergone sufficiently detailed surveys to establish their formation, dimensions and basic characteristics so that they may be mined and processed under optimum conditions, as well as the distribution of the mineral in the deposit, its grade, physical properties, minerological characteristics and harmful components. All these characteristics are determined chiefly by means of direct physical work (wells, galleries, shafts, etc.), using extrapolation of geological, geophysical and geochemical data to a limited extent.

Quantities have been calculated with a relatively high degree of accuracy, although estimation errors could be as high as 50% in a number of deposits. Such estimates are suitable for planning mining activities.

Category R-1 may be equated with a number of the most common terms used currently for classifying resources.

/R-1 =

R-1 = Proven, certain, demonstrated, identified, located, explored, etc.

Category R-2 covers estimates of resources in situ that are directly connected with discovered deposits; however, unlike in the case of category R-1, estimates are provisional and essentially based on general geological information corroborated by direct measurements at a number of points. Dimensions and form are inferred by analogy with neighbouring deposits falling within category R-1, on the basis of general geology and structural considerations, and through analysis of direct and indirect indications of the presence of mineral deposits. Figures arrived at in this category are less definite than those in category R-1; estimation errors may be over 50%. The estimates in category R-2 are mainly suitable for planning new exploration activities, with a view to future reclassification in category R-1.

Category R-2 may be compared with the current classifications that distinguish between probable, inferred, semi-proven, etc.

Category R-3 corresponds to resources that have yet to be discovered but are thought to exist in common deposits that may be discovered. Estimates of in situ quantities are made chiefly on the basis of geological extrapolations or geophysical or geochemical indications, or by statistical analogy. The existence and size of all deposits in this category are necessarily speculative. Such deposits may or may not actually be discovered in the coming decades. The estimates falling within this category indicate what opportunities there are in the field of exploration, as well as long-term prospects regarding the supply of raw materials. Information on resources in category R-3 should be provided in the form of a range of figures so as to reflect their low level of accuracy.

This category may be compared with current classifications distinguishing between possible potential, not discovered, hypothetical, projected, etc.

Any other material of lower economic potential should be referred to as a "formation" and be accompanied by an explanation of the basis and significance of the estimates.

Categories R-1 and R-2, in particular, may be subdivided as follows:

E = In situ resources regarded as exploitable in a given country or region under the prevailing socio-economic conditions and with available technologies.

/S =

S = The remaining in situ resources that are not regarded as being of current interest but that could become so owing to foreseeable economic and technological changes.

Subcategory S may be further subdivided to obtain an estimate of marginal resources "M" that could be exploited in the more mediate future as a result of normal or anticipated changes in economic or technical circumstances.

All the categories and subcategories described concern estimates of the in situ quantity of metals or minerals. It is considered important also to specify the recuperable quantity of a mineral or metal. Such quantities express with greater accuracy the volume that may be reflected in the supply of minerals. It is therefore recommended that a parallel series of categories and definitions of recuperable quantities should be established, in addition to the categories and subcategories already mentioned. This would permit utilization of one series or of both series in conjunction with each other, as appropriate. It is proposed that the symbols r-1, r-2 and r-3 should be used for recuperable quantities. The letters E, S and M could be used in both cases for the subcategories. However, there can be no general definition of "recuperability" nor of the point in the mining and treatment process at which the level of "recuperability" is to be assessed. Such questions must be settled individually in the case of each product.

If the proposed classification system comes to be used extensively for international communication of information on mineral resources, merely the first step towards general harmonization of the classification of such resources will have been taken. The work of collecting, aggregating and disseminating estimates on resources at the international level is a task that is currently carried out by only a few specialized agencies in the developed countries, the International Atomic Energy Agency, in the case of uranium, and the World Energy Conference, in the case of other sources of energy.

Lastly, it should be stressed that the proposed classification should be adjusted to the individual requirements of the various mineral products. For example, it is perhaps necessary to establish higher levels of accuracy than those already mentioned (R-1, R-2, R-3, etc.).

/44. The

44. The inventory of proven and probable reserves in Latin America shows that there are considerable resources, in terms of both metallic and non-metallic minerals. The most important deposits in the former group are iron ore, bauxite, copper, manganese, rutile and nickel. In the latter group the most extensive deposits are of phosphate rock, nitrates, sulphur and borax. The resources in question are largely concentrated along the zone adjacent to the Cordillera of the Andes and in Brazil, Mexico and the Caribbean (see table 19).

45. However, the common denominator of the countries of the region is the need for greater knowledge of their mineral resources in order to be able to exploit them. For example, it is pointed out in that connexion that exploration activities cover only 5% of Mexico's potential mining area 24/ and 10% of that of Bolivia.25/ Assessment of potential reserves would establish whether there are extensive deposits of copper, bauxite, iron ore, tin, silver, zinc, lead, manganese and nickel. Such resources would be concentrated chiefly in Brazil (iron ore, tin, manganese and zinc), Chile (copper), Cuba (nickel), and Mexico (silver and lead) (see table 20).

46. In recent years most countries have started new geological survey programmes and have completed preparation of their national geological maps (scales 1:5 000 000 and 1:1 000 000). Countries such as Argentina, Brazil, Chile, Colombia, Ecuador, Mexico, Peru and Venezuela and the countries of Central America are conducting activities to locate and identify mineral deposits and have embarked on preparation of the corresponding metalogenic maps.26/ In the case of Bolivia, this work has been completed for the Andean area corresponding to the Nazca plate.27/ Analysis of these maps permits the following conclusions of a very general nature to be drawn.

(a) Mexico would appear to have great mining potential, and it is considered that in order to gain precise knowledge of this the exploration work should be continued at the semi-detailed and detailed level over an area of more than 1.5 million km2.

---

24/ See Salas.

25/ See Bolivian Ministry for Planning and Co-ordination, 1978.

26/ See Salas.

27/ See Claure Velasco et al.

/Table 19

Table 19

LATIN AMERICA: PROVEN AND PROBABLE RESERVES OF METALIC ORES, 1978 ($R_1 + R_2$)

(Thousands of tons of metal content)

| Product | Total reserve | Share in percentages by subregions | | | | Countries with greatests reserves | |
|---|---|---|---|---|---|---|---|
| | | Group 1 a/ | Group 2 b/ | Group 3 c/ | Group 4 d/ | Country | Percentage |
| Antimony | 648 | 66 | - | 34 | - | Bolivia | 56 |
| Bauxite | 6 026 500e/ | - | 42 | 1 | 57 | Brazil | 42 |
| Bismuth | 24 | 79 | - | 21 | - | Bolivia | 79 |
| Cadmium | 14 | - | - | 100 | - | Mexico | 100 |
| Copper | 189 445 | 76 | - | 20 | 4 | Chile | 57 |
| Columbium | 8 165 | - | 100 | - | - | Brazil | 100 |
| Chromium | 1 390 | - | 86 | - | 14 | Brazil | 86 |
| Tin | 1 587 | 62 | 38 | - | - | Bolivia | 62 |
| Iron ore | 53 772 700e/ | 51 | 30 | 1 | 18 | Bolivia | 48 |
| Iridium | 2 | - | 100 | - | - | Brazil | 100 |
| Lithium | 1 270 | 100 | - | - | - | Chile | 100 |
| Manganese | 61 319 | 33 | 65 | 1 | 1 | Brazil | 65 |
| Mercury | 9 | - | - | 100 | - | Mexico | 100 |
| Molybdenum | 2 806 | 96 | - | 3 | - | Chile | 88 |
| Nickel | 23 879 | 3 | 2 | - | 95 | Cuba | 67 |
| Silver | 49 | 39 | - | 61 | - | Mexico | 61 |
| Platinum | 31f/ | 100 | - | - | - | Colombia | 100 |
| Lead | 11 484 | 35 | 21 | 43 | 1 | Mexico | 43 |
| Rhenium | 1 360 | 100 | - | - | - | Chile | 87 |
| Rutile | 55 100 | - | 100 | - | - | Brazil | 100 |
| Selenium | 57 | 91 | - | 9 | - | Chile | 68 |
| Tantalium | 3 | - | 100 | - | - | Brazil | 100 |
| Tellurium | 3 | 100 | - | - | - | Peru | 100 |
| Thorium | 54 | - | 100 | - | - | Brazil | 100 |
| Tungstun | 77 | 51 | 23 | 26 | - | Bolivia | 51 |
| Uranium | 236 | 5 | - | 95 | - | Mexico | 95 |
| Vanadium | 136 | 100 | - | - | - | Chile | 100 |
| Zinc | 15 536 | 45 | 29 | 26 | - | Peru | 45 |

Source: See table 11 of the statistical annex.

a/ Argentina, Bolivia, Colombia, Chile, Ecuador, Peru and Venezuela.

b/ Brazil, Paraguay and Uruguay.

c/ Costa Rica, El Salvador, Guatemala, Honduras, Mexico, Nicaragua and Panama.

d/ Bahamas, Barbados, Cuba, Grenada, Guyana, Haiti, Jamaica, Dominican Republic, Suriname and Trinidad and Tobago.

e/ In terms of unprocessed ore.

f/ Tons.

/Table 20

Table 20

LATIN AMERICA: POTENTIAL MINERAL RESERVES ($R_3$), 1976

(Thousands of tons of metal content)

| Country | Copper | Thin | Manganese | Nickel | Silver | Lead | Zinc |
|---|---|---|---|---|---|---|---|
| Argentina | - | 7 | - | - | - | - | - |
| Bolivia | - | 1 750 | 3 283 | - | - | - | - |
| Brazil | - | 3 748 | 17 074 | - | - | - | 3 226 |
| Colombia | - | - | - | 50 | - | - | - |
| Chile | 111 220 | - | - | - | - | - | - |
| Cuba | - | - | - | 1 645 | - | - | - |
| Guatemala | - | - | - | 90 | - | - | - |
| Mexico | - | 48 | 8 274 | - | 83 | 5 000 | 1 482 |
| Peru | 34 220 | - | - | - | 37 | 4 000 | 2 267 |
| Dominican Republic | - | - | - | 10 | - | - | - |
| Other countries | 85 560 | - | - | 226 | 19 | 3 000 | 3 489 |
| Total potential reserves | 231 000 | 5 553 | 28 631 | 2 021 | 139 | 12 000 | 10 464 |
| Total proven and probable reserves | 189 445 | 1 587 | 61 319 | 23 879 | 49 | 11 484 | 15 536 |
| Total reserves | 420 445 | 7 140 | 89 950 | 25 900 | 188 | 23 484 | 26 000 |

Source: United States Department of the Interior, Bureau of Mines, Mineral Facts and Problems, Washington, 1976, and table 19.

/(b) The

(b) The majority of the Central American countries have a geological makeup displaying conditions similar to those of the volcanic formation of the Sierra Madre in Mexico: a potential which has not been fully explored. It is also possible that some countries may have geological characteristics similar to those of the cupriferous district of Panama.

(c) The geological studies of Argentina, Bolivia, Chile, Colombia, Ecuador, Peru and Venezuela point to great mining potential in the Andean subregion, which should consequently be explored, especially with a view to diversifying the mining production of these countries.

(d) The territory between the mouths of the rivers Orinoco and Amazon could prove to be a mining area of great importance once suitable means of access to the interior of the jungle have been established and the corresponding geological and mining studies have been made.

(e) The territorial area and the geological and mineral characteristics of Brazil make possible the use of indirect exploration methods, which are being successfully used in the projects RADAM-Brazil and I-100.

(f) The geological and mining studies made in Argentina appear to indicate considerable possibilities of increasing its mining production, to which end exploration should be concentrated mainly on the Andean region from the province of Jujuy to the province of Neuquén.

(g) The eastern part of the territory of Paraguay displays geological characteristics pointing to the existence of deposits of iron ore and other minerals, which should be confirmed by geophysical and geochemical explorations.

47. To sum up, it may be said that the proven and probable reserves of various minerals (R1, R2) in the region are sufficient not only to cover its needs for the next hundred years (on the basis of past demand), but also to maintain the expansion of its exports of rhenium, uranium, lithium, bauxite, colombium, iron ore, nickel, molybdenum, selenium and tellurium. In constrast, it will be necessary to find new reserves in the case of another group of minerals which could be exhausted in a period of less than 30 years. These minerals include chromium, platinum, silver, tungsten, zinc, antimony, bismuth, cadmium, tantalum and thorium (see table 22). Initial investigations on potential reserves (R3) give grounds for assuming that in the long term the region could play a more important role in the production of minerals.

/48. In

48. In the period 1976-1978, Latin America's reserves represented 37% of world reserves of copper, 36% of bauxite, 24% of iron ore, 18% of molybdenum, and 16% of tin. If we consider the potential resources (R3) of the world and of Latin America, these percentages could rise to 19% for tin, 25% for iron ore, 21% for nickel and 10% for zinc. The region's share would go down, however, in the case of bauxite (35%), copper (31%) and lead (8%). The mineral resources (R1 and R2) of the developing countries as a whole constituted 73% of world reserves of tin, 70% of those of bauxite, 55% of the reserves of copper and nickel, and 44% of those of iron ore. The biggest share of the developed market economy countries in world reserves of minerals corresponded to lead, and, in decreasing order of importance, to molybdenum, chromium and platinum, and zinc. The centrally planned economies, for their part, had the biggest shares in reserves of tungsten, manganese and mercury (see table 21).

49. For the group of the 14 main metals, world reserves (including those of Latin America) are not likely to be sufficient to cover the demand of the next 30 years (projected at a growth rate similar to that of the period 1947-1974), except in the case of chromium, iron ore and manganese, which would last somewhat longer before running out. Taking into account the fact that mining projects usually have lead times of seven to ten years, and that an investment is generally considered to be justified when the reserves guarantee 20 to 30 years of life for the project, then the following metals would have critical exhaustion periods: zinc (15 years), silver and mercury (17 years), tungsten (23 years) and copper and platinum (27 years). If the projected rates of production in Latin America are maintained, the metals with critical exhaustion periods in the region would be chromium (4 years), platinum (14 years), tungsten (18 years), silver (20 years) and zinc (25 years). The Latin American exhaustion periods would be longer than those for the world as a whole, however, in the case of bauxite, copper, tin, iron ore, mercury, molybdenum and nickel. In analysing this exhaustion period it is necessary to take into account also the possibilities presented by the potential resources (R3), which, once proven, would increase the total resources of various metals (see tables 21 and 22). These increases would be proportionately greater in the case of Latin American reserves than in those of the world as a whole for tin, iron ore, nickel and zinc.

/Table 21

Table 21

LATIN AMERICA: RELATIVE IMPORTANCE OF PROVEN AND PROBABLE MINERAL RESERVES, 1976-1978

(Percentages)

| Product | Developed market economies | Centrally planned economies | Developing economies | Latin America ($R_1+R_2$) | Percentage share of Latin America | |
|---|---|---|---|---|---|---|
| | | | | | Potential reserves ($R_3$) | Total reserves ($R_1+R_2+R_3$) |
| Bauxite | 27 | 3 | 70 | 36 | 32 | 34 |
| Copper | 35 | 10 | 55 | 37 | 17 | 31 |
| Chromium | 54 | 35 | 11 | 1 | - | - |
| Tin | 8 | 19 | 73 | 16 | 21 | 19 |
| Iron ore | 32 | 24 | 44 | 24 | 28 | 25 |
| Manganese | 36 | 42 | 22 | 2 | 2 | 2 |
| Mercury | 38 | 40 | 22 | 1 | - | - |
| Molybdenum | 63 | 18 | 19 | 18 | - | - |
| Nickel | 40 | 5 | 55 | 13 | 32 | 21 |
| Platinum | 54 | 45 | 1 | 1 | - | - |
| Lead | 68 | 9 | 23 | 9 | 7 | 8 |
| Tungsten | 31 | 49 | 20 | 9 | - | - |
| Zinc | 50 | 27 | 23 | 9 | 10 | 10 |

Source: See Leontief and Mikesell and tables 19 and 20 of the text of this document.

/Table 22

Table 22

EXHAUSTION OF PROVEN AND PROBABLE RESERVES, 1978

| Product | At the world level | | | Latin America | | | |
|---|---|---|---|---|---|---|---|
| | Growth rate of demand | | Year of exhaustion | Growth rate of projected production 1980-2000 b/ | Year of exhaustion | Other products c/ | |
| | Historical 1947-1974 | Projected 1980-2000 a/ | | | | Mineral | Year of exhaustion |
| Bauxite | 9.8 | 10 | 2013 | 3.2 | 2350 | Antimony | 1977 |
| Copper | 4.8 | 5 | 2007 | 8.8 | 2047 | Bismuth | 1985 |
| Chromium | 5.3 | 5 | 2034 | 5.0 | 1984 | Cadmium | 1983 |
| Tin | 2.7 | 2 | 2011 | 1.9 | 2043 | Columbium | 2278 |
| Iron ore | 7.0 | 5 | 2026 | 7.8 | 2270 | Iridium | 2018 |
| Manganese | 6.5 | 5 | 2028 | 5.0 | 2026 | Lithium | 12272 |
| Mercury | 2.0 | 2 | 1997 | 2.0 | 2174 | Rhenium | 597148 |
| Molybdenum | 7.3 | 5 | 2011 | 5.0 | 2210 | Rutile | 2210 |
| Nickel | 6.9 | 5 | 2010 | 6.5 | 2250 | Selenium | 2199 |
| Silver | 2.2 | 2 | 1997 | 2.0 | 2000 | Tantalum | 1999 |
| Platinum | 9.7 | 10 | 2007 | 10.0 | 1994 | Tellurium | 2089 |
| Lead | 3.8 | 2 | 2011 | 2.1 | 2016 | Thorium | 2004 |
| Tungsten | 3.8 | 5 | 2003 | 5.0 | 1998 | Uranium | 4562 |
| Zinc | 4.7 | 5 | 1995 | 2.4 d/ | 2005 | Vanadium | 2049 |

a/ See Mikesell.
b/ See Leontief, table 14 of the statistical annex and tables 26 and 27 of the text.
c/ Projected at a rate of 10%.
d/ Rate adjusted in accordance with consumption of refined products. See tables 19, 23 and 26 of the text.

/50. The

50. The various results given by the metal reserve balances for Latin America permit the following lines to be sketched for a possible regional policy of investments in mining prospection and exploration (see table 22).

(a) Chromium, platinum and tungsten: it might be desirable to give priority to mining prospection and exploration work in view of the critical exhaustion periods of the proven and probable resources. A similar policy should be followed, for the same reason, in the cases of antimony, bismuth and cadmium, tantalum and thorium.

(b) Tin and nickel: possible increase in exports and exploration work, taking into account the exhaustion periods at the world level and the relatively large size of the proven, probable and potential resources of Latin America.

(c) Copper and bauxite: possible increase of exports and of prospection work, in view of the longer exhaustion periods of Latin America's proven and probable reserves compared with world reserves and the possible decrease of the region's share in potential reserves (see table 21).

(d) Manganese, lead, silver and zinc: possible increase in exploration work in view of the possibilities of probable and proven resources (see table 19) and the critical exhaustion periods for silver and zinc at both the regional and world levels.

(e) Iron, colombium, lithium, rutile, rhenium, selenium, tellurium and uranium: possible increase in exports, in view of the size of the resources compared with the rate of expansion of regional demand.

(f) Mercury, molybdenum: increase in exports and in mining prospection and exploration works, in view of the short exhaustion period at the world level.

## 2. Geographical distribution of world production and consumption of the main minerals

51. Generally speaking, mining and metallurgical activity in Latin America is directed towards the international market, since except in the case of lead domestic consumption does not exceed 30% of production, while in the case of cadmium and bauxite it is as little as 7%. Total exports range from 66% of the production of lead to 136% of the production of tin. Imports, for their part, vary between 1% for bauxite to 63% for tin. In absolute terms, the biggest volumes of production and exports correspond to iron ore (74 and 54

/million metric

million metric tons of metal content), bauxite (8.5 and 8.1 million), copper (1.5 and 1.3 million), manganese (1.3 million), zinc (1.0 and 0.9 million), lead (0.5 and 0.3 million) (see table 23).

52. The value of the extraction of minerals in Latin America increased from US$ 1 400 million to US$ 3 800 million in 1970 dollars over the period 1950 to 1977 (see table 12 of the statistical annex), with an annual growth rate of 3.8%. At the level of individual products, the biggest growth rates over this whole period were achieved by sulphur, iron ore, nickel and manganese, while the lowest rates corresponded to gold and nitrates (-3.8% and -3.9%, respectively). This growth was not regular over the whole period, however: on the contrary, generally speaking there were high rates in the subperiod 1950-1960, going down in subsequent periods. The different growth rates at the product level have meant that the structure of the value of production has concentrated even more on copper, iron ore, zinc, bauxite, nickel, tin and lead, which increased their share from 74% to 90% over the period 1950-1977. If five more products are added to these, the resulting group of 12 products represented nearly 98% of the value of mining production in 1977 (see table 24).

53. The value of world production of the mineral extraction sector in 1976 was around US$ 57 billion, of which 68% was contributed by the following metals: iron ore (23%), copper (17%), gold (9%), nickel (5%), zinc (5%), tin (3%), and lead, silver and bauxite (2% each). The other metals represented 6% of the value given above, while non-metallic minerals accounted for 26%, the main among them being phosphate rock (5%), potash (4%), nitrates (4%), asbestos (3%) and sulphur (2%). The biggest contribution corresponded to the developed market economy countries (50%), while 25% corresponded to the centrally planned economies and the remaining 25% to the developing countries, among which Latin America's share was over 10%.28/ At the country level, 57.8% of the total value of production was accounted for by the USSR, the United States, Canada, South Africa and Australia. They were followed in order of importance by seven developing countries which contributed 17% of this value, among them Chile, Peru, Brazil and Mexico (see table 25).

---

28/ See United Nations, E/C.7/97.

/Table 23

Table 23

LATIN AMERICA: MINING SUPPLY AND DEMAND, AVERAGE 1976-1978

(Tons of metal content)

| Product | Production | Apparent consumption | Imports | Exports | Other products | | |
|---|---|---|---|---|---|---|---|
| | | | | | Mineral | Production | Imports |
| Bauxite a/ | 8 502 549 | 460 000 | 57 451 | 8 100 000 | Antimony | 17 000 | 2 623 |
| Cadmium | 2 000 | 145 | 176 | 2 031 | Bismuth | 2 160 | 52 |
| Copper | 1 492 000 | 381 000 | 235 594 | 1 346 594 | Columbium | 12 000 | - |
| Tin | 37 946 | 10 400 | 23 773 | 51 319 | Chromium | 336 000 | 97 728 |
| Iron ore | 73 580 012 | 21 353 000 | 1 672 988 | 53 900 000 | Iridium | 23 | - |
| Nickel | 66 000 | 11 100 | 8 824 | 63 724 | Lithium | 54 | - |
| Lead | 492 000 | 213 000 | 46 362 | 325 362 | Manganese | 1 345 000 | 158 041 |
| Zinc | 1 007 000 | 246 500 | 158 983 | 919 483 | Mercury | 73 | 298 |
| | | | | | Molybdenum | 12 384 | 2 201 |
| | Percentage breakdown | | | | Platinum | 1 | 49 |
| Bauxite | 100 | 6 | 1 | 95 | Silver | 3 739 | 296 |
| Cadmium | 100 | 7 | 9 | 102 | Rhenium | 1 | - |
| Copper | 100 | 26 | 16 | 90 | Ruthenium | 105 000 | - |
| Tin | 100 | 27 | 63 | 136 | Selenium | 114 | 16 |
| Iron ore | 100 | 29 | 2 | 73 | Tantalum | 68 | - |
| Nickel | 100 | 17 | 13 | 96 | Tellurium | 12 | - |
| Lead | 100 | 43 | 9 | 66 | Thorium | 1 000 | - |
| Zinc | 100 | 24 | 16 | 92 | Tungsten | 4 443 | 37 |
| | | | | | Uranium | 40 | 165 |
| | | | | | Vanadium | 861 | 581 |

Source: See tables 11 and 13 of the statistical annex.

a/ Alumina content.

/Table 24

Table 24

LATIN AMERICA: EVOLUTION OF STRUCTURE OF MINING PRODUCTION, 1950-1977a/

| Product | Percentage breakdown | | Growth rates | | | | |
|---|---|---|---|---|---|---|---|
| | 1950 | 1977 | 1950-1977 | 1950-1960 | 1960-1970 | 1970-1977 | 1976-1977 |
| Copper | 47.1 | 53.5 | 4.3 | 5.2 | 2.3 | 5.8 | 9.6 |
| Iron ore | 1.7 | 11.1 | 11.3 | 22.2 | 7.7 | 2.1 | -10.8 |
| Zinc | 6.8 | 6.7 | 3.7 | 3.6 | 3.9 | 3.7 | 1.9 |
| Bauxite | 2.9 | 6.3 | 6.8 | 13.1 | 7.0 | -1.8 | 7.3 |
| Nickel | - | 5.2 | 10.1 | - | 12.0 | 7.5 | -0.2 |
| Tin | 8.3 | 3.6 | 0.6 | -3.9 | 4.6 | 1.5 | 2.8 |
| Lead | 7.5 | 3.5 | 0.8 | 1.1 | 0.9 | 0.5 | 5.9 |
| Subtotal | 74.3 | 89.9 | 4.5 | 5.5 | 3.8 | 4.1 | 4.9 |
| Silver | 10.4 | 5.3 | 1.2 | 1.8 | 0.8 | 0.8 | 7.7 |
| Sulphur | 0.1 | 1.2 | 15.2 | 42.4 | 1.3 | 2.1 | -20.4 |
| Gold | 5.1 | 0.7 | -3.8 | -1.8 | -4.7 | -5.4 | -30.7 |
| Nitrates | 4.5 | 0.6 | -3.9 | -5.6 | -3.2 | -2.6 | -9.2 |
| Manganese | 0.2 | 0.1 | 8.1 | 16.8 | 8.2 | -5.2 | -2.6 |
| Subtotal | 20.3 | 7.9 | 0.1 | 1.1 | - | -1.1 | -9.1 |
| Total | 94.6 | 97.8 | 3.9 | 4.7 | 3.3 | 3.6 | 3.6 |
| Total production | 100.0 | 100.0 | 3.8 | 4.5 | 3.4 | 3.3 | 2.0 |

Source: See table 12 of statistical annex.

a/ Calculated on the basis of values of production at 1970 prices.

/Table 25

Table 25

COUNTRY SHARES IN VALUE OF WORLD MINING PRODUCTION[a], 1973

| Country [b] | Percentage share of total value of world production | Per capita value (US$) |
|---|---|---|
| Soviet Union | 18.5 | 41 |
| United States | 13.9 | 37 |
| Canada | 10.4 | 256 |
| South Africa | 10.4 | 226 |
| Australia | 4.6 | 189 |
| Chile | 3.2 | 176 |
| China | 3.2 | 2 |
| Zambia | 2.8 | 311 |
| Zaire | 2.4 | 52 |
| Peru | 1.9 | 66 |
| Brazil | 1.8 | 9 |
| Mexico | 1.7 | 15 |
| France | 1.3 | 14 |
| India | 1.2 | 1 |
| Sweden | 1.1 | 74 |
| Poland | 1.1 | 17 |
| Philippines | 1.1 | 14 |
| Federal Republic of Germany | 1.1 | 10 |
| Japan | 1.0 | 5 |
| Mongolia | 0.9 | 328 |
| Namibia | 0.8 | 477 |
| Marocco | 0.7 | 23 |
| Liberia | 0.6 | 198 |
| Bolivia | 0.6 | 54 |
| Venezuela | 0.6 | 27 |
| Subtotal | 86.9 | 61 |
| Latin American countries included above | 9.8 | 25 |
| World total | 100.0 | 14 |

Source: See United Nations, E/C.7/97, and CELADE, Boletín Demográfico, Vol. XIII, Nº 6, July 1980.

a/ Calculated on the basis of the mining production for 1976, excluding extraction of hydrocarbons.

b/ Countries with production growth more than US$ 250 million.

54. The high growth rates of metallic mineral production achieved by the centrally planned economies in the period 1950-1968 enabled them to increase their share in world production.29/ Up to 1973, the structure of total production did not vary to any great extent, although there were some changes at the product level. The share of the developing countries in production increased in the cases of nickel, iron ore and vanadium, while it went down in the case of lead, zinc, silver, tin and tungsten.30/ In the period 1973-1978, mining extraction in Latin America grew more rapidly than in other regions, but even so its indexes of production with respect to 1970 did not reach the levels corresponding to the centrally planned economies. In contrast, the indexes of metal production were higher than those of other regions, thus reflecting a process of higher industrialization over that period (see figures 2 and 3).

55. Figure 4 shows how world metal production, measured in terms of value added, evolved parallel to the production of manufactures in the period 1973-1978, showing larger variations when production of manufactures went down in 1975, and smaller increases in the period 1976-1978, when the production of manufactures increased considerably. In contrast, the extraction of minerals showed constant evolution in 1976 and 1977, but went down in 1978, thus departing from its parallel course with the production of metals in the period 1973-1975. It is possible that this may have been caused by the joint effect of a higher degree of recovery of metal from the primary ores and a higher degree of recovery of secondary metal from scrap. If this tendency is maintained, the ore requirements, in terms of fine content, will gradually go down for each unit of metal produced: a situation which must be taken into account in defining investment policy by projecting higher growth rates for the metallurgical industry than those for the ore extraction industry.

56. Table 26 shows the figures corresponding to the percentage distribution of proven reserves, production of minerals and metals, and world consumption of metals for the period 1976-1977, with its projection to the year 200.

---

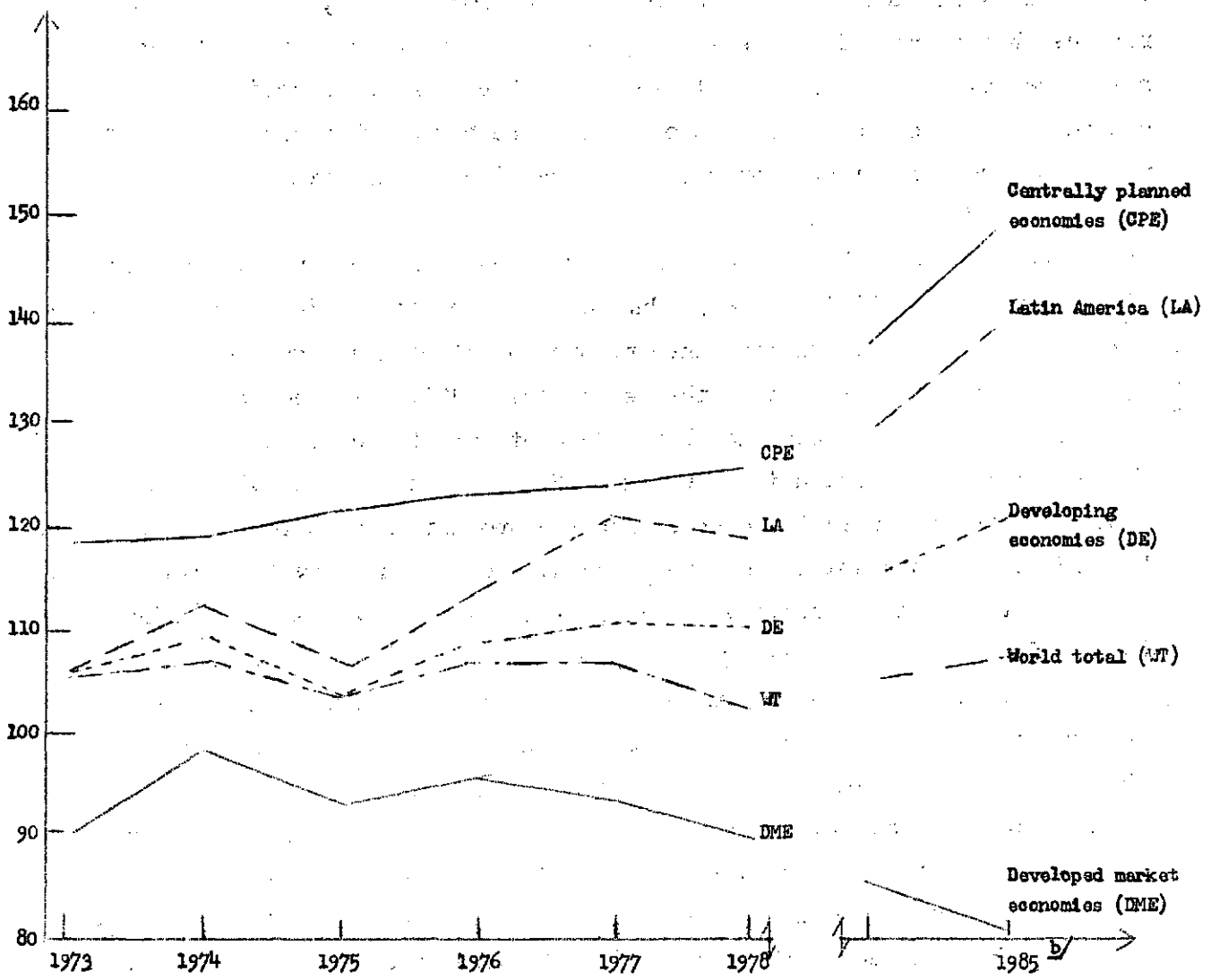
29/ Ibid.

30/ See ESCAP, E/ESCAP/NR.6/6.

/Figure 2

Figure 2

LATIN AMERICA : COMPARATIVE EVOLUTION OF EXTRACTION OF METALLIC MINERALS a/
(Index : 1970 = 100)




Source : U.S. Department of Interior, Minerals Yearbook, 1976.

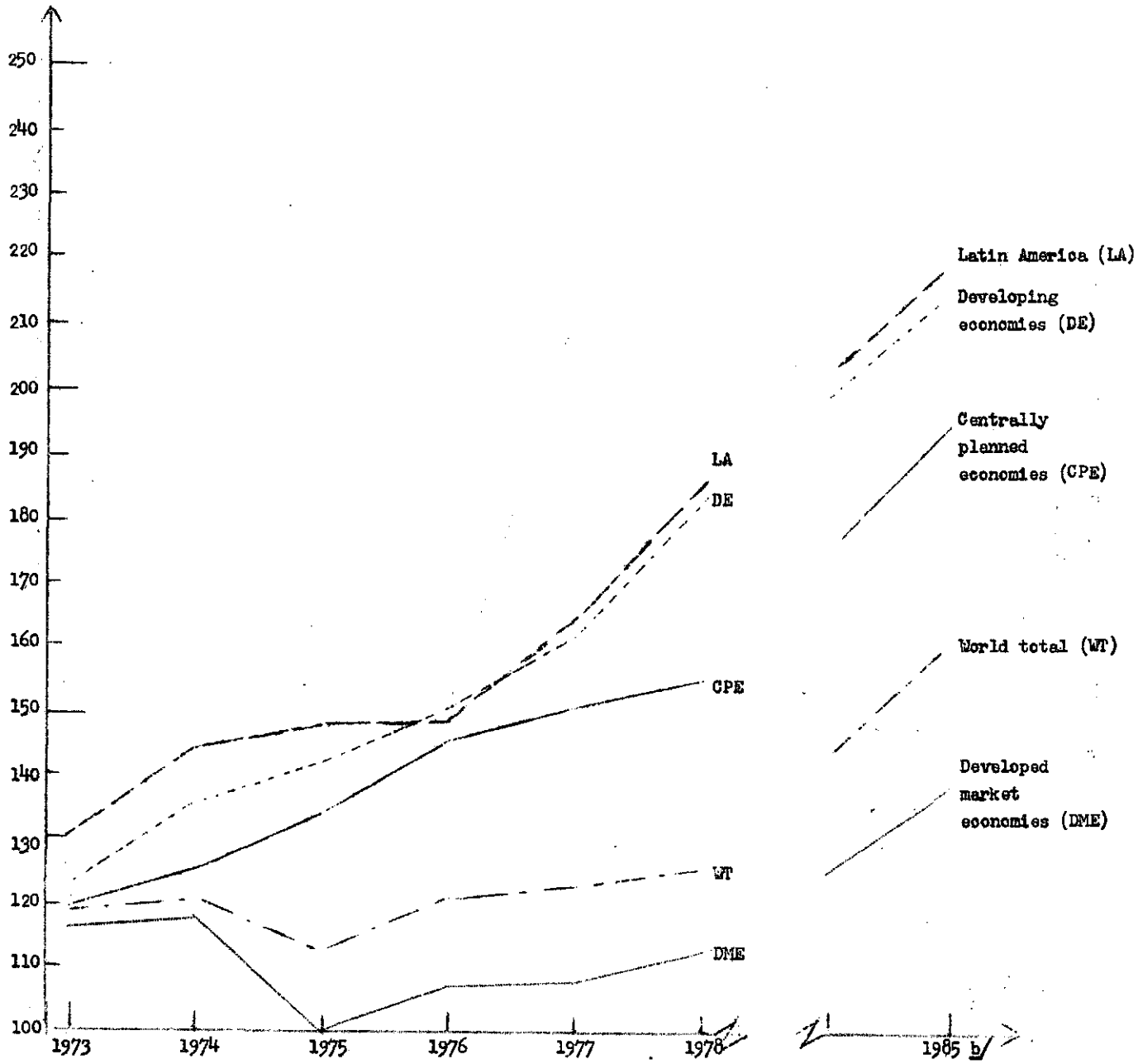
a/ Calculated on the basis of the value added, at constant prices.

b/ The projection for 1985 is based on the trends for the period 1972 - 1978

/Figure 3

Figure 3

LATIN AMERICA : COMPARATIVE EVOLUTION OF METAL PRODUCTION a/
(Index : 1970 = 100)




Source : U.S. Department of Interior, Minerals Yearbook, 1976.

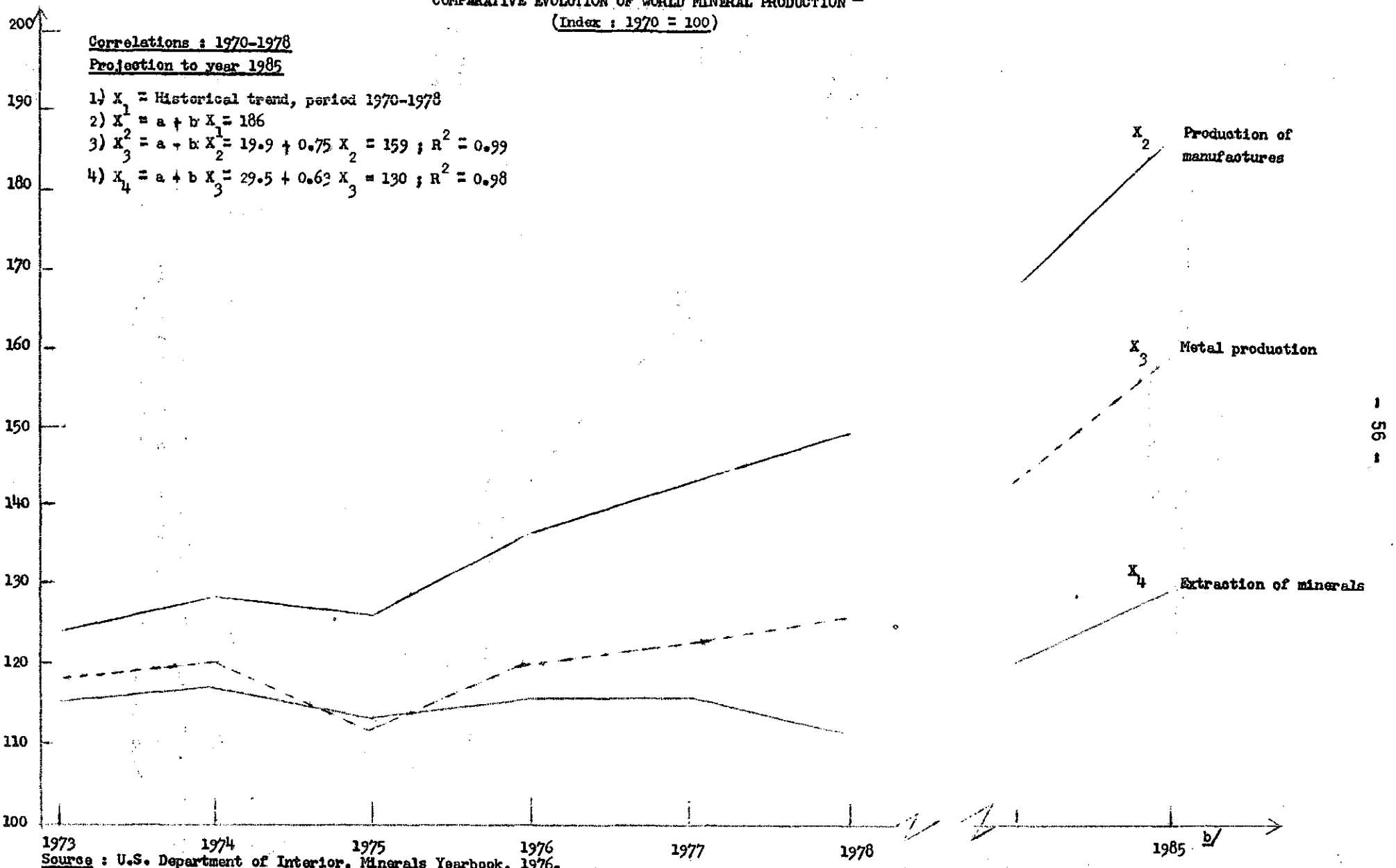
a/ Calculated on the basis of the value added, at constant prices.

b/ The projection for 1985 is based on the trends for the period 1972 - 1978.

/Figure 4

Figure 4

COMPARATIVE EVOLUTION OF WORLD MINERAL PRODUCTION a/
(Index : 1970 = 100)




Source : U.S. Department of Interior, Minerals Yearbook, 1976.

a/ Calculated on the basis of the value added, at constant prices. b/ The projection for 1985 is based on the trends for the period 1972-1978.

/Table 26

Table 26

BREAKDOWN OF WORLD RESERVES, OUTPUT AND CONSUMPTION OF METALS, 1976-1977, AND PROJECTION TO THE YEAR 2000

(Percentages on the basis of volumes)

| Product | Geographic area | Proven and probable reserves, 1976-1978 | Production | | | Consumption of refined products | |
|---|---|---|---|---|---|---|---|
| | | | Period 1976-1977 | | Projection to the year 2000 for refined products | Period 1976-1977 | Projection to the year 2000 |
| | | | Ores and concentrates | Founded and refined | | | |
| Copper | Latin America | 37 | 18 | 13 | 29 | 4 | 9 |
| | Asia and Africa | 18 | 25 | 25 | 20 | 15 | 17 |
| | North America, Western Europe, Oceania | 35 | 34 | 37 | 32 | 55 | 46 |
| | Socialist countries | 10 | 23 | 25 | 19 | 26 | 28 |
| Iron ore and iron | Latin America | 24 | 15 | 3 a/ | 17 | 3 | 16 |
| | Asia and Africa | 20 | 3 | 21 | 22 | 13 | 18 |
| | North America, Western Europe, Oceania | 32 | 45 | 45 | 34 | 57 | 37 |
| | Socialist countries | 24 | 37 | 31 | 27 | 27 | 29 |
| Zinc | Latin America | 9 | 15 | 5 | 8 | 4 | 8 |
| | Asia and Africa | 14 | 12 | 17 | 15 | 19 | 24 |
| | North America, Western Europe, Oceania | 50 | 44 | 47 | 50 | 48 | 36 |
| | Socialist countries | 27 | 29 | 31 | 27 | 29 | 32 |
| Bauzite | Latin America | 36 | 26 | 2 b/ | 27 | 3 | 5 |
| | Asia and Africa | 34 | 19 | 13 | 34 | 14 | 21 |
| | North America, Western Europe, Oceania | 27 | 39 | 62 | 33 | 61 | 51 |
| | Socialist countries | 3 | 16 | 23 | 6 | 22 | 23 |
| Nickel | Latin America | 13 | 9 | - | 13 | 2 | 13 |
| | Asia and Africa | 42 | 12 | - | 23 | 18 | 21 |
| | North America, Western Europe, Oceania | 40 | 60 | - | 50 | 53 | 39 |
| | Socialist countries | 5 | 19 | - | 14 | 27 | 27 |
| Tin | Latin America | 16 | 21 | 11 | 20 | 6 | 8 |
| | Asia and Africa | 57 | 71 | 67 | 56 | 26 | 32 |
| | North America, Western Europe, Oceania | 8 | 8 | 22 | 16 | 68 | 52 |
| | Socialist countries | 19 | - | - | 8 | - | 8 |
| Lead | Latin America | 9 | 14 | 10 | 9 | 5 | 6 |
| | Asia and Africa | 14 | 8 | 10 | 9 | 10 | 20 |
| | North America, Western Europe, Oceania | 68 | 44 | 45 | 52 | 55 | 44 |
| | Socialist countries | 9 | 34 | 35 | 30 | 30 | 30 |

Source: See table 21 in the body of the text and tables 13, 14 and 16 in the statistical annex: ILAFA, La siderurgia latinoamericana en 1977-1978 y sus perspectivas al 2000, Santiago, Chile, 1979 and Leontief.

a/ Steel.

b/ Metallic aluminium.

/Using the

Using the available information, this distribution was carried out for the following groups of countries: (i) Latin America and the Caribbean; (ii) Asia and Africa; (iii) Canada, the United States, Western Europe and Oceania, and (iv) the socialist countries. The estimates for the year 2000 were made on the basis of the trends recorded during the period 1950-1977 and projections made earlier.31/ 32/ Generally speaking, the criterion used in this estimate was to try to equalize the proportion of mineral production with the proportion of reserves and to increase Latin America's contribution to the production of metals. Consumption trends, for their part, show a relative diminution as regards the share of the countries in the third group (the developed countries) and an increase in the shares of the other groups. The situation for each product in the period 1976-1977 was as follows:

(a) Copper: Latin American proven reserves represented 37% of proven world reserves, contributing 18 and 13% of the output of ores and metals. Consumption of metals was only 4%, making Latin America one of the major export regions where both ores and metals were concerned. The percentage of the output of ores and metals of Asia and Africa was greater than that of their reserves, which in turn was greater than that of their consumption, with the result that that region is a net exporter of metals. The proportion of the output of ores and metals of the Western developed countries and developed countries of Oceania was almost the same as their share of world reserves (35); however, their consumption was higher, since it represented 55% of world consumption, which is why that area may be regarded as a net importer of ores and metals. The percentage of the consumption and output of the area covered by the countries with centrally planned economies was greater than their share of world reserves (25 and 10%, respectively), which means that that area should be classified as a net importer of ores.

(b) Iron and steel: 56% of world reserves are concentrated in the developed and socialist countries, where consumption of iron and steel is greater than the above-mentioned reserves (84%) and at a similar level to that of the output of ores. In contrast, output of metals was relatively low,

---

31/ See Mikesell.

32/ See Leontief.

/owing to

owing to Oceania's high volume of exported ore to Japan and the volume of metal imported from Japan by the groups in question. Latin America, which has 24% of world reserves, only produced 15% of the ore and 3% of the metal, the same proportion as that of its consumption, which thus made it a major exporter of ores, particularly from Brazil to Japan. Owing to the above-mentioned pattern, Asia and Africa, which have 20% of reserves, only produce 3% of the ore and 21% of the metal, which was a higher percentage than that of consumption (13%), with the result that this area may be regarded as a net importer of ore and a net exporter of metal.

(c) Zinc: the percentage of reserves and output was similar (77%) to that of the consumption of the developed and socialist countries as a whole, with the differences from one group to the other referred to below. Output was slightly lower than consumption and reserves in the developed countries, which means that they could potentially be self-sufficient as a group. The opposite situation applies in the group of socialist countries, which thus constitutes an area of net importation of ores and exportation of metals. Asia and Africa attained a lower percentage with regard to output of ores and a higher percentage with regard to output of metal than that corresponding to their reserves, but those percentages were, in turn, lower than that of their consumption, which made the area a net importer of both ore and metal. Latin America attained a higher percentage with regard to output of ore than that corresponding to its reserves, but its output of metal was proportionately lower than that of its reserves and similar to that of its consumption, which is why it may be regarded as a net exporter of ore.

(d) Bauxite and aluminium: the most extensive bauxite deposits are located in Latin America (36%) and Asia and Africa (34%); however, the highest percentage of output and consumption of aluminium (85%) is concentrated in the other two groups of countries, which makes the first two groups of countries net exporters of ore.

(e) Nickel: 82% of the reserves of nickel are concentrated in Asia and Africa and in the developed countries; however, output and consumption were concentrated in the developed and socialist countries (80%), with the difference that the former group were net exporters and the latter net importers. The output levels of Asia and Africa were proportionately lower than their

/consumption and

consumption and reserves, which means that that area should be regarded as a net importer. The percentage of Latin America's output was also lower than that of its reserves and greater than that of its consumption, with the result that the region may regard itself as a net exporter of the product in question.

(f) Tin: there is no data available on the socialist countries' output and the consumption of tin, but it is estimated that the relevant percentages would be lower than that of their reserves. The percentage of metal output was higher than that of the developed countries' reserves, although it did not equal the high percentage of their consumption, which makes that group of countries a net importer of both ore and metal. The percentage of Asia and Africa's output was higher than that of their consumption, for which reason both may be regarded as net exporters of metal. The situation was similar in Latin America, except for the fact that Latin America was a net exporter of ore and metal.

(g) Lead: the developing countries' percentage of output was lower than that of their reserves (68%) and consumption (55%), making the countries in question an area of net importation of metal. Their output was higher than their consumption and reserves (35, 30 and 9%, respectively), making them net exporters of metals and possibly net importers of ores. In the group of Asian and African countries output maintained the same volume as that of their consumption but was below the level of their reserves. Latin America's percentage of output was higher than that of its consumption and reserves, placing it in the position of a net exporter of ore and metal.

57. In short, Latin America was an exporter with regard to the seven ores considered and the metals copper, tin and lead. The other areas of net exportation were: Asia and Africa with regard to exportation of bauxite and the metals copper, steel and tin; North America, Western Europe and Oceania with regard to nickel, and the socialist countries with regard to iron ore and iron and the metals zinc and lead. The Western developed countries and Oceania were areas of net importation of copper, zinc, bauxite and tin in the form of ores and of the metals copper, steel, tin and lead. The socialist countries were areas of net importation of copper, zinc and bauxite ores.

/58. On

58. On the basis of proven reserves and the projection of consumption of metals to the year 2000, Latin America's output and exportation policy could be described as follows:

(a) High growth rates in output of the following ores: copper, iron ore and nickel; and of the following metals: copper, steel, zinc, aluminium, nickel, tin and lead.

(b) An increase in the share of world exports of the following metals: copper, steel, aluminium, tin and lead.

59. On the basis of the criteria set forth, a projection to the year 2000 of Latin American output and exportation of ores and metals and consumption of metals was prepared, with the following characteristics: (see table 27)

(a) The annual growth rate of output of ores would vary between 1.9% in the case of tin and 8.8% in the case of copper.

(b) Taking previous extraction indices as a basis, proven reserves at 1978 would be exhausted within a period varying from 25 years in the case of zinc to 370 years in the case of bauxite.

(c) The annual growth rates of output of metals have been projected as being between 3.5% in the case of lead and 22% in the case of aluminium.

(d) It has been estimated that there will be a growth rate of 3.2% in the case of iron ore exports and of 6.8% in the case of copper exports. The remaining exported ores will have negative rates in order to enter the process of metallurgical output.

(e) Growth rates of exportation of the metals lead, tin and copper have been estimated at 2.3, 5.1 and 10.5%, respectively. It is assumed that by the year 2000 Latin America will have a share in exportation of the metals iron and aluminium, whereas its share of exportation of zinc and nickel will drop, in the first case owing to the relative scarcity of zinc reserves and in the second case owing to competition from surplus production over and above consumption of the Western developed countries and the developed countries of Oceania.

Taking the above projections as a basis, Latin America's share of output and consumption of metals will increase until the year 2000 with regard to output of ores, whereas, with the exception of iron, its share of exports will drop, this hypothesis being based on the assumption that an accelerated process of metallurgical industrialization will take place at the regional level.

/Table 27

Table 27

LATIN AMERICA: PROJECTION OF THE EVOLUTION OF THE MINING SECTOR TO THE YEAR 2000

(Thousands of tons of metal content)

| Product | Period | Years of duration of proven and probable reserves at 1978 a/ | Output of ore | Output of metals | Consumption of metals | Net exports | |
|---|---|---|---|---|---|---|---|
| | | | | | | Ores | Metals |
| Copper | 1976-1977 | 67 | 1 418 | 918 | 381 | 500 | 537 |
| | 2000 | - | 9 970 | 7 720 | 2 425 | 2 250 | 5 295 |
| Growth rate | | - | 8.8 | 9.7 | 8.4 | 6.8 | 10.5 |
| Iron | 1976-1977 | 290 | 112 945 | 22 000b/ | 26 000b/ | 86 945 | - |
| | 2000 | - | 629 500 | 448 000b/ | 432 000b/ | 181 500 | 16 000b/ |
| Growth rate | | - | 7.8 | 14.0 | 13.0 | 3.2 | - |
| Zinc | 1976-1977 | 25 | 916 | 319 | 247 | 597 | 72 |
| | 2000 | - | 1 586 | 1 450 | 1 450 | 136 | - |
| Growth rate | | - | 2.4 | 6.8 | 8.0 | -6.2 | - |
| Bauxite | 1976-1977 | 370 | 21 167 | 338c/ | 460c/ | 20 707 | - |
| | 2000 | - | 44 018 | 32 749c/ | 6 363c/ | 11 269 | 26 386c/ |
| Growth rate | | - | 3.2 | 22.0 | 12.1 | -2.6 | - |
| Nickel | 1976-1977 | 270 | 67 | 67 | 11 | - | 56 |
| | 2000 | - | 287 | 287 | 287 | - | - |
| Growth rate | | - | 6.5 | 6.5 | 15.2 | - | - |
| Tin | 1976-1977 | 63 | 40 | 22 | 10 | 18 | 12 |
| | 2000 | - | 61 | 61 | 23 | - | 38 |
| Growth rate | | - | 1.9 | 4.5 | 3.7 | - | 5.1 |
| Lead | 1976-1977 | 36 | 488 | 344 | 213 | 144 | 131 |
| | 2000 | - | 781 | 760 | 537 | 21 | 223 |
| Growth rate | | - | 2.1 | 3.5 | 4.1 | -8.0 | 2.3 |

| Product | Percentage breakdown | | | | | | |
|---|---|---|---|---|---|---|---|
| | Output of ores, 1976-1977 and 2000 | Output of metals | | Consumption of metals | | Net exports | |
| | | 1976-1977 | 2000 | 1976-1977 | 2000 | 1976-1977 | 2000 |
| Copper | 100 | 65 | 77 | 27 | 24 | 73 | 76 |
| Iron | 100 | 19 | 71 | 23 | 69 | 77 | 31 |
| Zinc | 100 | 35 | 91 | 27 | 91 | 73 | 9 |
| Bauxite | 100 | 2 | 74 | 2 | 14 | 98 | 86 |
| Nickel | 100 | 100 | 100 | 16 | 100 | 84 | - |
| Tin | 100 | 55 | 100 | 25 | 38 | 75 | 62 |
| Lead | 100 | 70 | 97 | 44 | 69 | 56 | 31 |

Source: See table 21 in the text and tables 13 and 14 of the statistical annex; ILAFA, La Siderurgia Latinoamericana en 1977-1978 y sus Perspectivas al 2000, Santiago, Chile, 1979.

a/ Years of duration of proven and probable reserves at 1978, in accordance with average output for the period 1978-2000.

b/ Steel.

### 3. Other characteristics of international trade in ores and metals

60. In 1976 65% of the total value of international trade in ores, metals and metal products was accounted for by the developed countries' exports, 26% by those of the developing countries and the remaining 9% by those of the countries with centrally planned economies. Among the second group of countries, Latin America contributed only 6% of such trade.33/ In turn, exported ores and metals represented 6.4% of total trade. During the period 1970-1977 the evolution of metal prices was favourable, with the exception of the price of copper, which means that the increase in the value of Latin American exports was to a greater extent attributable to such evolution than to the evolution relating to its physical volume (see table 28).

61. In 1976 80% of Latin American exported ores and metals were destined for the developed market-economy countries, 12% for the countries of the region itself, 7% for the countries with centrally planned economies, and only 1% for other developing countries. It should be borne in mind that, if the proportion of proven reserves is maintained, Asia and Africa will be potential importers of zinc and lead and the socialist countries will be potential importers of copper, iron, bauxite, nickel, tin, zinc and lead. The chief selling markets of the exports of other developing countries were also in the developed countries, which absorb 71% of such exports. An aspect that should be stressed is that 25% of such exports were destined for developing countries and that Latin America absorbed 1%. The groups of developing and socialist countries focused their exports on countries in their own areas in percentages amounting to 69 and 63%, respectively. Eighteen per cent of the exports of the former group of countries were destined for developing countries, whereas 29% of the exports of the latter group were destined for developed countries. In short, 73% of the ores and metals exported in the world came from developed countries, 10% from the other developing countries, 10% from the socialist countries and 10% from Latin America. Developed countries accounted for 67% of imports, the socialist countries for 15%, other developing countries for 14% and Latin America for 4%, which means that the group of developed market-economy countries and Latin America may be regarded as areas of net exportation (see table 29).

33/ United Nations, Monthly Bulletin of Statistics.

/Table 28

Table 28

LATIN AMERICA: INDEX OF MINERAL EXPORTS

| Product | Period (index 1970=100) | Value | Price | Volume |
|---|---|---|---|---|
| Bauxite | 1970-1975 | 189 | 142 | 133 |
| Copper | 1970-1977 | 122 | 93 | 131 |
| Tin | 1970-1977 | 310 | 294 | 105 |
| Lead | 1970-1977 | 183 | 204 | 90 |
| Zinc | 1970-1977 | 314 | 200 | 157 |
| Nickel | 1972-1977 a/ | 194 | 176 | 110 |

Source: See tables 6, 12, 26 and 32 in the text and tables 2, 5 and 7 of the statistical annex.

a/ Index 1972=100.

/Table 29

Table 29

BREAKDOWN OF INTERNATIONAL TRADE IN ORES, METALS[a/] AND METAL PRODUCTS, 1976

(Percentages)

| Imports \ Exports | Latin America | Other developing economies | Developed market economies | Centrally planned economies | Total ores and metals exported | Share of exported ores and metals | Share of total exports |
|---|---|---|---|---|---|---|---|
| Latin America | 12 | 1 | 80 | 7 | 100 | 7 | 6 |
| Other developing economies | 1 | 24 | 71 | 4 | 100 | 10 | 17 |
| Developed market economies | 4 | 16 | 69 | 11 | 100 | 73 | 67 |
| Centrally planned economies | 2 | 6 | 29 | 63 | 100 | 10 | 10 |
| Share of imported ores and metals | 4 | 14 | 67 | 15 | | 100 | 100 |

Source: See United Nations, Yearbook of International Trade Statistics, 1977.

a/ Calculated on the basis of the value of exports.

62. An estimate of possible trends in international trade in ores and metals until 2000 in net terms at the level of each region has been made on the basis of the projections in table 26. According to this projection, Latin America will export copper, iron and bauxite ores and metals to the market-economy developed countries and the socialist countries, and lead to Asia and Africa; zinc ores to Asia and Africa and metal containing tin to the developed countries (see table 30).

63. In the period 1970-1978 total Latin American imports at current prices grew at an annual rate of 19.7%. In the same period ores and metal and engineering products grew at an annual rate of 18%. Taking imports in this group as a whole, ores (20%) and metal-based plant and machinery (18.5%), had the highest growth rates. However, it should be borne in mind that imported ores and metals represented over 6% of total imports, whereas imported engineering products accounted for 36% of such imports (see table 31). The projection to the year 2000 assumes that Latin America will be able to meet its requirements relating to ores and metals that are currently being met by other geographic areas, as a basis to support the regional process of manufacturing engineering products (see table 30 once again).

64. Taking 1970 as a basis, the price index for ores and metals at 1978 was lower than that for exported primary products, excluding the index for hydrocarbons in both cases, but higher than the index for manufactured exports (252, 257 and 219, respectively). In the same period the price index for ores was higher than that for metals, which would appear to indicate a lower relative increase in the cost of processing charged in respect of the smelting of ores.34/ During the period 1950-1979 the evolution of prices for ores was favourable in nominal terms; however, if those prices are deflated in order to establish the evolution of their real value, it will be noted that that evolution was unfavourable as follows: throughout the entire period in the case of lead and zinc, in the 1950s in the case of tin, from 1976 onwards in the case of copper, and in 1976 and 1978 in the case of bauxite (see table 32). Between 1970 and 1978 the terms of trade for metals, as compared with the prices of manufactured goods, were generally unfavourable, with the exception of those of tin, for which prices began to be favourable from 1974 onwards. The other

34/ See United Nations, E/C.7/96.

/Table 30

Table 30

PROJECTION OF THE BREAKDOWN OF NET INTERNATIONAL TRADE IN ORES AND METALS TO THE YEAR 2000

(Thousands of tons)

| Imports \ Exports | Latin America | Asia and Africa | North America, Western Europe and Oceania | Socialist countries | Total |
|---|---|---|---|---|---|
| Latin America | | | | | |
| Bauxite | - | - | 29 516 | 8 139 | 37 655 |
| Copper | - | - | 2 903 | 4 642 | 7 545 |
| Tin | - | - | 38 | - | 38 |
| Iron ore and iron | - | - | 121 600 | 75 900 | 197 500 |
| Lead | - | 244 | - | - | 244 |
| Zinc | - | 136 | - | - | 136 |
| Asia and Africa | | | | | |
| Bauxite | - | - | - | 15 947 | 15 947 |
| Copper | - | - | - | 302 | 302 |
| Tin | - | - | 89 | 23 | 112 |
| Iron ore and iron | - | - | - | 42 600 | 42 600 |
| Nickel | - | - | - | 466 | 466 |
| North America, Western Europe and Oceania | | | | | |
| Nickel | - | - | - | 31 | 31 |
| Lead | - | 282 | - | 1 758 | 2 040 |
| Zinc | - | 1 695 | - | 839 | 2 534 |

Source: See table 26 in the text and table 16 in the statistical annex.

/Table 31

Table 31

LATIN AMERICA: EVOLUTION AND BREAKDOWN OF IMPORTED ORES AND METAL PRODUCTS[a/]

| Lines | Percentage breakdown 1978 | Growth rate 1970-1978 |
|---|---|---|
| Metal-bearing ores and scrap containing metal | 1 | 20.0 |
| Iron and steel | 4 | 16.2 |
| Non-ferrous metals | 1 | 15.0 |
| Other products manufactured with metal | 2 | 14.6 |
| Plant and machinery in the field of transport | 34 | 18.5 |
| Total ores and metal products | 42 | 18.0 |
| Total Latin America imports | 100 | 19.7 |

Source: See table 17 of the statistical annex.

a/ Calculated on the basis of the FOB value of exports to Latin America at current prices.

/Table 32

Table 32

EVOLUTION OF THE NOMINAL AND REAL PRICE OF ORES ACCORDING TO QUOTATIONS OF THE LONDON METAL EXCHANGE

(Indices, 1950 = 100)

| Period | Deflator a/ | Aluminium (bauxite) | | Copper | | Tin | | Nickel | | Lead | | Zinc | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Nominal | Real | Nominal | Real | Nominal | Real | Nominal | Real | Nominal | Real | Nominal | Real |
| 1951-1955 | 119 | 133 | 112 | 149 | 125 | 114 | 96 | 132 | 111 | 108 | 91 | 95 | 80 |
| 1956-1960 | 125 | 165 | 132 | 138 | 110 | 104 | 83 | 163 | 130 | 81 | 65 | 70 | 56 |
| 1961-1965 | 130 | 164 | 126 | 169 | 130 | 143 | 110 | 178 | 137 | 75 | 58 | 76 | 58 |
| 1966-1970 | 136 | 180 | 132 | 274 | 201 | 166 | 122 | 226 | 166 | 90 | 66 | 85 | 63 |
| 1971-1975 | 221 | 220 | 100 | 293 | 133 | 264 | 119 | 363 | 164 | 136 | 62 | 215 | 97 |
| 1976 | 306 | 286 | 93 | 286 | 93 | 373 | 122 | 502 | 164 | 154 | 50 | 217 | 71 |
| 1977 | 336 | 364 | 108 | 266 | 79 | 524 | 156 | 558 | 166 | 211 | 63 | 180 | 54 |
| 1978 | 382 | 306 | 80 | 276 | 72 | 626 | 164 | - | - | 225 | 59 | 180 | 47 |
| 1979 | 433 | - | - | 403 | 93 | 752 | 174 | - | - | 411 | 95 | 227 | 52 |

Source: See table 5 of the statistical annex and United Nations, E/C.7/96.

a/ See CIF unit value of manufactured products exported from developed countries to developing countries.

/metals for

metals for which the terms of trade were favourable during the period in question were zinc between 1972 and 1977 and lead in 1973 and 1974. The most unfavourable evolution applied to copper, particularly in 1972 and during 1975-1978.

65. The future evolution of the prices for ores and metals does not seem very favourable in absolute terms in the long term, since the latest projections indicate that their growth until the year 2000 will be lower than that attained in the period 1955-1980.35/ For example, it is estimated that the annual growth rate, which was 12.5% in the period 1970-1978, will be around 4.5% in the period 1970-2000, with a marked acceleration in the period 1970-1990 and a sharp drop in the 1990s. The explanation for this evolution could be the gradual exhaustion of proven reserves during the first period and utilization of probable reserves during the second period. To the uncertainty concerning the volume and cost of exploiting probable reserves it is necessary to add the uncertainties concerning the possibilities with regard to, and output cost of, substitutes and recovery of secondary metals from scrap. Depending on the behaviour of the above-mentioned factors, it is estimated that the price of copper and lead could rise at an annual rate of 1 to 10% in the case of the former product and of 2 to 9% in the case of the latter product. Nickel and zinc prices will rise at annual rates of 6%, those of bauxite at rates of approximately 2% and that of iron will remain virtually constant. It is considered that the behaviour in question will also be irregular during the various periods, it being estimated, for example, that the outlook for copper will be more favourable in the short term but will subsequently decline in the medium term. Similar behaviour is anticipated in the case of the price of bauxite and aluminium, but in connexion with the medium and long-term period.36/

66. At the same time, despite efforts to stabilize or improve prices, it is estimated that prices will continue to be subject to strong fluctuations in the short term, depending on changes in the two components of demand, consumption and establishment of stocks of a commercial or strategic nature. Relatively speaking, it is estimated that the increase in the price of ores and metals will be greater than that of other primary products and of manufactures, which means that the terms of trade will be favourable for the major exporters of the products in question, perhaps to a great enough degree to cover their trade deficits.37/

---

35/ Ibid.

36/ See United Nations, E/C.7/96.

37/ See Leontief.

## III. FORMATION AND DISTRIBUTION OF MINING INCOME

67. One of the basic characteristics of mineral economies is the existence of a financial surplus or income defined as the income remaining over and above the "normal" remuneration of factors of production. "Normal" remuneration means the minimum earnings necessary to induce the employment of these factors of production. This income may be generated and distributed throughout the whole production and marketing process, from the extraction of the ore until the final products are sold.

68. The generation and distribution of mining income depend on the following factors:38/

(a) Differences in the quality and presentation of the ore and in access to it and transport costs mean that a surplus is generated by the richest deposits which are provided with adequate transport infrastructure and lower exportation and marketing costs - a surplus which for this reason is called the differential income.

(b) The relative scarcity of a product due to exhaustion of the known deposits or by its concentration among a small number of producers may generate surpluses when accompanied by a rapid and sustained price increase as is happening in the case of hydrocarbons and, to a lesser degree, that of tin (scarcity rent).

(c) Monopolistic rents can arise as a result of the structure of the international market for each product. Generally speaking, there are no open markets for some minerals, which are subject to monopolistic and monopsonistic structures. First, when products are concentrated in a small number of countries or in specific areas, there is the possibility of producer-country cartels or associations with enough power to impose certain price levels on the international market. Second, transnational corporations which intervene in various stages of production and marketing not only exercise a powerful influence on the market because of the magnitude of their operations but also siphon off some of the mineral rent by providing ore transformation, transport and marketing services in which they also hold

38/ See Nankani.

a monopoly position. Thirdly, by building up commercial stocks or strategic reserves, it is possible to devise speculative ways of generating and appropriating this kind of surplus.

(d) Quasi-rents in the mining industry arise from the transfer of the excess costs of the factors of production to the consumer. So much capital is required to do this that many projects exhaust the possibilities of ordinary means of financing, especially those provided by multilateral agencies for development promotion. In this case, the main sources of financing are concentrated in suppliers of machinery and technology, commercial banks or transnational corporations engaged in production and marketing, which, to compensate for the risks involved in this kind of investment, raise the cost of the capital. At the same time, national wage policy or trade-union action may mean that miners' wages can obtain a surcharge.

(e) Sharp short-run price fluctuations due to variations in demand in the presence of low cost and production elasticity may result in either positive or negative rents which will make the income of producers higher or lower than anticipated.

### 1. Application of Ricardo's principle to mineral rent

69. David Ricardo's land rent principle may be applied to mining with the difference that in agriculture the fertility of first-rate land may be maintained or even improved while in the case of mining, ore deposits are gradually being exhausted.

70. Deposits would be classified in four categories depending on their metallic content (degree of purity of the ore they contain).39/ As a general rule, deposits in the second and third categories are now under exploitation while known deposits in the first category are probably virtually on the brink of exhaustion. It must, however, be borne in mind that both the exploitation of minerals and the countries in which minerals occur are in different cycles or stages of a cycle,40/ and it is precisely those differences which generate or increase mineral rents, as will be observed from the following outline:

---

39/ See Mamalakis.

40/ See Nankani.

/(a) During

(a) During the past century the price of all minerals with the exception of precious metals was determined on the basis of production costs. Deposits containing ore with a high metallic content would require low levels of technology in the phases of both extraction and reduction, and for that reason the price of minerals obtained from them was relatively low. The gap between costs and prices gave rise to mineral rent, but the deposits were exhausted without the producer country deriving any further advantage from them.41/

(b) The demand for metals began to rise at the beginning of the century, and their prices rose proportionately, which generated a considerable surplus (or scarcity rent), which in some cases constituted the financial base of the future transnational corporations in the sector. For example, prior to the First World War, the cost of producing one ton of tin was 30 pounds sterling, while its price exceeded 200 pounds. As a result, deposits in the first category were exploited on a very rapid rate, resulting in the depletion of most of them. Second-category deposits then began to be exploited, for which it was necessary to invest heavily in infrastructure and in the extraction and reduction of ore in order to be able to keep costs at the level of prices, so that first-category deposits which had not been depleted or had been discovered subsequently produced differential rent.

(c) The steady increase in demand resulted in the depletion of many second-category deposits, so that, in the same way, third-category deposits with new technology and capital requirements, especially in the recovery phase of extractive metallurgy, began to be exploited. The similarity in the prices and the exploitation costs of third-category deposits has meant that first- and second-category deposits generate another differential rent.

(d) It is possible that this process may continue with the exploitation of fourth-category deposits; however, the cost increment might be curtailed by the production of substitutes, the recovery of secondary metals from scrap and the mining of deep sea nodules. There are, for example, indications that the metallic contents of world copper reserves is less than 1% on average while the cost of exploitation is around US$ 0.80 a pound. There

---

41/ See Mamalakis.

/are, however,

are, however, places in the world where deposits with contents of between 0.3% and 4% have been under exploitation at costs varying from US$ 1.30 to 0.30 a pound, with a marked differential rent resulting from those in the latter group. If, for example, the price exceeds US$ 1.60 a pound, aluminium or secondary copper would be in a good position to compete with primary copper.42/ It should be borne in mind that not only are these differences in quality in different deposits, but different degrees of purity can also be found in the same deposit. At a specific level of exploitation or standard of reduction, there will be a given number of mineral reserves with an average or standard content. If the reduction standard is lowered, the number of such reserves will increase, but the metallic content will decrease. This will result in higher extraction costs because it will be necessary to dig deeper and handle a larger quantity of ore, and in higher reduction costs because large surpluses originally produced by a deposit may later on begin to decline sharply - a problem which should be considered when the legal foundations of the mining industry are laid.

71. The presentation of deposits is another factor which may generate differential rent because of variations in extraction costs and concentration. Metals may be disseminated in rock (porphyry or porphyritic rock), generally with a low metallic content, and may lie deep or close to the surface. When ore is close to the surface, it may be extracted through an open-pit system, which lowers the cost of extraction. Complex mineral may also be found concentrated below the surface in fissures, veins or pockets, which means high extraction costs but perhaps lower reduction costs because of the higher metallic content. The exploration of the ocean floor has made it possible to determine the existence of small nodules of complex minerals which may be extracted by, for example, suction pumps.

### 2. The relative scarcity of mineral resources

72. Because of the high cost of mineral prospecting and exploration, private investment is usually made in quantities sufficient to identify reserves which guarantee the viability of new projects and is not aimed at making an inventory of the mineral resources of a country or region. In exploitation

42/ See Mining Corporation of Panama.