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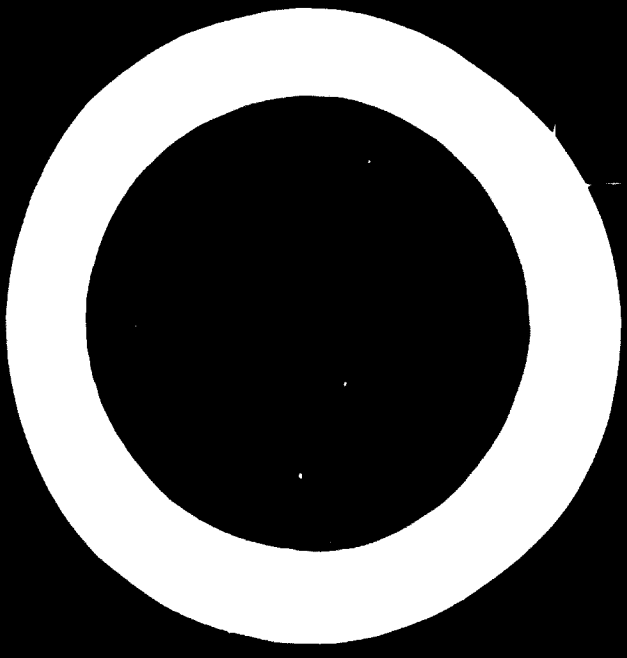
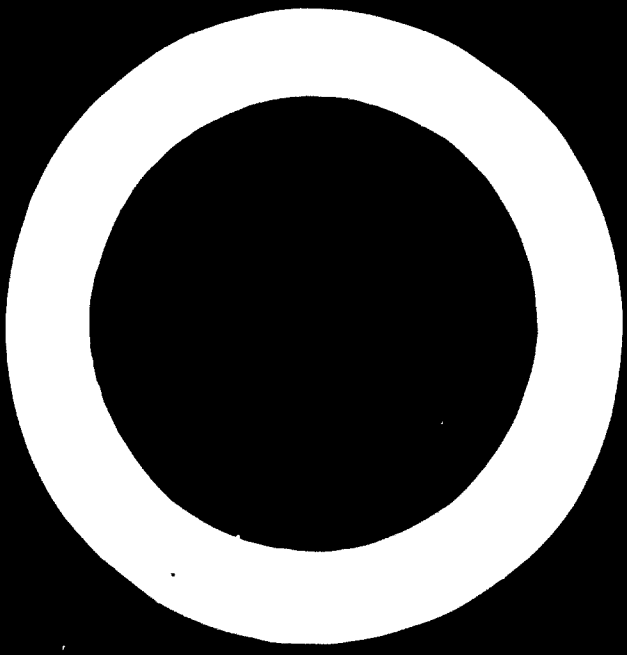
NON-FERROUS METALS

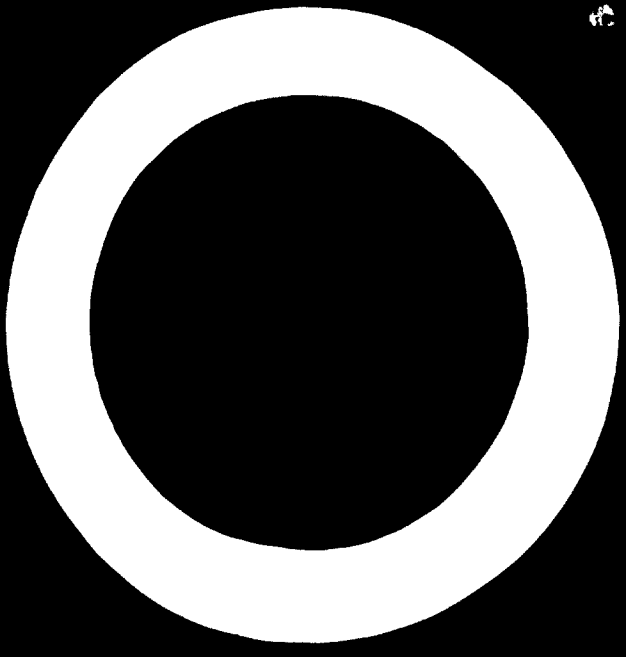
A Survey of their Production and Potential in the Developing Countries

UNITED NATIONS





NON-FERROUS METALS
(COPPER, ALUMINIUM, TIN, LEAD AND ZINC)



UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
VIENNA

NON-FERROUS METALS

(COPPER, ALUMINIUM, TIN, LEAD AND ZINC)

A Survey of their Production and Potential in the Developing Countries

UNITED NATIONS
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Foreword

The studies in the series "Industrial Branch Reports", of which this is the first to be published, were initiated by UNIDO with the objective of assessing the current position of the main industrial branches in the developing countries. In addition to this stock-taking function, these studies were also intended to help diagnose the issues and problems confronting such industries. A secondary objective was to appraise their growth potential and to suggest ways and means of encouraging this growth. Since the Second United Nations Development Decade was inaugurated as a concerted effort in international development, the latter objective has become of primary importance. Emphasis has shifted towards the need to view industry in long-range perspective, and the Development Decade has introduced a new dimension by providing a scale of reference for gauging the long term prospects of various industrial branches in the developing countries.

It was considered desirable, therefore, to re-orient the industrial branch reports to include them as an essential part of the Second Development Decade activities of UNIDO. Hence, studies in this series have been integrated, whenever possible, into the new series of studies on "Perspectives for Industrial Development in the Second United Nations Development Decade."[1] Some studies, such as the present one, were at an advanced stage of preparation, however, and it was not desirable to incorporate them in the later series. A companion study on the cement industry is also scheduled for publication in the industrial branch report series, which may be re-activated in the future should the circumstances require. The format and cover design adopted for the perspective studies are being used for the industrial branch reports to indicate their close relationship.

The scope of the present paper is limited to the five main non-ferrous metals, namely, aluminium, copper, lead, tin and zinc. Part I explores the interrelationship between non-ferrous metal resources and economic development, and Part II surveys non-ferrous metal resources and production in the developing countries. Part I was contributed by Mr. A. W. Brace, consultant, economist and metallurgist for Metal Information Services Ltd, United Kingdom. Part II was prepared by the Non-ferrous Metals Information Institute of the USSR for UNIDO, with additions and revisions by Mr. Brace. The views and opinions are those of the consultants and do not necessarily reflect the views of the UNIDO secretariat.

[1] See, for example, *Perspectives for Industrial Development in the Second United Nations Development Decade: The Textile Industry*, ID/63, UNIDO, New York, 1971.

The authors, having selected the material from many sources, acknowledge that they cannot ensure correct or uniform spelling for the hundreds of place names referred to and accordingly disclaim responsibility for the spelling in cases where it could not be established. The regional geographical groupings used are intended for the convenience of comparison in the field of non-ferrous metals.

CONTENTS

Explanatory Notes

For the purpose of this report the term "non-ferrous metals" implies the five principal metals – namely, aluminium, copper, lead, tin and zinc. Other non-ferrous metals such as nickel etc. are not included.

The data contained in this report are based on published information available early in 1970. Because of the usual delays in publication of production and trade statistics, such data are given only up to 1968, but 1969 figures are included where available. To provide a convenient ten-year period for comparisons, the year 1959 has been used as a base year and detailed figures are also given for the years 1965 to 1968 as far as possible.

Reference to tons indicates metric tons (1,000 kg), unless otherwise specified.

Reference to dollars ($) is to United States dollars.

In the statistical tables a dash (–) indicates that the amount is nil or negligible. Three dots (. . .) indicate that the data are not available or are not separately reported.

The following chemical symbols are used as convenient abbreviations for compounds that are frequently referred to in the report:

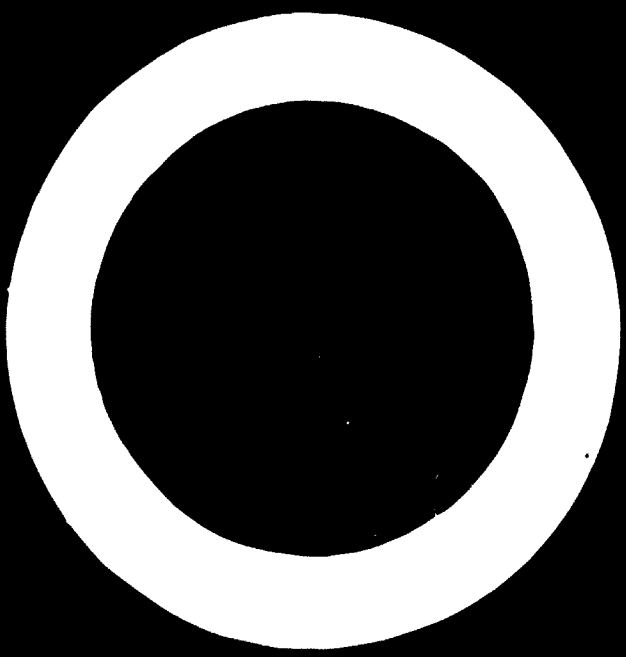
Al_2O_3 = alumina
SiO_2 = silica
Fe_2O_3 = iron oxide
TiO_2 = titania

The following abbreviations are used in this publication:

CIPEC	Intergovernmental Council of Copper Exporting Countries
ENAMI	Empresa Nacional de Mineria (state-owned mines of Chile)
IBRD	International Bank for Reconstruction and Development
ITC	International Tin Council
IWNFMC	International Wrought Non-Ferrous Metals Council
LME	London Metal Exchange
LNG	Liquefied natural gas
MINDECO	Mining and Industrial Development Company (Zambian government-owned holding company)
MVA	Megavoltampère
RCD	Regional Co-operation for Development
USAID	United States Agency for International Development
ZALIS	Zinc and Lead International Service

PART I

NON-FERROUS METAL RESOURCES AND ECONOMIC DEVELOPMENT



NON-FERROUS METALS AS A RESOURCE BASE

Non-ferrous metals are essential to an advanced industrial economy. It is difficult to envisage modern society without the availability of copper for multiple applications in power generation and electrical machinery, of aluminium for road and air transport, lead for batteries and building, zinc for die-casting and the hot-dip galvanizing of steel, or of tin for solders and tinplate. Since these metals are required inputs for a large number of industries, and for the economic infrastructure generally, the industries producing them are usually regarded as basic, i.e. they are necessary to the proper functioning not only of manufacturing industries, but also of agriculture, trade, transport and defence.

Few metals are found in a pure state. The ore generally contains many other substances of little or no economic value. While the so-called precious metals, e.g. gold, silver and platinum, can be mined in chemically uncompounded form, the non-ferrous metals are mined in the form of chemical compounds or minerals. Thus, aluminium is mined as an ore known as bauxite, in which the aluminium is combined with other elements, usually oxygen and hydrogen. Bauxite also contains substantial amounts of iron oxide, smaller amounts of silica and titania, and some traces of other oxides or hydroxides. Copper may occur in a variety of forms. These are mainly oxides and sulphides, but they are often closely associated with other metals such as lead, zinc, nickel and iron. Lead and zinc may occur as separate ores, but some zinc is frequently present in lead ores and vice versa. Complex ores containing copper, lead and zinc in varying amounts are sometimes found and they provide a valuable source of these metals. Silver and gold may also occur in small but economically important quantities in copper, lead and zinc ores, and the extraction of these precious metals may increase the economic value of such deposits as a whole. Tin occurs mainly as an oxide (cassiterite). In some deposits quantities of wolfram, columbite and tantalite are also found with tin ore. These other minor metals are of growing economic importance.

After such ores have been mined they undergo a complex series of processes in order to prepare them for extraction. The methods of preparation vary according to the chemical composition and physical characteristics of the ores. At this stage the ores are usually referred to as concentrates, although the term is not employed with regard to aluminium (the equivalent stage is the production of alumina prior to its electrolytic reduction to aluminium).

The conversion of concentrates to metal is carried out in a variety of ways, frequently involving heating under conditions of chemical reduction with or without the use of electricity. The primary metal so produced may then be even further refined. The refined product can be rolled, extruded,

drawn, forged or cast into shapes which then become the raw materials for the many complex engineering and finishing operations involved in producing capital and consumer goods.

Metallic ores as an economic resource

Ores of non-ferrous metals are widely but irregularly distributed over the earth's surface. They constitute part of the natural resources of the countries in which they are found. Natural resources *per se* may be of uncertain economic importance to the development of a given country. Their significance depends on whether, at a given time, they are, or seem likely to become, a valuable economic resource. The economic value of an ore body is related to the cost of the necessary complementary factors of production and to the strength of market demand. It does not depend primarily on the qualities of the ore, such as its chemical composition, its physical characteristics, mode of occurrence etc., although these do have some significance, but rather on a complex of present and future market influences. While ores might be regarded as natural resources, and the semi-fabricated products made from the metal in those ores as produced resources, in practice the distinction is generally blurred, since human skills and effort, as well as capital (produced resources), are normally required in order to improve the economic productivity of natural resources.

The possession of ores is of great importance to developing countries as a potential source of wealth and earner of foreign currency. Each country with known ore deposits has a natural resource that is uniquely its own, that is, its sovereign property (unless it has alienated its rights). No two ore bodies are equivalent as an economic resource, however, since the costs of the complementary factors of production necessarily vary. Each ore body must be taken as an economic entity, and for this reason much of the data on the extent of ore occurrence, composition and properties must be treated with considerable caution in that they provide only a partial indication of an ore's economic significance.

Factors influencing development of metallic ore mining

Many factors may inhibit the development of metallic ores. Climatic extremes, such as extreme heat or cold, drought or super-abundant rainfall may adversely affect the cost of developing such resources. A further factor is accessibility. Once the existence of an ore body is known, its commercial exploitation requires the transport of capital goods and other factors of production to the site; the ore, concentrates, or refined metal must then be shipped to markets. In some circumstances a decision by the state to provide roads, power stations etc., which cut the cost of developing the resource, can be crucial to the decision to go ahead with its exploitation. Trends in market price, both short-term and long-term, can have an overriding influence in opening up (or closing down) a mining operation. Short-term price changes can affect those mines already in existence that operate at the margin of

profitability. Long-term influences may largely determine the rate at which entirely new mining ventures can be financed, or whether existing ones will remain profitable.

Institutional factors are also important in the development of natural resources. Developing countries have only a limited or embryonic capital market and are highly dependent on the international money market and resources for financing mining projects. The fiscal policies of developing countries vary from country to country, and factors such as the terms of mining leases, restrictions on land use, extent of monopoly held by existing companies, level of taxation and depreciation provisions, ability to remit convertible currency to foreign countries for servicing loans or dividend payments, as well as the political climate, may inhibit or stimulate the conversion of a natural resource into an economic resource.

Even if these factors are favourable, however, it must be recognized that such natural resources will remain unused and valueless when the costs of production and transport exceed the price the resultant products can command in the market. On the other hand, a too rapid expansion in the capacity to produce primary metals may result in over-production, a fall in market prices and consequent loss in total export earnings, a decline in profitability, and wide repercussions on the whole industry on an international scale. Postponing the development of natural resources until they can make a valuable contribution later is therefore a normal and prudent course.

Development economics and non-ferrous metals

In general the developing countries are characterized by a relatively abundant supply of natural resources (such as reserves of metallic ores) and a relative scarcity of capital and labour, but they are also characterized by a high marginal productivity of capital and labour. This high marginal productivity may attract capital for investment in these resources if other conditions are suitable. As the level of investment in a given country rises, the relative scarcity of factors of production changes; labour—particularly specialized, skilled labour—becomes an increasingly scarce factor of production, and its cost rises. As the marginal productivity of capital declines with a country's economic growth, that country's attractiveness to foreign investment diminishes. Developing countries hence should tend to become increasingly dependent upon capital generated within the economy.

Much of the above discussion concerning the production of primary metals reflects the imbalance of economic development between various countries, with the main demand coming from advanced countries. Still, the ability to produce primary metals provides a developing country with a potential economic advantage in establishing a semi-fabricating industry, since a productive unit that is integrated from ore to semi-fabricated product has advantages in terms of profitability and the strength to resist temporary adverse economic conditions. Further, development of semi-fabricating capacity may result in a saving of imports and stimulate the growth of engineering and other metal-using industries.

It is important to keep in mind, however, that within the context of economic development the existence of natural resources such as metallic ores is only one factor in the entire complex of social, cultural, political, institutional and economic factors that may affect the potential for economic growth. Not all of the developed countries are well endowed with natural resources. Apart from favourable conditions for agriculture, Denmark, for example, has virtually no natural resources, but this has not precluded its development as an advanced economy with a high standard of living. Some developing countries included in this survey appear to have a limited potential for promoting non-ferrous metal production, but this need not be a major obstacle in the way of economic growth.

Regional aspects

A pronounced feature of the current production of non-ferrous metals is the localization of their output in a few centres. Of the total output of 24.6 million tons of bauxite in developing countries in 1968, the Caribbean countries Dominican Republic, Guyana, Haiti, Jamaica and Surinam—accounted for 19.2 million tons; production of primary aluminium in that area was confined to Surinam with an output of 43,800 tons.

In the same year, output of mine production of copper totalled 2.17 million tons for all developing countries, of which 1.88 million tons were accounted for by Chile, Zaire, Peru, and Zambia. This situation basically pertains if the figures for refined metal production are considered: the same four countries accounted for 1.15 million tons of refined copper production in 1968 out of a total of 1.27 million tons for all developing countries.

Production of lead and zinc exhibits a similar pattern: in the same year 267,700 tons of refined lead were produced by Mexico and Peru out of a total of 344,000 tons for all developing countries, and Mexico and Peru were also significant producers of refined zinc, with a combined output of 146,700 tons. Zaire and Zambia had a combined output of 116,100 tons of zinc; the four countries thus accounted for 262,800 tons out of a total of 308,000 tons for all developing countries.

In terms of refined tin production, the countries of South-East Asia —Indonesia, Malaysia and Thailand—accounted for 119,000 tons out of a total of 135,000 tons for all developing countries. If figures for mine production are considered, the position is nearly unchanged, except that Bolivia emerges as another major producer; here the domestic refining industry is currently small but is in the process of being modernized and expanded.

It is difficult to predict possible changes over the next twenty years in this pattern of regional distribution of production for each of the main metals. It seems likely that the dominant position of the major producing countries, in terms of size of output and importance, is unlikely to be seriously challenged, although some diminution in their relative share of the total world output may be expected.

It would be ill-advised to discount completely the possibility that as exploration proceeds major deposits might be found in one or more countries,

leading to the development of an industry that could attain the status of a major world producer.

The countries that are now leading producers possess an industry organized to supply world markets owing to their links with large international companies. Countries with more modest resources and outputs may still find it desirable to develop their industry, although initially they may process ores only up to the concentrates or alumina stage and export their production. There are greater benefits to be obtained, however, if a complete, integrated industry can be established that is linked to the expansion of the domestic economy.

The projections of many developing countries for future demand for non-ferrous metals show modest requirements in terms of the size of plant and utilization of modern technology. Some experts argue that it is not necessary for developing countries to start by installing the most advanced equipment; instead, the technology should be related to the stage of economic development and the size of the available market. One device for widening the size of the domestic market is a programme of regional economic co-operation and integration, either a free-trade-area agreement or an arrangement limited to a particular range of activities. Such provisions for economic co-operation naturally require a favourable political climate before the full economic benefits can be realized.

In view of the uneven distribution of natural resources over the surface of the earth, there is a logical incentive to regional co-operation in developing these resources. Iran and Pakistan, for example, co-operate in a joint project to develop aluminium, and there is a possibility of similar co-operation in North Africa. Such regional schemes require a careful examination of the economic characteristics of the region concerned and a basis of political agreement. For many countries having a limited resource base, regional co-operation is likely to be increasingly considered.

PROBLEMS IN PROMOTING INVESTMENT IN NON-FERROUS METALS

Part II of this survey provides a summary, country by country, of the published information on the actual and potential production of non-ferrous metals in the developing countries. The complexity and magnitude of the task make it impossible to do other than deal with broad outlines and provide some indication of possible future developments. For each country there are relevant data that are not published and that remain unavailable to the authors of this report. Some of the information represents the results of survey work carried out by private companies or others, and understandably it has not been released to the public.

This study naturally does not present a case for investment in any one country or particular project. It attempts rather to put into perspective the developments of the past decade and the problems involved in attracting capital for investment in non-ferrous metal production.

Assessment of national potential

There are wide variations in the extent to which developing countries possess the natural resources that form the basis of non-ferrous metal production. To stimulate production a government must plan on the basis of the resources available. It must assess what kind of industry it is going to develop, decide what the size and range of the operation will be between mining the ore and the fabricated product, and determine what metals it is able to promote on an economic basis. Few countries have the economic resources to produce all metals from mine through to end product, but most need to produce metals they do possess as ores, although the processing may only consist of the semi-fabrication operation of converting ingots of refined metal into forms usable by consumer industries.

If countries where the extent of surveying is limited are excluded, developing countries can be grouped into three main categories:

(1) Countries having a negligible or limited resource base for the primary production of such metals. These countries must confine themselves mainly to building up the facilities for semi-fabrication to meet the needs of domestic metal-using industries. They may also be able to participate in regional development schemes for the production of primary metals in conjunction with neighbouring countries having a broader or economically more favourable resource base.

(2) Countries having a sufficient potential for development, in terms of a favourable resource base and market possibilities to enable them initially to become minor suppliers of ores or concentrates to one or more of the developed market countries. This may lead later to the establishment of domestic refining and semi-fabricating facilities where economically viable, possibly directed to export. The problem is often one of timing, since production economics tend to dictate a relatively large unit size.

(3) Countries having major ore reserves and allied resources, and a sufficient comparative advantage in production costs in the long run so that they can regard themselves as major producers. They have a substantial enough surplus over domestic requirements to meet the needs on a long-term basis of the international market. Relatively few countries are in this position and rarely because they possess more than one metal. Those that are in this category, however, face the dangers associated with an economy that is highly dependent on earnings obtained from a single export commodity.

Within the limits of this broad classification are obvious degrees of difference. The economic viability of non-ferrous metal production depends upon the cost of the factors of production in a given country. Many countries may be in a position only to build an integrated industry based on one metal

or at best two. While the attractiveness of an integrated industry is obvious, it is risky to promote such an industry on the basis of short-sighted economic nationalism, leading to production costs that are out of line with those prevailing in the international market. Such a course of development is conducive to the misuse of scarce capital and resources, and in the long run harms the economy, although in the short run the policy may have political advantages.

The advantages and drawbacks of a country's potential for promotion of non-ferrous metal production must be weighed in the balance. All developing countries are faced with selecting priorities for investment. An obvious case exists for the development of metal production as a basic industry from a political viewpoint because of its importance to national defence, and from an economic standpoint because of its role in promoting the growth of engineering and other metal-using industries and in stimulating over-all economic growth through the multiplier effect. If the potential is great enough to allow the continued production of an exportable surplus, useful foreign currency is earned. Mining and metal production normally have an impact on the economic infrastructure, leading to the provision of new roads, improved ports and communications of all kinds, as well as to an increase in the production of electrical energy, thus benefiting the economy as a whole. Such enterprises usually need to attract foreign capital and expertise, which can in due course be diffused more widely through the education and training of the local population. Development stimulates growth of other sectors of the economy, and the success and profitability of the enterprise usually provide a basis for personal savings for investment, as well as profits that may be used to diversify the economy.

Certain disadvantages, however, must be weighed against such attractions. Metallurgical mining and production make virtually no contribution to raising agricultural efficiency, often a crucial factor in economic growth. There have been some exceptions involving open-cast mining operations; on their completion the land has been restored and converted into highly productive agricultural estates. Moreover, the primary metals industry has little effect in promoting the growth of light industry, and it offers very limited employment for women. It is a highly capital-intensive industry and requires a relatively small labour force in relation to the capital employed. Wages paid in the industry tend to be high, and this may create friction with other segments of the population, engaged in different sectors of the economy and earning significantly lower salaries. Further, increased industrialization results in a need for greater expenditure on social services, housing and other urban facilities. Nevertheless, many countries would consider these drawbacks a small price to pay for building up a profitable basic industry.

Creation of a favourable investment climate

The results of this survey make clear that the developing countries possess a considerable part of the known ore reserves in the world and do not lack projects competing for scarce investment capital. The most important

consideration is that there is likely to be for some time to come a serious shortage of capital for investment in such projects, with interest rates tending to remain high by conventional standards. This situation may well lead to competition between countries to attract available capital.

An examination of the problem of attracting capital must start with the recognition that the greatest danger facing developing countries is the failure to obtain capital on suitable terms, in a world where high interest rates seem likely to remain for some time. The attraction of foreign capital involves the creation of an environment conducive to investment without jeopardizing national interests, and this is often a matter of political skill. Tangible incentives are those associated with taxation and fiscal policies, mining legislation and import-duty concessions.

Taxation and legal factors

A major factor in attracting capital is the provision of a favourable tax climate. Most major mining projects have a moderate to high risk associated with them and a medium- to long-term gestation period. A tax holiday over a period of years is one of the principal means available to encourage investment, although circumstances often exist where provisions for accelerated write-off are even more attractive than a tax holiday, depending upon the taxation system. The granting of exclusive prospecting licences for companies genuinely prepared to explore for minerals, with the provision that these licences are surrendered after a given period and with the safeguard of a minimum annual expenditure, can provide an inducement to genuine exploration activities. Prospectors also need assurance that after spending significant sums on exploration, they will not be arbitrarily excluded from the right to develop any deposit that they find. Obvious legal problems are connected with this assurance, but the intention should be clear to all prospective investors.

A modification of policy might be considered relating to the practice of levying a tax on physical production, usually in the form of a levy per ton produced or exported. The drawback to this method is that when market conditions are unfavourable, the levy system becomes a serious burden, especially if the company is operating at a loss, while in better times it forms only a small part of the charge on gross profits. Many companies would prefer a simple single-tax system based on a tax on net profits, so that the government obtains a revenue related to the profitability of the venture, enjoys high income in prosperous times but avoids adding to burdens in periods of slump. The suspicion may exist that profits may be falsely declared by foreign companies and the fraudulence escape detection by tax authorities or government-appointed accountants. It should be possible for this problem to be overcome, however, by the creation of an independent service for accountancy and auditing of such projects, possibly provided by the International Bank for Reconstruction and Development (IBRD).

Once a project begins to make progress, it creates demands for imports of machinery, equipment and materials for its functioning. Concessions by way of duty-free imports of all essential items not available locally are made by some countries, and these help to reduce the total capital required to initiate a project. Provision must be made for bringing in essential foreign personnel to provide expertise not locally available, and their salaries should be, in part at least, convertible into the currency of their country of origin.

A major investment in the production of non-ferrous metals requires a large amount of capital, and foreign investors can only be attracted if they can obtain assurances of the possibility of repatriating dividends earned and capital, if required, after a minimum investment period, plus some guarantee of protection against nationalization without full compensation. Further, governments should allow foreign companies to exercise full and effective management, both technical and financial, since this is essential to the growth and profitability of a large project.

Finding a basis for partnership

Most major international concerns considering foreign investment in the 1970s may embark on them only on the basis of a partnership with local private interests and/or the governments of the countries concerned. This partnership requires that both the government and foreign company accept certain obligations which are, however, to their mutual benefit. In addition to creating an acceptable political and economic environment, once agreement has been reached, it is to everyone's benefit naturally if the whole project is conducted on a basis of mutual trust. Major mining projects entail extensive preliminary planning, for the initial exploration is followed by a series of preparatory studies and assessments, evaluation of transport and location economies, and determination of the potential profitability of alternative schemes by means of sophisticated management techniques such as discounted cash flow, critical path analysis etc., in conjunction with Electronic Data Processing techniques to expedite obtaining such information. Failure by either party at this stage to disclose vital data can jeopardize the whole project.

Size is no assurance of success. Large projects make major demands on scarce management skills, and a single failure involving a large project becomes a calamity both for the country and company concerned. There is always the danger that disagreement will arise between the parties involved. Where the problem is serious and fundamental and cannot be mutually resolved, many investors would welcome agreement on the part of developing countries to use international arbitration procedures, which are readily available through the United Nations, as a means of settling disputes.

The foreign company has important and serious obligations to the co-operating country. A major obligation is that the foreign company should undertake to employ and train as many local citizens as possible at all levels of management, and as quickly as possible. Many of the larger international

companies are aware of this and have well worked-out schemes for such training. Disagreement may arise over the speed with which such training can be implemented and properly completed. Unless there is an understanding on the part of the company of the capacity of the people to learn, as well as a recognition by the government and the employees that it takes years to acquire the skills required to run a complex industry, there is a danger of mutual distrust.

A further obligation involves the recognition by companies that the interests of the national economy require that any commodity exported should represent the maximum value added that is economically feasible at a given stage of development. This implies an undertaking that the ore mined should be processed as far as possible towards the final product within the country of origin. This is a problem primarily of relative costs, of optimum scale of operations and of the cost of transport to available markets. It is important to the developing countries because, in addition to maximizing revenue, it may contribute to reducing demand for imports of refined or semi-fabricated metals.

High risks are involved in exploration and development, but the measures mentioned above can help companies to offset some of them. Once the stage has been reached where a definitive plan of development and operation has been drawn up, and major financing is required, companies should be prepared to consider local share issues at fair terms. The exact arrangement will obviously depend on circumstances. In some cases the whole project may have been conceived on a partnership basis with major participation of a government-supported financial institution. Even so, the economy is likely to benefit if capital can be subscribed to by private investors within the developing country itself. Where it is a venture entirely promoted by private capital with some degree of government approval and support, suitable terms will have to be negotiated between local and foreign interests. In this event, the natural desire of the country to control its own resources must be recognized.

If genuine partnership is the agreed aim of both parties, and if it is recognized that foreign companies have basic obligations to their shareholders and are making a contribution to the country's economy, it is implied as well that the foreign company must be sensitive to and appreciative of the hopes and ideals of the developing country, and sympathetic to the problems it faces.

It has been suggested that it might benefit a group of countries or all developing countries to agree on standard articles of association for foreign companies investing in such enterprises. These would cover some of the problems and provisions suggested above. The value of this step would be to avoid the problem of the multiple legal and other requirements that investors must face when dealing with widely different legal frameworks in the various countries.

INTERNATIONAL CO-OPERATION ON MARKET PROBLEMS

Some reference must be made here to the most difficult problem of market policy. Because of the crucial importance of metallic ores or refined metals to their economies, many developing countries have an understandable desire to find means of ensuring that individually, or collectively, the best possible price is obtained for the export of these products. The ways to achieve this assurance have been varied and are influenced both by the past history of these commodities as well as by the extent to which market fluctuations have interfered with the export of particular metals. This situation may be best examined by referring to the metals individually.

Tin

The International Tin Council (ITC) is the body concerned with the marketing of tin. The First International Tin Agreement went into operation on 1 July 1956 and was succeeded by second and third agreements in 1961 and 1966. A new agreement was approved in 1971. The appendix to this chapter gives the basis of the agreement and describes the functioning of the International Tin Council. Essentially, the agreement establishes floor and ceiling prices. A buffer stock manager acts on instructions from the council to operate an agreed buffer stock. Depending on the assessment of the market situation, quantities of metal from the buffer stock are sold if the trend in price is considered to be towards the ceiling; stock is bought if the trend shows a continued fall towards the floor price. Producers have been fortunate in that over-all price trends have been upwards, increasing from a floor/ceiling price of £640/£880 sterling per ton when the first agreement went into operation in 1956 to a floor/ceiling price of £1,280/£1,630 sterling per ton in 1969.

Copper

Of all the metals traded internationally in quantity, the price fluctuations of copper have presented the most serious problems. The London Metal Exchange (LME) price and the American domestic producers' price sometimes show wide discrepancies. The crux of the problem is that the LME price often reflects a very limited market in terms of the total tonnage of copper sold in the world, and it therefore shows wide fluctuations that are regarded as unrealistic. Another complication is that since users can buy forward on LME, they may get caught with over-priced stocks on their hands, since the "hedging" facilities of the LME may provide inadequate safeguards. Over recent years, where the main fluctuations have been "high" relative to the producer price, the copper industry has been increasingly concerned with the threat of substitution by other materials having a better record of price stability.

Because of these and other difficulties, the four major producing countries—Chile, Peru, Zaire and Zambia—have set up an Intergovernmental Council of Copper Exporting Countries (CIPEC) to act as an advisory body.

One of its first actions has been to place a contract with a specialist consulting organization to carry out a study of the factors influencing the pricing of copper, and to make suggestions for improvements in the present methods of marketing copper. This initiative is to be welcomed, and the results will be awaited with interest in many quarters apart from the producing countries themselves. The feeling exists in many quarters that a marketing approach is needed similar to that used in the chemical industry for its newer bulk products. An undertaking of this kind will require international agreement, and it will entail a high degree of discipline on the part of participating countries not to make any change if a shortage develops in the early period of operating a new marketing system that could provide opportunities for short-term profits. This happened with the ill-fated attempt to introduce producer price and price leadership in the market in the period 1963 - 1964.

One other aspect worth noting in relation to copper production concerns the membership of CIPEC. Although the present members represent the major producing countries in the developing part of the world, it might be beneficial for long-term co-ordination to find ways of associating some of the smaller producing countries, such as Cyprus, Mexico, the Philippines and Turkey, with the work of the Intergovernmental Council.

A similar body in the field of semi-fabricated products is the International Wrought Non-Ferrous Metals Council (IWNFMC), which provides opportunities for exchange of information and a meeting place to facilitate contacts between primary producers and non-integrated semi-fabricators of all countries.

Lead and zinc

There is no specific organization dealing with lead and zinc from the standpoint of the interests of the developing countries, but the matter has been reviewed by the International Lead-Zinc Study Group in which all the larger producing countries are represented. The desire of larger companies in the industry to help the developing countries is evident from the creation of ZALIS (Zinc and Lead International Service), which is financed jointly by the Zinc and Lead Industries Association of the United States, the Zinc and Lead Development Associations of the United Kingdom, the Australian Lead and Zinc Development Association and the Japan Lead-Zinc Development Association. Its functions are to stimulate domestic consumption in the developing countries by promoting use of these metals and by providing up-to-date technical information for manufacturers and prospective manufacturers of lead and zinc.

Valuable though this service is there may well be a need for some co-ordination of policies and exchange of information between the main producers in the developing countries, such as Mexico, Morocco, Peru, Zaire and Zambia.

Aluminium

There is no international body concerned with aluminium, or with specific branches of aluminium production such as the mining of bauxite,

There are national bodies such as the Aluminium Association of the United States, the Aluminium Federation in the United Kingdom and similar national organizations in the main European producing countries. In Europe there is some supranational co-ordination through the European Wrought Aluminium Association, but this is mainly in the field of semi-fabricated products.

There is no international organization under whose auspices information can be exchanged and trends compared and co-ordinated among the main bauxite-producing countries. Some organization might serve a useful role in disseminating information on market trends, in raising questions as to royalties and other payments made in bauxite mining, and in making projections of future demand for bauxite, as well as policy on smelter location in such countries.

STATISTICS ON THE OVER-ALL METAL RESOURCES AND PRODUCTION OF THE DEVELOPING COUNTRIES

Ore reserves

The existence of metallic ores is first established by geological surveys. A great deal of expertise is involved in assessing whether a particular geological formation is likely to possess useful deposits of the main non-ferrous ores. If a preliminary survey locates promising areas, more detailed surveying is undertaken, and a variety of techniques may be employed to obtain further information. Detailed evaluation is done by drilling and removing a large number of samples taken at plotted points over a limited terrain of the area involved. From this data calculations are made of probable reserves. These estimates are subject to error, however, since it is possible to extrapolate only the data obtained from a limited number of samples for the whole area. The use of the term "proved and probable" indicates that a careful survey has been made and that the estimates are as reliable as is possible within the limits of the techniques used and of the costs considered justifiable for a survey.

Caution is necessary in interpreting such figures, not only because they are merely a reflection of the extent of the surveying carried out, but also because unseen factors can exist, such as limited local geological faults that may make a deposit unworkable over an area that had been expected to be productive. In addition, geological surveying and exploration is expensive; also, once deposits have been found that are sufficiently attractive in economic terms to justify exploitation, the figures of reserves often represent merely the amount of ore known likely to be suitable for exploitation over a sufficient period ahead to justify investment in the project. A limit to the life of some mines may be predicted, and their reserves can be assessed with reasonable accuracy. With others, however, the reserves may be known to be considerable and quoted figures may be well below the total actually available.

Estimates of changes in developing countries' share of proved and probable reserves of the main non-ferrous metal ores over the decade 1958–1967 are

Table 1

SHARE OF THE DEVELOPING COUNTRIES IN THE TOTAL PROVEN AND PROBABLE RESERVES OF BASIC NON-FERROUS METAL ORES IN 1958 AND 1967

(Recoverable metal content)

Metal	Reserves in 1958			Reserves in 1967			Average annual growth of reserves, 1958 – 1967	
	World total (million tons)	Share of developing countries (million tons)	Share of developing countries (per cent)	World total (million tons)	Share of developing countries (million tons)	Share of developing countries (per cent)	World total (per cent)	Developing countries (per cent)
Aluminium (bauxite)	428.0	320.0	74.8	2,551.0	1,428.0	[illegible].0	22.0	18.0
Copper	86.0	54.0	62.8	163.0	104.0	64.4	7.4	7.6
Lead	20.0	3.7	19.1	49.0	12.0	25.1	10.7	14.1
Zinc	37.0	4.8	12.8	71.0	17.0	23.6	7.5	14.9
Tin	1.44	1.26	87.1	2.9	2.6	89.6	8.7	9.0

Table 2

SHARE OF THE DEVELOPING COUNTRIES IN THE TOTAL MINE PRODUCTION OF NON-FERROUS METAL ORES IN 1958 AND 1968

(Recoverable metal content)

Metal	Output in 1958			Output in 1968			Average annual growth of output, 1958 – 1968	
	World total (thousand tons)	Share of developing countries (thousand tons)	Share of developing countries (per cent)	World total (thousand tons)	Share of developing countries (thousand tons)	Share of developing countries (per cent)	World total (per cent)	Developing countries (per cent)
Aluminium	17,374	12,723	73.2	37,998	24,557	66.1	11.9	4.7
Copper	2,958	1,308	44.2	4,393	2,167	50.4	4.8	7.0
Lead	1,835	711	38.7	2,225	870	39.1	2.1	2.2
Zinc	2,490	724	29.1	3,828	914	23.8	5.4	2.6
Tin	118	110	93.2	184	172	93.7	5.5	5.6

given in table 1 in terms of recoverable metal content. The relative share of bauxite reserves in the developing countries declined during this period owing to the discovery of very large deposits in Australia. Their share of reserves of copper ores remained relatively unchanged. The increase in lead and zinc ores has resulted from an increase in the known lead-rich deposits in Mexico, Morocco and Peru, and in zinc-rich ores in Argentina, Mexico, Zaire and Zambia.

Mine production

With regard to mine production (table 2) the trends for the developing countries over the period 1958–1968 were not favourable, except for copper. There was an over-all decline in the developing countries' share of output of aluminium, from 73.2 per cent to 66.1 per cent. The position for lead and tin remained virtually unchanged, but there was a decline in the developing countries' share of zinc mine output owing mainly to a large expansion of Canadian output. Copper mine production exhibited an increase in the developing countries' share owing mainly to increased output in Chile, Peru, Zaire and Zambia, and some expansion in the Philippines.

Refined metal production

The total production of refined metals over the period 1958–1968 (table 3) reflects the trends in mine production, but there are important differences. The output of aluminium in the developing countries in 1968 was only 6.1 per cent of the world output. There has been a trend to increase the amount of bauxite converted into alumina in the developing countries, but the pattern in the location of smelters has tended to favour market-oriented locations in the industrialized countries, rather than the construction of smelters in the developing countries near where the ore is mined.

The pattern for tin has been quite the opposite, with over 70 per cent of refined tin production in 1968 taking place in the developing countries where the ore is mined. For zinc the position over the years 1958–1968 changed little, while for copper and lead there was some decline in the developing countries' share, with the amount of refined metal produced in these countries being substantially lower than the mine output expressed in metal content. Except for tin, there would appear to be a strong preference by the large international producers for locating refineries in the industrialized countries.

Consumption

The statistics for consumption (table 4) are also of interest, in that they reflect the progress in industrialization. By far the largest increase in metal consumption in the developing countries was the increase in consumption of aluminium, almost 39 per cent over the period 1958–1968. The biggest increase in aluminium consumption was in India, where consumption in 1958 was 15,600 tons and in 1968, 128,000 tons, partly owing to economic growth but also to a domestic shortage of copper. Brazil also evidenced sub-

Table 3

SHARE OF THE DEVELOPING COUNTRIES IN THE TOTAL PRODUCTION OF REFINED NON-FERROUS METALS (FROM ALL SOURCES) IN 1958 AND 1968

Metal	Output in 1958			Output in 1968			Average annual growth of output, 1958–1968	
	World total (thousand tons)	Share of developing countries (thousand tons)	Share of developing countries (per cent)	World total (thousand tons)	Share of developing countries (thousand tons)	Share of developing countries (per cent)	World total (per cent)	Developing countries (per cent)
Aluminium	2,816	61	2.2	6,608	417	6.1	13.8	68.0
Copper	3,428	858	25.0	5,401	1,271	23.7	6.0	4.8
Lead	2,120	298	14.0	2,637	344	13.0	2.4	1.5
Zinc	2,335	195	8.4	3,684	308	8.4	5.8	5.8
Tin	127	54	42.5	192	135	70.3	4.2	15.0

Table 4

SHARE OF THE DEVELOPING COUNTRIES IN THE TOTAL CONSUMPTION OF NON-FERROUS METALS (FROM ALL SOURCES) IN 1958 AND 1968

Metal	Consumption in 1958			Consumption in 1968			Average annual growth of consumption, 1958–1968	
	World total (thousand tons)	Share of developing countries (thousand tons)	Share of developing countries (per cent)	World total (thousand tons)	Share of developing countries (thousand tons)	Share of developing countries (per cent)	World total (per cent)	Developing countries (per cent)
Aluminium	2,479	78	3.1	6,992	382	5.5	18.2	38.9
Copper	2,821	184	6.5	5,163	233	4.5	8.3	3.8
Lead	2,120	120	5.7	2,630	160	6.0	2.4	3.3
Zinc	2,327	141	6.0	3,695	307	8.3	5.4	11.8
Tin[a]	143	15[a]	10.5	172	16[a]	9.1	2.0	6.7
Total	9,890	538	5.4	18,652	1,098	5.9		

a Tin figures are estimates only and should be treated with caution.

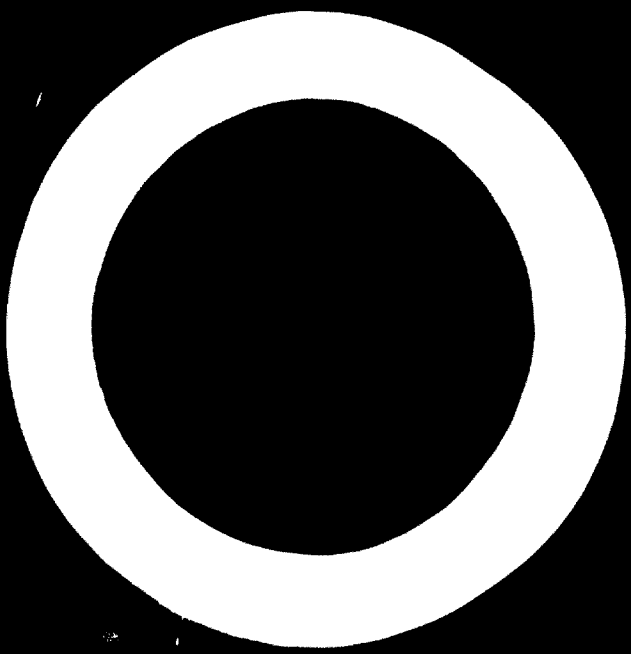
stantial advances in aluminium consumption, which increased from 26,000 tons in 1958 to 80,200 tons in 1968. Here again, a domestic shortage of copper was a factor. In both countries the internal market has been assessed as warranting a significant investment in expanding domestic smelter facilities. Over-all, the consumption of aluminium in the developing countries is higher in actual tonnage than that of any of the other non-ferrous metals.

By contrast, the increase in developing countries' copper consumption was less than one half that of the world average over this period. This reflects the fact that copper is used mainly in the more technically advanced sectors of the economy, and that the shortage of copper in some of the developing countries led to increased consumption of aluminium as a substitute.

The pattern of lead and zinc consumption in 1958 – 1968 reflects primarily a growth in the usage of lead for batteries and zinc for galvanizing steel. The growth in the usage of lead in the developing countries was greater than the world average, and of zinc more than double the world rate. A particularly active area has been South-East Asia where total zinc consumption in 1968 was estimated to be 83,000 tons, of which about 55,000 tons were for galvanizing. The United States Military Forces may have consumed about 12,000 tons of this total. In Latin America as a whole, lead consumption was estimated for 1968 at 153,000 tons and zinc at 137,000 tons. The main growth has been in Argentina and Mexico, and to a lesser extent in Brazil.

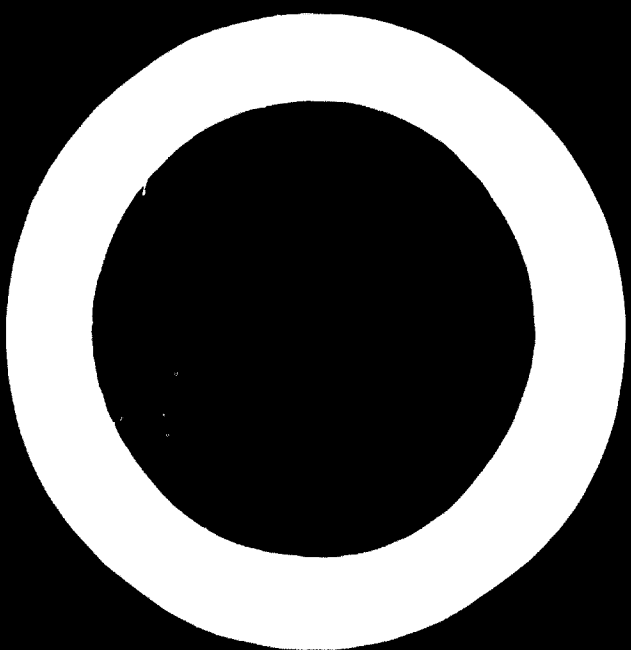
Galvanizing is a major industrial outlet for zinc in all of these countries. In Brazil, however, 20 per cent of the zinc is used in making brass, whereas brass-making is small in most other countries in Latin America. Battery cans account for 15 per cent of the consumption of zinc in Argentina, but their production is small in the other countries. Batteries and cable sheathing are major outlets for lead in these countries. Lead sheet and pipe account for 30 per cent of the outlet in Argentina but for only 10 – 25 per cent in the other countries. In Mexico, production of litharge pigment accounts for about 50 per cent of consumption.

The increase in tin consumption is estimated at only 1,000 tons over the decade for the developing countries. Statistics are not sufficiently reliable for any significance to be attached to these figures, however, since over-all the discrepancy due to unreliability may be ± 1,000 tons.



PART II

SURVEY OF COPPER, ALUMINIUM, TIN, LEAD AND ZINC PRODUCTION IN THE DEVELOPING COUNTRIES



AFRICA

CENTRAL AFRICA

Burundi

This Central African State became an independent kingdom in 1960 and in 1966 proclaimed itself a republic. To the north it neighbours on Rwanda, to the east and south-east it adjoins Tanzania, and its western neighbour is the Republic of Zaire. The country is very mountainous, being mainly at an elevation of 1,500 – 2,000 m with some mountains rising to around 3,000 m. This terrain is broken up by deep river valleys. The climate is tropical with a long hot, dry season. Most of the population of 3.3 million (1968 estimate) live in the lower-lying areas and the river valleys. The total land area amounts to 27,834 km².

Burundi has no railways; a network of stone-surfaced roads and other tracks provide the main means of transport and communicatio. Navigation on Lake Tanganyika also provides a cargo route into Tanzania and connects with its railways and the Zaire rail and river system. Airports exist a Bujumbura (the capital) and Kitega.

Aluminium, copper, lead and zinc

There are no known deposits of the ores of these metals, nor are there refining or semi-fabricating activities connected with these metals.

Tin

There are a number of small but rich tin-bearing deposits in the country; these form an extension of those of Zaire, and are usually alluvial deposits of cassiterite in combination with bastnaesite, the latter being the more important. Table 5 indicates the growth in production of tin-bearing ores in Burundi.

Table 5

OUTPUT OF TIN-IN-CONCENTRATES – BURUNDI

(Tons)

	1962	*1965*	*1966*	*1967*	*1968*
Bastnaesite	–	150	200	300	525
Cassiterite	24	17	50	96	149

In 1968, 8 tons of colombo-tantalite ores and 11 kg of gold were also mined.

This production is based mainly on the mine at Karonje (bastnaesite with some cassiterite) and at Murebe (mainly cassiterite). Further exploration of the Ruzizi plain was carried out in 1967–1968, financed by credits from Deuxième Fonds Européen de Développement. A further survey in the Congo-Nile region with United Nations support was made in 1968.

Cameroon

The Federal Republic of Cameroon is a Central African country of 5.5 million inhabitants, having a coastline of over 300 km on the Atlantic Ocean. Nigeria provides its north-western boundary, and Chad an irregular north-east boundary, which continues with the Central African Republic on the east and the People's Republic of the Congo and Gabon to the south. Cameroon lies on the equator, and the climate is hot, very humid on the coast but increasingly arid to the north-east and east. The total land area is 475,400 km².

The country has two main perennial river systems, one flowing into the Gulf of Guinea, and the other to the north flowing into the Benue river or the Lake Chad depression. Apart from the coastal strip the country is above 300 m elevation. The Cameroon Highlands on the north-west coast and the hills in the north rise to over 1,000 m.

The country has a small railway system, amounting to 520 km, running from Douala on the coast to Yaoundé, and from Douala to M'Kongsamba. A project exists for a Trans-Cameroon line, extending the Douala-Yaoundé line to N'Gaoundéré and then further into the Republic of Chad. The main seaport is Bonaberi (near Douala), and other port facilities exist at Victoria and Kribi. In the north Garoua is an important river port on the Benue river. Connexions with international airlines exist at Yaoundé and there is an internal airline network.

There are no known resources of coal and oil, but natural gas has been found and further prospecting is proceeding. There are very considerable hydroelectric resources and potential, which account for the fact that over 95 per cent of the power generated is hydroelectric; this amounted to 1,008 million kWh in 1966.

There are large bauxite deposits in the country and deposits of tin ores, rutile titanium dioxide and gold have also been located.

Aluminium

The country possesses extensive bauxite deposits, estimated at over 20 billions tons, of which 900 million tons are proved and probable. The bauxite is of fairly high quality with a 40–50 per cent Al_2O_3 content. If the estimated reserves are proved, the country would rank third in the world for total reserves. The richest deposits of lateritic bauxite are found 120 km to the south-west of N'Gaoundéré on the Adamawa Plateau; these have approximately 42 per cent Al_2O_3 content. Other deposits are found in the Dschang and Foumban area, near Fongo Tongo, to the north of Douala,

with probable reserves amounting to 46 million tons of 46 per cent Al_2O_3 content. A further deposit of similar quality exists in the Bangam area, amounting to 45 million tons, and a small deposit of about 4 million tons exists near Bambontos.

Mining of the bauxite at Fongo Tongo is carried out under the auspices of the Syndicat de Recherches des Bauxites du Cameroun, which is owned by the French company Pechiney (Cie de Produits Chimiques et Electrométallurgiques). Data on production of bauxite is not available. There are facilities only for drying the bauxite and there is no alumina production.

An aluminium reduction plant has been built at Edea of 52,000 tons/annum capacity, operated by the Compagnie Camerounaise de l'Aluminium Pechiney-Ugine (Alucam), a company in which the French aluminium producers Pechiney and Ugine hold 48.5 per cent and 12.0 per cent of the capital respectively[1], with most of the balance held by Belgian and French financial interests and 3 per cent by the Cameroon Government. The plant operates using alumina imported initially from France and now from the Compagnie Internationale pour la production de l'Alumine (FRIA) in Guinea. It commenced operations in 1957 and is currently operating at capacity. The data for production of primary metal imports of alumina and imports and exports of aluminium ingot are given in table 6.

Table 6

PRODUCTION, IMPORTS AND EXPORTS OF ALUMINIUM INGOT — CAMEROON

(Thousand tons)

	1959	*1965*	*1966*	*1967*	*1968*	*1969*
Primary aluminium production	42.3	50.5	48.2	48.3	45.4	46.7
Alumina imports		85.0	45.5	...	...	...
Aluminium exports	43.0	45.4	45.4	46.5	49.5	...
Aluminium imports	...	...	4.3	4.7	...	...

A semi-fabricating plant was also established in 1968 at Edea, Société Camerounaise de Transformation de l'Aluminium, with participation by Alucam and other French financial interests. This plant consists of a rolling mill with ancillary equipment and facilities for producing aluminium hollowware and other semi-fabricated products. The initial capacity of the plant is 5,000 tons/annum which is planned to be expanded to 10,000 tons/annum.

Copper

Small deposits of copper ore have been found in the north-east around Tiffol. The Cameroon Geological Service (with French assistance) is conducting surveys for copper-bearing ores in the western region of the country around Ntole, Mamfe and Cumba. More recently a copper ore body has been discovered in the north at a location in the Poli area 100 km south of Garoua, but its quality and extent are unknown.

[1] Since compiling this report Pechiney have acquired Ugine's aluminium interests, both in France and overseas.

Tin

There are a number of deposits of cassiterite in various parts of the country, but data on ore reserves and quality are not available. Production of from 40 - 45 tons is centred at Mayo-Darle, 55 km south-west of Bana in the west. The original alluvial deposits have been worked out and production is now based on poorer quality deposits. Recent prospecting in the region has failed to locate any significant tin deposits. There are also indications of cassiterite deposits in the vicinity of Garva. Prospecting for tin deposits and other minerals is continuing with the assistance of the Federal Republic of Germany, France, the United Kingdom of Great Britain and Northern Ireland and the United States.

Since 1961 the mining in the Mayo-Darle area has been carried out by Société de Fibre Mécanique, and concentrates are produced of 60 - 70 per cent tin content and exported to the Netherlands and Spain.

The Central African Republic

The Central African Republic lies just north of the equator, situated between Cameroon and the southern part of the Sudan, with Chad to the north and the People's Republic of the Congo and the Republic of Zaire to the south. It attained independence in 1959. Its population of 1.49 million (1968 estimate) is spread unevenly over an area of 624,930 km², the eastern and north-eastern regions being very thinly populated. The three large towns are in the southern part of the country: the capital, Bangui (population 35,000), Berbérati (population 38,000) and Bossangoa (population 31,000).

The country is made up mainly of a plateau ridge averaging 600—900 m elevation with an east-north-east trend. The Kare Massif in the west and the eastern heights have peaks up to 1,400 m. The climate is equatorial in the southern half with temperature averaging 27 °C and a diurnal variation of 8 - 11 °C; the northern half is less severe with a rainy monsoon season from June to October and a dry season from October to March. Rainfall ranges from 120—180 cm per year.

Economic progress is impeded by lack of ready access to the coast in the absence of railways. Most exports travel down the Ubangi and Congo rivers, or by road westwards to Yaoundé or Douala in Cameroon. There are few all-weather roads in the country; the main towns and smaller population centres are connected by a network of dirt roads.

The economy is overwhelmingly agricultural, and largely of subsistence agriculture. The main export crops are coffee and cotton, with some rubber, sisal and oil palms. There is some small-scale industry associated with processing these products, some brewing and a textile combine. The current economic plan provides for investment of 5,600 million CFA francs in industrial ventures.

Aluminium

Exploration of the country is incomplete, but there are so far no reports of bauxite occurrences, nor is there any industry associated with this metal.

Copper, lead and zinc

There have been reports of occurrences of copper and zinc in the country but no information has been published on their economic significance. There is no industry associated with the production or fabrication of these metals.

Tin

Occurrences of cassiterite at Ippy, Bria and Yalinga were scheduled for investigation with the help of an expert from the Federal Republic of Germany during 1964, but no report on this investigation has been published.

The People's Republic of the Congo

This Central African Republic of approximately 1 million inhabitants lies across the equator. In the south-west it has a short coastline on the Atlantic, and its neighbour to the east is the Republic of Zaire. To the north is the Central African Republic and Cameroon, and on the west it has an irregular boundary with Gabon. The relief of the country is varied, ranging from a 300-m plateau in the east and south to hills rising to 500–1,000 m in the north-east. To the south-west the coastal region is flat and sandy. The climate is typically equatorial with temperatures of around 27° C and with rain exceeding 150 cm/annum. The total land area is estimated to be 342,000 km².

The main river pattern is formed by the eastern tributaries of the Congo river which provide the boundary with Zaire. These rivers are slow-flowing and navigable the year round. There are also shorter rivers on the south-west of the main watershed that are fast-flowing, with numerous rapids, and are not navigable. Pointe-Noire on the Atlantic Ocean provides the main foreign cargo and passenger shipping connexions. A railway line of 512 km in length connects Brazzaville with Pointe-Noire. Connexion with international air services is provided by the airport of Maya-Maya (Brazzaville).

There are no known coal or oil deposits. The country has considerable hydroelectric resources: in 1966 six stations produced an output of 27.9 million kWh out of a total output of 45.5 million kWh.

Deposits of bauxite, copper, iron, lead and tin ores, potash and gold are found in the country.

Aluminium

Exploration for bauxite deposits has been carried out on the Kouji plateau in the north-west. These deposits are red bauxite (ferrons laterites) which are of little value as aluminium ores, having a 37.5 per cent Al_2O_3 content and 4.7 per cent SiO_2 content, with the balance mainly iron oxides. There is no aluminium reduction industry in the country. For many years a scheme has been under study for the construction of a large dam and hydroelectric station on the Kouilou river which would have an aluminium output of 250,000 tons/annum. There are considerable problems associated with this scheme, not the least being that of financing such a large undertaking. Considerable potential also exists for the development of low-cost power for metallurgical industries.

Copper

The eastern Niari basin has been the source of metallic ores over a period of years. The Mindouli mine was in operation from 1911 to 1932 and produced approximately 11,500 tons of sulphide ore, representing approximately 6,000 tons of metal. The main problem associated with mining in this area is the economic working of scattered deposits of complex composition, which present considerable problems in extraction of the metal content. These are the so-called black-earth *(terres-noires)* ores which contain calcareous substances, sand, oxides of lead, manganese and copper, and copper carbonates and silicates.

Reserves of these ores around Mindouli are estimated at 450,000 tons of ore of approximately 5.5 per cent copper content. A further 200,000 tons are known to exist in the vicinity of Moubiri with approximately 5 per cent copper content, and 35,000 tons are known at Reneville with a 5.8 per cent copper content.

A small sulphide ore body is known at N'Zala-Mimodi which has a 2.3 per cent copper content and is estimated to contain 1,500 tons of metal. A mixed oxide-sulphide ore deposit exists at the Boko-Congo mine amounting to 170,000 tons of ore of 3 per cent copper content.

Some copper also occurs in conjunction with the lead-zinc ores referred to below.

Lead and zinc

A mixed lead-zinc ore deposit was worked at M'Bouato-Hapito in the eastern Niari basin from 1939—1961; it produced a total of around 125,000 tons of concentrates containing 52 per cent lead, and 26,000 tons of zinc concentrates of 42 per cent metal content. The M'Passa mine was in production from 1961 to 1969 and produced 73,152 tons of mixed lead-zinc sulphides of 42 - 53 per cent lead and zinc content and 10,435 tons of copper concentrates of 10 - 42 per cent copper content. These ore beds are not as yet exhausted, but their further exploitation depends upon finding an economic method of working and treating them.

At M'Passa current research is directed at establishing whether there is sufficient heavy mineral in the deposits to amortize the cost of a flotation plant. In all, several hundred thousand tons of lead-zinc sulphides of 10 —15 per cent metal content, in conjunction with some 200,000 tons of sulphide ores containing 3.5 per cent copper, are proved and probable. In the same area there is a lead-zinc sulphide ore body at N'Zala-Diangala containing 49,000 tons of 9.8 per cent metal content.

In the M'Fouati-Hapilo sector, known reserves are estimated at around 700,000 tons of mineral containing 6 per cent lead and 14 per cent zinc in the form of carbonates. The Yango-Kouhenza deposit has been surveyed and is estimated to contain several hundred thousand tons of lead-zinc carbonates having a 30 - 40 per cent metal content. A small ore body has been found at Djenguile, 30 km west of M'Fouati; its reserves are estimated

at 334,000 tons of ore, which are oxides and carbonates containing 29 per cent lead, 9 per cent zinc and 4 per cent copper. More recently, lead sulphide mineralization in the Konilou district has been studied, but no information has so far been published.

Tin

A small alluvial deposit of cassiterite, associated with wolfram and columbium-tantalite, with 5—6 kg/m³ of metal ore was discovered in 1957 in the west of Mayombe near the Gabon border. Over the period 1958—1968 a total of 571 tons of tin and 12 tons of tungsten were produced. The recent cessation of mining is due to lack of reserves with an economic metal content.

Production statistics

Statistics for mine output of non-ferrous metal ores in the People's Republic of the Congo are given in table 7.

Table 7

MINE OUTPUT OF NON-FERROUS METAL ORES — PEOPLE'S REPUBLIC OF THE CONGO

(Tons)

	1965	*1966*	*1967*	*1968*	*1969*
Copper	67	356	906	846	...
Lead	2,961	2,648	1,408	400	4,942
Tin	44	48	53	25	32
Zinc	6,909	6,178	3,286	929	...

Gabon

The Republic of Gabon became independent in 1960. It is situated on the west coast of Central Africa between Cameroon, Equatorial Guinea and the People's Republic of the Congo. Its population of 473,000 (1968 estimate) live mainly in the river valleys and on the inland dissected plateau, whose elevation is between 500 m and 1,000 m. The total land area amounts to 267,000 km². The climate is equatorial with little seasonal variation and abundant rainfall throughout the year. Much of the country is covered by rain forest. The main town is Libreville (population 53,300), which is the capital and principal port; Libreville and Port Gentil handle ocean-going vessels.

The country is hampered by poor road communications and has no railways. The budget for road construction (1966—1970) was 2,300 million CFA francs per annum. Libreville and Port Gentil also have airports linked to the international routes.

Natural gas output is approximately 17.5 million m³; 3.4 million tons of oil were produced in 1967, and there is a refinery in Port Gentil with an annual capacity of 620,000 tons. The country is a large producer of manganese ore, as well as uranium, gold, cocoa, coffee and timber. Much of the economy is of shifting cultivation, subsistence agriculture.

Aluminium

Surveying of the country is incomplete, but so far there are no reports of occurrences of bauxite. There is no industry associated with the refining or semi-fabrication of aluminium, and imports are very small.

Copper

There have been indications of copper in the Makkou-Booue area, but investigations have not shown the mineralization to be extensive. Surveys have also been made by the Bureau de Recherches Géologiques et Minières (BRGM, France) to the west of the Ofooué river, south-east of Etéke, where the geological formation is similar to that in the Zaire copper belt. No confirmation of deposits of commercial importance has yet been made.

Lead and zinc

Possible occurrences of lead-zinc ores are being investigated on the coast north of Libreville and Mayanba, where conditions are considered favourable to the occurrence of these metals.

Tin

There are no reports of occurrences of tin ores in the territory.

Rwanda

This Central African Republic, which became an independent kingdom in 1960 and a republic in 1961, is situated to the east of the Republic of Zaire and to the west of Tanzania. On the south lies Burundi, with whom it shares a degree of geographical and cultural similarity. On the north its neighbour is Uganda. The climate is tropical, modified by elevation, with a temperature range of 10 –30 C and two wet seasons – one from February to May and the other from October to December. Rainfall ranges from around 95 cm to over 150 cm/annum in the east of the country. The main part of the country lies on a plateau of 1,500—1,800 m with some heights rising to over 2,000 m. In the far south-west the elevation falls to around 1,000 m. The population, which totals 3.1 million, is primarily rural and engaged in agriculture. There are only two large towns, Kigali (population 10,000) and Butaré (population 4,500). The total land area is 26,300 km².

There are no railways in the country, but it has a well-developed road network totalling 6,000 km, of which 2,200 km are metalled roads classified as "routes nationales". There are two main access routes to the ports. The southern route goes via Bujumbura (Burundi) and then by boat across Lake Tanganyika and rail from Kigoma (Tanzania) to Dar es Salaam, a total of approximately 1,200 km. The northerly route is from Kigali to Kampala (Uganda) by road and then by rail to the port of Mombasa (Kenya) and totals approximately 1,500 km. Navigation on Lake Kivu also provides communication with Zaire. The airport near the capital, Kigali, provides international service and the airport near Cyangugu can accommodate DC 4 aircraft. There are also seven domestic airfields.

In 1966 the total electricity generated was 48.1 million kWh, of which 46.8 million kWh was produced by hydroelectric stations. There is an estimated potential of 4,250 million kWh of hydroelectric output, if the resources can be developed. Natural gas has been found in Lake Kivu, and total reserves of 57 billion m^3 of methane, as well as other chemicals, are estimated to exist. The country possesses workable deposits of cassiterite, wolfram, beryl, columbo-tantalite and some amblygonite (lithium). Gold has been mined and further useful deposits are considered to exist.

Aluminium, copper, lead and zinc

There are no known deposits of ores of these metals in the country, and no refining or semi-fabricating works are concerned with these metals.

Tin

Deposits of tin-bearing ores occur that are considered to be an extension of those in the neighbouring Republic of Zaire. They are found mainly in the west around Katemba in pegmatites, or in alluvial lodes in the district around Rutongo north of Kigali, or in the vicinity of Rwinkwanu in the east, and they are open-cast mined. Table 8 gives the production data for concentrates over recent years. The concentrates normally contain 72—74 per cent tin.

Table 8

PRODUCTION AND EXPORT OF TIN-IN-CONCENTRATES — RWANDA

(Tons)

	1959	*1965*	*1966*	*1967*	*1968*
Production	1,100[a]	1,420	1,300	1,322	1,350
Exports	...	1,502	1,345	1,325	1,330

a Includes some production from Burundi.

In addition to tin concentrates there is also some production of columbo-tantalite and wolframite. In the ores as mined these minerals average about 1.2 – 1.5 kg/m^3. The concentrates are exported mainly to Belgium but also to Zaire.

Recent explorations indicate that the main reserves are to be found in primary beds. Total ore reserves are estimated at 65,000 tons, of which 20,000 tons are proved or probable.

The Republic of Zaire

The Republic of Zaire (formerly the Democratic Republic of the Congo) became independent in 1960. Its population numbers approximately 16 million. It occupies a large area (2.345 million km^2) of Central Africa. The Congo river is the main river in a country-wide river network forming the eastern and major part of the Congo basin. The country has a small coastline of 35 km running northwards from the point where the Congo discharges into

the Atlantic Ocean, and for some distance the north-west and western boundary is formed by the Congo river, then by the Oubangui river, which separates the country from its neighbour, the People's Republic of the Congo. To the north lies the Central African Republic and Sudan, and to the east are Uganda, Rwanda and Burundi. To the south-east is Zambia and to the south-west Angola.

The country lies across the equator, with the characteristic equatorial climate of high temperatures and high rainfall—150 cm/annum or higher and high humidity, although in the south in Katanga province the climate is drier (100 cm/annum). The coastal belt is low lying and relatively dry. Most of the country occupies a plateau over 300 m in elevation; in the Katanga province the undulating plateau rises to over 1,000 m. The ridges in association with the Central African Rift valley, which form the eastern border, rise to over 4,000 m in places.

The railway system totals 4,600 km and primarily serves the needs of the copper belt of Katanga province. The line from the copper belt runs north-westwards to Port Francqui on the river Kasai; this provides connexions with the river transport system, which has a direct link to the capital, Kinshasa. A further railway line connects Kinshasa with Matadi, the main port on the Congo estuary. A branch line from the Port Francqui line runs from Kamina northwards to Kindu with a further branch to Albertville on Lake Tanganyika. This connects with the Congo river transport system. The railway system was primarily designed as part of the Trans-African system, which carried most of the traffic from the Zambian and Congo copper areas, with a branch at Tenke going westwards through Angola to the port of Benguela. A further, rather circuitous route runs through Zambia and Rhodesia to the port of Beira in Mozambique. The transport of copper involves a journey of from 2,100 to 2,785 km by rail before reaching the coast. River transport is generally of great importance internally to the country, handling around 70 per cent of its imports and 60 per cent of its exports. International airport facilities exist at Kinshasa and there are a number of internal airfields. The total length of roads is 15,300 km with a limited amount of macadam roads in the copper belt and around the main towns.

There are small deposits of coal being worked in the country which are supplemented by imports. There has been little surveying for natural oil and gas deposits. Of the 2,664 million kWh of electricity produced in 1968, hydroelectric generation accounted for 2,607 million kWh. A feasibility study is under way to develop a large hydroelectric station on the river Lualaba to serve the copper belt.

The economy of the country is highly dependent on mining. Cadmium, germanium, silver, gold, palladium and platinum concentrates are exported for processing, mainly to the Hoboken refinery in Belgium. Zaire is the world's leading producer of cobalt, which is associated with copper, for whose (smelter) production it ranks sixth in the world (excluding the centrally planned economies), and it is also an important producer of zinc.

Aluminium

Bauxite deposits are known in the Inga-Sumbi area of the lower Congo and in the north-east between the Ituri, Bima and Rubi rivers. The Al_2O_3 content varies between 34 and 52 per cent, and the silica content is low (< 0.5 per cent SiO_2). These deposits are estimated to consist of 100 million tons of proved and probable reserves.

There is currently no mining undertaken of the bauxite deposits, nor is there any reduction plant. As long ago as 1956 an international syndicate was set up under the auspices of the Belgian Goverment to study the feasibility of a plant at Inga, between Kinshasa and Matadi. This project has now reached the detailed planning stage in which the Société Italo-Congolaise d'Activités Industrielles (Italian consulting engineers) and the Société de Traction et d'Electricité (Belgian) are involved. According to the studies made by the earlier group at Inga, the potential exists for the generation of 25 million kWh continuously, which renders it one of the most potentially important sites in the whole of Africa. Nevertheless, the problems of creating the necessary infrastructure, of providing financing and personnel are correspondingly large.

Copper

The copper belt of the Republic of Zaire is situated in the province of Katanga near the border with Zambia. The combined Katanga-Zambian copper belt, which is part of the same geological structure, extends over an area of approximately 500 km in length and 300 km in width; the greater part lies within the boundaries of Zaire. Basically, there are two types of ore encountered: a sulphide ore body of 3 – 5 per cent copper content that occurs around Kipushi and is deep-mined, and oxidized ores which lie near the surface and which, in the more important deposits, are of 6 – 8 per cent copper (but range between 1 and 10 per cent) and are mainly open-cast mined. Small amounts of zinc (~ 2 per cent) and cobalt (0.2 – 1.7 per cent) are also contained in these deposits. Total reserves have been estimated at 36 million tons of which 18 million tons are considered proved and probable. The annual rate of ore extraction is over 10 million tons.

The industry was established by the Belgian company, Union Minière du Haut-Katanga (UMH-K). In 1967 an agreement was reached whereby the ore reserves and production facilities of UMH-K were transferred to a Congolese company, Société Générale Congolaise des Minerais. The Société Générale de Belgique provides technical, production, recruitment and marketing services on a commission basis. Data on mine output of copper ore, production and exports of blister and refined copper are summarized in table 9.

The copper belt is adjacent to that of Zambia, being part of the same geological structure. More recently, attention has been devoted to the exploration for copper in other parts of the country where the geology suggests the possible existence of metalliferous ores.

The present copper industry is centred in Katanga province near the Zambian border and ranges from mining and dressing of the ore, production of concentrates, to smelting and refining. Cobalt is also extracted at the refineries, but gold, silver, platinum and palladium are recovered at the Hoboken refinery in Belgium. The mines, concentrators, smelters and refineries are listed in tables 10, 11 and 12 together with recent data on their output and characteristics.

Table 9

PRODUCTION AND EXPORT OF COPPER ZAIRE

(Thousand tons)

	1959	1965	1966	1967	1968
Mine production	282.3	288.6	316.9	321.5	325.5
Smelter production of copper	281.9	288.6	316.9	321.5	325.5
Refined copper production	156.0	152.6	157.6	161.0	167.0
Export of blister copper	123.6[a]	136.0	159.3	160.5	159.5
Export of refined copper	158.3[a]	152.6	157.6	161.0	166.0

a These figures include some exports from Rhodesia and Nyasaland.

Table 10

CHARACTERISTICS AND OUTPUT OF COPPER MINES ZAIRE

Location of mine	*Type of mining operation*	*Characteristics of ore*	*Output of ore 1968 (tons)*
Western group			
Musono	Open-pit	Oxide and mixed	1,350,721
Kamoto	Open-pit	Mixed sulphide-oxide	2,423,759
Kamoto	Underground	Mixed sulphide-oxide	9,093[a]
Ruwe	Open-pit		1,031,516
Southern group			
Kipushi	Underground	Mixed Cu-Zn	1,134,762
Central group			
M'sesa	Open-pit	Oxide	945,275
Kambove (west)	Underground	Mixed sulphide-oxide	203,673
Kakanda	Open-pit	Siliceous oxide	912,135

a This mine is at low output because of problems in getting the ore out of the mine.

A more recent development has been the formation of the Société de Développement Industriel et Minière du Congo, in which the Government

Table 11

CHARACTERISTICS AND OUTPUT OF PLANTS PRODUCING COPPER CONCENTRATES — ZAIRE

Location of plant	*Type of ore processed*	*Ore treated (1968) (tons)*	*Production of concentrates*	
			Tons	*Analysis*
Western group				
Kolwezi	Siliceous oxide	2,691,929	...	...
	Mixed sulphide-oxide	1,276,956	...	...
Kamoto[a]	Sulphide-oxide	1,800,000	95,042	39.66% Cu 2.53% Co
		(capacity)	527,129	25.78% Cu 2.50% Co
	(Dolomitic oxide)[b]	—	68,906	19.57% Cu 1.75% Co
Ruwe	Sulphide-oxide	2,023,200	75,610	23.85% Cu
	(in washing plant)		98,792	7.84% Cu
Southern group				
Kipushi	Cu-Pb-Zn sulphide	1,128,242	217,166	28.92% Cu
			208,043	56.47% Zn
			48	39.74% Pb
Central group				
Kakanda	Siliceous-oxide	790,855	128,626	26.37% Cu 0.77% Co
Kambove	Mixed sulphide-oxide	1,057,923	12,400	45.62% Cu 2.30% Co
			127,593	24.01% Cu 0.41% Co
	(Dolomitic oxide)		39,447	19.88% Cu 1.52% Co
Kambove	Washing plant	200,700	85,847	8.44% Cu
			4,029	13.95% Cu
			996	18.27% Cu

a The capacity of the Kamoto plant was increased in 1968 and is planned to be expanded up to 4 million tons of ore annum.

b Some ores are treated with dolomitic limestone to facilitate refining.

Table 12

PRODUCTS OF COPPER SMELTERS AND REFINERIES—ZAIRE, 1968

Location	*Source of concentrates*	*Output*	
		Product	*Tons*
Lubumbashi	Kipushi	Raw copper	18,894
	Ruwe	Blister copper	69,847
	Kambove	Cadmium and germanium for processing	3,169
Shituru[a]	Kakanda	Copper cathodes	126,519
(Likasa)	Kambove	Copper ingots	167,364
	Ruwe	Soluble anodes	35,824
	Kolwezi	Copper blanks	14,691
Luilu[a]	Kolwezi	Copper cathodes	125,420
		Copper blanks	9,930
Kolwezi	Kolwezi	Copper powder	6,162

a The refineries at Shituru and Luilu also produced 3,689 tons and 4,390 tons respectively of cathodic cobalt in 1968.

holds 15 per cent of the stock. The balance is held by Japanese companies; Nippon Mining Co. Ltd holds 57 per cent and the remainder is shared by Mitsubishi, Mitsui Mining and Smelting Co., Sumitomo Metal Mining Co., Toyo Zinc Co., Furukawa Mining Co. Ltd and Nissho Co. Ltd. The purpose of this company is the exploration of deposits in an area south of the present copper-producing region. Late in 1968 it was reported that a new deposit had been discovered by the company at Musoshi 80 km from Lumbubashi, with which there are road and rail connexions, and 10 km from the Zambian border, near the Bancroft mine in Zambia. Reserves are estimated at 30 million tons, containing 3.3 per cent copper. Exploitation of the deposit is planned to start in 1971, in conjunction with the building of an ore-dressing plant with an output of 40,000 tons/annum. Because of the long and costly haul involved in shipping to Japan, the company is actively studying the possibility of extending facilities to produce blister copper. Other drilling at Kisenda indicates possible copper reserves of 20 million tons of ore whose copper content has not been disclosed.

Lead and zinc

Zinc is mined in conjunction with copper at the Kipushi mine and is processed there as concentrates that are then supplied to the Kolwezi plant of the Société Métallurgique Katangaise, which is owned jointly by the Government of Zaire and Belgian metallurgical companies. Some of the zinc concentrates, however, are exported. The plant has a nominal capacity of 60,000 tons/annum and also produces a few hundred tons/annum of cadmium and small amounts of silver, gold and germanium. The plant produces zinc by the electrolytic process. Some lead concentrates are also produced that are refined at the Jadotville-Shituri plant; this small production is used domestically. The plant also produced 1 578 tons of copper in 1968 as a by-product of these operations.

Total reserves of zinc are estimated at 2 million tons, of which 1 million tons are regarded as proved or probable. The extent of the lead reserves, which are small, have not been reported.

Data on production and exports of zinc ores, concentrates and refined metal are given in table 13.

Table 13

MINING, PRODUCTION AND EXPORTS OF ZINC ORES, CONCENTRATES AND REFINED ZINC - ZAIRE

(Thousand tons)

	1959	*1965*	*1966*	*1967*	*1968*	*1969*
Mine production	71.0	119.2	117.0	122.0	119.3	114.0
Refined zinc production	54.8	57.0	61.5	61.5	62.6	63.7
Exports of zinc ore and concentrates	75.1	89.6	94.8	79.5	92.1	...
Exports of refined zinc	54.5	56.0	51.0	57.2	67.1	...

Tin

The total tin reserves of the country are estimated at 500,000 tons, of which 200,000 tons are proved and probable. The two areas of the country in which it occurs are around Manono in Katanga and the Maniema area of Kivu province in the north. The Manono deposit has a cassiterite content varying between a few hundred grams and 2 kg/ton per m^3; and it contains columbite-tantalite to the extent of ~4.5 per cent of the cassiterite content. Estimated reserves of this field are 100,000 tons. This deposit has been worked for over 60 years by Compagnie Géomines, which has facilities for processing the ore through to the final production of refined tin. In all, more than 3 million tons/annum of tin-containing deposits are handled, and smelted to produce refined tin. Currently, the operation is carried out by a new company, Société Congo-Etain in which 50 per cent of the capital is owned by the Government of Zaire and 50 per cent by Société Général Congolaise des Minérais.

The Société des Métaux Etain operates in the Maniema area with headquarters at Kalima, working alluvial cassiterite deposits that contain 0.5 – 1.5 kg/m^3 of cassiterite and also eluvial and primary tin deposits. After washing, crushing and primary concentration, a final beneficiation is done in two process plants which produce a concentrate containing up to about 75 per cent tin. There are four other small producers of tin in the Kivu area. Production of tin concentrates is approximately the same for both companies. Table 14 gives statistics for the production of tin concentrates and refined tin.

Table 14

PRODUCTION OF TIN CONCENTRATES AND REFINED TIN – ZAIRE

(Tons)

	1959	*1965*	*1966*	*1967*	*1968*	*1969*
Mine production (tin content) ...	9,400	6,211	6,295	7,013	7,377	7,500
Refined tin production	3,400	1,800	1,800	1,809	1,800	1,800

Having the advantage of nearness to European markets and established commercial connexions, Zaire could become an increasingly important supplier of tin with improved mining, preparation and beneficiation techniques. Further prospecting for tin ores will be a necessary adjunct to such a development.

Zambia

Zambia was proclaimed an independent republic in 1964. The country borders on the Republic of Zaire to the north, Angola to the west, Rhodesia and Mozambique to the south-east, Malawi to the east, and Tanzania to the north-east. It has a population of 4.05 million (1969 estimate), much of which is concentrated in the copper belt.

Zambia lies mainly on a plateau of 1,000 – 1,500 m elevation. The Zambezi river and its main tributaries, the Kafue and Luangwa, break up the tableland

into plateaux interspersed with some mountains rising to over 2,250 m. The Zambezi river is known for its rapids and falls, and especially for the famous Victoria Falls. The total land area amounts to 746,169 km².

Although the country lies within the tropics, its elevation for most of its area relieves it from the high temperatures and humidity associated with the deep river valleys. The year is divided into three seasons – a warm rainy season lasting from October to April, which is followed by a cool, dry winter and a short hot, dry season from mid-September to late October. Rainfall ranges from 75 cm/annum in the south to 140 cm in the north.

The country has 35,000 km of roads, of which 1,625 km are bituminous roads and some 5,700 km are macadam roads. The current development plan provides for bituminizing the Great North Road, which runs from Livingstone near the Rhodesian border via Kabwe and north-eastwards via Serenje, Mpika and Makonde into Tanzania. The only railway line through the country runs from the copper belt, where it connects with Zaire and the port of Lobito in Angola; the southern branch runs through Lusaka and Livingstone into Rhodesia.

Owing to the country's distance from the sea, communications with the outside world are of vital importance. Before Zambia broke diplomatic relations with Rhodesia, it imported and exported goods mainly by the railway running through Rhodesia to the port of Beira in Mozambique. Now it exports goods by the railway running through Zaire to the port of Lobito in Angola and by road to the port of Dar es Salaam in Tanzania. Construction of the 1,600 km railway from Ndola (Zambia) to the link via the Tanzanian rail system with the port of Dar es Salaam (Tanzania) has begun. The programme is scheduled for completion in 1973. Several roads going in the northern direction are under construction. Connexions with international airlines are provided by the Lusaka airport, and there are smaller domestic airports.

The hydroelectric power station at Kariba, located on the south bank of the Zambezi river in Rhodesian territory, is owned jointly by the Rhodesian and Zambian Governments and supplies approximately two thirds of the country's electricity, which amounted to 3,101 million kWh in 1967. Political considerations have led to the commencement of construction of a new hydroelectric station on the Zambian side of Kariba, which will be of 600 megawatt output. The country has been short of power since the breaking of diplomatic relations with Rhodesia; power is imported from the Congo copper belt.

Coal resources are being rapidly expanded to satisfy the growing requirements of industry, as illustrated by the following output figures: 1966 – 114,000 tons; 1967 – 423,000 tons. A new mine at Siankandobo near Mamba is expected to be able to produce 50,000 tons/month. The country's need for oil is completely met by oil imports. In September 1968 a new pipeline between Dar es Salaam and the Ndola copper electrolytic plant in Zambia was put into service. Mining and production of copper, lead, zinc and cobalt make up the range of products of the non-ferrous metal industry of Zambia.

Aluminium

There are no known resources of bauxite in the country, nor are there any reduction facilities. A copper wire and cable project is intended to incorporate provision for production of about 1,000 tons/annum of semi-fabricated aluminium in the form of wire and cables.

Copper

Zambia is one of the major world producers of blister and refined copper. It is known to have considerable reserves of copper, estimated at 54 million tons; 27.4 million tons are considered proved and probable. The ore is characterized by a relatively high copper content which usually ranges from around 2.4 to 4.8 per cent, averaging 3.4 per cent. The economic advantages of this relatively rich ore are offset by the fact that the major ore bodies being worked are underground and the costs of removal of the ore are higher than for the large open-pit mines such as in Chile where the copper content is lower. Some of the newer mines which have recently come into operation in Zambia are open-pit operations.

The copper industry in Zambia contributes 44 per cent of the gross national product and around 95 per cent of export earnings. Table 15 gives data on mining production and exports of copper.

Table 15

OUTPUT OF COPPER ORES, BLISTER AND REFINED COPPER AND COPPER EXPORTS — ZAMBIA

(Thousand tons)

	1959	*1965*	*1966*	*1967*	*1968*	*1969*
Mine production	543	696	623	663	685	719
Blister copper — production	539	696	596	633	663	704
Blister copper — exports	165	160	90	80	92	107
Refined copper — production	371	522	494	535	551	603
Refined copper — exports	358	510	502	528	545	618

Until the recent nationalization of the Zambian copper industry, it was owned by two international companies, each having financial links with other metallurgical mining companies in the United States and the United Kingdom. Since nationalization the Zambian Government has aquired a 51 per cent interest in the industry through a government-owned holding company, Mining and Industrial Development Company (MINDECO). The group of companies formerly owned by the Anglo-American Corporation is now operated as Nchanga Consolidated Copper Mines Ltd, and the former Roan Selection Trust group now operates as Roan Consolidated Mines Ltd. The copper industry was nationalized by the Mines and Minerals Act which became law on 1 January 1970. The terms of the agreement reached within the provisions of the Act are summarized in the appendix to this chapter.

The following table summarizes the present structure of the Zambian copper industry:

Table 16

PRESENT STRUCTURE OF THE ZAMBIAN COPPER INDUSTRY

Nchanga Consolidated Copper Mines Ltd
(51% Mindeco Ltd and 49% Zambia Copper Investments Ltd)

Chingola Division

Mines:
- Chingola (underground)
- Chingola (open-pit)
- Mimbula (open-pit)
- Titula (open-pit)
- Nchanga (open-pit)
- Nchanga (underground)

Concentration plant: Chingola

Konkola Division

Mines:
- Konkola (underground)

Concentration plant: Konkola

Under development: Kansanshi

Rokana Division

Mines:
- Mindola North (underground)
  - Central (underground)
  - South (underground)
- Bancroft (underground)

Concentration plant: Nkana
Smelter: Nkana

Under development:
- Bwana Mkubwa (open-pit)
- Mindola North (open-pit)

Concentration plant: Bwana Mkubwa

Broken Hill Division

(Operations referred to under lead and zinc)

Roan Consolidated Mines Ltd
(51% Mindeco Ltd, 12.25% Zambian Copper Investments Ltd,[a] 20% Roan Selection Trust International Inc., and 16.75% public holdings)

Mufilira Division

Mine: Mufilira (underground)

Concentration plant: Mufilira
Smelter and electrolytic refinery: Mufilira

Luanshya Division

Mine: Luanshya (underground)

Concentration plant: Luanshya
Smelter: Luanshya

Chimbuluma Division

Mines:
- Chimbuluma (underground)
- Chambishi (open-pit)

Concentration plant: Chambishi

Under development:
- Kalengwa (open-pit)
- Chambishi (underground)

Ndola Copper Refinery Division

Ndola electrolytic refinery

[a] Zambian Copper Investments Ltd is a company registered in Bermuda to acquire the assets formerly owned by Anglo-American (Central Africa) Ltd.

The production of copper in Zambia is one of the largest and most advanced operations in any developing country. The mining methods used are modern and efficient. Recently developed techniques are employed to process the ore such as fluidized-bed roasting and oxygen-enriched air for reverbatory smelting. To enable some difficult refractory ores and wastes of 2.5—4 per cent copper content to be processed economically, the Torco process has been developed and is now operated on a production scale.

In view of the overwhelming importance of copper to the economy, the Government has taken various measures that are intended to produce significant short and long-run benefits. The planning target envisaged the increase of copper production to 750,000—850,000 tons annually by 1969—1970 and to 910,000—1.2 million tons by 1979—1980. Specialists for the copper industry are being trained to replace non-Zambian employees by qualified Zambians. A special "Zambianization" committee has been established, and the representatives of the Government, of the producing companies and of trade unions participate in its work. To encourage the development of a domestic semi-fabricating industry, the government-owned mining and industrial development company signed an agreement with a consortium of Phelps Dodge Copper Corporation, Svenska Metallverken A/B, Anglo-American Corporation and Roan Selection Trust for investment of $4.2 million in a copper-fabrication plant, which will also engage in aluminium semi-fabrication.

The Government of Zambia, along with the Governments of Chile, the Republic of Zaire and Peru, participates in the work of the Inter-Governmental Council of Copper-Exporting Countries (CIPEC) whose aim is to defend the interests of copper-producing countries.

Lead and zinc

All known lead and zinc reserves are concentrated in one large deposit at Broken Hill near Kabwe in the central region of the country. Proved and probable reserves of lead are estimated at 550,000 tons; zinc proved and probable reserves amount to 1.16 million tons. Lead content of the ore is 11—15 per cent, averaging 12.5 per cent, and the content of zinc is 25—29 per cent, averaging 26.4 per cent. Other small deposits of lead and zinc are known to exist, but these have not been surveyed. The figures for production, consumption and exports of lead and zinc ores and refined metal are given in table 17.

Table 17

MINING, PRODUCTION, CONSUMPTION AND EXPORTS OF LEAD AND ZINC — ZAMBIA

(Thousand tons)

	1959	*1965*	*1966*	*1967*	*1968*	*1969*
Lead ore—mine production	15.0	34	21	20	23	24
Zinc ore—mine production	42.0	47	32	54	67	51
Primary refined lead—production	14.0	21	20	20	23	24
Primary zinc—production	30.0	47	42	45	54	51
Primary lead—consumption	1.0	4	4	5	6	6
Refined lead—exports	9.4	16	26	17	17	23
Primary zinc—exports	31.0	45	39	40	39	51

Mining is carried out as an underground operation. The output of the mine is 300,000 - 500,000 tons of ore annually. All of the ores mined in the country are dressed and sent to smelters for further treatment. Lead and zinc are processed at three works, situated at Broken Hill and belonging to the Broken Hill Division of Nchanga Consolidated Copper Mines Ltd (formerly Zambian Broken Hill Ltd).

One of the plants went into operation in 1962. The capacity of the plant is 25,000 tons of zinc, with a purity of 98.5 per cent, and 18,300 tons of lead, with a purity of 99.99 per cent (1968 data). In addition, the plant produces Dore alloy. It operates by means of the Imperial Smelting Company process. The electrolytic zinc plant at Broken Hill produces 30,500 tons of zinc of 99.95 per cent purity, electrolytic cadmium, sulphuric acid, zinc powder and leaded zinc.

Almost all lead produced in the country (with the exception of 4,000 tons which cover the country's needs) and all the zinc are exported, mainly to South Africa and to the countries of West Europe.

Tin

Tin ore is extracted in small quantities. From 1961 to 1966 from 1 to 24 tons (in terms of tin concentrate) were extracted per annum near Chova in the northern part of the country. In 1967 the mine was shut down.

APPENDIX

(1) Terms of the agreement reached between the Government and the mining companies

Assets acquired: All mining and metallurgical assets of Rhokana Corporation, Nchanga Consolidated Copper Mines Ltd, Bancroft Mines Ltd, Rhokana Copper Refineries Ltd, Mufilira Copper Mines Ltd, Luanshya Mines and Mwinilunga Mines (Kalengwa Mine).

Price: Based upon book value as of 31 December 1969.

Payment: By issue of MINDECO bonds, fully and unconditionally guaranteed by the Government of the Republic of Zambia. Bonds are freely negotiable; repayment is to be in US dollars, and interest at 6 per cent per annum is to be free of Zambian taxes. Payment is to be made in equal semi-annual instalments.

Period of repayment: The debt will be paid off in eight years for assets acquired from Roan Selection Trust, and in twelve years for assets acquired from Zambian Anglo-American.

Acceleration of payment: In the event that payment for assets acquired is less than two thirds of the dividend received by MINDECO, payment will be equal to two thirds of the dividend received. This clause did not apply during 1970 for former Roan Selection Trust properties, and during 1970 and 1971 for former Anglo-American properties.

Fees for management and sales: Services currently provided to individual companies will continue to be provided by the former parent companies, Anglo-American (Central African) Ltd and Roan Selection Trust, to the new companies. Management consulting and sales agency fees have been fixed at one and a half per cent of gross turnover plus 2 per cent of profits after mineral tax but before income tax. Although details are still to be worked out on these, the agreement for management fees will run for a minimum of ten years to coincide with the anticipated repayment period.

Non-mining assets: All assets not acquired by MINDECO will be externalized, in the case of Roan Selection Trust to the United States, and in the case of Anglo-American to Bermuda.

Taxation: During the period of bond repayment, there will be no increase in taxation beyond the present effective 73.05 per cent of profits, as a result of the new mineral and income taxes.

Dividends: During the period of bond repayment, dividends will be freely remittable outside Zambia. Dividends will be equal to consolidated profit after taxes and after providing for capital and prospecting expenditure.

In addition there have been tax changes and new legislation covering mining activity in the country.

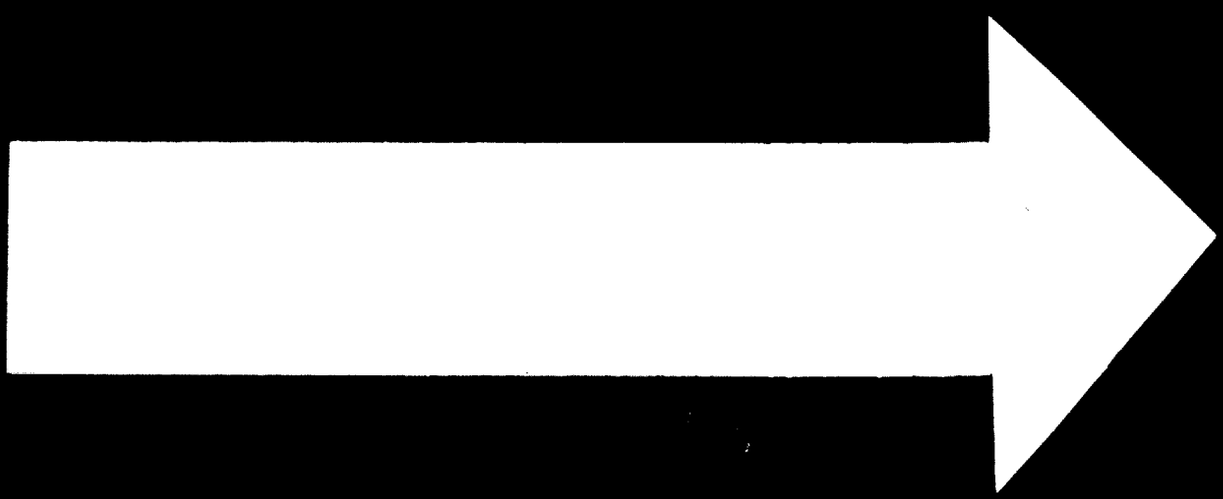
Tax reform: Previously, payments to the Government consisted of a royalty, an export tax and an income tax on profits less royalty and export tax. Royalty and export tax were determined on the basis of an average of prices on the London Metal Exchange, above certain levels and irrespective of costs of production. This tax structure is to be replaced by a mineral tax and an income tax both based upon profits.

(2) The Mines and Minerals Act of 1969

This act vests in the President on behalf of the Republic, "all rights of ownership in, or searching for, mining and disposing of minerals". Thus, all the previously held mining rights (prospecting licences, special grants and mining locations) revert to the state. The bill contains a schedule listing properties for which mining licences will be granted. It covers all those mining operations currently in production.

A simplified system of graduating from prospecting to exploration to mining licences is provided for in the new act. Pre-conditions are imposed for the granting of each type of licence; they include minimum expenditure requirements, presentation of detailed plans of action, maximum holding periods, and the right of the state to acquire an interest in any mine developed in a prospecting area. Prospecting licences will be issued for specific areas and minerals, and they will grant the exclusive right to the holders to search for specified minerals in specified areas for a period of four years.

Large areas of the country are now accessible for the first time for prospecting and exploration.



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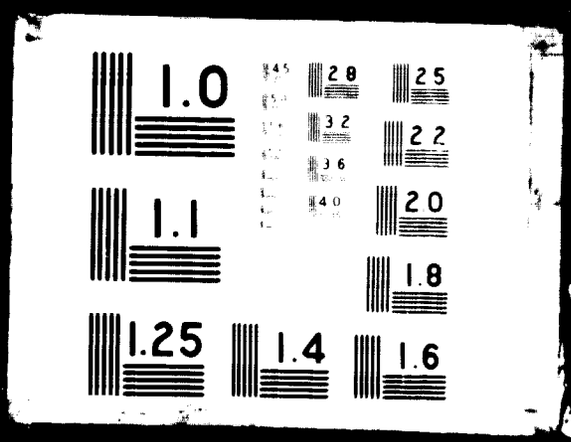


East Africa

Kenya

The Republic of Kenya is an East African state that became independent in 1964. To the north of Kenya are Ethiopia and the Sudan, to the west is the frontier with Uganda, and its southern neighbour is the United Republic of Tanzania. The south-eastern boundary is provided by the Indian Ocean. The population of 10.9 million (1969 census) is largely concentrated in the south and south-west, particularly in the Kenya Highlands. The total land area amounts to 583,000 km².

The country lies on the equator but, apart from a lowland coastal plain of about 200 km in width, it is on high land, ranging from 500 m in the east and north to 2,000–3,000 m in the Kenya Highlands. The climate in the coastal belt is hot and humid, but around Nairobi the temperature range is 10° to 28° C and around Lake Victoria, from 16° to 30° C. Rainfall varies across the country; it is low in the north but ranges from 85 cm to over 175 cm/annum over the rest of the country. In the Highlands there are two rainy seasons—the "long rains" from March to June and the "short rains" from October to December.

The port of Mombasa is East Africa's principal port. It is connected by rail to Nairobi and from there continues into Uganda; another branch at Voi connects with Tanzania. There are other branch lines comprising approximately 2,700 km in all. These lines are all narrow gauge and single track, except at stations. The rail system is being modernized with diesel locomotives replacing wood-burning ones. The planned railway link through Tanzania to Zambia when completed will be of great importance to the whole system. There are over 40,000 km of roads, excluding towns, of which only 2,500 km are bituminized; a similar length is all-weather, gravel-surfaced roads. The Mombasa-Nairobi road is bituminized, and the whole route to Kampala (Uganda) will soon be similarly surfaced. The Kenya section of the Great North road from Tanzania via Namanga and Nairobi to Tororo in Uganda is under construction as a bituminous highway and is scheduled for completion in 1970. International airline connexions are provided at Embakasi near Nairobi, and local air charter companies provide an internal air taxi service.

The main source of power in Kenya is hydroelectricity, with some thermal stations using fuel oil for steam raising. Some power is imported from the Owen Falls station in Uganda. The Seven Forks hydroelectric scheme on the Tana river is now well under way and will utlimately provide 250,000 kW of power, which is about two and a half times the 1966 figure. In 1966 power generated was 346 million kWh. There are no known resources of coal or oil, but Kenya has an oil refinery at Mombasa which had an output of 2.1 million tons in 1969.

Aluminium

There are no known bauxite deposits in the country nor is there an aluminium reduction industry. A small sheet-rolling plant existed in Mombasa but its current status has proved difficult to determine. It is believed now to be solely concerned with the production of finished goods.

Copper

There is only one complex ore deposit known to have commercial potential, and that is situated at Macaldor near Lake Victoria. Estimated total reserves are 2 millions tons, containing 1.2—2.2 per cent copper, 2—3 per cent zinc and 42 g/ton of silver. A survey has been initiated by the Department of Mines and Geology of the area to the north-east of Kitale and Meru, where the geology indicates the possible existence of copper ores. The only semi-fabricating plant is East African Gables Ltd, Nairobi, which engages in wiredrawing in conjunction with cable manufacture.

Lead, tin and zinc

Recent surveys have revealed the existence of lead-zinc ores, also containing some silver, in the Kilifi district, and a joint Kenyan-Romanian company has been formed to exploit these deposits which are considered to have commercial potential.

Malawi

The Republic of Malawi is to the east of Zambia, to the west of Mozambique, and on the western side of Lake Nyasa. Tanzania borders on the north and north-east. The physiography of the country is profoundly influenced by large-scale faulting, characterized by the north-south trending Rift Valley where the northern fault scarp of the Livingstone mountains plunges 500 m below the surface of nearby Lake Nyasa and the Ruarwe scarp falls to about 530 m below the lake. The highland plateaux are mainly over 1,200 m in altitude, falling to 600—1,200 m in the western part of the country. The Nyika Uplands in the north and the Zomba and Mlanje massifs in the south rise to 2,000—3,000 m. The climate is tropical, modified by elevation, with a wet season from November to April and a dry season from May to October. Rainfall is plentiful, ranging from 2—28 cm per annum in the northern highlands to 63—89 cm in the Shire Valley.

The population numbers 4.28 million (1968 estimate). The capital is Zomba (approximately 20,000 population); and Blantyre is the main commercial and industrial centre. The total land area of the country amounts to 96,000 km².

A single track, 3 ft 6 in-gauge railway runs from Salima, near the southern end of Lake Nyasa, through Blantyre-Limbe and southwards via Marka to the port of Beira in Portuguese Mozambique; it totals 590 km. Work has been started on an extension to the line from the northerly port of Nacala-Mozambique to Entre Rios and is planned to connect with the present Malawi north-south line. The total road system amounts to approximately 10,000 km,

with approximately 600 km bituminized. Transport by boat on Lake Nyasa is important for the shipment of goods. International airport facilities are provided at Blantyre-Limbe, and there are internal services to a number of airfields.

The economy is overwhelmingly agricultural, with plantation crops such as tea, groundnuts, tobacco and raw cotton being major earners of foreign currency. Grain crops, rice etc. are grown mainly for local consumption. Most industry is concerned with the processing of these crops. Cement and brick production, motor vehicle assembly, furniture and cigarette manufacture are examples of non-food activities. The country has no coal or oil resources. However, the Nkula Falls hydroelectric plant and the planned Shire River station point to a potentially very useful hydroelectric source.

Geological mapping was completed in 1968 and areas were located that could contain economic deposits of copper, chromite, gold, nickel, tin and zinc, in addition to the bauxite deposits already known.

Aluminium

Bauxite deposits estimated to total 60 million tons of an average of 43 per cent Al_2O_3 have been discovered on the Mlanje plateau near Bamako. The deposits are expected to be exploited when the hydroelectric plant under construction at Cahara Basin on the Zambezi river in Mozambique starts operation. Transport costs appear to be such that it may be uneconomic to plan initially for production of alumina for export.

Copper

Deposits of copper ore were discovered in 1964 at Makok, south-west of Nsanje, but details of the extent of these deposits do not appear to have been published. These deposits are being developed by the Makoko Smelting Company. Two small smelters are being built; they should shortly be in production and employ about 100 persons. An investment of $40,000 is involved, of which $8,000 is being provided by the Otavi Mining Co. of South Africa.

Lead, tin and zinc

Details of the occurrences of these metals do not appear to have been published, although data is in the possession of the Government.

Somalia

The Somali Republic became independent in 1960 as a result of the merger of the former British Somaliland Protectorate and the previous Italian Trustee Territory of Somalia. It occupies an area in the vicinity of the north-east "horn" of Africa, with long coastlines on the Indian Ocean and the Gulf of Aden. Its land frontiers are with Ethiopia to the west and south-west, and Kenya to the south.

The country as a whole is semi-desert. The northern plains are particularly arid and give way inland to the maritime range of the Ogo Highland, which

rises to 2,400 m and descends southwards into the vast tilting Sawl Haud plateau, which has an average height of 900 m but is much higher towards the Ethiopian border. The southern part of the country is of only moderate relief and becomes higher and more broken as the border with Ethiopia is approached.

The estimated population of 4.5 million (1968) is largely nomadic. The capital, Mogadiscio, has a population of around 100,000. Other large towns are Hargeisa (population 50,000), Chisimaio (population 30,000) and Berbera (population 20,000). The total land area is 637,000 km².

There are no railways in the country and the road system is rudimentary, consisting largely of tracks developed from usage over the years. There are two asphalt all-weather roads running north and south from the capital and totalling 600 km. The other roads are essentially dry-weather roads. A national commercial airline, Somali Airlines, provides connexions primarily with other countries in East Africa and the Near East. The main international connexions are available via Nairobi. There is little internal air traffic.

There are no known domestic coal or oil resources and there is only a modest generation of electricity, serving primarily the main towns. The country has essentially a pastoral economy based on livestock rearing. In southern Somalia, especially along the Scebeli and Guiba rivers, are plantations producing sugar cane, bananas, durra, maize, oilseed and fruit. Industry is primarily associated with these activities but also includes leather tanning, footwear and leatherwear, weaving of cloth, and meat and fish canning. Deposits of iron ore are known to exist in the south, and gypsum, beryl and columbite are found in the north, although none of these are exploited.

Aluminium

There are reports that bauxite deposits were discovered by a United Nations investigating team in 1967 which may prove to be of economic value, but further details do not appear to have been released. There are no reduction or semi-fabricating plants.

Copper, lead and zinc

There are reports of possible exploitable occurrences of copper and lead-zinc ores (and other non-ferrous metals) in the northern mountainous region and in the Baidoa-El Bur area.

Tin

Small deposits of cassiterite are known to exist at Dalan, but they are estimated to amount to only 53 tons to a depth of 30 m, containing a minimum grade of 0.35 per cent tin and with a stoping width of 91 cm. Quartz veins not yet exposed might yield a further 80 tons.

The United Republic of Tanzania

The United Republic of Tanzania was established in 1964, combining Tanganyika and Zanzibar. Situated in East Africa, it borders Kenya and

Uganda on the north, Mozambique, Zambia and Malawi on the south, and the Republic of Zaire, Rwanda and Burundi on the west. Its population of 13 million (1969 estimate) tends to be spread unevenly, partly owing to the incidence of the tsetse fly. Much of the southern highlands and the western region have a low population density. The total land area is estimated to be 942,000 km².

The greater part of Tanzania consists of an interior plateau with a mean altitude of about 1,000—1,500 m, and a low plain along the coast of the Indian Ocean. The island of Zanzibar is low lying and of coral formation. The climate is tropical but with variations according to topography. The coastal, southern and north-western areas have a high rainfall, while the central area is dry with rather unreliable rains. There are two rainy seasons in the north with peaks in April and October, and only one in the south.

Several major rivers have immature gradients and exhibit seasonal variations in the flow of water. For these reasons it is difficult to utilize them for power or navigation except for short stretches. The main ports are Dar es Salaam, Tanga and Mtwara.

The country has a network of about 2,900 km of railways. The main railway line runs from the port of Dar es Salaam to Tabora, where it forks west to the port of Kigoma on Lake Tanganyika and north to the port of Mwanza on Lake Victoria. Other railway lines run inland from the ports of Tanga and Dar es Salaam to Arusha and Nachingwea respectively; they also connect with the Mombasa-Nairobi line in Kenya and thence with Uganda. There has been continuous improvement and extension of the road network, which now amounts to a total of 6,100 km; more than 1,200 km of this are all-weather bituminous roads and 1,300 km are all-weather gravel roads. International airline connexions are provided at Dar-es-Salaam airport, and the country has an internal air network.

Total reserves of coal in Tanzania are estimated to amount to more than 800 million tons. Recent surveying has estimated inferred coal reserves of about 1,500 million tons, of which 500 million tons have been indicated by drilling. There are several deposits of coal including those at Ruhuhu to the east of Lake Nyasa, at Illima in the Rungwe district on the north-western shore of Lake Nyasa and Lake Rukwa coalfield near Mbosi and in the Songwe-Kwara area of the Rungwe district. None of these are currently being worked, primarily because transport costs appear to be unfavourable.

There are no natural fuel resources in the country other than wood. Most electricity is thermally generated, but at the Moshi and Mandera stations 28,000 kW are planned to be added to a previous generating capacity of 70,000 kW. No recent figure for total power generated is available.

Aluminium

Bauxite deposits have been located near Amani in the Usambara highlands about 80 km west of Tanga. These deposits are probably extensive in the many areas of thick forest and soil cover, but not enough work has been done on them. There is no large-scale prospecting programme being carried

out at present. Analysis of samples from Amani showed an average content of 57.7 per cent Al_2O_3, 10.5 per cent SiO_2, 1.2 per cent Fe_2O_3, and 1.6 per cent TiO_2; samples from two other localities were found to be high in SiO_2 and low in Al_2O_3.

The country accordingly has no alumina or aluminium reduction plants, but it has a small aluminium rolling mill at Dar es Salaam, operated by Aluminium Africa Ltd. which is owned by the Chandaria family. It has hot and cold rolling facilities for sheet production and can also produce corrugated roofing sheet. It has a nominal capacity of 5,000 tons/annum, but production is believed to be around 3,000 tons/annum. Imports of semi-fabricated aluminium products are around 400 tons/annum.

Copper

Although small occurrences of copper ores have been noted and there has been some sporadic mining on a small scale, to date no large deposits of potential importance have been found. There are no semi-fabricating facilities in the country, and imports of semi-fabricated copper rarely exceed 100 tons/annum.

Lead and zinc

Zinc has never been produced on any commercial scale—the mine at Mpanda was for the copper-lead industry and has since been closed. The mining of this deposit started in 1950, was expanded by 1955 with the installation of a new concentrator capable of treating about 1,200 tons of ore per day, but was eventually shut down in 1960 due to the exhaustion of the ore reserves.

Tin

The total of tin reserves is not known, and figures quoted for grade range from 1—3 kg of tin per m^3. The tin content in the extracted ores is 1 per cent. The main tin-bearing region of Tanzania, Karagwe, is situated in the north-west of the country in the western lake region. The company, Kyerewa Syndicate, which is affiliated with Straits Trading Co. Ltd of Singapore, is engaged in the extraction and production of tin at the Kaborishike mine at Kyerewa. A concentrator capable of treating about 1,000 tons of ore per day was installed in 1958. Steps were later taken to increase this but without an appreciable effect. Several tin claim holders are mining in the area, and their output is sold to the British Metal Corporation at Kikagati in Uganda. The country produces around 400 tons of tin concentrates per annum, and the concentrates (containing 72.5 per cent of tin) are exported to Malaysia for smelting at the plants of Straits Trading Co. Ltd.

Uganda

This East African country of 9.53 million population (1969 estimate) became independent in 1962. It adjoins the Republic of Zaire on the west. To the north is the Sudan, and Kenya is its eastern neighbour. To the south is

the United Republic of Tanzania, and Rwanda and Burundi border it on the south-west corner. Most of the country is plateau of 1,100 - 1,500 m elevation, and it lies on the equator with a temperature range of from 18° to 27° C. Rainfall ranges from at least 75 cm to 150 cm/annum in the Lake Victoria zone; there are two rainy seasons. Large areas of the central and southern parts of the country adjoining the lakes are swampy. The total land area amounts to 236,000 km².

Lake Victoria, Lake Albert and Lake Kyoga and the Albert Nile are important for cargo transport. The main outlet for export goods is via the railway line that passes through Nairobi (Kenya) and links with the port of Mombasa: it must cross the Rift Valley in Kenya with a 1 in 50 gradient, rising to 2,800 m and then descending. The main railway line runs from Tororo via Jinja through to the Kilembe copper mines in the south-west of the country. A branch at Jinja connects to Namasagali on Lake Kyoga. A north-westerly branch extends from Tororo to Soroti and continues to Pakwach on the Albert Nile. It is planned to bridge the Nile here and extend the railway on to Arua. The road network comprises 5,560 km of all-weather roads, of which 1,230 km are two-lane bituminized highways maintained by the Government. A further 18,000 km of roads, some of which are only passable in dry weather, are maintained by local authorities. A road has recently been completed from Katunguru, on the south of Lake George, via Kasese and Kilembe and connecting with Lukero in Zaire. International airline connexions are provided by the airport at Entebbe.

There are indications of the existence of natural gas and oil in the country, but there is no production. Imports of oil amount to 130,000 - 150,000 tons/annum. Almost the entire electricity supply is generated by the Owen Falls hydroelectric station. The total power generation in 1969 amounted to 730 million kWh, of which 218 million kWh were exported to Kenya.

A number of minerals are known to exist, but so far their exploitation has been limited. There is production of beryl, cobalt, columbite/tantalite, copper, wolfram and tin, and a very small production of gold. Geological exploration is incomplete.

Aluminium

There are no known deposits of high-grade bauxite. There are a number of low-grade bauxites in various provinces, but these are essentially ferrigunous laterites. Recently, the Cable Corporation of Uganda was set up to manufacture cables using imported aluminium and copper; it is a joint venture of the Mehta Group and Sumitomo Electric Industries of Japan.

Copper

The production of copper is centred in Kilembe where the estimated total reserves are 8 million tons, of which the proved reserves are 4.4 million tons containing ~1.9 per cent copper and 0.18 per cent cobalt. The deposit is worked by Kilembe Mines Ltd, which is jointly owned by Falconbridge Nickel Mines Ltd and Chilex Ltd. The ores are sulphide-pyrites which are

processed and converted to blister copper at Jinja. An agreement was entered into in 1968 between the company and Nippon Mining Co. Ltd (Japan) whereby the latter would take the entire output of blister copper.

More recently, another copper deposit has been located in the same area at Bukangama whose reserves are estimated at 5 million tons of ore. An agreement concluded with the Federal Republic of Germany in 1963 provided for technical assistance in mapping mineral resources over a two-year period.

There is no domestic semi-fabricating industry.

Data for mine output and production of blister copper are shown in table 18.

Table 18

MINE OUTPUT AND SMELTER PRODUCTION OF BLISTER COPPER — UGANDA

(Thousand tons)

	1959	*1965*	*1966*	*1967*	*1968*	*1969*
Mine output	12.1	16.3	16.2	15.0	15.2	16.6
Smelter production of blister copper	12.1	17.2	16.1	14.6	15.6	16.5

Plans have also been recently announced by Kilembe Mines Ltd to produce cobalt at around 1,000 tons/annum from cobaltiferous pyrites which occur as a by-product of copper production.

Lead and zinc

Exploration so far carried out has not revealed the presence of useful deposits of lead and zinc ores, and there is no domestic lead or zinc semi-fabricating industry.

Tin

The total tin reserves of the country, proved and probable, are estimated to be 2,000 tons. These are essentially an extension of the Zaire deposits and are mined in the Ankole area of Kizegi. Columbite occurs in conjunction with cassiterite. Kilembe Mines Ltd are carrying out further prospecting in the area. Total production of tin concentrates, containing 70 per cent tin, amounts to 100—200 tons/annum.

THE MAGHREB COUNTRIES

Algeria

Algeria is regarded geographically as a Maghreb country, with a climate and physical characteristics similar to those of its neighbours, Morocco and Tunisia. The main contrast is between the Mediterranean climate of the northern coastal belt, with its hot dry summers and rainy winters, and the vast southern desert area which comprises 80 per cent of the land area. In consequence, the water resources are limited and there are no navigable rivers. Rivers are used in the north for irrigation. The population is estimated to number 12.9 million (1968) and the land area is 2.376 million km².

The country has a well-developed network of roads consisting of 22,000 km of metalled highways and 34,000 km of other roads. Two major highways connect the ports of Algiers and Oran with the south of the country and its southern neighbours, Mali and the Niger. The coastal road connects the ports of Oran, Algiers, Bougie and Annaba with Morocco to the west and Tunisia to the east. The railway system is also well-developed; the main trunk line from Marrakesh (Morocco) to Tunisia follows the coast, with three connecting branches to the south of the country. In all there are 4,500 km of track, including 1,637 km of narrow gauge. The country is also well served by international airlines, with regular services to the United States, France, Morocco, Tunisia, Switzerland and the Soviet Union.

The country possesses large reserves of oil and natural gas which are concentrated in the Sahara; the oil fields are in the neighbourhood of Hassi-Messaoud and Edjeleh. The gas fields are at Hassi-R'mel, the gas being pumped to Arzew (near Oran) where there is a liquefaction plant. Oil is carried by three pipelines to the Algerian ports of Arzew, Bougie and La Skhirra. The electricity output was 1,119 million kWh in 1966, of which 355 million kWh was generated by hydroelectric stations. The thermal generation is based on coal at Bechar (although reserves are modest) and oil and gas near Annaba and Bougie. Fuel production figures for 1966 were: 100,000 tons of coal, 42 million tons of oil and 2.0 billion m^3 of natural gas.

The country has been incompletely surveyed geologically. However, lead, zinc, copper and small silver and mercury deposits are being worked, and a significant expansion is likely, particularly in the production of lead-zinc ores. Specific information is given below on the production and reserves of non-ferrous metals.

Aluminium

The country has no known bauxite resources and no alumina manufacture or aluminium reduction. The large natural gas resources could provide the means of generating the sufficiently large quantities of power needed by metallurgical industries, but in the absence of the discovery of suitable domestic ores, any domestic aluminium industry would have to be based on imported raw materials.

A small semi-fabricating industry exists which was established by French aluminium interests prior to the country's independence. This consists of a small rolling mill, L'Aluminium Africain in Algiers, and an extrusion and wire plant, Sté Nouvelle des Laminoirs et Tréfileries d'Afrique, also in Algiers, which produces some electric cables to meet domestic needs. It engages in fabrication of both aluminium and copper wire. Reliable statistics on the industry's output are not available, but the total output is believed to be about 1,000—2,000 tons/annum. A project for an aluminium smelter, producing 60,000 tons/annum and using natural gas for power generation, is under study. The proposal envisages the importation of bauxite from the alumina plant in Sardinia.

Copper

Copper ores occur in Algeria in complex form in compounds with lead and zinc. Existing geological data indicate the possible presence of ores containing considerable copper in the northern part of the country, and a large prospecting programme has been scheduled by the Bureau Algérien de Recherches et d'Exploitation Minières. The most important deposits are at Ain-Barber and C. Cavallo. The following data give estimates of the total ore reserves of the country and of the two principal sources.

Total proved and probable reserves 63.5 million tons

Ain-Barber

Total reserves ..... 3 million tons
Proved and probable..... 0.23 million tons

(Average analysis—2.8 per cent Cu, 2.7 per cent Zn, 0.8 per cent Pb)

C. Cavallo

Total reserves ..... Not available
Proved and probable..... 2 million tons

(Average analysis—2.5 per cent Cu, 5 per cent Zn, 5 per cent Pb)

The Ain-Barber deposits consist of seventeen ore-bearing veins, of which four are exploited by underground mining, with an average monthly output of 2,300 tons, which it is planned to increase to over 4,000 tons per month to provide a nominal 50,000 tons/annum capacity. The C. Cavallo deposits are being developed to provide an additional capacity of 240,000 tons/annum. The concentrates from Ain-Barber are exported to Europe, mainly to the Federal Republic of Germany.

The only plant engaged in semi-fabrication is an extrusion, wiredrawing and cable plant, Sté Nouvelle des Laminoirs et Tréfileries d'Afrique located at Algiers, which also processes aluminium.

Table 19 summarizes data on production, exports, imports and consumption of copper in various forms.

Table 19

PRODUCTION, EXPORTS, IMPORTS AND CONSUMPTION OF COPPER IN VARIOUS FORMS—ALGERIA

(Thousand tons)

	1960	*1965*	*1966*	*1967*	*1968*
Mine production	...	1.0	1.1	1.0	1.0
Exports of concentrates	0.4	2.7	1.6	1.6	1.0
Imports of refined copper	...	2.0	2.0	2.0	...
Consumption of refined copper	...	1.8	1.9	1.5	1.5

Lead and zinc

There are numerous small and medium-sized lead-zinc ore deposits, of which the lead content ranges from 0.15 per cent to 10 per cent (average 2.2 per cent), the zinc content from 0.7 to 17.3 per cent (average 6 per cent), and with a copper content of from 0.8 to 3 per cent. Silver occurs in combination with these deposits in a ratio of 250–300 g/ton with occasional richer veins. Workable deposits of mercury are located in the Azzaba region near Ismail, and promising deposits have been reported at M'Rasnia. In all, over 70 different deposits of lead-zinc ores have so far been confirmed in the northern part of the country. Statistics on lead and zinc ore production, exports of concentrates and consumption of refined lead are given in table 20.

Table 20

PRODUCTION, EXPORTS AND CONSUMPTION OF LEAD AND ZINC IN VARIOUS FORMS – ALGERIA

(Thousand tons)

	1959	*1965*	*1966*	*1967*	*1968*
Lead ore – mine production	11.3	10.5	5.0	4.2	5.2
Lead concentrates – production	8.0	9.5	10.4	4.0	4.0
Lead concentrates – exports	14.5	11.5	8.2	6.0	...
Refined lead – consumption	3.5	2.5	0.9	1.3	1.3
Zinc ore – mine production	36.0	37.0	14.1	6.7	15.4
Zinc concentrates – exports[a]	...	54.5	...	13.3	...

[a] Gross weight (not metal content).

The largest mine is at El-Abed from which the ore is shipped to an ore-dressing plant in Morocco. Plans exist to increase its capacity to 3,000 tons/day. The Sidi-Kamber mine has only small reserves, which may be supplemented by those of the adjacent Bnduk deposits. The limited reserves of the Ouarsenis and Ain-Barber mines will require considerable prospecting for new deposits. The development of a lead-barytes deposit at Djebel Ichnoul (60 km from Batna) and construction of an ore-dressing plant with a capacity of 100,000 tons/annum of processed ore are planned for the near future. An agreement for developing mining of lead-zinc ores from new deposits at Guerrouma and Sakoniode was signed in September 1969 with the Polish company, Centrozap.

The following are estimates of lead and zinc reserves:

(Thousand tons)

Total lead reserves	545
Proved and probable	307
Possible	238
Total zinc reserves	1,032
Proved and probable	676
Possible	356

The ores from the various mines are treated at a number of mills and ore-dressing plants; these are listed in table 21, which also gives their nominal ore-crushing capacity and output. A new mill is under construction at El-Abed for treatment of sulphide ores.

The lead concentrates produced are exported mainly to Belgium, France, the Federal Republic of Germany, Italy, Japan, Morocco and Tunisia; and the zinc concentrates to Belgium, France, the Federal Republic of Germany, Italy, Japan, Morocco, Spain, the United Kingdom and the United States. Prior to nationalization of the Moroccan facilities lead-zinc ores were treated at the Bou-Beker plant in Morocco. It now appears that a lead flotation plant has been constructed at Djebel-Gustar to replace this facility.

Refined lead is imported and converted into sheet, tubes etc. at the S.A.M.A.B.E. plant at Blida. The plant has a nominal annual capacity of 3,500 tons with an annual output of about 1,500 tons of sheet and 500 tons of tubes and pipes.

Table 21

ORE-CRUSHING CAPACITY AND OUTPUT OF ALGERIAN NON-FERROUS METAL MILLS

Mills	*Nominal capacity input of ore (thousand tons per annum)*	*Typical output of concentrates (thousand tons per annum)*			*Metal content of concentrates (per cent)*			*Per cent of metal recovered*		
		Pb	*Zn*	*Cu*	*Pb*	*Zn*	*Cu*	*Pb*	*Zn*	*Cu*
Kherzet-Youssef	120	5.8	23.5	—	70	55	—	85	85	--
Kef-Oum-Thebaul ..	120	2.8	5.7	7.2	65	50	25	75	75	75
Cavallo	240	5.9	6.8	13.0	60	50	20	70	70	70
Buduk	100	1.9	5.6	3.0	65	55	25	80	80	70
El-Abed	500	10.0	50.0	—	70	58	—	85	93	—
Was-Oudina	60	3.4	3.1	—	70	55	—	85	80	—
Wad-mesidjet	60	2.4	5.1	—	70	55	—	85	85	—
Djebel-Ichmoul.....	80	5.6	—	—	70	—	—	90	—	—
Guerrouma	80	2.2	7.6	—	65	55	—	80	80	—
Gar-Ruban	150	5.5	8.7	—	70	55	—	85	80	—
Djebel-Gustar	60	1.1	—	—	60	45	—	70	70	—
Ma Zoula	150	4.5	—	—	65	—	—	75	—	—
Gergur	80	—	7.8	—	—	55	—	—	80	—
Tresel	60	1.8	2.8	—	70	50	—	85	80	—
Ouarsenis	34	0.6	3.1	—	63	53	—	...	...	...
Sidi Kamber	28	3.2	1.9	—	79	58	—	...	...	...
Ain Barber	24	0.3	0.7	—	44	49	27	...	...	...

Tin

There is no tin mining in the country, although cassiterite occurs in almost all rivers of the region, and around Beni-Bel-Aid, 65 km north-west of Constantine, are small areas of ore consisting of layers of tin-bearing greisens embedded in sericitic and chlorite slates in layers of up to one metre thickness. The commercial importance of these deposits needs further evaluation.

The Libyan Arab Republic

The Libyan Arab Republic is bounded on the north by the Mediterranean. Neighbouring countries are Tunisia and Algeria to the west, the Niger and Chad to the south, Arab Republic of Egypt and the Sudan to the east. In many respects the country a transition from the Maghreb countries to the Nile Valley. The climate is essentially desert except for the moderating influence of the Mediterranean in the coastal region. The main road system is based on the coastal road connecting with Tunisia to the west and with the Arab Republic of Egypt to the east. Two main roads run southwards from Tripoli to Ghadames and into Algeria, and from Misurata to Sebha. There are no railways in operation. The main seaports are Tripoli and Benghazi, which also have airports. The airport at Tripoli provides international air service. The total land area amounts to about 1.8 million km². The main centres of population are primarily on the coastal strip.

Total production of electricity thermally generated was 76.2 million kWh in 1967. The main resource of the country is oil; 125.4 million tons of crude oil were produced in 1968. Natural gas associated with the crude oil has been little used to date, but a liquefaction plant has been built at Marsa Brega and the exportation of liquid gases has begun.

Non-ferrous metals

There are no known metallic ores in Lybia and no domestic metal industry. An aluminium building products factory has been established in which the British company, Critall-Hope Ltd. is involved in partnership with Libyan interests. A study under UNIDO auspices is being made of the possibility of basing an aluminium reduction plant in the country, utilizing natural gas as a power source, and with the participation of neighbouring Maghreb countries. Recent import statistics for the main non-ferrous metals in all forms are contained in table 22.

Table 22

IMPORTS OF THE MAIN NON-FERROUS METALS – LIBYA

(Tons)

	1965	*1966*	*1967*
Aluminium	1,100	1,361	2,213
Copper	165	1,361	944
Lead	219	271	407
Tin	21	62	67
Zinc	631	452	468

Morocco

The Kingdom of Morocco is situated on the north-west coast of Africa and has geographical similarities to its neighbouring states, Algeria and Tunisia to the east. The whole region was referred to by the early Arab

geographers as *Dachia-el-Maghrib* (the Western Isle), connoting its relative isolation from the main Arab world by sea and by the great desert. The main relief is supplied by the Atlas mountains running south-west to north-east across the country, with the elevation of the south-eastern plateau diminishing as the Sahara desert is approached. The main area of low relief is along the coastal strips facing the Atlantic Ocean and the Mediterranean Sea. The population numbers approximately 15 million (1969 estimate) and the land area covers 447,000 km².

The climate is Mediterranean, with mild wet winters and hot, dry summers. In the interior it is modified by continental climatic features which dominate under the influence of the Sahara desert to the south-east. The country becomes increasingly arid inland. A number of rivers flow from the heights of the Atlas range to the sea. These are used essentially for irrigation and hydroelectric power generation. They are not navigable, and the country as a whole has limited water resources.

The railway network totals 2,500 km, of which 760 km are electrified. The most important line runs from Marrakesh via Casablanca and through to Oran (Algeria). A main branch connects with Tangier, and two other lines connect with the mining areas. The Oujda-Bou Arfa section runs due south, crossing into Algeria. The total road network amounts to 50,000 km of which 15,900 km are metalled. The main port is Casablanca, which accounts for 75 per cent of the trade; Rabat and Tangier are also important ports. Airports at Tangier and Rabat provide connexions with the main international air routes.

Electricity production in 1968 amounted to 1,599 million kWh, of which 1,077 million kWh were produced by hydroelectric stations. There are two thermal stations, one at Roches Noires, Casablanca, and the other at Oujda. A third thermal station is under construction at Djerada, near coal reserves amounting to 65 million tons. Production of coal in 1966 amounted to 451,000 tons, of which a small amount was exported to France, Italy and Algeria; coke and anthracite are imported. Production of oil in 1968 amounted to over 88,000 tons, and of natural gas, to 10.8 million m³. Some of the natural gas is supplied for drying phosphate rock; it is also processed at the Sidi Kacem plant and shipped as LNG (liquified natural gas). The Sidi Kacem and Mohammedia refineries refine local crude oil supplemented by imported crude oil.

Morocco has known reserves of copper, lead, tin, zinc, nickel, cobalt, antimony, molybdenum and tungsten.

Aluminium

There are bauxite deposits of 40—55 per cent aluminium content in the Atlas mountains, and they are estimated at 20 million tons. Their remoteness, however, weighs against their commercial exploitation. There are no alumina or aluminium reduction facilities in the country.

There are two small plants engaged in the semi-fabrication of aluminium; a sheet and foil rolling mill at Mohammedia, Manufacture Marocaine

d'Aluminium, and nearby is an aluminium and copper wiredrawing and cable plant, Cie. Générale d'Electricité du Maroc. Imports of semi-fabricated aluminium amounted to 2,501 tons in 1965.

Copper

The present production of copper ores is modest and is mainly based on the mines of Bou-Skour, Djebel-Klakh and Azegour, and a small development at Touissit. The following summarizes the data on ore reserves:

Total copper ore reserves ..... 40,000 tons
Proved and probable reserves . 20,000 tons
Copper content ..... 2 3 per cent

Prospecting in the Jebilet, High Atlas and Anti-Atlas Mountains indicates the presence of copper ores of potential importance. The Bureau de Recherches et de Participations Minières and Omnium Nord Africain S.A. (French) have been drilling. An agreement has been signed with a Yugoslav group on exploration and also with the Japanese firm Mitsui Mining and Smelting Co. Production and export statistics are given in table 23.

Table 23

PRODUCTION OF COPPER ORE AND EXPORT OF CONCENTRATES — MOROCCO

(Thousand tons)

	1960	*1965*	*1966*	*1967*	*1968*
Production of ore	1.5	1.9	2.3	2.2	2.6
Export of concentrates[a]	1.5	1.6	2.1	1.7	1.6

[a] The main customers for these concentrates are the Federal Republic of Germany, Poland, Spain and Sweden.

Technical data on the three copper ore-dressing plants are summarized in table 24.

Table 24

OUTPUT CAPACITY OF COPPER ORE-DRESSING PLANTS — MOROCCO

Plant	*Enrichment method*	*Daily output capacity (tons)*	*Copper content*		*Electrical consumption (kWh/ton)*
			of ore (per cent)	*of concentrates (per cent)*	
Djebel-Klakh	Mechanical	36	2.65	28.0	-
	Drying	60	2.65	45.0	28.5
Bou-Shour	Flotation	150	2.02	30.4	21.0
Azegour		150	9.91	27.6	—

There is a small extrusion plant, Cie. Marocaine de Métaux et d'Entreprise located at Casablanca, which has connexions with the French company, S.A. Trefimétaux.

Lead and zinc

The production of lead and zinc dominates the non-ferrous metals industry of Morocco. It is based on mines at Touissit, Djebel-Aouam, Aouli, Mibladen and the treatment plant at Ksar es Souk. The mine at Bou-Beker, which was formerly a major producer, is now worked out and ceased production in 1969, but the concentrates' plant is still operative. Towards the end of 1968 an agreement was signed with the Algerian Government, under whose terms Algeria was to deliver 300,000 tons per annum of lead and zinc ores from the El Abed mine in Algeria for enrichment to the Bou-Beker ore concentrates' plant of the Société des Mines de Zellidja. Two new projects are featured in the current five-year-plan for lead production at Upper Monlouya and Bou-Madine. The former deposit contains an estimated 10 million tons of lead ore with a 3 per cent lead content. An annual production of 0.5—1 million tons of ore was originally envisaged, but a more modest project is now being planned. An agreement has recently been signed between the Bureau de Recherches et de Participations Minières and Société des Mines de Zellidja on the development of mining of lead deposits at Zeida, 30 km north-west of Midelt, in the Middle Atlas. The ore quality is considered comparable with that of the Mibladen and Aouli mines further to the north-west. These new deposits are estimated at 11 million tons of ore with 2.75 per cent lead.

The total reserves of the country for lead and zinc prior to this development were estimated to be the following, with a composition of 2—10 per cent lead and 3—5 per cent zinc:

		(Thousand tons)
Lead	Total reserves	1,600
	Proved and probable	1,200
Zinc	Total reserves	800
	Proved and probable	680

The most important deposits are those of Bou-Beker and Touissit in the north-east of the country near the Moroccan border. Some 300—1,200 g/ton of silver are also present. Table 25 gives the capacity and output characteristics of lead-zinc ore-dressing plants in Morocco. Table 26 gives data on production and exports of lead and zinc in various forms.

Table 25

CAPACITY AND OUTPUT CHARACTERISTICS OF LEAD-ZINC ORE-DRESSING PLANTS - MOROCCO

Plant	*Daily input capacity (tons)*	*Per cent metal content*		*Electrical consumption (kWh/ton of treated ore)*
		Ore	*Concentrates*	
Touissit	1,700	2.61—2.86	57.2—67.5	25.5
Aouli	1,440	3.35	74.8	43.0
Mibladen	1,500	8.35	72.1	29.0
Djebel-Aouam	560	1.10—9.50	52.0—67.2	35.0

Table 26

PRODUCTION AND EXPORTS OF LEAD AND ZINC IN VARIOUS FORMS — MOROCCO

(Thousand tons)

	1959	1965	1966	1967	1968	1969
Lead ore — mine production	91	63.0	73	73	81	77
Lead ore and concentrates — exports	90	66.0	66	50	58	41
Refined lead — production	31	17.2	19	21	24	27
Refined lead — exports	...	15.0	16	20	23	26
Zinc ore — mine production	56	49.0	46	40	33	34
Zinc ore and concentrates — exports	54	52.0	14	35	39	15

Only one refinery exists for the production of refined lead and that is at Oued el Heimer. It is operated by the Société des Fonderies Peñarroya-Zellidja, has an annual capacity to process 40,000 tons of concentrates, and produces around 25,000 tons of refined lead and 30,000 kg of silver. The concentrates for this plant are supplied by the plants listed in table 25, as well as by the nearby Algerian mines. There is no production of refined zinc in Morocco.

A small semi-fabricating plant in Casablanca, Cie. Marocaine de Métaux et d'Entreprise, is associated with the French Company, S.A., Trefimétaux, and it extrudes lead pipe as well as copper and brass sections. A second plant in Casablanca, Pimienta Fabrications Métallurgiques et Métalliques, produces lead pipe and sheet, as well as soft solder. A secondary metal refinery, Sté Africaine des Métaux et Alliages Blancs, located at Ain Sebaa, handles mainly lead, but also small tonnages of copper, tin, zinc and aluminium alloys.

Tin

A small pocket of tin ore has been worked at El Karit, with output varying between 6 and 15 tons/annum of ore of approximately 60 per cent tin content. A small refinery at the mine produces metal from the ore. The domestic consumption of tin averages 250 tons/annum which, with the exception of the above, is imported from Indonesia and Malaya. Figures for production and imports are given in table 27.

Table 27

PRODUCTION OF TIN CONCENTRATES AND IMPORTS OF REFINED TIN — MOROCCO

(Tons)

	1960	1965	1966	1967	1968
Production of tin concentrates	9	15	6.3	6.1	11.4
Imports of refined tin	166	210	145.0	245.0	280.0

Tunisia

Tunisia is the third member of the group of countries that geographically constitute the Maghreb region. It is bounded by the Mediterranean Sea on

the north and east; its neighbours are Algeria to the west and the Libyan Arab Republic to the south-east. The northern part of the country, encompassing about one third of the area, is mountainous with relatively high rainfall (90—145 cm/annum); the southern part is relatively flat without strong relief, and arid with rainfall rarely exceeding 35 cm/annum. The country shares the general Mediterranean climate of its neighbours with continental influences becoming stronger in the south. The population is estimated to total 4.6 million (1968) and the land area is approximately 156,000 km².

The few rivers that have a perennial flow are mainly small rivers running from the northern highlands into the Mediterranean; the largest is the Mejerda (460 km long).

The total power generation in 1966 was 678 million kWh, which was thermally generated, with the exception of 27 million kWh generated by hydroelectric stations. The country's oil and natural gas resources are an extension of the Algerian deposits. Proved oil reserves amount to 40.5 million tons, and the proved and probable reserves of natural gas amount to 14.2 billion m³. Oil production in 1967 was 2.5 million tons of oil with 9.3 million m³ of natural gas.

The road network extends 15,692 km, of which 6,713 km are main roads. A railway system, totalling approximately 2,100 km, connects with neighbouring Algeria and the Libyan Arab Republic, mainly following the coast with branch lines to Tozeur, also to Tébessa and Souk Ahras in Algeria. Connexions with the international air routes are provided by the airport at El Aouina near Tunis.

Aluminium

There are no known bauxite deposits in the country and no primary or semi-fabricating aluminium industry. Imports of semi-fabricated aluminium amounted to 400 tons in 1966, the main customer being a factory producing aluminium building products.

Copper

A number of small deposits have been located but none are of commercial significance. The domestic needs of industry are met by imported semi-fabricated copper amounting to approximately 700 tons.

Lead and zinc

As with Algeria, the lead-zinc deposits are the basis of the country's metal economy. There are about 50 known deposits, of which 20 are being worked. These are located mainly in the north and north-west. The main reserves are straight lead ores. The lead-zinc ores are of secondary importance and are processed at Bou-Ajabers. The most recent lead mine is at Djebel-Azered, near Foussan, which went into operation in 1967. A plant has been set up near Terji Hassin by a joint French-Tunisian Company, Peñarroya-Tunisie S.A. Estimates of the country's ore reserves, based on a recent United

Nations Development Programme Survey carried out in the Foussan region in 1967, amount to some 5 million tons of lead-zinc ores of about 5.5 per cent metal content. Figures for other reserves indicate about 250,000 tons of lead-zinc ores.

In addition to the plant for producing lead and zinc concentrates, a lead refinery is situated at Mégrine with an annual capacity of around 20,000 tons of refined lead. It produces some silver and antimonial lead, as well as rolled lead, using conventional technology for reduction of sulphide concentrates. The smelter is owned by Société Minière et Métallurgique de Peñarroya (French).

Statistics for mine output of lead and zinc ores, production and exports of refined lead, zinc ore and concentrates are given in table 28.

Table 28

PRODUCTION OF LEAD AND ZINC IN VARIOUS FORMS — TUNISIA

(Thousand tons)

	1959	*1965*	*1966*	*1967*	*1968*	*1969*
Lead ore — mine production	19	16	15	14	16	24
Refined lead — production	20	15	15	14	17	17
Refined lead — exports	22	14	12	12	14	14
Zinc ore — mine production	3	5	5	6	7	10
Zinc ore and concentrates — exports ..	2	3	3	7	—	3

The main export markets for refined lead are Czechoslovakia, France, Poland and Turkey. Zinc concentrates are exported to France.

Tin

There are no known deposits of tin ores in the country, nor is there an industry concerned with their processing and refining.

NORTH-EAST AFRICA

Egypt

The Arab Republic of Egypt lies at the north-eastern corner of the African continent. Its northern boundary is formed by the Mediterranean and the eastern boundary by the Red Sea. In strictly geographical terms the Sinai Peninsula, which borders on Israel, is in Asia. To the south is Sudan, and the Libyan Arab Republic is its western neighbour. The geography of the country, which has an area of 907,000 km², is dominated by large desert stretches. The main axis of economic activity is along the relatively fertile Nile Valley. The climate is predominantly hot and dry. The Nile, which runs 1,500 km within Egypt, provides its main source of water and is widely used for irrigation. In the desert areas sub-surface water, obtained from porous sandstone, provides the main source of water. The population is esti-

mated to number 31.7 million (1969) and is largely concentrated in the Nile Valley.

The country possesses a railway network of 4,510 km. Its main trunk route runs along the Mediterranean coast, southwards from Cairo along the Nile Valley to Aswan, and from Port Said to Suez. A loan of $12 million has been made from the International Bank for Reconstruction and Development (IBRD) for extending the present system. The highway network amounts to some 20,000 km, but only a small part of the total are metalled roads. Port Said and Alexandria are the main ports. The conflict with Israel, however, has closed the Suez Canal and the future importance of these ports remains uncertain. International airport facilities are provided by the airport near Cairo.

Crucial to the future economic development of the country is the Aswan Dam. This will add substantially to the country's capacity for generating electricity as well as provide a water reserve for irrigation. The eventual capacity of the Dam is planned to be 2,100 million kWh. In 1966 the total electricity generation amounted to 5,895 million kWh, of which 1,837 million kWh were from hydroelectric stations. The plan envisages a total electricity generation in the early 1970s of 10,000 million kWh from the Aswan Dam stations and an increase in thermal power generation to around 7,000 to 8,000 million kWh. This considerable addition to power resources is intended to provide a basis for the growth of large power-consuming industries such as metallurgical reduction plants.

Coal is not mined in the country, although deposits are known to exist in the Sinai Peninsula, which also contains oilfields that were producing 70 per cent of the country's crude oil output in 1967 prior to their occupation by the Israelis. The oilfields located along the Gulf of Suez have been expanded and their refinery capacity is being increased. Output of crude oil in 1968 amounted to 12 million tons.

Metallic ores containing copper, lead, zinc, tin, titanium, tungsten, molybdenum, beryllium, zirconium and small amounts of gold are found in the country. The extent of the geological surveying is limited and more extensive deposits than those at present known may later be proved. The country now has only an embryo industry for primary metal extraction, but it does have a useful semi-fabricating industry.

Aluminium

The country does not possess any known reserves of bauxite and similar ores. In the east near Gebel-Abu-Churuq, between the Nile River and the Red Sea, deposits of nepheline syenite have been discovered. Tentative estimates of reserves suggest 25—30 million tons are available with an average Al_2O_3 content of 22 per cent. Mining could be carried out by open-cast methods with little overburden to be removed. These ores are of low Al_2O_3 content by general industry standard, and it is only in the Soviet Union that a process has been developed on a commercial scale for treating them. This process requires the availability of large quantities of limestone which exist in the

north of the Nile Valley near Suez and in the south at El Minya. Deposits of of limestone are estimated at 1 billion tons at each location, and could also be developed by open-cast mining.

Much additional surveying will be necessary in order to establish the full extent of the reserves and their Al_2O_3 content before development plans are formulated. A careful technico-economic evaluation will need to be made to determine the practicability of obtaining Al_2O_3 from these ores at an economic cost. If the economics prove to be unfavourable, the industry would have to be based on imported material. It is understood that a project has been drawn up to build a smelter, with assistance from the Soviet Union, producing 40,000 tons/annum and using power from the Aswan Dam and imported alumina.

An aluminium semi-fabricating industry was begun in 1952 and has expanded quite rapidly from an output of 300 tons of semi-fabricated products in 1952 to 12,000 tons in 1967. Long-term planning envisages an output of 67,000 tons by 1980. Current capacity consists of the following facilities:

	(Tons)
Sheet and strip	15,000
Extrusions	5,500
Foil and collapsible tubes	1,000
Cables	11,500
Castings	5,000

The main production facilities are provided by the Egyptian Copper Works S.A.E., Alexandria, which rolls sheet, strip and foil; General Metals Co., Cairo, which also rolls sheet and strip; Electro Cable Co., Cairo, which produces wire and cable; and the General Organisation for Military Factories, which has rolling, extrusion and wiredrawing facilities at Heiwan.

Copper

The main copper ores are complex ones that also contain lead and zinc and have an average copper content of 3 per cent. The total ore reserves with copper content are estimated to amount to about 70,000 tons, but no adequate data exists on proved and probable reserves. The main deposits reported have been at Um Semuki, east of Aswan, and also near Gebel Abu Swaile to the south of Aswan. Copper-bearing sandstone has been found in the Sinai Peninsula, but a detailed survey is needed to establish its potential economic value.

A well-developed copper semi-fabricating industry exists based on imported metal; plans for expansion envisaged a capacity of 14,000 tons/annum by the end of 1970. The three principal plants again are Egyptian Copper Works at Alexandria, which produces about 3,500 tons/annum of copper and brass sheets and circles, and 1,700 tons of extrusions; General Metals Co., which produces sheet, strip and wire; and the Electro Cable Egypt Co., Mostorad, which produces copper wire and cable and has a nominal capacity of 40,000–50,000 tons/annum but operates at a more modest level of output. Other plants engaged in copper semi-fabrication are a rolling mill, Les Con-

structions Métalliques d'Egypte; a rolling mill, extrusion and wiredrawing plant, Tréfileries, Câbleries et Laminoirs d'Egypte; and an extrusion plant, National Metal Industries, all located in Cairo.

Lead and zinc

The Um Gheig deposit, 50 miles to the south of the Red Sea port of Quseir, has a high zinc and lead content. The Um Semuki deposit contains complex copper-lead-zinc ore with over 3.5 per cent copper content. Other ore bodies are known with 10 - 12 per cent zinc, 1.5 - 2 per cent lead and 2 - 3 per cent copper. The ore reserve estimates are:

(Thousand tons)

Total lead reserves ... 30
Total zinc reserves ... 900

Um Gheig deposits:

Lead reserves 20
Zinc reserves 140

The above estimates do not include reserves of sulphide ores; large-scale prospecting for such ores is needed.

The only plant for converting ores to refined metal is the Egyptian Smelting Co., which produces 3,000 tons of refined lead and zinc from local ores. The plant also refines secondary lead, and small amounts of silver, gold and platinum, as well as around 1,500 tons of lead oxide pigments.

Tin

Present geological surveys have shown the existence of cassiterite, tungstenite and metallic sulphides in quartz veins embedded in granite and in slate. The main deposits are mixed tin-tungsten ores located at Igla, Abu-Dabbab and Nuweiba, near the Red Sea and 200 km to the east of Idfu.

The data on these reserves is given in table 29.

Table 29

TIN RESERVES IN EGYPT

Location	*Surveyed area (thousand km²)*	*Depth of tin-bearing sands (m)*	*Sand reserves (thousand m³)*	*Tin content (kg m³)*	*Tin reserves (tons)*
Abu-Dabbab	148	1.7	254	2.8	712
Nuweiba	185	2.7	500	0.9	478
Igla	112	1.2	136	4.7	644

There is currently no mining of these deposits, which need further evaluation.

Ethiopia

The Kingdom of Ethiopia has a long history of independence, and apart from the Italian occupation from 1936 to 1941, it is one of the few African countries that was not formerly a colony. The population numbers 23.7 million (1968 estimate), and the total land area is 1.237 million km².

The country is largely mountainous and volcanic in origin, with several peaks exceeding 3,500 m and many others over 3,000 m in height. The recently acquired territory of Eritrea (by resolution of the United Nations) is a mountainous hogsback range of up to 3,000 m height interposed between the Red Sea and the Sudan. The lower elevations and the valleys between the major ridges are hot, and the Danakil desert in the east is dry and arid. The higher plateaux are well watered with a more general climate and two well-marked seasons—a dry winter from October to May and a rainy summer from June to September.

The Franco-Ethiopian Railway Co. (jointly owned by the two Governments) operates a line of metre gauge from Addis Ababa (the capital) to Djibouti, the port in Somalia on the Gulf of Aden, a total of approximately 800 km. In Eritrea the Government owns the line from Massawa on the Red Sea to Asmara and Agordat—a total of 320 km with a 95 cm-wide track. The government-maintained road system totals 6,200 km, which are mainly all-weather, and 850 further km are being constructed with assistance from IBRD and the US Agency for International Development (USAID). International air services are operated from Addis Ababa and there are air services to the main provincial centres.

The economy is almost entirely based on agriculture and cattle breeding. Coffee is by far the most important export, followed by pulse, oilseed, hides, goatskins and sheepskins. There is a small but growing industry producing cotton yarn and fabrics, canned foods, cement, sugar, salt, footwear, cigarettes, building materials and paint. These industries are mainly centred around Addis Ababa and Asmara, and total about 150 establishments.

The installed electrical generating capacity was 120 megawatts in 1968. Oil is refined at Assab at a plant with an annual capacity of 500,000 tons of crude oil.

The mineral resources of the country are undeveloped and much surveying still remains to be done. Gold is produced at Adola in the south, and there are definite indications of copper, nickel, lead and manganese.

Aluminium

There are no known deposits of bauxite or other high-aluminous ores, and no industry is engaged in the refining or production of semi-fabricated products. Imports of aluminium in all forms amounted to 352 tons in 1965.

Copper

Early surveys conducted in the late 1930s and early 1940s indicated the presence of copper minerals in a number of valleys in the Chercher region, and a deposit in the Galetti valley in the form of malachite containing 24 per cent copper and 3 per cent cobalt. In Eritrea a copper deposit at Adi Haschi, Hamasian, was proved, with an estimated 30,000 tons of copper ore averaging 3 per cent copper in the form of carbonate at the surface and

pyrites at depth. The deposit was also reported to contain approximately 40 g/ton of gold. The presence of veins of chalcocite, chrysocolla and malachite was also reported in dibasic rocks in the lower Anseba valley, but their continuity has not been proved.

More recently further drilling has been carried out in the same area, on Mount Saccar near the Asmara-Massawa road about 50 km from Asmara. The Duval Corporation of Tucson, Arizona, obtained leases to the deposits. Drilling has also been carried out at Adi Rissi. Discussions have been proceeding with the Japanese firm, Nippon Mining Company, with a view to concluding an exploration agreement covering an area around Asmara expected to contain copper minerals.

Lead and zinc

Lead minerals are reported to exist in the Candala and Chercher districts, but their commercial possibilities do not appear to have been evaluated. The presence of galena has been determined in a small vein near Saganeit in Eritrea, but this was not considered to be a siting likely to be commercially significant.

Tin

Cassiterite has been reported in veins of pegmatite and quartz in the neighbourhood of Magiaian, but there appears to be no information as to further evaluation.

The Sudan

The Sudan borders the Red Sea on the north-east for approximately 450 km. Its neighbour to the north is Egypt and to the north-west the Libyan Arab Republic; on the east it adjoins Ethiopia; to the south lie Kenya, Uganda and the Republic of Zaire; and on the west it abuts the Central African Republic and Chad. There are three main climatic zones. The northern belt between Khartoum and the Egyptian frontier is very dry, with a small winter rainfall. The central belt extends 460—500 km from Khartoum, has moderate rainfall concentrated in the four months of June to October, and produces the main agricultural cash crops. The southern region has high rainfall, large areas of swamps, and is remote from main centres. The river Nile, with its Blue Nile and White Nile branches, is of major importance to the Sudan; it prevents the central and northern areas from becoming desert and also provides over 3,000 km of navigation. Apart from the Nile system, the other Sudanese rivers are largely seasonal streams. The population is estimated to number 14.8 million (1968), and the land area covers 1.204 million km².

Communications are largely based on the steamer services on the Blue and White Nile and on a railway system centred on the north-south route from Wadi Halfa to Sennar, with an eastern branch going from Atbara to Port Sudan, a branch to Kassala via Gedaref that rejoins the main north-south line at Sennar, and a number of other branch lines, totalling in all

4,750 km of 3 ft 6 in-gauge. Apart from the largest towns and 40 km of road north from Khartoum to Khogalab and 180 km south from Khartoum to Wad Medani, 3,500 km of roads are merely tracks, although a substantial lorry traffic operates. Khartoum has an international airport.

Power generation in the Sudan in 1966 amounted to 262 million kWh, much of it being produced by hydroelectric stations. Oil and natural gas have not so far been found in the country, although their presence is suspected in the region of Trinkitat on the Red Sea, and further north near the border with Egypt. Deposits of bauxite, copper and lead ores have been found.

Aluminium

There are deposits of lateritic bauxite of 45—55 per cent Al_2O_3 on the Napephara and Tsitagana plateaux. The total reserves of this ore are calculated to be about 100 million tons.

There is no domestic reduction or semi-fabricating industry.

Copper

The main source of copper ores are two deposits of sulphide ores in the south-west of Darfur province. The main deposit exploited down to a depth of 150 m is estimated to contain 280,000 tons of copper; the ore has an average copper content of 2.78 per cent and 0.3 oz/ton of gold. The second deposit has not been developed and little data is available on it. Evidence of copper ores has been discovered in the region of Port Sudan, Gedaref and in the south of Darfur province. The latter is considered likely to contain at least 250,000 tons of copper, but the other sites are not thought likely to be economic sources.

Licences to work the Hofrat en Nahas deposits in the south-west of Darfur province have been granted to the American company, African Mining Co., and to the Italian company, Pera Trading. Mine production of copper ore in 1967 yielded 280 tons of copper.

There are no domestic reduction facilities nor is there a semi-fabricating industry. About 300 tons of semi-fabricated metal are imported.

Lead and zinc

Small lead ore deposits have been found in the Kutum area of Darfur province, and 721 tons of concentrates were exported to the Federal Republic of Germany in 1967. Experts believe that the southern part of the country, particularly the south-western area that borders on the Republic of Zaire, merits exploration.

Tin

Small deposits of tin ores exist in the Kafia-Kingi district of the Darfur province, and some evidence of their existence has been noted in the region of Sabaluka on the Nile.

Southern Africa

Botswana

The Republic of Botswana became an independent state in 1966. To the north its neighbour is Zambia. Rhodesia forms its north-east boundary, and South Africa surrounds it to the south-east and south. The territory of South-West Africa (administered by the Republic of South Africa) provides the western boundary. The population of 593,000 (1967 estimate) lives mainly in the east and in the vicinity of the three main towns, Francistown, Gaberones and Serowe. The total land area of the country amounts to 575,000 km².

Much of the country consists of an undulating plateau averaging 1,000 m above sea level, but around Ghanzi in the west and Kanye and Serowe in the south and east the land rises to over 1,300 m. About two thirds of the territory is occupied by the Kalahari desert in the west, where the rainfall is 25 cm or less; the east and north rainfall ranges from 40 cm to 70 cm/annum. In the latter areas the climate is milder, but as a whole the country experiences a wide temperature range—warm to hot by day and cold at night with frosts in the winter. The northern part of the country has a large area of salt pan. Water is often difficult to obtain, but irrigation is carried out on farms in the east run by non-indigenous farmers.

The main route for moving goods in and out of the country is the railway line leaving Rhodesia and running near the south-east border into South Africa; it amounts to 600 km. The three main roads run from Maun to Francistown, from Ghanzi to Gaberones, and in turn connect with the international road from Francistown to Gaberones, which provides access to Rhodesia and South Africa. The total highway network amounts to 8,000 km and consists mainly of well-graded, gravel-surfaced or earth roads. The Francistown to Maun sector of 500 km length has been reconstructed with financing provided by IBRD. The airport at Gaberones, the capital, provides weekly flights to Johannesburg where connexions can be made with international airlines. There are a number of airfields and landing strips in the country.

Electricity production in 1966 was 19.7 million kWh, of which 4.1 million kWh was generated by hydroelectric plants. Imported oil is the main source of fuel. Prospecting for oil is being carried out in the southern part of the Kalahari desert by the V. P. Blair Oil Co. Two large seams of medium-grade, non-coking coal have been found at shallow depth, not far from the railway line at Mamabula; reserves of the lower seam are estimated to be 163 million tons, and of the upper seam (of poorer quality), 245 million tons. There is obviously potential here for the development of coal mining.

At present asbestos and manganese are being mined, as well as small quantities of gold and silver. As will be detailed below, an important deposit of copper and nickel ores has been discovered and plans for its exploitation are well advanced.

Aluminium

There are no known deposits of bauxite in the country, and the amount of aluminium consumed in finished goods is very small.

Copper

Total reserves of sulphide and oxide ores in the country are currently estimated at 33 million tons, of which 29 million tons are considered proved and probable. Botswana Roan Selection Trust Ltd has been established to exploit the copper-nickel ores discovered in Selibe-Pikwe, 96 km to the south-west of Francistown, with an estimated capital investment of $75–$110 million. The Selibe deposit contains 1.2–1.6 per cent copper and 0.6–1.5 per cent nickel.

In addition to the mining investment, it is estimated that an investment of $50–$60 million will be needed to provide extensions to roads and other transport facilities, electricity generation, water supply etc. Financial support for these facilities is being provided by the Government of Botswana and IBRD. The operating centre for the project is expected to be located near the dam on the Shashi river, 24 km south of Francistown. Possible construction of a thermal power station using the Mamabula coal is also being studied. Water for processing requirements will be taken from the Okavango river.

Another ore body has been located at Mitsitomma, containing 2.1–2.9 per cent copper in conjunction with small quantities of lead and silver. The establishment of a pilot beneficiation plant to process these ores is under consideration. A further source of copper-nickel ores is in the Tati district in the north-east of the country, where it is planned to develop a mine with an output of 100,000 tons of ore per year. There are considered to be sufficient reserves of copper-bearing ores for fifteen years of production. Further prospecting for these ores is being carried on in this district.

Lead and zinc

There are no known lead and zinc-rich ores in Botswana, nor is there any form of industry concerned with these metals.

Swaziland

Swaziland, which achieved independence in 1968, is completely land-locked. It is nearly surrounded by the Republic of South Africa, apart from a length of its eastern border where it adjoins Mozambique. The country has a population of 389,000 (1966 estimate) and a land area of 17,000 km². The terrain is basically that of a plateau tilted upwards in the west to around 1,500 m and descending in a series of steps to a height of 300 m in the east. The main part of the country is covered by gneiss and schist of the Paleozoic rocks. The climate shows marked regional differences. The Highveld is humid with a mean temperature of 18° C and has a high rainfall, ranging from 10 to 24 cm/annum; the Middleveld is subtropical and drier, with 7.5 to 11.5 cm/annum rainfall;

and the Lowveld has low rainfall, of 5 to 9 cm/annum, and a temperature of 22° C.

A railway line runs from Ngwenya in the eastern part, where iron ore is mined, through Mahlanya and Sipofaneni northwards to Mlawula, and from there into Mozambique to connect with the port of Lourenço Marques. The country has a road network mainly of gravel-surfaced roads. A bituminous road has been built from Oshoek in the west through Mbabane and Manzini to a point some 22 km from Stegi in the east.

In addition to iron ore, mining of asbestos is a main source of export earnings. Deposits of beryl, gold pyrophyllite, barytes and tin are also known to exist.

Aluminium

There are no bauxite deposits in the country and there is no likelihood of their occurrence; nor is there a semi-fabricating industry, and imports of fabricated aluminium products are small.

Copper, lead and zinc

There are no known deposits of ores of these metals, and such geological information as is available does not suggest their possible occurrence. Imports of copper, lead and zinc in all forms are small.

Tin

There are small deposits of cassiterite, in conjunction with wolframite, which are worked in the vicinity of Mbabane. The richest of these deposits has already been worked out. The annual production of tin concentrates is of the order of 2 tons (tin content) per year. In recent years pegmatite veins containing cassiterite have been found near Forbs-Rief, 20 km north of Mbabane. Proved deposits are estimated at 50,000 tons of ore containing 0.37 per cent tin. A small plant has been built for the production of concentrates, which are processed in South Africa.

West Africa

Dahomey

The Republic of Dahomey in West Africa became independent in 1960. It has a short southern coastline (125 km) on the Gulf of Guinea. It is flanked on the west by Togo, on the north by the Upper Volta and the Niger and on the east by Nigeria. It has an estimated population of 2.53 million (1968) and an area of 115,800 km². The administrative capital is Porto Novo (population 74,500), the main port and business centre is Cotonou, and Abomey (population 42,000) is another large town. It has a high population density compared with many African countries, and a large proportion of the population lives in the southern half of the country.

Four main geographical zones run horizontally across the country: a narrow sandy coastal strip, a succession of intercommunicating lagoons, a clay belt, and a sandy plateau in the north. Apart from the coastal and lagoon belt, much of the country is over 200 m above sea level, with isolated hills up to 400 m; the Atakora massif in the north-west reaches 650 m. The climate is typically tropical West African, modified slightly by the geography of these zones; it is equatorial with a steady temperature of 22 – 34 C and two wet and two dry seasons. The country has an unusually low annual rainfall for West Africa, especially in Lower Dahomey where it is less than 100 cm.

Dahomey has 5,886 km of roads, of which 594 km are bituminized. A metre-gauge railway line, totalling 580 km, connects Cotonou with Abomey and Parakou, and Cotonou with Pobe and Pahon-Segboroué on Lake Ahémé. The main port is Cotonou, which also has an airport linking Dahomey with other West African capitals and with Paris.

The economy is primarily agricultural with maize, millet and groundnuts as the main crops; cattle, sheep, goats and pigs are also reared. Steps have been taken to build up local processing industries, which suffered initially from over-ambitious planning.

Aluminium

There are no reports of bauxite occurrences in the country, and there is no aluminium reduction industry. In 1965 a small rolling mill, Aluminium Alcan du Dahomey, was set up; it has a nominal capacity of 1,500 tons/year of sheet, including corrugated and other roofing sheet. The company is owned 51 per cent by Alcan Aluminium Ltd. and 49 per cent by the Banque Dahoménne de Développement and private investors. It has been granted a five-year tax and import levy exemption.

Other non-ferrous metals

Prospecting and surveying is being carried out by the Bureau de Recherches Géologiques et Minières (France), Prakla GmbH (Federal Republic of Germany) and the government Service des Mines, but so far there have been no published reports of occurrences of these metals.

Ghana

This West African Republic attained independence in 1960. It adjoins the Ivory Coast to the west and the Republic of Togo to the east. To the north and north-west it abuts the Upper Volta, and on the south it has a coastline on the Atlantic. Ghana has the general characteristics of a tropical rainfall climate, but its position and relief produce four distinct climatic regions: the eastern coastal belt which is warm and fairly dry; the warm and humid western region; the inland tropical rain-forest belt which is warm and humid; and the hot and dry northern region. In the south the maximum semi-annual precipitation occurs in March–July and September–October.

In the north there is only one wet season, May—October, and the rainfall is lower (~ 125 cm/annum) than in the south (150—250 cm/annum). The coastal plain and the Volta river valley in the east are of relatively low relief. The Ashanti hills and hills in the northern plateau rise up to 500 m in height. The total area of the country is estimated at 238.5 million km².

Ghana has no natural harbours, but artificial harbours have been constructed at Takoradi, which has seven quay berths; and Tema, which is larger and has been extended in recent years, is provided with a dry dock. The country has a narrow-gauge railway network approximating an "A" in shape, with Kumasi at the apex and Accra and Takoradi at the feet, and a number of small branch lines. The system totals 1,350 km, and it handles 1.8 –2 million tons of freight per annum. The road system amounts to over 30,000 km, of which approximately 5,575 km are surfaced, either macadam or bituminous. Construction of an additional 1,300 km of feeder roads has also been authorized. As part of the Volta river development, motor ferries are now operating on the Volta Lake from Akosombo to Kete Krachi, and the use of the Volta system as a whole is planned to improve transport between north and south. International air connexions are provided at Accra airport.

Power resources of the country are based mainly on hydroelectric output; a major contribution comes from the Volta river scheme, which supplied 97 per cent of the country's output of electricity in 1967. The country has no oil resources, but a refinery at Tema supplies virtually all the requirements for refined petroleum products.

Ghana produced 727,121 fine oz of gold in 1968 and is also an important producer of industrial diamonds. Manganese ore is produced from the mine at Nsuta, near Tarkwa, and is an important export. The other major non-ferrous metal ore is bauxite.

Aluminium

The main bauxite deposits worked at present are lateritic bauxite, or gibbsite, located in the western region around Kamayerebo 75 km to the north-west of Dunkwa. The dried ore is transported by rail from Dunkwa to the coast for export. The operating company is the British Aluminium Company Ltd, which produced 350,000 tons in 1967. The following are estimates of total reserves in the various major known deposits.

	Reserves (million tons)
Kamayerebo–Afloh (western region) ..	32
Asafo (western region)	25
Nyinahin (Ashanti region)	168
Mount Ejuanema (eastern region)	4
Atewa Hills (eastern region)	60
Proved and probable reserves	110

The country also has its own aluminium reduction plant operated by the Volta Aluminium Co. Ltd at Tema, which utilizes power from the Volta

hydroelectric plant. This project has a long and involved history; at present the company is owned 90 per cent by Kaiser Aluminum and Chemical Corporation and 10 per cent by Reynolds Metals Company, both American companies. The initial capacity was 105,000 tons/annum, which is being expanded to 150,000 tons/annum. Output in 1968 was 110,000 tons. The works currently operate with imported alumina, but a plant is planned with a capacity of 610,000 tons/annum which will utilize local ore. The plant produces its own pre-baked anodes, and casts the metal into ingots and billets for export, mainly to the United Kingdom and the United States.

The country also has a small semi-fabricating plant, Ghana Aluminium Products Ltd. at Tema, which is owned 60 per cent by Alcan Aluminium Ltd of Canada and 40 per cent by the Ghana Government. It is a sheet rolling mill with corrugating equipment and a capacity of 9,000 tons per annum of sheet and strip including corrugated roofing sheet. Ghana Pioneer Aluminium Co., Tema, produces hollowware and other fabricated products. The output of this plant is destined for the domestic market.

Data for bauxite and aluminium production for the country are summarized in table 30.

Table 30

BAUXITE AND ALUMINIUM PRODUCTION - GHANA

(Thousand tons)

	1959	*1965*	*1966*	*1967*	*1968*	*1969*
Bauxite production	150.2	319.7	322.9	351.0	284.7	269.0
Aluminium production	-	-	-	39.7	111.6	111.0

Other non-ferrous metals

There are no other known deposits of non-ferrous metal ores of commercial importance in the country, nor are there any semi-fabricating activities.

Guinea

The Republic of Guinea became an independent state in 1958. To the north it borders on Senegal and Mali, and to the east its neighbour is the Ivory Coast. To the south lies Liberia and to the south-west, Sierra Leone. It has a western Atlantic coastline of approximately 400 km. The climate is tropical - hot with high rainfall except in the north. Although the coastal strip is lowland, much of the country lies on a plateau of 400 – 500 m, with an area of more broken relief in the mountain region of Djalon and the Guinea highlands in the south-east. The population of the country is estimated at 3.7 million (1968), and the total land area is 250,000 km².

There is a narrow-gauge railway line from Conakry, the main port, to Kankan. The highway network amounts to 3,500 km which are dirt roads. The port at Conakry is being reconstructed to provide the extra facilities

needed to cope with bauxite and alumina exports resulting from the expansion of the bauxite mining industry.

The country possesses no known resources of coal and oil. Electricity production is based on hydroelectric plants and amounted to 174 million kWh in 1965. The country has large potential reserves for the development of hydroelectric power.

Aluminium

There are very large deposits of bauxite in Guinea, the largest known reserves on the African continent. The ore is of high quality containing 45–60 per cent Al_2O_3 and low silica content, around 1–2 per cent. The deposits are lateritic gibbsitic bauxite, often with small amounts of böhmite. The bauxite deposits are spread over several regions in addition to important deposits on the islands of Kassa and Tamarra in the Los archipelago. The details of these deposits are contained in table 31. Estimates of bauxite reserves are:

	(Million tons)
Total bauxite reserves	71,900
Proved and probable reserves	600

Statistics for production and export of bauxite and alumina are given in table 32.

Table 31

GEOGRAPHICAL DISTRIBUTION AND CHARACTERISTICS OF THE MAIN BAUXITE DEPOSITS IN GUINEA

Region	*Location*	*Thickness of bauxite deposit (metres)*	*Total reserves (million tons)*	*Composition of ore (per cent)*	
				Al_2O_3	SiO_2
Boké	90 km north-east of Boké	15	400 – 700	55	5.0
Badi	15 km south-east of Kimbo	...	150 – 300	40 – 45	2.0
Kindia	130 km north of Conakry and 19 km south-west of Kindia	7.5 – 9	100	40 – 45	2.5
Dabola	200 km north-east of Kindia	...	100	47 – 48	2.0
Tougué-Dabola	Between Dabola and Tougué	4.5 – 9	...	47 – 48	2.5
Los Islands	West of Conakry	5.10	5	51 – 54	4.5

Production so far has been confined to the deposits around Badi-Kimbo near the mouth of the Konkouré river. These deposits are being worked open cast by FRIA (Compagnie Internationale pour la Production de L'Alumine), an international consortium in which the partners are Olin Mathieson Chemical Corporation (United States, 38.5 per cent), Pechiney S.A. (France, 23.2 per cent), Société Ugine-Kuhlman (France, 7.5 per cent), Cofimer (France, 5.8 per cent), British Aluminium Co. Ltd (10 per cent), Swiss Aluminium Ltd (10 per cent) and Vereinigte Aluminium-Werke A.G. (Federal Republic of Germany, 5 per cent). This operation also involves alumina production at Kimbo, which reached 529,980 tons in 1967.

Table 32

PRODUCTION AND EXPORT OF BAUXITE AND ALUMINA — GUINEA

(Million tons)

	1959	1960	1965	1966	1967
Bauxite mined	296	1,378	1,870	1,500	1,560
Alumina production	—	185	520	525	530
Bauxite exports	276	705	244	35	...
Alumina exports		171	...	520	...

Mining of another major deposit, based on the bauxite deposits at Boké, was scheduled to begin in 1970 under the direction of Compagnie des Bauxites de Guinée. This company is a partnership between the Government of Guinea and an international consortium with the following participation: Republic of Guinea (49 per cent) and Halco (Mining) Inc. (51 per cent). Halco (Mining) Inc. comprises the following companies: Aluminum Company of America (27 per cent), Alcan Aluminium Ltd (Canada, 27 per cent), Harvey Aluminum Inc. (United States, 20 per cent), Pechiney and Ugine-Kuhlmann (France, 10 per cent), and Vereinigte Aluminium-Werke A.G. (Federal Republic of Germany, 10 per cent).

The development of these deposits requires the construction of a railway line from Sangaredi to the port of Kamsar, and improved port facilities at Kamsar. The mining and ore treatment facilities, equipment, services, transportation equipment, and residential accommodation for the workers will be provided by the company at a cost of $99 million. Halco will also train 800 local personnel as mining technicians. Contributions to the infrastructure are estimated to cost $85.5 million, which is to be met by a loan from the International Bank for Reconstruction and Development (IBRD). The complex is expected to be completed by 1972 and to produce in the first five years about 5 million tons per annum. Part of the agreement involves planning the development of an alumina plant next to the bauxite-drying plant at Kamsar and an aluminium reduction plant. The Sangaredi deposits are of high quality, with 58—60 per cent Al_2O_3 and only 1—2 per cent SiO_2.

Other potential production centres exist in the Boké area, outside of the area allocated to Compagnie Bauxites de Guinée, where deposits amounting to 160 million tons of high-grade bauxite (52 per cent Al_2O_3) exist in the Diandian and Ourougbe districts. Development would require construction of 56 km of railway to connect with the Kamsar-Sangaredi line and the purchase of rolling stock, residential and other supporting facilities, as well as quay and loading facilities in the port of Kamsar.

Another possibility for development lies in the ore deposits near Kindia, 120 km from the railway line to Conakry, where reserves are estimated at 85 million tons averaging 40—42 per cent Al_2O_3 and 5—6 per cent SiO_2. Development of these deposits is considered likely to require construction of an ore-crushing plant, reconstruction of the railway line to Conakry, and

extensions in the port there. A project for an alumina plant at Kamsar has been under active consideration.

There is no semi-fabricating industry, but there is a plant, Société Guinéenne de Fabrication, which produces corrugated sheet and kitchen utensils from imported sheet and is jointly owned by the Government of Guinea and Harvey Aluminum Inc. Expansion is envisaged to reach an output of 13,000 tons/annum of corrugated sheet. At this level provision of domestic rolling mill facilities would seem to be logical.

The Ivory Coast

The Republic of the Ivory Coast achieved independence in 1960. Its West African neighbours are Ghana to the east, the Upper Volta and Mali to the north, Guinea to the west and Liberia to the south. It has a southern coastline on the Atlantic of approximately 600 km in length. This coast lacks natural shelter for shipping, and has the hazard of off-shore sandbars backed by lagoons. The capital, Abidjan, has port facilities provided by a sea connexion from the lagoon through the Vridi Canal, which is only 3 km long and varies from 10—20 m in depth. The population totals 4.01 million (1968 estimate) and the land area is 491,500 km².

The country has a typical West African tropical climate with high rainfall and a semi-annual maximum. The coastal belt is of low relief, but most of the country lies on a plateau of from 200—500 m above sea level. There are a number of rivers flowing southwards to the Atlantic, but these are not of great significance for commerce.

Aluminium

Bauxite deposits are found in the region of Bondoukou, about 300 km north-west of Abidjan, near Lakota on the Sassandra river, and near Bouaflé. No data is available on estimated reserves, but a company, Sodemi (Société pour le Devéloppement Minière de la Côte d'Ivoire), has been set up to exploit these deposits. There is no other domestic aluminium industry.

Other non-ferrous metals

Apart from manganese ores, no other non-ferrous metal ores have so far been proved in the country, nor is there any domestic fabricating industry.

Mali

The Republic of Mali became independent in 1960. It is an inland country to the south-west of Algeria, with Mauritania providing the main border on the west. Its other neighbours are Niger, the Upper Volta, the Ivory Coast, Guinea and Senegal. It has a land area of 1.204 million km² and a population of 4.79 million (1968 estimate). The capital, Bamako, has a population of 170,000; other large towns are Mopti (population 32,400), Kayes (population 28,500) and Segou (population 28,100).

The country covers much of the southern Sahara, and has vast plains with little relief. It lies mainly at 200 m to 500 m elevation, with the Adrar des Iforas in the east rising to over 650 m. The climate is tropical but without heavy rainfall; there is a dry season from November to April and low rainfall over the rest of the year, ranging from 10—20 cm/annum on the edge of the Sahara to 50 cm in the more southerly parts of the Niger valley, which provides the main drainage.

A railway line runs from the Senegal border through to Bamako and then to Koulikoro. An agreement was signed in 1968 whereby the People's Republic of China undertook to extend the railway from Kourrousa-Kankan in Guinea to Bamako. There are 12,080 km of roads in the country of which 7,500 km are all-weather, including the 669 km of the Dakar-Niger metalled road. The Niger river is also an important transport route having a navigable length in Mali of 1,782 km. The airport at Bamako connects with international services via Dakar.

Agriculture dominates the economy and is largely subsistence, with semi-nomadic raising of herds in the north and more settled crop production where rainfall is more favourable. The main exports are cotton, groundnuts, rice, meat and dried fish.

Aluminium

There are reports of very extensive bauxite deposits on the Manding plateau lying south-west of Bamako and extending to the frontier with Guinea, near the river Niger. The total reserves are estimated to amount to 800 million tons, of which 550 million tons are considered proved and probable, with an average content of 43 per cent Al_2O_3. The deposits are not being worked. Their remoteness from the sea and problems in economic power generation mitigate against the economic attractiveness these deposits might otherwise have.

Copper, lead and zinc

Recently a mixed ore body containing 4.0—6.5 per cent of copper, lead and zinc and estimated at 500 million tons has been located in the Kati area west of Bamako. This deposit has not yet been fully evaluated. There is no metalworking industry in the country and imports are very small.

Tin

There is no evidence available of possible occurrences of tin in the country.

Mauritania

The Islamic Republic of Mauritania achieved independence in 1960. It has a coastline of over 900 km on the Atlantic Ocean.

Its southern neighbours are Senegal and Mali; the latter also forms the eastern boundary. In the north-east corner it has a boundary with Algeria and in the north-west with Spanish Morocco. Its population is 1.10 million, and the land area totals 835,000 km².

Much of the country lies on a plateau of around 400—500 m in height but with a lowland plateau adjacent to the Atlantic Ocean and lower relief towards its eastern boundaries. The country, which is mostly desert, has a hot, dry tropical climate. The Senegal river is the only river with a perennial flow.

Transport and communications are sparse, and construction of a railway line from Fort Gouraud to Port Etienne at the northern end of the coastline, a length of 675 km, was completed in 1968, primarily to enable iron ore to be exported. A branch line to Akjoukt is also planned. The main trunk road to the north is the Nouakchott-Atar highway connecting with Tindouf in Algeria. There are no asphalt roads; the network of 2,700 km of roads are earth tracks. Communications within the country are very dependent upon air transport, and there are 22 airstrips.

The fuel resources are very limited, but part of the El-Djouf basin, which on the Algerian side is known to contain oil and natural gas, lies in the north-east. Total electricity generation in 1966 was 60.3 million kWh.

Aluminium

There are no known bauxite reserves nor is there a semi-fabricating industry, and the consumption of aluminium is very small.

Copper

There are known to be quite large reserves of copper ore in the country. A major part are to the north-west of the town of Akjoukt. These are oxide ores of 2.5—2.9 per cent copper, containing 3 g/ton of gold and estimated to contain 7—9 million tons of copper. There are a further 22—23 million tons of sulphide ores in the same area, of which 18 million tons are considered suitable for open-cast mining and 4—5 million tons will require underground mining. The copper content of these is estimated to be approximately 1.5 per cent, and the ores contain 1 g/ton of gold.

A second ore body of importance is the Gebb-Mogrin deposit, which is a sulphide ore averaging 2 per cent copper, 1 g/ton gold and also containing 30—35 per cent magnetite. Oxide ores are also found in this location which average 2.9 per cent copper, 3 g/ton of gold and 50 per cent magnetite. From these two sources it is expected to produce annually 56,000 tons of copper concentrates containing 27 per cent copper and 10 g/ton of gold from the sulphide ores, and 15,000 tons of concentrates containing 66 per cent copper and 40 g/ton of gold from the oxide ores.

The total estimated reserves of copper are 590,000 tons, with a copper content of between 1.5 –2.9 per cent, or an average of 2 per cent. There are also large reserves of lower-grade ore of approximately 0.9 per cent copper content.

The Akjoukt deposits are being developed by Mining of Mauritania Co., which is owned jointly by the Government of Mauritania (23 per cent), Charter Consolidated (an Anglo-American Corporation affiliate, 47 per cent), French

private firms (19 per cent) and French Government companies (11 per cent), involving a $60 million investment. A beneficiation plant was due for completion in 1970 with a capacity of 50,000 tons/annum of concentrates.

Initial mining was to be of oxide ores followed by the sulphide ores. Over the initial eleven-year period, a total of 446,000 tons of copper and 31 tons of gold was expected to be mined and exploitation of the mine was expected to last for eighteen years. Construction of crushing and flotation plants, water supplies, compressor house, power-generation plant, storage facilities, administrative and service buildings and mining equipment was budgeted at $20 million. A further $6 million was to be spent on the construction of a township for 400 workers and their families, as well as for 90 foreign specialists. A new road to ship the concentrates to the port of Nuakchott was to be constructed and the port facilities expanded. The concentrates plant is also intended to handle ore from the Gebb-Mogrin deposit. More recently, prospecting has revealed important indications of copper deposits in the Guidimaka and Oum Kadiar areas.

Lead, tin and zinc

There are no known deposits of lead, tin or zinc ores, nor is there a local industry working these metals.

The Niger

This West African republic of 3.63 million inhabitants (1968 estimate) attained independent status in 1960. It is a land-locked country with no coastline and covers an area of 1.279 million km². In the south it borders on Nigeria and Dahomey, to the west its neighbours are Mali and the Upper Volta and in the east the Republic of Chad. Its northern neighbours are Algeria and the Libyan Arab Republic. As would be expected from such a geographical situation, as well as the fact that the entire country lies in the tropics, it is hot and dry with large areas of desert. Most of the country is on a plateau of over 300 m above sea level. There are no perennial rivers in the Niger, but wadis are quite widely distributed throughout the country.

The Niger possesses a road network consisting of 415 km of bituminized roads, 2,490 km of improved permanent earth roads and 4,542 km of consolidated earth roads of a semi-permanent kind. There is no railway system. Connexions with international air routes are provided by the airport at Niamey.

At present there are no known domestic fuel resources. Oil-prospecting surveys were made in 1964 in the neighbourhood of Jado and Talak by the Petropar Company. Data on electrical energy produced in the country are not available.

Aluminium

At present there are no known bauxite deposits, and there is no aluminium reduction or semi-fabricating industry.

Copper

Traces of copper ores have been discovered in the Agadèz area. A geophysical survey of the Aïr-Liptaka area is under way and is expected to take three and a half years. This is being carried out with United Nations support, the Niger contributing CFA francs 28.3 million in 1969 and the United Nations CFA francs 87.6 million; in 1970 the respective contributions were CFA francs 19.6 million and CFA francs 71.4 million.

Lead and zinc

A mixed lead-zinc-tin ore body is known to exist in the neighbourhood of the Aïr mountain range to the north-east of Agadèz. Signs of the existence of galena ores were noted recently in Timia and Aylak.

Tin

This is the only metal actually in production at present. There are no figures available of the estimated reserves. The cassiterite deposits in the Aïr region sometimes contain wolframite. In the El Maki and Timia areas alluvial deposits of cassiterite are being mined and processed as concentrates. Production amounts to about 70 tons/annum of a concentrate containing 70 per cent tin, which is refined at the Makeri Smelting Co. plant in Nigeria. Mining is carried out by a state-owned company, Société Minière de Niger.

Nigeria

The Federal Republic of Nigeria attained independence in 1960. It is the most populous of the West African states, having 62.6 million inhabitants (1968 estimate). Its eastern boundary is with Cameroon; it has a boundary of 200 km along Lake Chad with the Republic of Chad; the Niger lies to the north, and the western boundary is provided by Dahomey. The southern boundary is the 650 km seaboard on the Gulf of Guinea. The total land area amounts to 877,000 km^2.

The country has distinct geographical regions, consisting of a low-lying coastal area and an inland belt of tropical rain forest extending about 250 km over gradually rising terrain, broken by scattered hills. This gives way to an undulating plateau with a general elevation of 650 m, rising to 1,300 to 2,000 m in the centre and along parts of the eastern frontier. This plateau forms the middle savannah belt, which in turn gives way to the drier areas of the north, eventually merging with the near semi-desert of the Republic of the Niger. In the north many streams and rivers are waterless in the dry season, and ground water is therefore important.

There is a well-developed dense river system of which the Niger and the Benue rivers are the largest and have numerous tributaries; more than 6,500 km are navigable. In the north, where there is little surface water, underground water channels are of great importance. At the delta river mouths sand bars prevent the entry of all but the smallest vessels. Dredging of the Escravos river mouth and the building of the mole allows ships of up

to 6.5 m draft to enter the river and reach Warri, and ships using the Benin river can operate as far as Sapele. The main port is Apapa (near Lagos); others are at Warri, Port Harcourt, Calabar and a number of minor harbours. An oil terminal has been built at Bonny and Escravoz.

The major towns are linked by all-weather roads; approximately 16,500 km of these are bituminized out of a total of approximately 85,000 km. A narrow-gauge railway line system, covering approximately 3,300 km, runs north from the main ports of Apapa and Port Harcourt converging at Kaduna, then branching out with two lines to the north-east and one to the north-west. Ikeja airport, near Lagos, provides links with international air routes.

The country has important fuel resources. Low-grade coal is mined mainly around Enugu, with an annual output of around 750,000 tons. Oil was found in the Niger river delta; output grew from 0.85 million tons in 1960 to 21 million tons in 1966. Output of natural gas amounted (in 1966) to 176 million m^3. Further prospecting for oil continues. Electricity generation in 1967 amounted to 1,163 million kWh, of which most was from thermal stations. A major addition to electricity capacity is the Kainji Dam and Kura Falls stations, which began operation in 1968 and will have a total capacity of 1.2 million kW when completed.

The country has important reserves of tin, lead and zinc, and there is a less significant output of columbite, tantalite, wolfram, molybdenite and gold.

Aluminium

There are no known bauxite deposits of commercial significance and there is no aluminium reduction industry. A semi-fabricating plant, Alcan Aluminium of Nigeria Ltd, has been established at Port Harcourt, in which Nigerian financial interests have a 12.5 per cent holding. Its nominal capacity is 5,000 tons per annum of rolled products. Facilities for producing corrugated sheets from rolled strip for building and constructional uses are provided by an associate company, Flag Aluminium Products Ltd, at Kaduna. The import of semi-fabricated products was 1,300 tons in 1966.

Copper

There are no known commercial copper ores in Nigeria, and there is no semi-fabricating industry.

Lead and zinc

The country has lead and zinc ore deposits whose existence has been known for a long time, but the extent of geological exploration has been limited and their industrial exploration is quite recent. The area in which these deposits are found extends in a narrow belt for about 600 km from Ogoja through Benue and Adamawa to Bauchi province. The main occurrences are at Ameka, Nyeba, Arufu, Abakaliki, Zurak and Ishiapu. The deposits in Ogoja province are considered likely to be the most promising, based on results from lodes prospected by several mining companies. Estimates of possible reserves vary widely, ranging from 10 to 600 million tons of ore, but

there are no really reliable figures of reserves available. Where the ores are being worked their content has been analysed as ~10 per cent lead and 7.3 per cent zinc. A geophysical exploration programme has been proposed (but not implemented), using the induced polarization method.

Small quantities of lead (up to 1,000 tons/annum) and zinc (up to 500 tons/annum) were produced up to 1960 from the Zurak deposits in the northern part of the known ore-bearing zone. Currently, the Nigerian Lead Zinc Mining Company has been mining ore at Enuigba and Amari in Enugu province. At Enuigba 200 tons/month of lead-zinc concentrates were produced in 1967 and at Amari 175 tons/month. A ten-year contract has been concluded for supply of these ores and concentrates to Metallgesellschaft A.G., Federal Republic of Germany.

Tin

This is the most important branch of the Nigerian non-ferrous metal industry. Reserves of tin are estimated at 110,000 tons, which are all considered proved and probable. The average content of the cassiterite in the tin-bearing sands is 0.5 kg/m³.

The main tin-producing region is located on the Jos plateau in the northern part of the country. Most of the tin mined is from alluvial deposits, which are characterized by their small size. Mining methods vary and include suction dredging, dragline buckets, quarrying, manual digging, hydraulic techniques and various mechanical means.

All the tin produced is processed into concentrates and some of it is converted into refined tin at the works of the Makeri Smelting Co. Ltd, Jos, which also processes concentrates (70 per cent tin) from the Niger. The largest company, Amalgamated Tin Mines of Nigeria, accounts for about 50 per cent of the production of tin concentrates. Most of the producers are British companies and members of the Nigerian Chamber of Mines. Data on the output and exports of tin concentrates and imports, exports and consumption of refined tin are summarized in table 33. In addition to refined tin, there is some production of tin alloys and solders.

Table 33

PRODUCTION, IMPORTS AND EXPORTS OF TIN IN VARIOUS FORMS — NIGERIA

(Thousand tons)

	1958	*1964*	*1965*	*1966*	*1967*	*1968*	*1969*
Tin concentrates—production	5.6	8.9	9.7	9.7	9.5	9.8	8.7
Refined tin—production	—	8.9	9.5	10.1	9.3	10.0	9.0
Refined tin—imports	0.5	0.02	—	—	—	—	—
Tin concentrates—exports	8.3	8.0	—	0.5	—	—	—
Refined tin—exports	—	—	10.5	11.5	9.4[a]	11.2	...
Refined tin—consumption	0.1	0.1	0.1	0.1	0.1	0.1	...

[a] Eleven months only.

Senegal

The Republic of Senegal became independent in 1960. It is situated on the west coast of Africa with Mauritania to the north and Guinea to the south; its eastern border is with Mali. The country has an estimated area of 197,161 km². The population is estimated at 3.80 million (1968), and the capital, Dakar, has a population of approximately 475,000; Kaolack, Thiés, Rufisque, Saint Louis, Ziguinchor and Diourbel are towns of from 25,000 to 70,000 inhabitants.

The climate is characterized as "Sudanese" or transitional between dry desert and moist tropic. North of a line joining Thiés with the lower Taleme the climate is Sahelian (peculiar to the edge of the southern Sahara). The two main seasons are rainy and dry; the rainy season lasts from June to October in the Sahelian zone, from May to October in the Sudanese zone, and from May to December in Casamanie in the south, with annual rainfalls ranging from 152 cm in the south to 35.5 cm in the north. There is a transitional period between the wet season and the dry season. The country is generally of low relief with sandy clay plains, gently undulating sandstone knolls and dry river valleys.

The country has five railway lines: Dakar to Kidira (and thence into Mali), Thiés—Saint Louis (193 km), Guinguinéo—Kaolack (22 km), Louga—Linguère (129 km) and Diourbel—Tonba (46 km). There are no all-weather roads, and internal communications rely on a series of tracks, plus the all-year river service from Saint Louis to Podor (210 km), and the Saint Louis-Kayes river service which operates from July to December. The Saloum and Casamance rivers are navigable to a limited extent. International air connexions are provided at the airport near the capital, Dakar, which is also the main port.

The economy is predominantly agricultural with wide regional variations, and includes cattle and stock raising, growing of millet, groundnuts, natural gums, rice and maize. The main industrial activity is centered around Dakar and is largely associated with processing of products from the agricultural sector.

The country has no known coal or oil reserves.

Aluminium

There are no reports of occurrences of bauxite deposits in the country, and there is no aluminium reduction or semi-fabricating industry.

Other non-ferrous metals

Geological survey work has been in progress with assistance from the United Nations Special Fund. The French organization, Bureau de Recherches Géologiques et Minières, has been engaged in exploration work in the Kedougan area of south-east Senegal. In the Falémé district, surveys have indicated the presence of copper, zinc and other non-ferrous metals near the Bambadji Massif. The Kouroudiako district is considered the most promising one for finding significant deposits of copper. There is no semi-fabricating industry in the country and imports of non-ferrous metals are few.

Sierra Leone

This country achieved the status of an independent state in 1961. It lies on the west coast of Africa, with an Atlantic coastline of more than 300 km. In the north and north-east it borders on Guinea, and in the south-east its neighbour is Liberia. The land area occupies a total of 72,323 km². The population numbers 2.5 million (1968 estimate).

The climate is tropical with varied weather conditions, consisting of monsoon periods, dry harmattan spells, periods of moderate to heavy rainfall and rainless but humid intervals. No part of the country receives less than 250 cm per annum of rainfall and in some areas it reaches 500 cm or more. The country is made up of a coastal plain with mangrove swamps, an inland area of higher relief which reaches up to 2,000 m in the Loma Mountains and Tingi Hills in the north and north-east, and a small, commercially important area around Freetown on the west coast where on the peninsula the mountains rise to over 1,000 m. On the south-east portion of the coast there is a series of long inlets facing Sherbro Island, and these connect with navigable rivers that are important waterways.

The country has meagre fuel resources; its main fuel requirements are met by imported oil products which amount to from 325,000 to 385,000 tons. Electric power generation reached just over 109 million kWh in 1966. This was added to significantly by the opening in 1967 of the Guma Valley hydro-electric plant, which has a capacity of 2,400 kW. Of the country's electricity output, 80 per cent is consumed by the city of Freeport. Over the next five years at least $7.5 million will be spent on improving the supply in the western province.

The country possessed just over 500 km of narrow-gauge railway, but as a result of a survey made by the World Bank in 1967, the system is in the process of closing down. The road network amounts to some 650 km of bituminized roads and over 7,500 km of laterite roads. The construction of the second stage of the Tonkolili-Kono road — 64 km of bituminous road that will shorten the distance from Freeport to Sefadu by 165 km — was scheduled for completion by mid-1970. A further project now under way is a bituminous road from Bo to Kenema (approximately 75 km). The country has an international airport at Lungi. Cline Town (adjacent to Freetown), is being expanded as a port and will soon be able to accommodate six ocean-going vessels at the same time.

The country has significant resources of iron ore, rutile titanium dioxide, bauxite and diamonds, which are being exploited commercially. Other minerals found in the country are platinum, molybdenite, columbite and cassiterite (tin ore), but none of these have so far been assessed as having commercial importance.

Aluminium

The total reserves of bauxite are currently estimated to exceed 30 million tons with a 50—60 per cent Al_2O_3 content. These are mainly concentrated in the Mokanji Hills near Moyamba (southern provice) and

are currently being mined by Sierra Leone Ore and Metal Co. Ltd, a subsidiary of Swiss Aluminium Ltd. Mining commenced in 1963 when 30,400 tons were produced; the figures for recent years of production and exports are summarized in table 34. There is no alumina production nor are aluminium reduction facilities available, and limited potential for hydroelectric development may well mitigate against the establishment of a local reduction plant. There is no local semi-fabricating industry; requirements for metal products are met by imports, which are negligible.

Table 34

PRODUCTION AND EXPORT OF BAUXITE — SIERRA LEONE

(Thousand tons)

	1965	*1966*	*1967*	*1968*	*1969*
Production	207.3	275.2	334.5	470.3	442.3
Exports	173.5	240.5	329.2	462.9	...

Other non-ferrous metals

There are no known ores of other non-ferrous metals of potential economic importance in the country, nor is there any semi-fabricating industry.

Togo

Togo is the western neighbour of Dahomey, and adjoins Ghana, with the Upper Volta to the north. It has an estimated population of 1.7 million (1968 estimate) and a land area of 56,700 km². In terms of climate and geography it is very similar to its neighbours: it is tropical West African with two periods of maximum rainfall.

Non-ferrous metals

There are no known deposits of non-ferrous metal ores, and no industry connected with refining or semi-fabrication of these metals. A mineral exploration programme was begun in 1968 with field work undertaken by the Institut Géographique Français and the Bureau de Recherches Géologiques et Minières of France. The results of this programme are not known at present.

The Upper Volta

The Republic of Upper Volta is situated to the north of Ghana and the neighbouring territories of the Ivory Coast, Togo and Dahomey. On the north-west it has a frontier with Mali and on the north-east with the Niger. It occupies an area of 274,122 km² and has a population of 5.15 million (1968 estimate). The capital is Ouagadougou (population 171,500), and Bobo Dioulasso (population 68,000) is another large town.

The country is largely flat and monotonous with some sandstone cliffs and rocky hills; granitic domes provide some contrast in the north and north-

east. The country lies mainly at 300–500 m above sea level. The river network consists primarily of the upper basins of Comoe and Volta and their tributaries. The climate is transitional from tropical to desert and varies from "Sudano-Guinean" in the south-west to "Sahelo-Sudanese" (between dry desert and moist tropic) over the rest of the country. The latter region has a short rainy season of two to four months and rainfall from 28 cm to 97.5 cm/annum, and the south-west has a single rainy season in August–September, with rainfall exceeding 100 cm/annum.

The railway from the port of Abidjan (The Ivory Coast) runs north and north-east, terminating at Ouagadougou. The road system totals 16,662 km, of which 5,989 km are all-weather roads. French airlines provide services with international connexions via Ouagadougou or Bobo Dioulasso airports. There are no known domestic fuel resources.

The economy is almost entirely based on cultivation of crops and rearing cattle and sheep. Only 6 per cent of the land is cultivated, however, and since little suitable land is available, production is primarily for domestic purposes. Small amounts of livestock, groundnuts and cotton are exported. The main industries are vegetable oil extraction, sugar refining, cotton ginneries and industries associated with building. Lack of energy is a serious handicap to industrial development.

Aluminium

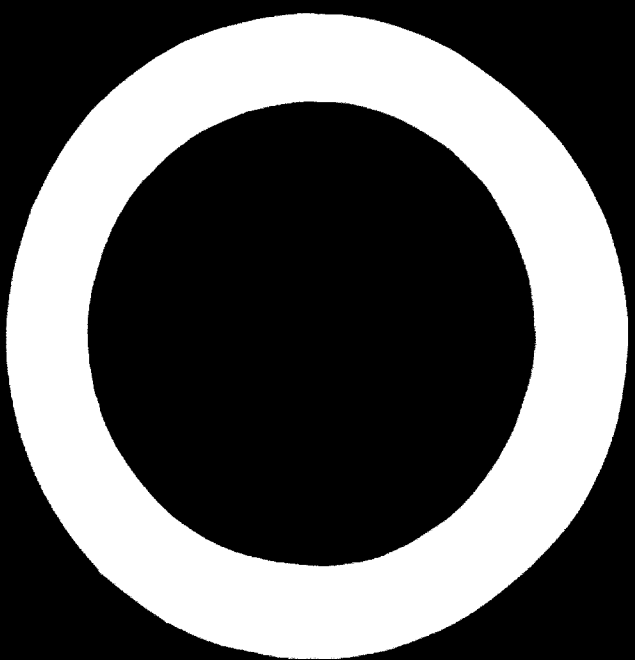
There are reports of small bauxite deposits occurring in the country, which is incompletely surveyed, but there is no industry associated with its mining, refining or semi-fabrication.

Copper

Prospecting by a team under the auspices of the United Nations Development Programme has revealed the presence of extensive copper deposits at Diénéméra, north-east of Gaoua. The deposits are understood to be of low grade but could prove to be exploitable. Indications of copper (as well as antimony, molybdenum and nickel) have been found near Kaya.

Lead, tin and zinc

There are no reports of occurrences of ores of these metals.



THE AMERICAS

THE CARIBBEAN

The Dominican Republic

This country of 3.9 million inhabitants (1968 estimate), covering an area of 48,442 km², lies in the Caribbean Islands and occupies the eastern half of the island of which the western half is the Republic of Haiti. The next island to the east is Puerto Rico. The country has a tropical, humid climate, with uniform high temperatures on the lowlands and more moderate temperatures in the mountains in the west.

The railway system totals 1,400 km and consists of two lines, one running along the south coast and the other running from Santiago to Sanchez on the coast. The road network exceeds 5,000 km and is largely earth or macadam.

The country has no known fuel resources. Power generation totalled 699 million kWh in 1968. Deposits of iron ore, bauxite, nickel, zinc, gold and non-metallic minerals are known to exist. Falconbridge Nickel Mines planned to exploit the nickel deposits in the east of the country.

Aluminium

Bauxite reserves amount to 100 million tons, of which 60 million tons are high grade and the balance marginal. These are located on the Sierra de Bahonico. The largest deposit, which is exploited by open-pit mining, is at Cabo Rojo where the operating company is Alcoa Exploration Co. Other deposits are located at Puerto Plata, Maria Trinidad Sanchez, Pedernales, Barahona and Independencia. The company, Los Azules, has mining rights at San Cristobal, and Cia Dominicana de Desarrollo y Fomenta C. por A. has rights at Independencia. The bauxite mined is of 45—49 per cent Al_2O_3 content with an average of 5.6 per cent SiO_2 (reaching 9.1 per cent in some areas) and around 20 per cent iron oxides. Data on production and exports of bauxite are given in table 35.

Table 35

PRODUCTION AND EXPORTS OF BAUXITE — DOMINICAN REPUBLIC

(Thousand tons)

	1959	*1965*	*1966*	*1967*	*1968*	*1969*
Bauxite production	771.2	893.0	818.4	983.0	985.0	1,093.0
Bauxite exports	404.1	981.7	853.0	1,016.0	994.3	...

The Government would like to promote construction of an aluminium smelter and in 1967 commissioned a feasibility study for such a plant. Subsequently, the Bank for Industrial Development refused a loan for a feasibility study of the construction of an aluminium smelter on the grounds that the price at which bauxite would be sold by Alcoa to the projected smelter would be economically unfavourable under prevailing conditions.

Intensive exploration is being carried out by Bellomar Inc., mainly in Pedernales province, and results indicate the probable existence of further important deposits which should provide assurance of adequate reserves. One problem that requires attention is the present lack of water for preliminary washing of the ores and processing into alumina. This will necessitate boring new wells to tap subterranean sources; the only other available sources would involve desalination.

Copper

Mining of copper ores from the Mata Granda deposits commenced in 1967; the ore has a copper content of about 2 per cent and reserves are estimated at 40 million tons. The output of the mine is planned to reach 30,000 tons/annum. Imports of copper and its alloys are estimated to amount to just over 1,000 tons/annum. A concession was granted to Trani Casting Corporation in 1968 to explore a concession in Las Canitas for manganese and copper, but no further information has been published on the progress of this exploration.

Lead, tin and zinc

There are no known deposits of ores of these metals and no plants concerned with the refining or semi-fabrication of these metals. Zinc ores are believed to exist in complex form near Pueblo Viego. These ores also contain some gold and silver as well as pyrites, and the Government is anxious to encourage private companies to undertake exploration, since the existence of a large ore body is suspected.

Haiti

The Republic of Haiti occupies the western part of an island in the Caribbean chain, lying to the east of Cuba and to the west of Puerto Rico. The climate is tropical, torrid and humid on the windward hillsides but drier in the sheltered valleys. The country is mountainous, rising to over 2,000 m, with a narrow coastal plain. Its population of 4.8 million (1968 estimate) occupies mainly the coastal areas. The total land area amounts to 27,800 km².

The country has a small railway system amounting to 254 km. It has 4,000 km of roads of which about 400 km are macadam. An airport facility is provided near the capital, Port-au-Prince.

Output of electricity has varied from year to year; it averages around 75 million kWh. There are no known domestic fuel resources, although the Atlantic Refining Co. has obtained a licence to prospect and produce oil in the country.

Aluminium

The country possesses considerable bauxite resources, with proved reserves amounting to 25 million tons. The main deposits are located in the south on the Rochelois Plateau, south-west of Miragoane. Other occurrences are reported near Beaumont in the Hotte Masif, Savane Zombie in the Selle Massif and Savane Terre Rouge, north-west of Gonaives. The sole company producing bauxite is Reynolds Haitian Mines Inc. Data for production and exports are summarized in table 36.

Table 36

PRODUCTION AND EXPORTS OF BAUXITE – HAITI

(Thousand tons)

	1959	*1965*	*1966*	*1967*	*1968*	*1969*
Bauxite production	302.4	382.6	361.4	375.8	477.4	776.0
Bauxite exports	291.0	330.0	283.0	367.7	442.2	...

Copper

Copper ore deposits, amounting to 90,000 tons, proved and probable, are located in the Terra Nuove area. The deposit is one of Charlcopyrites, containing ores with a copper content of 1.7—2.2 per cent; it was first mined in 1960. These deposits are exploited by underground mining, and production has been in the region of 3,000—5,000 tons copper content per annum, which is planned to be expanded in the near future to over 7,500 tons; gold is recovered as a by-product. A concentrates plant, in conjunction with the Meme mining operation, has a capacity of 1,500 tons/day input of ore and produces concentrates of 35 per cent copper content. These are mainly exported to Japan and Spain. An associate of the Canadian Honeywell Company has been prospecting for copper in recent years and in 1968 reported the discovery of a new deposit. Late in 1969 the Helcana Mining Corporation S. A. reported copper-bearing ores near the surface in an area centred on Plaisance, to the north-east of the existing Sedren mine. Domestic consumption of copper is less than 100 tons per annum; requirements are met by imports from the United States.

Lead, tin and zinc

There are no known deposits of these metals in the country nor are there refining or semi-fabricating plants associated with these metals.

Jamaica

This country of 1.92 million population (1968 estimate) is an island of 11,424 km² in the Caribbean Sea, lying to the south of Cuba, with Haiti and the Dominican Republic to the north-east. The climate is tropical and humid with a rainfall of 50—100 cm/annum. The country has a coastal

plain; inland it rises to 300–500 m and locally in the east to 1,000 m. There are a number of small rivers, of which the Black river is navigable for 40 km. The main port is the capital, Kingston, which has an international airport, and another airport is provided at Montego Bay. A narrow-gauge railway system has a route mileage of just over 330 km; a road network totals over 11,000 km.

Electricity production in 1966 amounted to 870 million kWh, of which 111 million kWh was generated by hydroelectric plants. There are no other fuel resources available in the country.

Aluminium

The country has important bauxite deposits which were first mined commercially in 1952. Major deposits are found in the districts of Manchester, St. Ann, St. Elizabeth and Trelawny, and smaller deposits exist in St. Catherine, Clarendon, St. James, Portland, Hanover and Westmoreland. Total reserves are estimated at 600 million tons, of which 400 million are considered proved, with an average Al_2O_3 content of 50 per cent.

Information on the production of bauxite and of alumina is provided in table 37.

Table 37

PRODUCTION OF BAUXITE AND ALUMINA—JAMAICA (1967)

(Thousand tons)

Company	*Bauxite*	*Alumina*
Alcan Jamaica Ltd	2,012	828
Alcoa Minerals of Jamaica Inc.	1,034	(800)[a]
Kaiser Bauxite Co.	4,163	—
Reynolds Jamaica Mines Ltd	2,059	—
Revere Jamaica Alumina Ltd	[a]	(200)[a]
Alumina Partners of Jamaica Ltd.	[a]	(862)[a]

[a] Planned capacity.

Data on production and exports of bauxite and alumina and imports of aluminium are given in table 38.

Table 38

PRODUCTION AND EXPORTS OF BAUXITE AND ALUMINA AND IMPORTS OF ALUMINIUM—JAMAICA

(Thousand tons)

	1959	*1965*	*1966*	*1967*	*1968*	*1969*
Bauxite production	5,208	8,651	9,061	9,267	8,525	10,498
Bauxite exports	4,235	6,893	7,132	7,257	6,212	...
Alumina production	...	732	803	838	922	1,102
Alumina exports	406	721	791	824	907	...
Aluminium imports—all forms	...	2,093	2,711	4,475	...	...

The growth of output in Jamaica will be considerable over the coming years, since expansion or new facilities are being planned by each of the major United States producers, particularly for alumina production.

A small semi-fabricating plant, Alcan Products of Jamaica Ltd, located in Kingston, produces corrugated sheet from imported strip for the local roofing and building market, and also operates an extrusion press.

Copper

Several unexplored low-grade copper ore deposits have been reported. More recently, work has been in progress in Gallas Valley evaluating a copper-nickel-cobalt ore body that is considered promising. Further exploration is being carried out on the east of the island. An agreement has been approved with Cominco Ltd and Burrex-Mines Ltd to develop a 25 km² copper prospect in Gallas Valley. Imports of copper in all forms total about 200 tons/annum.

Lead, zinc and tin

There are no known deposits of these metals in the country nor is there a refining or semi-fabricating industry associated with them. Imports of such metals are small: less than 100 tons/annum for lead and zinc and 500 tons/annum for tin and its alloys.

Trinidad and Tobago

Apart from its oilfields, the only other minerals found in the country are asphalt, limestone and white sand suitable for glassmaking. Metalliferrous ores have not been located in the course of the geological explorations so far carried out.

Mexico and Central America

Costa Rica

The Republic of Costa Rica is located in Central America, having Nicaragua as its neighbour to the north and Panama to the south. The land area amounts to 51,000 km² and the population numbers 1.63 million (1968 estimate). The capital, San José, has over 185,000 inhabitants and a further 266,000 live in towns with more than 25,000 inhabitants. The literacy rate is the highest of any Latin American country. The coastal lowlands have a tropical climate, but the interior plateau, with a mean elevation of 1,250 m, enjoys a temperate climate. There are no major rivers of navigational or commercial importance.

Two railway systems totalling about 800 km connect San José with Limón, the Atlantic port (Costa Rican Railway Co.) and San José with Puntarenas, the Pacific Port (operated by the state-owned Ferrocarril Electrico el Pacifico). There are 3,250 km of all-weather roads, including a section of the Pan-American highway, but the part of this highway leading into Panama may be impassible in the wet season. The international airport at El Coco can handle modern aircraft and provides internal services as well as

connexions with other Central American countries and with the United States.

Agriculture is the principal industry of the country, and there are extensive forests and woodlands. In some areas there are soil erosion problems. Coffee accounts for about one half of the country's foreign exchange earnings, and cocoa, maize, sugar, tobacco, rice and potatoes are widely grown. Dairy farming and cattle raising are also important sectors of the agricultural economy. Industrial development is still at a relatively low level and is mainly associated with the processing of agricultural products.

Electrical power generation amounted to 529.9 million kWh in 1965, derived largely from hydroelectric stations in the interior. There are no known reserves of coal and oil, but an oil refinery was completed in 1966.

Aluminium

Deposits of lateritic bauxite occur in the Valle de San Isidro de El General, in San José province, with an Al_2O_3 content of 35 per cent. Total reserves are estimated to amount to 150 million tons. These deposits are owned by Alcoa of Costa Rica Inc., a subsidiary of the Aluminum Company of America. An agreement signed at the end of 1968 between the Government and Alcoa for a 25-year period, and automatically renewable for 25 years, has given the company the right to design, construct, operate and own an alumina-refining plant of 400,000 tons capacity at Punta Uvita on the Pacific Coast, together with provision by the Government of port facilities and a 50-km road connexion. Completion was expected to take about three years.

The agreement also gives the company the exclusive right to exploit 150 million tons of bauxite in the concession area and thereafter 50 per cent of that remaining, with the state having the right to use the remainder. It also specifies that the company will utilize about 1.3 million tons of dry bauxite per year for its alumina plant requirements. The company has the right to sell the products at the company's discretion, except for 50,000 tons/year which must be sold at prevailing prices to any aluminium reduction plant that may be set up in Costa Rica.

Imports of semi-fabricated aluminium amounted to 808 tons in 1968.

Copper

The discovery of a copper ore body has been reported at Puriscal, near San José. Austin Development Corporation (United States) has obtained concession rights to 20,000 acres in an unnamed area. North Bordulac Mines Ltd (United States) has been examining copper prospects near the Panama border that are considered geologically similar to those in Panama nearby. Imports of copper in all forms in 1967 amounted to 242 tons, mainly of semi-fabricated products.

Lead and zinc

There are no known deposits of lead and zinc ores and there is no local fabricating industry other than a hot-dip galvanizing plant. Zinc imports amounted to 1,221 tons in 1967.

El Salvador

This Central American Republic lies to the south-east of Guatemala and to the south of Honduras. It has a coastline of approximately 400 km on the Pacific Ocean and a total land area of 21 393 km². Most of the population of 3.15 million (1967 estimate) live on the coastal plain and in the foothills. Inland the terrain is mountainous with an average altitude of 650 m but with many peaks of extinct volcanoes rising to 2,000 – 2,500 m. The climate is tropical, but is modified inland by the altitude, with a wet season from May to October and a dry season for the remaining months. There are a number of small rivers flowing into the Pacific of which the principal one is the Rio Lempa. A number of lakes lie in the craters of extinct volcanoes; the largest is Ilopango, which is a short distance from the capital, San Salvador.

The Pan-American highway traverses the country, and there are a total of 8,527 km of roads, of which 3,256 km are all-weather roads and 1,055 km are paved. There are approximately 55,000 motor vehicles registered in the country. A railway system totalling 740 km runs east-west across the country with links into Guatemala and Mexico. The main ports are La Union, La Libertad and Acajultla. International air connexions are provided by the airport near San Salvador.

Much of the economy is based on agriculture, with cotton, coffee and sugar being among the main crops; livestock rearing is the other major sector. Approximately one third of the land area is used for crop raising and a similar area is used for livestock. Food-processing industries exist, as well as textiles, tanning, cement and light engineering industries. A steel re-rolling mill is situated in Zacatecolua. There are no known domestic fuel resources.

The mineral deposits of the country are incompletely surveyed, but a three-year investigation of mineral resources, financed by the United Nations Special Fund, is nearing completion. Some centuries ago gold and silver were mined in the country.

Aluminium

There are no reports of bauxite deposits in the country and there is no aluminium reduction industry. An aluminium extrusion plant, Alcoa de Centro America S.A., is located in San Salvador and is a subsidiary of the Aluminum Company of America. Production of aluminium extrusions amounted to 822 tons in 1967. Data for imports for the same year are not available; in 1966, however, 896 tons of semi-fabricated products (mainly sheet and strip) were imported.

Copper

There are no confirmed reports of deposits of copper ores in the country and no smelting or refining industry exists. A cable plant, Phelps Dodge Copper Products de Centro America S.A., a subsidiary of Phelps Dodge Corporation (United States), operates at Ilanpango, 11 km west of San Salvador and has both copper and aluminium wiredrawing and cable-making

equipment. Imports of copper into the country, both as metal and semi-fabricated products, totalled 1,737 tons in 1967.

Lead, zinc and tin

There are no known deposits of these metals in the country nor is there any industry associated with their processing. In 1967 imports of lead amounted to 114 tons of ingot and 217 tons of semi-fabricated products; imports of zinc in all forms totalled 485 tons.

Guatemala

This Central American Republic has a population of 4.7 million (1968 estimate) and is bordered by Mexico on the north, by British Honduras on the east and Honduras and El Salvador on the south-east; its southern boundary is provided by the Pacific Ocean, and it has a short coastline in the east on the Caribbean Sea. The north of the country and a strip along the Pacific coast are lowland, but the south and south-west are mountainous, attaining over 2,500 m in the highest parts. The climate is hot and dry in the lower elevations and more temperate on the plateau and mountains, with rainfall ranging from 50—150 cm/annum. The land area totals 108,889 km².

The country has a nationalized railway network totalling 1,150 km; the main lines link the capital, Guatemala City, with the ports of San José and Champerico on the Pacific coast and Puerto Barrios on the Caribbean. The Pan-American highway crosses the country, and is metalled, but the rest of the approximately 7,000 km of highways are earth roads.

Electricity production amounted to 520 million kWh in 1966; it was mainly generated by hydroelectric stations. There are no known deposits of coal, lignite or crude oil and natural gas. Deposits of non-ferrous metal ores have been reported at a number of locations.

A three-year survey costing $1,189,000, with a United Nations contribution of $719,000, was recently completed. The main exploration activity has been centred in the departments of Chiquimala, Zacapa, El Progreso, Jalapa, Huehuetango and El Quiche. On 21 January 1967 deposits of iron ore and bauxite were decreed to be in the national reserve, except where concessions had already been granted.

Aluminium

There are no known bauxite deposits and no aluminium semi-fabricating industry exists, apart from some small foundries. Imports of aluminium semi-fabricated products have been averaging 600—800 tons/annum over recent years.

Copper

A deposit at Mataquescuintia, 75 km south-east of Guatemala City, 1,700 m above sea level, is reported to have an average copper content of

2.5 per cent and also to contain 0.31 g/ton of silver. The extent of these reserves has not been determined, but the mineral-bearing zone is 180 m long, 45 m wide, and of 120 m thickness. Currently, an evaluation is being made of the commercial potentialities of this deposit. There are indications elsewhere of copper and copper-gold ores, and exploration is currently concentrated in the departments of Chiquimulilla, Zacapa, El Progreso, Jalapa, Huehuetenango and El Quiche.

Consumption of copper and its alloys is estimated to amount to about 200 tons/annum and is supplied by imports from the United States.

Lead and zinc

There are small deposits known in which amounts of copper, silver and gold occur in conjunction with lead and zinc. There is little information published on these, but they are provisionally estimated at 160,000 tons of lead with 80,000 tons proved and probable, and 120 million tons of zinc of which 60,000 tons are proved and probable. There has been some production of these ores, but it is steadily declining. In 1958 production of lead ores amounted to 8,000 tons (metal content) and of zinc ores to 5,000 tons, but by 1968 production had declined to 700 tons of lead and there was no reported production of zinc ores (this amounted to 400 tons in 1967). Domestic consumption of lead and zinc is small; lead is mainly used in batteries.

Data on production and exports of lead and zinc concentrates are given in table 39.

Table 39

PRODUCTION AND EXPORTS OF LEAD AND ZINC CONCENTRATES – GUATEMALA

(Tons)

	1965	*1966*	*1967*
Lead concentrates – production	923	901	1,160
Lead concentrates – exports	30	864	300
Lead-smelter production	114	215	71
Lead – exports	76	16	...
Zinc concentrates – production	867	903	434
Zinc concentrates – exports	887	1,248	1,300

Tin

There are no known deposits of tin ores in the country and there is no industry associated with its refining.

Honduras

The Republic of Honduras, with 2.36 million inhabitants (1968 estimate), borders on Guatemala to the north, El Salvador to the south, and Nicaragua to the south-east. Its main boundary is its coastline on the Caribbean Sea, and it has a short southerly coast on the Pacific Ocean. A lowland coastal strip widens out to 80 km in the east; the rest of the territory consists of a

series of plateaux and ridges of 500—1,500 m in height. The land area is 114,670 km². The climate reflects its tropical location, being torrid and humid in the north and north-east, and hot but dry in the south.

A railway line along the Caribbean coast totals 1,500 km and roads totalling 2,000 km provide the main means of communication. The main roads connect the capital, Tegucigalpa, with the Fonseca Gulf on the Pacific side and with the Caribbean lowland strip. The capital has an international airport and there are landing strips within the country.

The output of electricity amounted to 204 million kWh in 1966, of which over 60 per cent came from hydroelectric plants. There is no mining of coal, but there are estimated to be about 1 million tons of hard coal and 4 million tons of brown coal in the country.

Deposits of metallic ores are reported, although only silver and gold are mined, and these on a small scale.

Aluminium

There are deposits of lateritic bauxite in the country which adjoin deposits in El Salvador. The combined resources are estimated at 10 million tons, with the major part in El Salvador. Imports of aluminium in all forms in 1966 amounted to 492 tons.

Copper

The existence of porphyritic copper ores was reported in the early 1960s. These have a low metal content, and there is little indication that they are likely to be commercially important.

Lead and zinc

Deposits of mixed lead-zinc ores are found in the country; reserves are estimated at 80 million tons of lead and zinc with an average content of 7.6 per cent lead and 7.7 per cent zinc. About 90 per cent of these reserves are in the neighbourhood of Rosario, department of San Pedro Sula in the west. This is mined at the El Mochilo mine, mainly to extract the gold and silver that are present, with the lead and zinc being recovered as by-products. The ores are processed in a concentrator having a capacity of 300 tons of ore per day. Compania Minera Los Angeles S.A. operates the Animas Mine, near Valle de Angeles, with the ore averaging 9.5 per cent lead, 11 per cent zinc and 400 g/ton silver. New lodes, reported as containing up to 14 per cent lead and 16 per cent zinc, with approximately 500 g/ton silver present, were found in 1967 by boring below the existing working level. These are regarded as a substantial increase in known reserves. Small amounts of lead and zinc are mined in the region of Akia-Tria, south-west of Tegucigalpa, with recovery of gold and silver. A licence was granted in 1967 to some Canadian companies to prospect over a 5,000 km² area in the Maya Mountains.

Output of concentrates and their export over recent years is given in table 40.

Table 40

PRODUCTION AND EXPORTS OF LEAD AND ZINC CONCENTRATES — HONDURAS

(Tons)

	1965	*1966*	*1967*	*1968*	*1969*
Lead concentrates — production	9,654	11,704	11,684	13,175	...
Zinc concentrates — production	11,126	13,393	13,086	14,783	...
Lead concentrates — exports	15,700	8,252	10,188	16,800	11,660
Zinc concentrates — exports	19,650	9,611	9,745	11,700	13,900

Imports of lead in all forms in 1966 amounted to 81 tons and of zinc to 51 tons.

Tin

There are no known deposits of stannous ores in the country and there is no industry associated with its refining.

Mexico

The United States of Mexico is a Federal Republic. It is the northernmost country of Latin America, with a population of 48 million (1969 estimate) and a land area of 1.969 million km². It has a frontier with the United States on the north and with Guatemala and British Honduras on the south-east. It is bounded by the Gulf of Mexico and the Caribbean Sea on the east, and the Pacific Ocean and Gulf of California on the west. Mountains and a central plateau occupy the greater part of the Mexican territory, with an average elevation of 1,000—2,500 m above sea level; the coastal strips are lowlands. In the south the climate of the country is tropical and it is damp all year round. In the north the climate is subtropical and dry. There is moderate to high rainfall over much of the country, with fast-flowing rivers that provide a source of hydroelectric power. There are also a few large lakes.

The main railway lines run from the central plateau, with its highly developed economy, northward to the United States, and extend to the south and into the Yucatán peninsula. The latitudinal railway lines provide connexions with the ports of the Pacific Ocean and the Gulf of Mexico. The total length of the railway lines exceeds 23,000 km. The main highways are: Nuevo Laredo—Mexico City—Tuxtla Gutiérrez; Mexico City—El Paso, Texas; Mexico City—Tijuana; Mexico City—Acapulco; Mexico City—Veracruz and Mexico City—Mérida. The total length of roads is 54,000 km; a further 7,500 km was under construction in 1966. International airport facilities exist at Mexico City, and an internal airline network exists.

Production of electrical power amounted to 22,840 million kWh in 1968 of which about one-half was accounted for by hydroelectric plants. Domestic coal production amounted to 2.6 million tons in 1968, crude oil production in the same year totalled 25.5 million tons, and natural gas output was 25,636 million m³. The country has reserves of many non-ferrous metals

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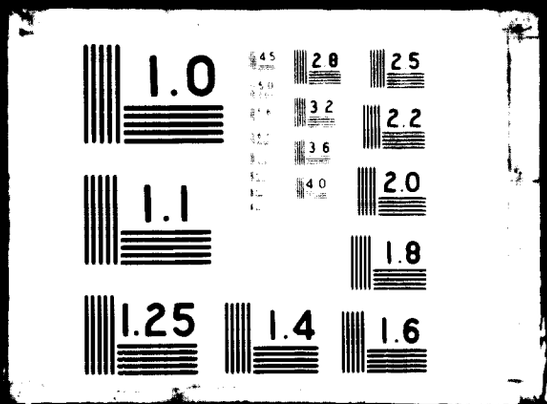

such as copper, lead, zinc, tin, antimony, gold and mercury, which are exploited commercially.

The Mining Law, passed in 1961 contained the provision that not less than 51 per cent of the shares of foreign firms operating in Mexico should be held by Mexican capital. It was not until 1965, however, that a group of Mexican industrialists was able to acquire a 51 per cent share in the American Smelting and Refining Company's interest in Mexico. The company has been renamed Asarco Mexicana. The process of "Mexicanization" has not so far been fully implemented in the copper industry, and the two major enterprises, Cia Minera de Cananea S.A. and Cobre de Mexico S.A., are still in the hands of the original owners. During 1966 and 1967 tax privileges were granted to enterprises employing Mexican capital that were engaged in the development of new mines or in the reopening of ones previously closed down.

Aluminium

For many years Mexico has had an aluminium semi-fabricating industry, but its primary aluminium industry dates from 1963 and it is based on imported alumina. The country lacks high-alumina bauxite deposits, but deposits containing 30—40 per cent Al_2O_3 are found in the states of Veracruz, Puebla, Oaxaca and Tabasco and between the towns of Tampico and San Luis Potosí. Research is also being fostered at the University of Guanajuato, with financial support from the state finance institution, La Nacional Financiera, on the development of an economic process for the extraction of aluminium from alunite, which occurs in the state of Guanajuato.

The aluminium smelter in operation at Carretera-Jalapa in the state of Veracruz is owned by Aluminio S.A. de C.V., which is jointly owned by the Aluminium Company of America, American and Foreign Power Co. Inc. and Mexican interests. The output of the plant is planned to reach 40,000 tons/annum by 1971. Reynolds Aluminio S.A. is building a smelter in the Malpaso-Dammes area, Tabasco State, in the south of the country; production will be based on imported alumina. Data on production of primary aluminium, consumption and imports of primary aluminium and imports of semi-fabricated products is contained in table 41.

Table 41

PRODUCTION, CONSUMPTION AND IMPORTS OF PRIMARY ALUMINIUM AND IMPORTS OF SEMI-FABRICATED PRODUCTS—MEXICO

(Thousand tons)

	1959	*1965*	*1966*	*1967*	*1968*	*1969*	
Primary aluminium production ..		19.2	21.2	21.5	22.5	32.4	(estimate)
Primary aluminium consumption .	9.5	20.0	21.0	21.5	24.7	32.9	
Primary aluminium imports	9.2	0.5	0.1	2.1	3.3	...	
Semi-fabricated products – imports .	...	4.4	1.2	2.2	1.6	...	

There are a number of semi-fabricating companies operating in Mexico. One of the largest of these is Alcan Aluminio S.A., which has a nominal capacity of 15,000 tons/annum of sheet and strip, foil, extrusions and wire, although actual production is believed to be about 7,500 tons/annum. The other major semi-fabricator is Reynolds Aluminio S.A., which has sheet and strip, foil and extrusion facilities; its output approaches 4,000 tons/annum, although the nominal capacity has been reported to exceed 19,000 tons. Aleomex S.A. is a subsidiary of the Aluminum Company of America and has the capacity to produce over 4,000 tons/annum of extrusions. A further rolling mill is that of Alumex S.A. de C.V., which is jointly owned by American Metal Climax Inc. and the American and Foreign Power Co. Inc., which are also associated with the extrusion and building products plant of Kawneer de Mexico S.A. de C.V.

Two further small extrusion plants owned by Mexican interests are those of Cuprum S.A. and Tubos y Perfiles de Aluminio Hall, S.r.l. de C.V.

Copper

Copper ores are mined and smelted at a number of widely separated sites, with over half of the production coming from the mine and smelter at Cananea. Production, exports and consumption of copper in various forms are given in table 42.

Table 42

PRODUCTION, EXPORTS AND CONSUMPTION OF COPPER IN VARIOUS FORMS MEXICO

(Thousand tons)

	1959	*1965*	*1966*	*1967*	*1968*	*1969*
Mine production	57.3	55.2	56.5	56.0	61.1	66.2
Blister copper production	54.7	51.9	51.3	50.2	52.5	56.6
Refined copper production	29.3	46.3	47.5	47.1	51.5	57.0
Refined copper consumption	17.4	36.1	30.1	34.2	56.0	64.9
Copper concentrates exports	...	1.0	1.2	2.1	1.2	4.1
Blister and refined copper exports	28.9	9.0	8.0	6.4	6.4	7.2
Semi-fabricated copper exports	...	...	...	1.3	4.2	8.6

The mining and smelting operations of the main companies are indicated in table 43. Total reserves of copper ores in the country are estimated to amount to 700 million tons (metal content), of which 300 million tons are considered proved. The copper content ranges from 0.7—4.7 per cent, averaging a little over 1 per cent. A single refinery, Cobre de Mexico S.A., is located at Atzacapotzalco and has close financial and management links with Cia Minera de Cananea S.A. de C.V. Seventeen plants are engaged in producing semi-fabricated products. The largest are Cobre de Mexico S.A.; Nacional de Cobre S.A., which is an Anaconda subsidiary; and Conductores Electricos S.A. de C.V., which has connexions with Cananea, Anaconda and Pirelli.

Table 43

LOCATION, OUTPUT AND CAPACITY OF MAIN PRODUCERS OF COPPER ORE AND BLISTER COPPER - MEXICO

Company	*Mine location*	*Annual output (thousand tons)*	*Smelter location*	*Annual capacity (thousand tons)*
Cia. Minera Asarco S.A.	Charcas Parral San Martin (Zacatecas) Santa Barbara	10	San Luis Potosi	5
Cia. Minera Mococozac S.A.	Concepción del Oro	8	Concepción del Oro	25
Cia. Minera de Cananea S.A. de C.V.	Cananea	35	Cananea	40
Cia. Fresnillo S.A.	Fresnillo de Gonzáles Echeverría	5	—	—
Minera Frisco S.A.	Parral	3	—	—
Cia. Metalurgica Mexico S.A.	Flojanles	...	—	—
	Hidalgo	...	—	—
	Concepción del Oro	...	—	—
Cia. Minera de Santa Rosalia	Santa Rosalia	5	Santa Rosalia	10

Lead and zinc

Mexico ranks as a major producer of lead and zinc. It has reserves of lead estimated at 19 million tons, of which 8.2 million tons are proved and probable, and zinc reserves of 33 million tons, with 8.6 million tons reported as proved and probable. The lead content ranges mainly between 1.3 and 5.6 per cent and the zinc content from 4—13 per cent, although some local deposits give much higher metal contents. There are over 200 known deposits distributed over 22 of the 29 states. Mining is mainly conducted underground. The majority of mines are small; only a few are large enough to have a reasonable level of mechanization. Although the deposits have been worked since the sixteenth century and are now mainly at a depth of 500—900 m, there are still large workable deposits. Data on mine output, exports of ores and concentrates, production, consumption and exports of refined metal are given in table 44.

Table 44

PRODUCTION, CONSUMPTION AND EXPORTS OF LEAD AND ZINC IN VARIOUS FORMS — MEXICO

(Thousand tons)

	1959	1965	1966	1967	1968	1969
Lead ore — mine production	190.7	169.4	168.2	165.8	161.7	166.4
Lead ore and concentrates — exports	4.0	6.0	2.0	1.0	1.0	...
Refined lead — production	189.0	164.0	171.6	170.0	172.1	169.5
Primary lead — consumption	26.2	56.1	59.8	64.8	70.2	98.6
Soft lead and antimonial lead — exports	148.3	109.6	112.7	97.5	100.6	87.2
Zinc ore — mine production (recoverable metal content)	263.9	233.0	238.4	236.6	238.6	251.6
Zinc ore — exports	351.0	281.1	273.7	252.9	276.0	285.5
Refined zinc — production	55.7	62.6	71.6	74.3	82.7	98.2
Primary zinc — consumption	18.1	32.7	35.4	36.6	38.9	44.3
Primary zinc — exports	408.0	25.9	39.3	35.7	37.2	38.3

There are strong indications of other large workable deposits, especially those reported near Sierra Magina in Chihuahua State and in Mexico State.

American Smelting and Refining Co. (ASARCO) was reported to be developing a new mine at San Martin with a capacity of 600 tons of mixed copper-lead-zinc ores per day; it was due for completion late in 1969. The company was also said to be expanding the output of the Santa Barbara mine from 800 to 2,000 tons of ore per day. Dressing of lead and zinc ores is undertaken at six plants, the largest of which are San Luis Potosí (2,900 tons/day), San Francisco (2,000 tons/day) and Parral (1,450 tons/day). Nearly all of the lead concentrates are refined in Mexico, but nearly 70 per cent of the zinc concentrates are exported, mainly to the United States and Japan.

Information on the main companies undertaking smelting and refining of lead and zinc is contained in table 45. In addition to these plants, there are facilities for production of zinc oxide, zinc dust and litharge, photo-engraving and other zinc sheets, as well as small plants for refining of secondary lead, zinc and other non-ferrous metals.

Table 45

LEAD AND ZINC SMELTING AND REFINING PLANTS IN MEXICO

Company	*Smelter location*	*Metal*	*Charge capacity (tons per annum)*
Asarco Mexicana S.A.	Chihuahua	Zn Pb	400,000
	Monterrey	Pb	182,000
	San Luis Potosi	Zn	Not operating
	Neuva Rosita	Zn	108,000
Cia. Minera de Peñoles S.A.	Torreón	Pb	511,000
Cia. Metalurgica Mexicana Peñoles S.A.	Monterrey	Pb	141,000
Zincomex S.A.	Saltillo	Zn	20,000
Zinc Industrial S.A.	Tlalnepantla	Zn	7,000 (output) (99.9% Zn)

Tin

There are modest reserves of tin in Mexico, estimated at 28,000 tons, of which 20,000 are considered proved and probable. There are more than 1,000 locations at which tin ores are known to occur, but most of them are either too small or of too low metal content to be of commercial importance. There is a small amount of mining of these ores, mainly in San Luis Potosí and Durango, amounting to no more than 1,000 tons/annum. Data on production and imports of concentrates and refined tin, and consumption of metal are contained in table 46.

Table 16

PRODUCTION, CONSUMPTION AND IMPORTS OF TIN CONCENTRATES AND REFINED TIN — MEXICO

(Thousand tons)

	1959	*1965*	*1966*	*1967*	*1968*	*1969*
Tin concentrates — production ...	..	0.50	0.80	0.58	0.52	0.50
Primary tin — production	0.4	0.96	0.96	0.96	0.96	0.96
Primary tin — consumption	1.21	1.20	1.20	1.56	1.60	1.60
Primary tin — imports	0.5	1.30	1.50	1.70	2.00	...
Tin concentrates — imports	-	0.20	0.20	0.10	...	...

The production of refined tin is undertaken by Estaño Electro S. A. de C. V. with a smelter and refinery at Tlahepantla. The concentrates are smelted in a reverbatory furnace and refined by electrolysis.

Nicaragua

The Republic of Nicaragua is situated in Central America and has as neighbours Honduras to the north and Costa Rica to the south. Its population numbers 1.85 million (1968 estimate). The largest town and capital is Managua with over 300,000 inhabitants, and there are seven other large towns with populations ranging from 25,000 to over 61,000. The country has a tropical climate and only low to moderate relief. Its land area is 148,000 km².

The Pan-American highway runs through the country totalling 368.5 km of paved road. In all 800 km of roads are paved out of a total of 6,124 km. The state-owned Pacific railroad of Nicaragua totals 403 km of single track, connecting Corinto, Chinandega, Leon, Managua, Masaya and Granada. The airport near Managua provides internal air services as well as connexions to other Central American countries and the United States. The main Pacific ports are Corinto, San Juan del Sur and Puerto Somoza; the east coast ports are El Bluff and Puerto Cabezas.

Agriculture accounts for employment of 65 per cent of the labour force and approximately 33 per cent of the gross national product. Cotton, coffee, sugar, sesame and bananas are major crops, and cattle raising is also important. The main industries are associated with processing agricultural products, but metal products, plastics components, cosmetics, textiles, paints and detergents are also produced. Gold and silver have been mined since the

sixteenth century; copper is mined and tungsten deposits are worked in Nueva Segovia. Power production in 1964 amounted to 156 million kWh mainly from diesel units.

The new Special Law on Exploration and Exploitation of Mines and Quarries, promulgated under Decree 1067 (20 March 1965), set up a National Mining Commission to establish fiscal and performance standards for concessionaires and to advise the Ministry of Economy on mining matters. The Office of the Director General of Natural Resources is now responsible for inspection and supervision of mining and quarrying operations. Rules for exploration and exploitation have been laid down and payments of guarantees, fees and taxes have been set, together with measures to protect landowners, entrepreneurs and the Government. The law also differentiates mines from quarries and establishes separate rules and definitions for each.

A survey of mineral resources, with assistance from the United Nations Special Fund, was completed in late 1966 and a report has been compiled.

Aluminium

There are no reports of the existence of bauxite deposits in the country, and there is no semi-fabricating industry. Imports of semi-fabricated aluminium amounted to 408 tons in 1965 and 757 tons in 1966.

Copper

Copper ore is mined at La Luz where proved and probable reserves total 3.7 million tons averaging 2.3 per cent copper with 0.093 oz/ton of gold, and at the Rosita mine where total proved and probable reserves are 0.66 million tons of ore averaging 2.7 per cent copper and 0.072 oz/ton gold. Mine production of concentrates, exported from 1965 to 1968, is given in table 47.

Table 47

MINE PRODUCTION OF COPPER CONCENTRATES — NICARAGUA[a]

(Tons)

1965	*1966*	*1967*	*1968*
10,187	9,764	9,336	11,517

[a] The entire production is understood to be exported.

Imports of semi-fabricated products were 133 tons in 1966 and 180 tons in 1967

Lead and zinc

There are no reports of the occurrence of lead and zinc ores in the country. There is a small amount of lead imported annually (100—200 tons) and of zinc (varying between 800 and 1,700 tons).

Tin

There is no known deposit of tin ore and tin consumption is very small.

Panama

The Panamanian Republic is the southernmost country of Central America, having Costa Rica as its neighbour to the north and Colombia to the south. The country has a tropical climate—warm and humid, with high rainfall, and a land area of 74,000 km². Between the Cordilleras de Veraguas and San Blas lies an east-west belt of valleys and high hills nearly 80 km wide. In this area are concentrated the east-west routes, including the internationally famous Panama Canal. About 40 per cent of the population of 1.42 million (1969 estimate) live in this zone. The Pacific plains and hilly lands of the Azuero peninsula have fertile soil and are the centre of banana production. The Sierra de Chiriqui and Cordillera de Veraguas are rugged and rainy; the northern slopes are uninhabited while the southern slopes account for about 13 per cent of the population. Citrus fruit, tobacco, fruit and dairy produce are produced on the southern slopes.

The Panama Railroad (owned by the Panama Canal Company) connects Anton on the Pacific with Mount Hope on the Atlantic and is approximately 70 km in length. Between David and Concepción there is a further line which has been recently extended to Guabito, and a third line runs from Suretka to the Costa Rican border—a distance of 80 km. There are 6,712 km of roads, including a section of the Pan-American highway. Less than 1,000 km of this total is concrete-surfaced or has similar all-weather paving. Tocumen Airport near Panama City provides connexions to other Central American countries.

There are no local fuel resources. Electricity generation amounted to 347 million kWh in 1967. Local industries include food processing, cigarettes, shoes, soap and cement. A petroleum refinery operates in Colon.

Aluminium

There are bauxite deposits in the provinces of Chiriqui and Veraguas estimated to total 25 million tons; information is lacking on their quality but it is believed to be about 40—43 per cent Al_2O_3. There are two fabricating plants, Aluminio de Panama S. A., which is owned by local interests and produced 1,200 tons in 1967, and Ingeniera Amado S. A., an associate of the previous company, which also produces sheet. Both are located in Panama City. The primary aluminium used is obtained from Canada. Imports of semi-fabricated products are currently restricted to 30 per cent of the 1963—1964 levels.

Copper

A minerals survey, carried out with United Nations assistance over the period 1966—1968, indicated the probable existence of important copper deposits in the Azuero area, including a porphyritic deposit with a 16 m overburden and a 50 m core averaging 0.95 per cent copper and 0.028 per cent molybdenum. The Government has given the right to several firms to

carry out surface studies but no concessions have been granted, and it is expected that these will await revisions of the present mining law.

There are no semi-fabricating plants in the country. Imports of semi-fabricated products in 1966 amounted to 207 tons.

Lead, tin and zinc

There are no reports of the occurrence of ores of these metals and no refining or semi-fabricating facilities exist in the country.

South America

Argentina

The Argentine Republic is the southernmost country on the Atlantic seaboard of the South American continent. The country's Atlantic coast runs northwards from the islands of Tierra del Fuego; its westerly boundary with Chile is formed by the Andes, and it borders Bolivia and Paraguay to the north, and Brazil and Uruguay to the north-east. The country has a total land area of 2.795 million km² and a population of 23.6 million (1968 estimate). The climate is influenced by various geographical factors: the eastern half of the country is lowland and the climate ranges from subtropical to temperate; the La Pampa areas of the southern half are steppe country with low rainfall and a mild subtropical climate. Further south the climate is temperate, becoming progressively colder and wetter the more southerly the location or with the modifying effect of the high rocky Patagonian plateau. The lowlands are drained by a river network. The most important rivers are the Paraná, the River Plate and the Uruguay, all of which are navigable. Agriculture is an important element in the economy, and the country has an established position as an exporter of meat and grain.

There is a well-developed railway network which totals 46,000 km and links the capital, Buenos Aires, with Chile and Bolivia. The road system totals more than 81,000 km, and there is an internal air network as well as regular international services from Buenos Aires. The main ports are Buenos Aires, Rosario, Santo-Fe and Bahia Blanca.

The country has significant oil reserves. Production is based on four separate fields: the Salta fields in the north, the Mendoza fields in central Argentina, the Nequen fields further south in the Andes foothills, and the Comodoro Rivadavia fields on the Atlantic coast around the Gulf of San Jorge in Patagonia. The total output in 1968 was 18.25 million tons. Production of coal amounted to 357,000 tons in 1966, and the total output of electricity in the same year was 15,400 million kWh, of which less than 10 per cent was generated by hydroelectric stations.

Aluminium

To date there have been no positive indications of bauxite deposits of commercial importance in Argentina, although low-grade deposits have

been reported in the area between Wanda and Colonia Lanus in Misiones province and other lateritic deposits in eastern Argentina around eastern Wanda, Colonia Lanus and Puerto Iguazu. There are extensive alunite deposits in Patagonia near Camarones, and steps are being taken with UNIDO assistance to examine the possibility of economic production of alumina from these deposits.

A recent government decree has given high priority to the establishment of an alumina-aluminium reduction industry in the country and will encourage investment by private investors in this project with supplementary help from the Government. A "Commission for the Planning of the Development of the Light Metal Industry" has been set up and charged with implementation of this scheme. It is expected to give early attention to deciding on the site. The erection of an alumina plant and aluminium smelter of around 40,000 tons/annum capacity in the vicinity of the Iguazu Falls near the Brazilian border had been previously suggested, but it is understood that an alternative location on the Patagonian coast at Puerto Madryn is favoured. An investment of $100 million has been mentioned, with the plant to become operational in 1974.

The country has a semi-fabricating industry that is dominated by three plants in which foreign companies are strongly represented. In addition, three medium-sized plants as well as a number of other small works are owned by local capital. The statistics on aluminium imports and consumption are summarized in table 48. There would appear to be a consistent underrecording of consumption, if the import figures for primary aluminium are correct.

Table 48

IMPORTS OF BAUXITE AND PRIMARY ALUMINIUM AND ALUMINIUM CONSUMPTION - ARGENTINA

(Thousand tons)

	1960	*1965*	*1966*	*1967*	*1968*
Bauxite - imports[a]	30.0	38.9	42.9	38.5	...
Primary aluminium - imports	14.8	36.2	31.5	26.5	31.9
Primary aluminium - consumption	...	25.0	25.0	31.0	25.0

[a] For abrasives, refractory and ceramic industries.

Copper

Argentina has ranked as a minor producer of copper ores, and until recently the total reserves of copper ores were estimated as only 30,000 tons with an average copper content of 2.5 per cent. These ores also contain small amounts of lead, zinc, silver and gold, with occasional occurrences of antimony and arsenic. An exploration programme, which was initiated in 1963 with the participation of the Phelps Dodge Company of the United States and financial assistance from the United Nations, has led to the discovery of a number of large porphyritic deposits in Mendoza and San Juan

provinces. Preliminary estimates assess these new reserves at not less than 100 million tons of ores, with a copper content of 0.7—1.7 per cent reported from the Paramillo section of the deposits. Some large lode deposits with a copper level of 1.2—1.8 per cent have also been reported in the same area; these offer the possibility of developing domestic production on a significant modern industrial scale. Currently there is a small production of copper ores (approximately 500 tons), and of concentrates, which are exported to Chile. The mine production, export of concentrates, imports and consumption of refined copper are summarized in table 49. (The discrepancy between the statistics of copper exported to Argentina as recorded by the exporting countries and the domestic figures for consumption should be noted.)

Table 49

MINE PRODUCTION, EXPORT OF CONCENTRATES, IMPORTS AND CONSUMPTION OF REFINED COPPER—ARGENTINA

(Thousand tons)

	1959	*1965*	*1966*	*1967*	*1968*	*1969*
Mine production	0.5	0.5	0.5	0.5	0.5	...
Concentrates—exports	...	0.2	0.3	0.3	0.2	...
Refined copper—imports[a]	16.9	27.4	31.4	26.4	31.9	30.5
Refined copper—consumption	11.3	23.2	14.2	20.0	22.0	34.0

[a] Based on statistics of exporting countries.

The country has a semi-fabricating industry whose output is in the region of 25,000—32,000 tons/annum[2] The largest companies in the industry are owned by foreign companies—Pirelli S. P. A., Anaconda Company, Trefimétaux S. A., L. M. Ericsson, Phelps Dodge Corporation and A/B Svenska Metallwerken. There are some smaller plants owned by local capital and these produce a wide range of sections, tube, sheet and strip, wire and cable. Some plants fabricate both copper and aluminium.

Lead and zinc

The country has estimated reserves of 1.1 million tons of lead and 1.5 million tons of zinc, which are mainly found in a large ore body in the region of Aguilar in Jujuy province, a mountainous area in the north-east. The ores prospected are high grade, containing 6.7—11 per cent lead (10.2 per cent average) and 7—16 per cent zinc (14.6 per cent average); there are also significant deposits of low-grade ore whose extent has not been determined. Lead and zinc, with copper as a by-product, are also mined at small but rich deposits at Castaño Viejo, San Juan province, and Tonsalito in Rio Negro province. The Government and private companies are engaged in further prospecting for new deposits. Silver is also produced as a by-product from lead and zinc mining. Statistics of mine production, refined metal production, exports and imports are given in table 50.

[2] The statistics for consumption are considered to be less reliable than the data for imports of refined metal. In addition there are imports of semi-fabricated products.

Table 50

PRODUCTION, CONSUMPTION AND EXPORTS OF LEAD AND ZINC AND IMPORTS OF ZINC - ARGENTINA

(Thousand tons)

	1959	1965	1966	1967	1968	1969
Lead						
Mine production (lead content) .	30.7	32.3	29.5	32.3	28.0	35.0
Refined lead—production	34.1	38.8	36.0	35.8	37.8	41.0
Primary lead—consumption	31.5	38.0	36.0	35.0	36.0	35.0
Lead ore—exports	—	0.2	0.2	0.2	0.7	...
Zinc						
Mine production (zinc content)..	40.6	29.7	26.4	29.0	26.2	31.7
Refined zinc—production	14.6	23.3	22.3	23.0	20.9	24.6
Primary zinc—consumption	16.9	27.0	23.0	22.0	25.0	31.0
Primary zinc—imports	...	3.0	2.0	2.5	...	...
Primary zinc—exports	...	0.1	0.7	0.9	...	...

Output of lead-zinc ores has been about 550 million tons per annum, which is converted into refined zinc and lead. The lead smelter of National Lead Co. at Barranqueras, Chaco province, produces 99.97 per cent lead, antimonial lead, and silver and copper matte from lead sulphide concentrates. A further refinery for producing lead alloys, solders, printing metals etc. is located at San Justo, Buenos Aires province; it also produces zinc die-casting alloys and secondary aluminium alloys for foundries. It is jointly owned by Brazilian, Peruvian and Chilean interests. A small refinery with an annual capacity of 1,600 tons of lead operates at Mataderos, Buenos Aires province.

A zinc distillation plant, Cia. Metalurgica Austral Argentina S.A.L.I.y.F., is based at Comodoro Rivadavia which has a capacity of approximately 15,000 tons/annum with the sintered concentrates being reduced by electro-thermal distillation as used in the St. Joseph Lead Co. process. The other two principal plants utilize the electrolytic process. Establecimientos Metalurgicos S.A.I.y.C. operates at Zarate and is owned by local capital. A further plant, Sulfacid S.A., associated with St. Joseph Lead Co. (United States), is located at Borghi, near Rosario, and uses concentrates from the mines at Aguilar owned by its associate company, Cia. Mineria Aguilar. This latter company inaugurated an expansion programme in 1967 providing for a 70 per cent increase in output of ore and concentrates at a cost of $4 million.

Tin

Argentina is one of the smaller producers of tin; its total ore reserves are estimated at approximately 10,000 tons, although this is likely to be much below the true reserves. These deposits are a southern extension of the Bolivian tin belt centred in Jujuy province, with the small field deposits

and tin lodes of the Abra Pampas district the main centre of production. Previously, most of the tin was produced from the silver-tin ores of the Pirquitas deposit, which contained 8—10 per cent tin and 1—2 per cent silver, but the field is practically worked out. More recently the Sierra Galan mine, an extension of the Pirquitas deposit, has been re-opened and is producing concentrates with a tin content ranging from 15—45 per cent. Statistics for production and exports of concentrates, production, imports and consumption of refined tin are given in table 51.

Table 51

PRODUCTION AND EXPORTS OF TIN CONCENTRATES; PRODUCTION, IMPORTS AND CONSUMPTION OF PRIMARY TIN — ARGENTINA

(Thousand tons)

	1959	*1965*	*1966*	*1967*	*1968*	*1969*
Concentrates — production	0.2	1.2	1.3	2.0	1.7	2.0
Concentrates — exports	...	...	...	0.8	0.8	...
Primary tin — production	0.1	0.1	0.1	0.1	0.1	0.1
Primary tin — imports	...	1.3	1.3	0.9	1.0	
Tin — consumption	1.7	1.4	1.5	1.8	1.8	1.8

The small domestic production of tin is accounted for by Cia Sudamericana de Industria Comercio S. A., in Buenos Aires. The concentrates, which are exported, are destined mainly for the United Kingdom, and primary tin imports are supplied from Malaysia and Singapore.

Bolivia

The Republic of Bolivia is situated in the eastern half of the South American subcontinent; it has an extensive north-east border with Brazil, and shorter frontiers with Paraguay to the south-east and Argentina to the south. The western boundary is formed by Peru and Chile. Geographically, two features dominate the relief of the country. The eastern and north-eastern parts are flat and of relatively low altitude, forming the "Brazilian Shield"; they are drained by rivers that flow northwards into the Amazon system. Although this region occupies roughly 60 per cent of the land area of 1.099 million km², it is inhabited by only 15 per cent of the total population of 4.4 million (1968 estimate). Much of the region is covered by dense forest, and there are also large areas of swamp. Poor communications, a thick alluvial surface stratum, and the general difficulties of a tropical climate make geological prospecting of this area very difficult. The southern and south-western parts of the country are dominated by mountain ranges and high plateaux which form part of the Andes system. Much of this part of the country, which is the centre of the main economic activities, lies from 2,000 m upwards above sea level. In this region the climate varies from cold and arid to warm and humid at lower elevations towards the Brazilian Shield.

These geographical features also hinder the development of inland transport. The railway network totals 3,700 km, of which 2,400 km are state-owned. Little data are available on the road network, but it is believed to be even less extensive than the rail system. In the less populous mountain areas pack animals are still widely used as a means of transport of goods. International airport facilities are provided near La Paz.

Bolivia has limited fuel resources, but the terrain and climate provide numerous sites for the development of hydroelectric power, which accounted for over 80 per cent of the 584 million kWh of electricity generated in 1966. Crude oil production amounted to 1.95 million tons in 1968, of which natural gas production was estimated to amount to 120 million m³. Domestic refining capacity amounts to 0.73 million tons/annum.

The Bolivian Andes have significant reserves of tin ores, and useful deposits of antimony and wolfram. Copper, lead and zinc ores are also mined in small quantities.

Aluminium

There was a report in 1955 of the discovery of bauxite deposits in Sud Ungas province and near Sure, La Paz province, but no information on their size and quality was published, nor has there been any information released subsequently. There are no primary or semi-fabrication plants in Bolivia.

Copper

Figures published by Corporationes Mineras de Bolivia in 1967 estimated copper ore reserves in the country to total 267,000 tons. The main deposits are found on high plateaux. The only mine in current operation is that of Japan Bolivia Mining Co. at Tiakari, which has ores of the chalcocite types averaging 2.2—2.5 per cent copper. Some copper is also recovered from the complex lead-zinc ores of the Matilde deposit, near Lake Titicaca.

Production of copper concentrates from these two Bolivian mines has been expanding over recent years, as can be seen from the following: 1959—2,200 tons; 1965—4,700 tons; 1966—5,700 tons; 1967—6,000 tons; 1968—6,900 tons; and 1969—8,300 tons. The concentrates are exported to Japan for smelting.

Deposits are known to exist in the Corocoro region, with seams of 0.5—6 m in thickness and 0.6—3 per cent copper content, and deposits have been reported at Caraigas (by the Japanese company) where 13 million tons of ore with a 5 per cent copper content have been reported.

There is no copper-refining or semi-fabricating industry in the country, and statistics on imports are not available.

Lead and zinc

According to Corporationes Mineras de Bolivia (Combinol) (1967), total reserves of lead are estimated at 234,000 tons, of which 125,000 are regarded as proved; for zinc the corresponding figures are 870,000 tons. Most of the deposits are of fairly high zinc content, but low in lead, and usually with a small amount of copper and some silver. In addition, the waste dumps from

tin and tin-silver mines contain significant amounts of lead and zinc, although an economic method of recovering these has not so far been worked out. Data on the mine production of lead and zinc as concentrates are summarized in table 52.

Table 52

MINE PRODUCTION OF LEAD AND ZINC AND EXPORTS OF CONCENTRATES - BOLIVIA

(Thousand tons)

	1959	*1965*	*1966*	*1967*	*1968*	*1969*
Lead - mine production	22.0	17.5	21.2	20.3	22.3	25.2
Lead - exports of concentrates ..	21.4	20.4	20.4	19.7	20.4	20.4
Zinc - mine production	3.4	13.0	11.8	16.0	10.0	34.2
Zinc - exports of concentrates...	3.2	13.0	11.8	16.0	11.0	34.2

The main lead-zinc deposits being worked are those associated with the Maria Louisa and Sechio-Chasaya mines in the Potosí district, which are mined under adverse conditions because of the difficult mountainous terrain. It is considered that these mines are approaching the end of their useful life. The main production of zinc ore is from the Matilde deposit on Lake Titicaca, whose reserves are estimated at 3.6 million tons of ore containing 2.0—2.5 per cent lead, 17—18 per cent zinc, 0.4 per cent copper and 50—60 g/ton of silver. These mines also have associated concentrates' plants whose entire production is exported. The output of the Matilde mine is being expanded to 50,000 tons/year of zinc and 4,500 tons/year of lead.

Tin

Bolivia is a major producer of tin, ranking third in the world for mine production in 1968. The Bolivian tin belt stretches for almost 800 km along a north-west/south-east axis, being virtually 100 km wide in the region of Titicaca Lake in the north-west and continuing to the border with the Jujuy province in Argentina. Data from Corporationes Mineras de Bolivia (Combinol) give total reserves of tin at 1.1 million tons, of which 690,000 tons are of ore, 230,000 tons are associated with old tailings and residues, and 220,000 tons are in field deposits. Proved and probable reserves total 390,000 tons, of which 250 tons are from undeveloped ore deposits. A further large deposit, which has not been fully evaluated, was discovered in 1967 near the Cellnani mine, 33 km north of La Paz; it is estimated to amount to about 2.4 million tons and to average 1.3 per cent tin content. The ore deposits in the north are not large and individually do not normally amount to more than 8,000 to 9,000 tons, but they are of high tin content (10—12 per cent). The major deposits are those stretching from La Paz to some distance south of Potosí centred on Oruro.

The major part of the industry is controlled by the state-owned Corporacion Minera de Bolivia, with major mines located at Callagua, Chorolque, Colquiri, Potosí, Oruro and Malmisa. A further large mine at Potosí is owned

by Minera del Cerro de Potosí. There are twelve ore-dressing plants owned by the state corporation in operation; refined tin was produced in Oruro, although it is not produced currently. An agreement has been signed with Klockner Industrie Anlagen A.G. (Federal Republic of Germany) for the construction of a new smelter 8 km east of Oruro with an initial capacity of 7,500 tons/annum and plans for expansion later to 20,000 tons/annum.

A central plant for beneficiation of low-grade tin concentrates produced at the individual dressing plants is also planned, and it will be able to supply the new smelter with high-grade concentrates of constant quality. Data for production, consumption and exports of primary tin and tin concentrates are given in table 53.

Table 53

PRODUCTION, CONSUMPTION AND EXPORTS OF TIN CONCENTRATES AND REFINED TIN — BOLIVIA

(Thousand tons)

	1959	*1965*	*1966*	*1967*	*1968*	*1969*
Concentrates — production	24.2	23.0	25.5	27.2	29.0	30.0
Concentrates — exports	24.0	20.3	24.6	25.5	28.8	...
Primary tin — production	0.9	3.4	1.0	1.0	0.06	0.10
Refined tin — exports	0.9	3.4	1.0	1.0	0.06	0.08
Refined tin — consumption	0.04	0.05	0.06	0.06	0.08	0.08

A reconstruction and development plan for the industry was initiated in 1961 following an agreement signed with the United States Agency for International Development (USAID), the Inter-American Development Bank and Saltzgitter Maschinen A.G. providing for a loan of $38 million for this purpose. This plan has resulted in an expansion of output, a reduction in operating costs and improved profitability. A further expansion of output to 40,000—42,000 tons/annum is now envisaged, mainly by opening up new mines and the recovery of metal from old dumps which had accumulated from the seventeenth to the nineteenth centuries when only the silver was extracted.

One of the improvements needed in the efficiency of the industry is a reduction of the loss of metal content during ore dressing, which may amount to as much as 50 per cent of the metal content of some of the more complex ores being processed. A possible solution may be the use of special pyro-metallurgical processing at the dressing and beneficiation plants treating these low-grade ores by using a sublimation process and then smelting the product in electric furnaces. Such an approach would need a carefully worked-out technical and economic assessment for each site where such processing might be beneficial.

Brazil

The Federal Republic of Brazil has the largest land area — 8.51 million km² — of any of the South American states, with a long coastline on the

Atlantic Ocean, which forms its north-eastern and eastern boundaries. To the north its neighbours are French Guiana, Surinam, Guyana, Venezuela, and Colombia, with Peru to the west, Bolivia and Paraguay to the south-west, and Uruguay to the south.

A large part of the total area of 8,360 km² is accounted for by the Amazon basin, which is characterized by dense tropical forests, difficult terrain and communications, and is only sparsely inhabited. Most of the population of 90.8 million (1968 estimate) live in the eastern half of the country where much of the surface consists of moderately dissected plateaux of 500—1,500 m elevation. In these areas the climate is much modified by the elevation and ranges from subtropical to temperate. These Brazilian highlands occupy about 60 per cent of the land area. There are a number of rivers in this part of the country, the main ones being the São Francisco, which runs north and east, and the southerly flowing Paraná, with associated tributaries. Other rivers flow eastwards into the Atlantic. Many of these rivers are interrupted by falls and rapids and have potential for hydroelectric development.

The railway system of 37,000 km, of which 2,400 km are electrified, is mainly concentrated near the eastern and south-eastern seaboard and does not form a continuous network. Several isolated rail lines provide access from inland to ports such as Recife, Fortaleza, São Luis and Camocim. Other major ports are Rio de Janeiro and Belém. The road network amounts to 375,000 km. International airlines serve the country, and there is a well-developed internal air network.

Production of coal amounted to 1.73 million tons (1966), and electricity generated amounted in the same year to 32,654 million kWh, of which 27,905 million was from hydroelectric stations. Crude oil production is centred on the Bahia and Carmopolis fields and totalled 8.1 million tons in 1968.

Aluminium

There are considerable bauxite deposits in the country which are estimated to total at least 200 million tons, of which at least 80 million tons are regarded as proved. The main deposits are located in the Pocos de Caldas plateau in the Minas Gerais State; they contain an average of 62 per cent Al_2O_3, with 1—5 per cent SiO_2 and 4—10 per cent Fe_2O_3, and are of the lateritic type. Proved reserves of this deposit are estimated to total 70 million tons. Other deposits exist between Agua da Prata and Mogi das Cruzes in São Paulo State, and deposits have been reported in the Amazon delta, Tiriaçu island at the mouth of the Tiriaçu river, Pará in the Amazon basin, and Barra do Pirai near Rio de Janeiro.

Brazil possesses a domestic aluminium industry based on the utilization of local bauxite and hydroelectric power, which produces a surplus over the requirements of the semi-fabricating plants operated by companies that also produce the primary metal. The situation is a complex one involving international companies, as well as local capital. Table 54 indicates the structure of the industry.

Table 54

STRUCTURE OF THE BRAZILIAN ALUMINIUM INDUSTRY

Company	*Bauxite mining*	*Alumina production (planned)*	*Primary aluminium (planned)*	*Semi-fabrication*
Aluminio Minas Gerais S.A. (100% Alcan Aluminium Ltd)	Near Saramenha, Ouro Preta (New mine planned in Amazon Delta)	Saramenha, Ouro Preta 60,000 tons (80,000 tons, 1971)	Saramenha, Minas Gerais 27,000 tons (50,000 tons, 1971)	Saramenha smelter (Properzi wire plant)
Alcan Aluminio do Brasil S.A. (100% Alcan Aluminium Ltd)				Utingo, São Paulo (rolling, extrusion)
Cia Brasileira de Aluminio S.A. (Brazilian interests)	Mogi das Cruzes Pocos de Caldas (São Paulo)	Sorocaba, São Paulo 40,000 tons (100,000 tons, 1970)	Sorocaba, São Paulo 20,000 tons (50,000 tons, 1971)	Sorocaba, São Paulo (rolling, extrusion)
Cia Mineira de Aluminio S.A. (68% Aluminium Co. of America; 6% Hanna Mining Co., US; 26% Brazilian interests)	Near Pocos de Caldas, São Paulo	Pocos de Caldas (50,000 tons, 1970)	Pocos de Caldas (25,000 tons, 1970)	
Aluminio Industria S.A. (100% Swiss Aluminium Ltd)	–	–	–	Pindamonhangaba São Paulo (extrusion)
Kaiser Aluminio de Brasil Ltd (100% Kaiser Aluminium and Chemical Corp.)	–	–	–	Lorena (wire and cable plant)
Industria Sul Americana de Metals S.A. (50% Revere Copper and Brass Inc., US; 50% Brazilian interests)	–	–	–	Conçalava, São Paulo (rolling)
Laminacoa Nacional de Metals (Brazilian interests)	–	–	–	São Paulo (town) (rolling, extrusion)

Statistics for bauxite mining, imports, exports and consumption of aluminium in various forms are summarized in table 55.

Table 55

PRODUCTION, IMPORTS AND EXPORTS OF BAUXITE, ALUMINA, PRIMARY AND SEMI-FABRICATED ALUMINIUM — BRAZIL

(Thousand tons)

	1959	1965	1966	1967	1968	1969
Bauxite production	97.0	193.4	249.9	302.9	313.7	340.0
Bauxite exports		2.2	2.3	2.2	...	...
Alumina production	...	60.0	68.0	86.9	90.0	87.0
Primary aluminium production	18.1	30.4	26.9	39.3	43.6	51.2
Primary aluminium imports	...	21.8	39.5	28.0	41.5	42.9
Semi-fabricated aluminium production	...	19.8	41.4	48.0	...	...
Semi-fabricated aluminium imports	...	0.4	1.4	1.1	...	...
Aluminium consumption	27.0	51.6	72.1	78.0	80.2	85.0

As is evident from the foregoing, the aluminium industry of Brazil has been expanding rapidly. The plant at Aluminio Minas Gerais S.A., which utilizes the Bayer process and pre-baked electrodes, is being expanded to twice its previous capacity with technical help from Alcan's Japanese Associate, Nippon Light Metal Co. The Sorocaba Alumina Plant of Cia Brasileira de Aluminio S.A. operates with the Bayer process and is being expanded to 100,000 tons/annum output, and the associated smelter, which utilizes Soderberg-Montecatini self-baking electrodes, is being expanded correspondingly. A new reduction plant at Pocos de Caldas, built by Cia Mineira de Aluminio S.A., is starting operation. Expansion of semi-fabricating facilities is also being planned by most of the companies in this field.

Copper

Brazil has so far ranked only as a minor producer of copper ores and refined copper, although substantial reserves of ores exist in the country. Until recently the main ore deposits were found in the neighbourhood of Mina do Camaeva in the Rio Grande do Sul State where there are a number of small mines producing ore of 1.3 per cent copper content. A further deposit located near Caraiba in Bahia State contains 0.9—1.2 per cent copper. The total of these reserves has been estimated at 1 million tons, of which 260,000 tons were considered to be proved and probable, with the copper content ranging from 0.7 per cent to 3.8 per cent and averaging 1—2 per cent.

In 1967, further large deposits were located in Pernambuco State, near the boundary with Bahia State, which are estimated to contain 150 million tons of ore. Another large deposit has been found near Petrolina in Bahia State, and in 1968 a further deposit was found in Suden, Minas Gerais State, with reserves estimated at 80 million tons of ore containing 0.9—1 per cent copper.

Data on production, consumption and imports of copper are summarized in table 56.

Table 56

PRODUCTION, IMPORTS AND CONSUMPTION OF REFINED COPPER — BRAZIL

(Thousand tons)

	1960	*1965*	*1966*	*1967*	*1968*	*1969*
Mine production	2.0	3.0	3.1	2.6	3.5	3.7
Smelter production	2.0	3.0	3.0	2.6	3.5	3.7
Refined copper production	2.0	3.0	3.0	2.5	3.5	3.7
Refined copper imports	29.0	32.6	42.4	36.4	49.0	49.7
Refined copper consumption	30.0	35.0	45.7	38.9	51.4	53.9
Semi-fabricated copper imports	19.8	...	0.5	0.5	0.7	0.9
Semi-fabricated copper production	...	...	...	63.0	86.4	90.8

Concentrates are produced at Itapeva and Camacoa containing 28—30 per cent copper, and are converted to blister copper at the Itapeva smelter; the copper is then refined at Atinga, 10 km from São Paulo, at a refinery with a capacity of 4,200 tons/annum. There are plans for increasing the output of electrolytic copper at this refinery to 15,000 tons/annum, with a corresponding increase in output from the Camacoa and Itapeva mines.

Brazil possesses a varied copper semi-fabricating industry with six plants producing sheet and strip, extrusions and tubes in copper and brass, as well as a number of plants engaged in wiredrawing and the production of cables. One of the largest wire and cable plants is linked with Pirelli S.p.A. of Italy. The rolling-mill and extrusion plant of Industrial Sul Americana del Metals S.A. is owned by Revere Copper Inc. (United States), and S.A. Marvin is jointly owned by Anaconda, La Centrale Finanziaria Generale (Italy) and Brazilian interests. The rest of the industry is based on Brazilian capital. The main centre of the semi-fabricating industry is São Paulo State, especially the town of São Paulo; other plants exist at Rio de Janeiro, Santiago and Belo Horizonte (Minas Gerais State).

Lead and zinc

Brazil possesses useful reserves of lead-zinc ores estimated to total 3 million tons of lead and 4 million tons of zinc, of which 1.1 million tons of lead and 1.6 million tons of zinc are considered proved and probable. The metal content of these ores varies widely, ranging from 1—7 per cent lead in one area to as high as 20—50 per cent lead in others; the zinc content ranges from 2.9—35 per cent with a few small pockets reaching as high as 45 per cent. Samples from over 100 locations show that the majority of the deposits have a metal content near the top of the range. More recently, zinc-rich calamine ores have been discovered in Vazante, Minas Gerais, having a zinc content of 30—45 per cent, and with reserves estimated at 6 million tons; these ores are now being worked. Other calamine ores exist in the area, amounting to a further 5—10 million tons, with an average zinc content of 17.4 per cent. A zinc deposit first reported at Paracuta, Minas Gerais, is now being prospected in detail, and is believed to have reserves amounting to 35 million tons of ore

with an average content of 11.6 per cent zinc. Brazil thus has the reserves that could make possible a significant expansion of output of zinc ores of good quality.

Lead and zinc are produced at modest levels for domestic consumption, but there are plans for an expansion of output, particularly of electrolytic zinc production. Mine production, refined metal output, consumption and import data are summarized in table 57.

Table 57

MINE PRODUCTION, REFINED METAL OUTPUT, CONSUMPTION AND IMPORTS OF LEAD AND ZINC — BRAZIL

(Thousand tons)

	1959	*1965*	*1966*	*1967*	*1968*	*1969*
Lead						
Mine production	5.4	16.0	22.0	23.0	21.0	22.2
Primary lead—output	5.4	15.8	15.6	17.3	15.8	18.0
Primary lead—consumption	17.6	24.0	22.9	23.8	25.0	28.0
Primary lead—imports	...	2.0	6.0	6.5	...	...
Zinc						
Primary zinc—output	—	0.1	0.5	2.1	2.6	5.0
Primary zinc—consumption	22.2	40.8	41.0	39.0	45.7	50.0
Primary zinc and alloys—imports	...	31.0	37.0	44.1	36.1	...

The lead-zinc ores are mainly excavated from open pits, and generally the output from individual mines is not large; the largest of them at Baquna in Bahia State does not produce more than 200,000 tons/annum. Other producing centres are Phumbum, São Paulo and Adrionopolis, Paraná. Calamine ores have been mined for some years at Itaguai, Vazante and Itacarambi near Yanuira (Minas Gerais). The latter deposits contain 4—5 per cent vanadium which is recovered as a valuable by-product.

Lead-smelting facilities are provided by Cia Brasileira de Chumbo at Panelas, São Paulo, which treates ores from the company's mines in the Phumbum region, and at Santo Amaro, Bahia, which processes ore from its mine at Boqueirão. Phumbum S.A.—Industria Brasileira de Mineracão operates a mine, ore-dressing plant and smelter at Adrianopolis, Paraná, and is associated with the first-named company. The maximum output capacity of these two plants is estimated to be 21,000 tons/annum. Electrolytic zinc refineries are operated by Cia Mercantil o Industria Inga at Itaguai, Rio de Janeiro, using local ores, and Cia Mineira de Metais has a refinery at Tres Marias, Minas Gerais, treating ore from the Vazante region. Both plants have expanded capacity significantly over recent years. A secondary lead refinery operates in the city of São Paulo.

Tin

Brazil is one of the smaller producers of tin and has reserves of the metal amounting to an estimated 20,000 tons, of which 10,000 tons are considered proved and probable. For some years there has been small-scale

mining of small place deposits and pegmatitic veins in Minas Gerais State, mainly around São João del Rei, where they are associated with columbo-tantalite and small amounts of beryl and lathium. Production commenced in 1962 near Porto Velho, Rodonia, on the upper Madeira river, where a large number of relatively small placer deposits occur of cassiterite, whose extent is very incompletely known. The cassiterite content varies from a few hundred grams to 60—70 kg/m³. Tin-bearing sands in this area have a cassiterite content of 20—60 kg/m³. The ores are dressed to produce concentrates of up to 75 per cent tin content; these are smelted at the Volta Redonda, Rio de Janeira, plant of Companhia Estanifera do Brazil, which in addition to producing refined tin has a plant for producing tin alloys for solders, printing metals, bearing alloys etc. The principal problem with the Porto Velho deposits is their inaccessibility, and the concentrates have to be transported by air to the refinery. The recruitment of labour is difficult and fuel and power present some problems.

Statistics on production, consumption and imports are summarized in table 58.

Table 58

MINE AND REFINED METAL PRODUCTION, CONSUMPTION AND IMPORTS OF TIN—BRAZIL

(Thousand tons)

	1959	*1965*	*1966*	*1967*	*1968*	*1969*
Mine production	1.6	1.2	1.3	1.6	1.6	1.7
Refined tin—production	1.2	1.4	2.2	2.1	2.1	2.2
Primary tin—consumption	1.6	2.0	2.0	2.1	2.1	2.2
Concentrates—imports	1.4	0.8	0.2	0.1	...	...

Chile

The Republic of Chile is the southernmost state on the Pacific coast of the South American subcontinent. Its coastline extends over 4,000 km from the border with its northern neighbour, Peru, to the southern tip of the continent. Its neighbours in the east are Argentina and Bolivia. The north of the country lies within the tropics, and the southern tip is well within the temperate zone, with cold damp winters and some snowfall. The climatic effects of latitude are considerably modified by the physical geography of the country. This is dominated by the relief provided by the central and eastern range of the Andes or Cordillera, which are generally over 3,000 m in elevation rising to over 6,000 m at the highest peaks, and the lower coastal range. In the southern half of the country there is a long coastal plain of irregular width, and in the north is an area with large desert plateaux.

The drainage pattern is characterized by short fast-flowing rivers that empty into the Pacific Ocean. Some of the rivers in the southern part of the country are longer because of the more favourable relief. These rivers are important for hydroelectric power generation and are used for irrigation. The

country has numerous small harbours as well as several major ports, of which Valparaiso is the most important.

Chile has a well developed railway system based on a north-south trunk route with connecting lines crossing the country from east to west. Connexions are also provided with the railway systems of Bolivia and the Argentine. The Pan-American highway runs from the Peruvian border south to the capital, Santiago, and then eastwards to the Argentine. The country also has a good road network and a transport fleet of motor vehicles for carrying goods. The terrain presents some communications problems and affects transport costs. International airport facilities are provided at Santiago, and there are a number of internal airports that are proving of increasing importance.

The country has useful fuel reserves with the annual production rate for coal running at around 1.5 million tons, and a small production of lignite. Oil is produced on the island of Tierra del Fuego at the southern tip of the country and production in 1968 was estimated at 3.7 million tons, with a refining capacity of 4.3 millions tons. Significant quantities of natural gas are being produced both from gas fields on the Tierra del Fuego and near the coast of the mainland opposite, with production in the region of 1.7 billion m^3 per annum. Electricity output in 1966 amounted to 6,662 million kWh, of which 4,168 million kWh were from hydroelectric stations.

Chile's population of 9.4 million (1968 estimate) is widely distributed but is mainly centred on the western and central areas of the northern half of the country. The capital, Santiago, accounts for a population of over 1.5 million; Valparaiso (population 219,000) and Concepción (population 120,000) are other large towns.

Chile is one of the world's major copper producers, and the largest producer of the metal in the developing countries. Gold, silver, mercury and molybdenum are also extracted, mainly as by-products from copper production. Iron-ore deposits are also an important resource. Copper provides 50—60 per cent of Chile's foreign exchange, about 8 per cent of its gross income, a significant part of revenues from taxation, but employs fewer than 1 per cent of the country's labour force. The country has a substantial agricultural sector: forestry, cellulose, meat and meat products. It also produces glass, textiles and other consumer goods, and has light-engineering and motor-vehicle assembly plants.

Aluminium

There are small bauxite deposits in the Montenegro district 40 km north of Santiago, but they are considered to be too small for commercial exploitation. The country has no alumina production or aluminium reduction facilities, but there are several plants with facilities for producing sheet and extrusions, and more recently wire and cables. Data for imports of ingot and semi-fabricated aluminium into Chile are summarized in table 59.

Table 59

IMPORTS OF ALUMINIUM INGOT AND PRODUCTION OF SEMI-FABRICATED ALUMINIUM CHILE

(Thousand tons)

	1959	1965	1966	1967	1968	1969
Aluminium ingot – imports[a]	1.1	3.5	3.2	3.7	3.3	4.4
Semi-fabricated aluminium – production	...	...	1.6	1.7	...	...

[a] Based on statistics of exporting countries.

The plants engaged in production of semi-fabricated aluminium are all based in Santiago. Table 60 provides data on their activities and estimated capacities.

Table 60

NOMINAL CAPACITY OF PLANTS PRODUCING SEMI-FABRICATED ALUMINIUM PRODUCTS CHILE

Company	*Products*	*Capacity (tons)*
Manufacturas de Cobre S.A.	Sheet, foil, wire	2,500
Fantuzzi Hijos y Cia	Sheet	600
Vidrios y Aluminio S.A.	Sheet, extrusions	800

The main suppliers of the unwrought aluminium are Canada and the United States.

Copper

Chile has large reserves of copper ore, which are estimated as totalling 59 million tons, of which 42 million tons are proved and probable. A further 92 million tons are considered as possible reserves. The copper content of these ores ranges from 0.7–3.5 per cent, averaging 1.5 per cent. Chile possesses 23 per cent of the world's total reported reserves of copper ores. The Chuquicamata mine is an open-pit mine, producing oxidized and sulphide ores with an average metal content of 1.5 per cent and with some molybdenum present. The El Salvador mine and the El Teniente mines are underground operations, producing sulphide and oxidized ores with 1–2 per cent metal content. The smaller mines are of varied character both with respect to method of working and metal content; some have veins with a copper content as high as 5–8 per cent. Mining operations are widely spread along the length of the country. The main centres are those associated with the major mines: Chuquicamata in the north; Potrerillos more central; and the El Teniente mine further south, about 100 km to the south-west of Santiago.

The ownership structure of the copper industry in Chile is relatively simple, due partly to the dominant position of three major companies, and also due to the fact that, unlike many of the Peruvian deposits, the copper ores of Chile are essentially of the oxidized and sulphide types and are relatively free from other metallic impurities except for molybdenum. The three major

producers are of American origin: the Andes Copper Mining Co., which operates the El Salvador mine, and the Chile Exploration Co., whose mine at Chuquicamata is one of the world's largest, are both subsidiaries of the Anaconda Company (United States); and the Braden Copper Co. (now operating as Sociedad Minera El Teniente S.A.) is an affiliate of Kennecott Copper Corporation (United States). The significance of these three companies to Chilean copper production can be gauged by the fact that in 1968 they accounted for just over 80 per cent of mine production, and they have a similar dominant position in terms of smelter and refinery production.

Among the smaller producers mention should be made of Empresa Minera de Mentos Blancos S.A., which operates a mine and smelter of approximately 20,000 tons/annum capacity; it processes oxidized ores with a high chloride content (0.4 - 1.5 per cent) and employs a unique hydro-pyrometallurgical technique in which the copper is extracted by precipitation as cupric chloride. A recent entrant is Cia Minera Andina, S.A., a subsidiary of the Cerro Corp. (United States), which is committed to developing a 60,000 tons/ annum project in partnership with Chilean interests. Another medium-size mine is that of Cia Minera Disputada de Las Condes, a subsidiary of the French company, S.A. Peñarroya. There has also been recent Japanese investment in Minera de Atacama Ltda. There are a number of other small mines, mainly owned by Chilean interests, some of which are linked financially with the state-owned company, Empresa Nacional de Mineria (ENAMI), which operates smelter and refining facilities using ore from the smaller mines. Early in 1970 a joint ENAMI-Geomin (Romanian) company, Soc. Mixta Explotadora de Minerales Polimetalicos, was set up, with a capital of $200,000 to develop mineral resources in northern Chile.

Decree No. 16,425, passed by the Chilean legislature in April 1966, authorized the acquisition by the Government of a share in the capital of major copper enterprises - 51 per cent of Braden Copper Co. (to be renamed Sociedad Minera El Teniente S.A.), 25 per cent of Anaconda's new Exotica mine and 25 per cent of Cerro's Rio Blanco mine. The Chuquicamata mine of Anaconda remains under its previous ownership. Since this report was written there have been further developments which have increased the degree of government control and ownership of the industry.

The recently published National Plan for the Development of Mining provides for an increase in the production of the small and medium-sized mines to 45,000 tons/annum by 1973, which is expected to contribute an additional $31 million to the annual balance of payments and provide 4,700 new jobs. The annual output of the (state-owned) ENAMI mines is to be expanded from the 1968 figure of 51,200 tons to 96,700 tons in 1972. Credit for this expansion, amounting to $40.6 million out of the estimated $85 million that will be required, has been provided by a consortium of Belgian, British and German Federal Republic banks. Specific projects envisaged by the plan are to expand the electrolytic refining plant of ENAMI at Las Ventanas to an output of 112,000 tons of electrolytic wirebars and the Paipote smelter

(ENAMI) to 36,000 tons year, to construct beneficiation plants at Baquedano, Calama, Paipote, El Salado, Vallenar and Combarbala, and to expand ENAMI plants at Cabildo, Domeyko, Manuel Antonio Matta and Mantos de la Luna. The over-all objective is to increase Chilean output to 1 - 1.2 million tons by the mid-1970s.

The structure of the copper industry in Chile (1968) is indicated in table 61, and data on production, exports and consumption of copper in its various forms are summarized in table 62.

Table 61

OWNERSHIP, LOCATION AND TYPE OF OPERATION OF COPPER MINES, SMELTERS AND REFINERIES IN CHILE (1968)

Company	*Original ownership*	*Location*	*Type of operation*
Andes Copper Mining Co.	Anaconda Co. (United States)	El Salvador Potrerillos	Mine and concentrates Smelter and refinery
Chile Exploration Co.	75% Anaconda Co. (United States) 25% ENAMI	Chuquicamata	Mine, concentrates, smelter and refinery
		Exótica	Mine and concentrates
Soc. Minera El Teniente S.A. (formerly Braden Copper Co.)	51% ENAMI 49% Kennecott Copper	Sewell Caletones	Mine and concentrates Smelter and refinery
Cia Minera Andina S.A.	75% Cerro Corp. 25% ENAMI	Rio Blanco	Mine and concentrates
Empresa Minera de Mantos Blancos S.A.	Hochschild	Mantos Blancos	Mine and concentrates, smelter and refinery
Cia Minera Disputada de Las Condes	S.A. Peñarroya (France)	(i) El Soldado (ii) Disputada (iii) Chagres	Mine and concentrates Mine and concentrates, smelter
Cia Minera y Comercial, Sala Hochschild S.A.		Carolina de Michilla	Mine and ore-dressing
Cia Minera Tamaya S.A.		Los Mantos	Mine and ore-dressing
Cia Minera Cerro Negro		Aconcagua	Mine and ore-dressing
Cia Minera de Tocopilla		Tocopilla	Mine and ore-dressing
Soc. Capote Aurifero de Freirina		Qu Gradita Morado Astillas	Mine and ore-dressing Mine and ore-dressing Mine and ore-dressing
Minera de Atacama Ltda	Mitsubishi (Japan)	Adrianitis	Mine and ore-dressing
Cia Minera El Molle		Coquimbo	Mine and ore-dressing
Chile-Canadian Mines S.A.	Noranda	Paposo	Mine and ore-dressing
Empresa Minera San Jose de Tuina S.A.	Latin-American Mines	Tuina Sierra Gorda	Mine and ore-dressing Mine and ore-dressing
Cia Minera Pudahuel	Chile	La Africana	Mine and ore-dressing
Cia Minera Merceditas	Chile	Santiago Prov.	Mine and ore-dressing
Cia Minera San Barbs	Chile	Arica	Mine and ore-dressing
Empresa Nacional de Minera (ENAMI)	Chilean Government	Paipote Las Ventanas	Smelter Smelter and refinery

Table 62

PRODUCTION, EXPORTS AND CONSUMPTION OF COPPER IN VARIOUS FORMS: CHILE

(Thousand tons)

	1959	1965	1966	1967	1968	1969
Mine production	545	585	637	660	658	687
Concentrates: exports	23	28	31	30	35	40
Blister copper: production	517	557	606	630	623	647
Blister copper: exports	256	274	235	241	224	188
Fire-refined copper: production	70	98	98	91	84	96
Electrolytic copper: production	177	191	259	295	310	357
Refined copper: exports	150	217	317	361	378	...
Refined copper: consumption	41	73	40	17	23	13
Semi-fabricated copper: exports	32	28	33	8	11	5

Chile also has facilities for production of semi-fabricated products. There are six plants engaged in such activities, the largest of which is Manufacturas de Cobre S.A., which also fabricates aluminium and has facilities for producing copper and copper alloys as sheet, strip, extrusions, tubes etc. The company, Conductores Electricos de Cobre, Cerillos, S.A., located at Las Cerillos near Santiago, produces wire and cable. The other plants are smaller and produce sheet and extrusions.

Lead and zinc

Chile has negligible resources of lead and zinc ores. The total lead reserves are estimated at 40,000 tons, of which 20,000 are regarded as proved and probable; the total zinc reserves are assessed at 20,000 tons with 10,000 tons proved and probable. The annual mine production ranges from 500—2,000 tons and is centred in the Aisén district. There are no refining or semi-fabricating plants associated with these metals.

Tin

There are no known deposits of tin ores in the country and there is no industry refining or fabricating tin and its alloys.

Colombia

The Republic of Colombia has a land area of 1.2 million km². It is located in the north-west of the subcontinent, with a coastline (broken by the Isthmus of Panama) on the Caribbean Sea and the Pacific Ocean. To the south its neighbours are Ecuador and Peru, and to the east Brazil and Venezuela. Much of the country is of low to moderate relief; but its most significant feature consists of the two ridges of the Andes range, the western Cordillera and the eastern Cordillera, which rise to over 4,000 m.

Most of the population of 21 million (1968 estimate) live in the western half of the country, particularly in the plateaux of the mountains. Although the country lies within the tropics, its climate is varied, ranging from tropical

to semi-tropical in the lowlands and foothills to temperate over much of the mountains, and even cold above 3,000 m. The sharp variation in relief makes for areas where heavy rainfall produces short, rapid rivers flowing into the Pacific and slower, broader rivers that flow westwards into the Amazon system. One major river, the Magdalena and its tributaries, empties into the Caribbean. The main ports are Barranquilla and Cartagena on the Caribbean and Buenaventura on the Pacific Coast. The Magdalena river is of importance for internal traffic. A short railway has been built to provide transit to another section further inland from the stretch between Puerto Wilches and Barracambermeja where rapids occur. There are several railway lines in the west and north-west of the country, forming a network totalling 3,467 km. There is an international airport at Bogotá and other airports provide mainly domestic services.

The road network is concentrated mainly in the populous western half of the country with over 10,000 km of macadam roads, of which the most important is the Pan-American highway running from the Panamanian border through to Ipiales near the frontier with Ecuador. Major trunk roads connect it with the capital, Bogotá, and also to Caracas.

The country has modest reserves of coal, with 1 million tons being mined annually. Generation of electrical power amounted to 6,350 million kWh in 1966 of which about two thirds came from hydroelectric stations; most of the balance was produced by oil-fired steam-generating plants. Production of crude oil for 1968 was estimated at 9.4 million tons, with a refining capacity of 1.89 million tons and consumption of 5 million tons.

Aluminium

Bauxite deposits were discovered in the country in the late 1950s in the western Cordillera at Yarumal near Medellin, and in the southern part of the eastern Cordillera. These deposits average 40—42 per cent Al_2O_3. More recently, deposits were discovered in the south-west in the department of Cauca which Kaiser Aluminum and Chemical Corporation has shown interest in exploiting. There is no domestic production of bauxite or of alumina. A project is being studied for the erection of a 30,000 tons/annum aluminium smelter near Choco on the Pacific Coast, utilizing hydroelectric power.

The country has a semi-fabricating industry of which the two largest plants are those of Aluminio Alcan de Colombia S. A. at Cali and Aluminio de Colombia Reynolds (Santo Domingo) S. A. at Barranquilla; both works have rolling-mill and extrusion facilities. A small cold-rolling mill, Industrias de Aluminio Munal, is located at Cali, and a plant producing aluminium and copper extrusions and wire, Industrias de Cobre y Aluminio Ltda. is based at Medellin. These are both owned by Venezuelan interests.

Data on the imports of bauxite, primary aluminium and semi-fabricated products are given in table 63. Imports of semi-fabricated products have totalled around 1,000 tons/annum.

Table 63

IMPORTS OF BAUXITE, PRIMARY AND SEMI-FABRICATED ALUMINIUM — COLOMBIA

(Thousand tons)

	1965	1966	1967	1968
Bauxite imports[a]	9.2	9.0	...	...
Primary aluminium imports[b]	5.6	6.3	3.9	8.0

[a] For use in abrasives, refractory and ceramic industries.
[b] Obtained from Canadian and United States export figures.

Copper

Deposits of copper ores are known to exist in the eastern Cordillera at a height of 2,000–3,000 m above sea level. They present considerable problems in terms of accessibility, however. More recently, new deposits have been located in the departments of Antioquia and Caldas which are now being evaluated. There are no plants producing primary copper, and the semi-fabricating industry is represented by Fabricas Colombianas de Materiales Electricas S. A. (a Phelps Dodge subsidiary) at Cali, Industrial Nacional de Conductores Electricos S. A. at Bogotá, which produces wire and cable, and Industrias de Cobre y Aluminio Ltda, which has rod-rolling, extrusion and wiredrawing facilities. Imports of semi-fabricated products amount to 600–1,000 tons/annum.

Lead, tin and zinc

There are no published reports of reserves of ores of these metals. As far as is known there are no occurrences of tin ores. Lead-zinc ores occur at Trontino in the department of Antioquia where they are obtained by underground mining. Output is estimated at up to 7,000 tons of metal content per year. Zinc is recovered at a small electrolytic plant in Bogotá, and the lead ores are exported.

In recent years there has been intensive prospecting, undertaken with assistance by experts from the Federal Republic of Germany and France, who have reported new occurrences of lead and zinc in the departments of Antioquia and Caldas. A more detailed investigation of the more promising deposits is now in hand.

Ecuador

The Republic of Ecuador lies in the north-west of South America; Colombia is its neighbour to the north and Peru to the south and east, and it has a western coastline on the Pacific. Its population of 5.7 million (1968 estimate) is distributed unevenly over a land area of 300,400 km²; the Cordillera, the central range of the Andes, which rises to over 5,000 m, is the main centre of population and economic activity. Lowland areas lie to the east and west of the mountain range; the lowland to the west is important for agriculture.

The country has a varied climate, ranging from tropical to semi-tropical in the lowlands and foothills, temperate over much of the mountain range but cold above 3,500 m. The country has adequate rainfall, and the main rivers flow eastwards into the Amazon system.

The main railway system runs approximately north-south, with a branch to the ports of Guayaquil and Salinas. The highway system amounts to over 10,000 km. International airlines operate from the airport near the capital, Quito, and there are domestic air services.

Electric power generation in 1966 was 700 million kWh, of which about 35 per cent came from hydroelectric plants. The country has scattered small coal deposits which have proved uneconomic to work. Oil is obtained on the Santa Elena peninsula; the output is around 290,000 tons/annum but is declining. Non-ferrous mining activity is primarily concentrated in gold, copper and silver; small amounts of lead and zinc are also mined.

Aluminium

There are no reports of the occurrence of bauxite deposits in the country and there is no refining or semi-fabricating industry associated with this metal.

Copper

There are no published estimates of ore reserves, but sulphide ores (3—4 per cent copper) and micaceous and gangue-containing copper ores are found in the gold/silver veins in the Macuchi and Inslivi prospects in the eastern slope of the Cordillera. Neither of these ore bodies, however, are worked.

Virtually all of the copper ore mined comes from the Portovelo mine in the Zaruma district, which processes the ore to concentrates totalling around 100 tons of copper per year. A cable plant, Cables Electricos Ecuatorianos C. A., is located in Quito and has links with the Phelps Dodge Corporation (United States).

Lead and zinc

There is currently no commercial mining of lead and zinc ores. Some lead and zinc occur in conjunction with the silver mined at Pilsun in the Zaruma district but these are not worked.

Guyana

Situated on the north-east coast of the South American land mass, Guyana, which became independent in 1966, has Surinam as its neighbour to the east and Venezuela to the west. Brazil also provides part of its western as well as its southern boundary. Over 86 per cent of the land area of 215,000 km² is forest, 10 per cent savannah, and just over 3 per cent is coastal belt where over 90 per cent of the population of 674,000 (1968 estimate) live. The climate is hot, ranging from 20°—35° C on the coast, equable and humid. There are two wet and two dry seasons, with the highest rainfall

from May to August. The rainfall varies over the range 60 – 150 cm/annum, being higher in the inland forest belt. The country is generally of low relief, parts of the coast actually lying 1 – 2 m below sea level, and it is protected by sea walls and dams. Hills rise to over 600 m in the west near the junction of the boundary with Venezuela and Brazil.

The country has a short railway line of 134 km from Parika via the capital Georgetown to New Amsterdam. The road network totals 600 km, and there are 650 km of navigable rivers with 25 km of canals associated with them. Connexions with international air services are available at Georgetown airport, and there are several smaller internal airports and landing strips.

Guyana lacks reserves of coal and crude oil and is largely dependent on imported fuel or domestic hydroelectric resources, for which there is considerable potential for development. Some fourteen sites should be listed as possible for development. A study completed in 1968 indicates the feasibility of developing a station at Tiboku Fall on the Mazarini river which could provide 65 megawatts of power for an aluminium smelter, with an additional commercial and domestic load. Total output of electricity in 1967 was 96.9 million kWh from the Georgetown system, which operates using diesel and steam plant. Output data from four other publicly and one privately owned plant are not available.

The economy of the country depends basically on agriculture, but bauxite mining and alumina production contribute a major share of export earnings. In addition to a substantial production of bauxite, manganese, diamonds and gold are mined. The production of manganese ore amounted to 114,998 tons in 1968, but mining of this ore has since ceased. There is a modest production of the other two minerals. Deposits of columbite, titanium, tungsten, mica and quartz have also been reported, but are believed to be small.

Aluminium

There are substantial bauxite reserves in Guyana, which are estimated to total 250 million tons of which 80 million tons are reported as proved. The Al_2O_3 content of these deposits varies between 50 and 60 per cent, with local beds reaching as high as 67 per cent. The SiO_2 content ranges from 3 – 12 per cent, and 2.5—5 per cent are iron oxides. There are also large reserves of lower-grade ores. The two major deposits being mined are the one in the neighbourhood of MacKenzie on the Demerara river, by Demerara Bauxite Co. Ltd, an Alcan Aluminium Ltd affiliate, and the one at Kwakwani on the Berbice river, by Reynolds Guyana Mines Ltd. Other deposits are known to exist in the Pakaraima mountains, the Blue mountains and the Oko mountains, in depressions associated with the river beds. An alumina plant operated by Demerara Bauxite Co. Ltd is located on the edge of the town of Mackenzie.

Data on bauxite and alumina production and exports are summarized in table 64.

Table 64

PRODUCTION AND EXPORTS OF BAUXITE AND ALUMINA - GUYANA

(Thousand tons)

	1959	1965	1966	1967	1968	1969
Bauxite production	1,701	2,919	3,358	3,460	3,723	4,306
Bauxite exports	1,674	1,758	2,023	2,283	2,364	...
Alumina - production		284	302	349	244	270
Alumina exports		275	297	269	265	...

Copper

A deposit of copper ore has been located at Groete Creek opposite Stampa Island on the Essequibo. Drilling has indicated an estimated 100 million tons of ore of 0.2 per cent copper content; 17 million tons of this amount contain 0.6 per cent copper and 15 g/ton gold. Showings of copper in the upper Demerara valley, the Blue and Oko mountains in the Puruni River basin have also been reported.

Lead, zinc and tin

There are no reports of the occurrence of these ores within the territory and no refining or semi-fabricating activities exist.

Paraguay

This South American Republic is unique for the fact of being completely land-locked. It is bounded by Brazil to the north-east and east, Bolivia to the north and west and Argentina to the south. It has a population of 2.35 million (1968 estimate), and has an area of 405,000 km². There are few large towns other than Asunción the capital (population approximately 220,000).

Situated between the Paraguay and Paraná rivers it has a subtropical climate. The Chaco zone is torrid. In the eastern half of the country, however, temperatures are around 20 °C in the May-September cool season, although they can rise to over 38 °C in the October-February hot season. Rainfall is around 100 cm along the Paraguay river, but rather less in the interior. Eastern Paraguay consists of a series of grassy plains intersected by abrupt ridges, none exceeding 750 m. Much of the central area consists of grassy plains and dense forests, marshy in some areas and with an extensive area of marshland at the Paraná-Paraguay confluence. To the west the Chaco plain rises uniformly, reaching a height of approximately 350 m towards the Bolivian border. The country suffers from periodic droughts and floods.

A railway system totalling 1,150 km includes a through route linking the capital, Asunción, to Buenos Aires in Argentina, and a second principal route links Asunción to Encarnación near the south-east border. A short line from Concepción via Horqueta links with the Brazilian rail system.

River steamers on the Paraguay river are also of importance for internal transport. The road system totals 6,250 km of which 1,000 km are asphalted.

The economy is highly dependent on the agricultural sector, with meat production and meat packing a major activity, as well as production of leather goods, textiles, vegetable oils and flour products. Cement is also produced as well as some small-scale light-engineering products.

There are no domestic fuel resources, and power generation depends largely on imported fuel oil. There are reports of iron, manganese and copper ore deposits in the country, but these have not been exploited. Surveying is incomplete and there are difficult communication problems in some areas.

Imports of aluminium in all forms in 1966 amounted to 39 tons, lead imports amounted to 56 tons and tin to 20 tons. Copper imports, in wire form, totalled 199 tons in the same year.

Aluminium

Bauxite deposits have been reported near San Juan Nepomuceno, Altos Piribebuy and Paraguari. These seem to be inferred from the deep weathering and laterization of most of the similar rocks in eastern Paraguay. Weathering and laterization of similar rocks in Brazil have provided bauxite of commercial grade. There is no aluminium semi-fabricating industry in the country.

Copper

Deposits of copper-bearing ores have been reported in the region of Paso Pinda, near Villa Florida, and are accessible from an unimproved secondary road. The deposit has been traced over an area of 50—100 m² by means of three test pits and several shallow open-cuts. Copper occurs as malachite and green oxidized products of sulphides, as films and veinlets along seams and joints of slightly fresciated aplite. There were no strong veins at the time of the 1959 reconnaissance and the outlook was not considered promising. Copper deposits have also been reported in and near Colmá Franz, 15 km north-east of Carmen del Paraná and 40 km due east from San Pedro del Paraná, and in many other places where the Sierra Geral basalt covers the south-eastern part of the country. There is a widespread popular belief, not so far confirmed, that Paraguay is rich in copper ores.

Lead and zinc

Lead ore, probably in the form of galena, has been reliably reported in Pedro Juan Caballero, from La Colmena (a farm colony) midway between Acahay and Ybytymi, and in a few other places, but there is no firm evidence that these deposits have commercial potential.

There are no reports of the existence of zinc ores.

Tin

There have been reports but no confirmation of sitings of cassiterite.

Peru

The Republic of Peru lies on the Pacific coast of South America, with its northernmost tip on the equator adjacent to Colombia and Ecuador. It has an irregular eastern frontier with Brazil and Bolivia and a short southern frontier with Chile. The total land area is estimated as 1.285 million km². The dominant geographical feature is the Andes mountain range, which rises from the narrow coastal belt and extends inland for a distance of approximately 350–500 km; much of this region has an elevation of over 3,000 m with peaks reaching over 5,000 m. In the north there is an area of low-lying plain that drains into the Amazon basin, and in the east is the Madre de Dios plateau, which is mainly of 300–500 m elevation.

Most of the population of 13.2 million (1969 estimate) live in the Andes, where the elevation modifies the effects of the tropical equatorial climate which dominates the lower-lying areas, giving a pleasantly warm environment by day but rather low temperatures at night; the extent of the temperature difference is influenced by altitude. Rainfall is relatively light—below 50 cm/annum. The main rivers are the Ucagali, Marona, Maranon and Huallaga, all of which flow east into the Amazon system. These rivers are navigable but are of relatively small importance for transport since they connect only with the Amazon and not with the Pacific coast ports that handle the export trade.

Peru is highly dependent upon motor transport, and it has a highway network of 40,000 km, including the Pan-American highway which runs the length of the country. Railways are much less important because of the difficult gradients involved in the steep climb from the coast up to the plateaux where the main population centres and economic activity are based. Transport of goods to and from the coast requires vehicles to negotiate a long and tortuous haul. Because of the difficult terrain and communications, pack animals are still in use for transport of goods, particularly in the remoter areas. An airport near the capital, Lima, connects with international services, and the internal network is being expanded.

The country has a modest production of coal—126 million tons in 1965. Oil production in the Madre de Dios hills in the east of the country totalled 3.7 million tons in 1968. Electricity production totalled 4,680 million kWh in 1966, of which about two thirds was generated by hydroelectric stations.

Peru is the world's leading fishing nation and supplies half of the world demand for fish meal. Agriculture forms an important sector of the economy and is being given particular attention in terms of improving its technical efficiency and output. Industrial activity consists of processing agricultural products, manufacture of chemicals and the assembly of motor vehicles. Rubber manufacture is to be started shortly.

Metallic mineral mining and the production of refined metals occupy a major sector of the economy. The country is an important producer of copper, lead and zinc; other metals such as antimony, bismuth, silver and

gold are also produced, largely as by-products of the processing of non-ferrous metals.

During the latter half of 1969 the Peruvian Government issued decrees that will have a significant effect on the structure of the mining industry. Decree 17791 (2 September 1969) was promulgated to promote the development of small and medium-sized mines. Decree 17792 (2 September 1969) was designed to ensure development of inactive concessions, and stipulated that concessions would be withdrawn of companies falling more than five months behind the work calendars, which were to be submitted by 31 December 1969. Subsequent to this study the Government issued Decree 18225 (14 April 1970), which gives it the monopoly to market all minerals and to refine copper, allows it to intervene directly in the minerals market, and provides powers to guarantee the rapid and full development of national mining. The Government plans to triple production over the next six years, and estimates that an investment of $1,000 million will be required. These measures are intended to ensure that the ownership base of the industry is widened and controlled by Peruvian interests.

Aluminium

There are no indications of bauxite occurring in the country nor of other high-alumina ores of commercial significance, and the geological data available indicate that occurrence of such deposits is unlikely. The aluminium industry is confined to semi-fabricating activities. The main company is Fábrica de Aluminio y Metales S. A., which is based at Vitarte, near Lima, and has a rolling mill with a nominal capacity of approximately 6,000 tons/annum and extrusion presses with a capacity of approximately 4,000 tons/annum.

An extrusion plant, Metales Industriales del Peru S.A., which is connected with the Cerro de Pasco Corporation, operates in Lima, as does a small cold-rolling mill, Industria Peruana de Aluminio Laminados S.A. Data on imports of refined aluminium and semi-fabricated products are given in table 65.

Table 65

IMPORTS OF REFINED ALUMINIUM AND SEMI-FABRICATED PRODUCTS - PERU

(Thousand tons)

	1959	*1965*	*1966*	*1967*	*1968*	*1969*
Aluminium ingot[a]	1.1	3.5	3.1	3.7	3.3	2.9
Semi-fabricated aluminium	...	2.3	1.6	1.7	...	...

[a] Based on export statistics of Canada and the United States.

Copper

Peru has developed rapidly as a major copper producer. In 1959 mine production was 50,500 tons; this figure had expanded more than fourfold, to 213,500 tons, in 1968. The first deposits that were developed are in the

south of the country; they are a northern extension of the Chilean copper deposits and are porphyritic. Subsequently, significant deposits have been discovered in the central and northern areas, and many of these consist of complex ores. The main characteristics of the Peruvian industry are the extent to which complex ores containing copper, lead and zinc are mined and processed and the complexity of the processing flowsheet owing to the occurrence and extraction of important minor elements, including not only silver and gold, but also antimony, arsenic, bismuth, cadmium, indium, molybdenum, selenium, tellerium and tungsten.

The reserves of copper-containing ores in Peru are so large that estimates are inevitably an understatement of the total available and suitable for commercial exploitation. A few years ago (1967—1968) reserves were quoted as 16 million tons, but subsequently new deposits have been discovered that have substantially increased the country's growth reserves. The Cerro Verde deposits, now being developed by the Anaconda Company's subsidiary, Cia Minera Andes del Peru, is estimated to have reserves of 1.4 million tons of copper contained in oxidized, sulphide and complex ores.

The Michiquillay deposits of Northern Peru Mining Corporation are believed to be substantial, and deposits at Berenguela, Antamina and Chalcombamba total at least 2 million tons of copper content. A similar quantity is believed to be available from a number of smaller deposits at Cobriza, Chapi, Condestable, Huaron and Huachocolpa. The existing deposits of the Morococha mine of the Cerro de Pasco Corporation have been fully evaluated, and although the reserves of the area currently being mined are reported as only 0.1 million tons of copper, an extension to these deposits is being explored that is estimated to contain between 154 and 327 million tons of complex ores averaging 0.76 per cent copper (with lead, zinc and silver also present). The country obviously has enormous future reserves of copper and other non-ferrous metals.

The mining and smelting of copper in Peru has been done largely by two American-owned companies, the Cerro de Pasco Corporation and the Southern Peru Copper Corporation, which between them account for about 80 per cent of the country's mine output and for its entire smelting and refining capacity. New entrants include the Anaconda Company (United States), Charter Consolidated and a Japanese group, so that there may well be a change in the pattern of production over the coming decade. The structure of the ownership of mining in Peru might appear simple in the sense that these two companies have the dominant position, but it is complex in terms of the relationships of the smaller mines to these two companies and others with international connexions. The Banco Minera de Peru has been charged by the Peruvian Government with the task of promoting the development of the smaller mines owned by Peruvian capital.

There are a small number of large mines and a considerable number of small and medium-sized mines. There is always a certain difficulty in providing up-to-date information on mining companies operating the smaller

mines. The data available relative to the mines engaged in producing copper in 1968 are summarized in table 66. Expansion of the industry to more than double its present size is planned for the early 1970s, with a capital investment approaching $500 million.

Table 66

OWNERSHIP LOCATION AND MAIN ORE CONSTITUENTS OF COPPER MINES IN OPERATION IN PERU (1968)

Company	*Ownership*	*Location*	*Main ore constituents*
Cerro de Pasco Corp.	United States	Morocôcha, Junin	Cu, Pb, Zn, Ag
		San Cristobal, Junin	Cu, Pb, Zn, Ag
		McCune	Cu, Pb, Zn, Ag
		Cerro de Pasco, Pasco	Cu, Pb, Zn, Ag
		Casalpalca, Lima	Cu, Pb, Zn, Ag
		Yauricocha, Lima	Cu, Pb, Zn, Ag
Southern Peru Corp.	United States	Toquepala, Tacna	Cu
		Cuajone, Moquegua	Cu
Algamarco – Cia Minera	Peru	Algamarca, Cajamarca	Cu
Andes de Peru – Cia	United States	Cerro Verde	Cu
Buenaventura – Cia de Minas	United Kingdom	Buenaventura	Cu
Banco Minero de Peru	Peru	Huachocalpa	Cu
Minas de Chapi S.A.	Japan	Chapi, Arequipa	Cu
Chungar – Cia Minera	Peru	Chungar, Pasco	Cu, Pb, Ag
Condestable – Cia Minera	Japan	Condestable, Mala	Cu
Minas de Cobriza S.A.	Not known	Cobriza, Huancavelica	Cu
Chungar – Cia Minera	Peru	Chungar, Pasco	Cu, Pb, Ag
Madrigal – Cia Minera	United States	Madrigal, Arequipa	Cu
Malago – Santolalla e Hijos	Peru	Tambora La Libertad	Cu, Pb
Millotings-Emp. Explotodora	Peru	San Juan, Lima	Cu, Ag
Melpa – Cia Minera	Peru	Llipa, Ancash	Cu, Ag
Minsur Ltd	United Kingdom/ United States	San Rafael, Puno	Cu, Sn
Northern Peru Mining Corp.	United States	Quiruvilca, La Libertad	
		Michiquillay	Cu, Pb
Pacococha, S.A.	Peru	Pacococha, Lima	Cu, Pb, Zn
Pativilca – Cia Minera	Peru	Mina Paul, Lima	Cu
Puquio Cocha, Soc. Minera	Peru	Alejandria, Junin	Cu, Zn, Ag
San Agustin Cia Explot. Minera	Peru	San Agustin, Cajamerca	Cu
Sayapullo S.A.	Peru	Sayapullo, Cajamerca	Cu, Pb, Zn
Unid. Minera (Banco Minero)	Peru	San Juan, Ajacucho	Cu, Pb, Ag
Santa Rita – Cia Minera	Peru	Morococha, Junin	Cu, Pb, Zn, Ag
Turmalina – Cia Minera	Peru	Turmalina, Piura	Cu, Mo

In addition to new mining activities, plants for ore dressing and production of concentrates are to be expanded. Ore-dressing plants and plants for the production of concentrates exist in association with most of the medium and larger plants and range in size from 100—2,000 tons/day. Some mines have facilities only for the simple ore-dressing operations. Some of the ores and concentrates are exported and the rest are smelted in Peru. The La Oroya, Junin, smelter of Cerro de Pasco Corporation has facilities for recovery of the various minor metals as well as for the production of blister and electrolytic copper, with capacities for these products of 50,000 and 45,000 tons/annum (1965) respectively. This smelter also undertakes smelting of concentrates from smaller independent mines on a toll basis.

The Ilo smelter of Southern Peru Copper Corporation uses the converter process and reverberatory smelting and has an annual capacity in the region of 175,000 tons of blister copper. There are no facilities for electrolytic refining.

Data on output, consumption, exports and imports of copper in all forms are summarized in table 67.

Table 67

PRODUCTION, CONSUMPTION, EXPORTS AND IMPORTS OF COPPER IN ALL FORMS — PERU

(Thousand tons)

	1959	*1965*	*1966*	*1967*	*1968*	*1969*
Mine production	50	177	184	186	213	199
Ore and concentrates exports	11	23	22	31	23	...
Blister copper production	33	158	153	164	188	170
Blister copper exports	6	118	115	123	148	145
Refined copper production	27	40	36	36	42	47
Refined copper exports	27	38	32	29	33	33
Refined copper imports	0.6	...	12	2.8	...	...
Semi-fabricated copper imports	0.6	...	0.9	0.8	0.6	0.6
Consumption – all forms	1.0	2.5	3.9	6.2	8.0	...

There is little semi-fabricating activity in the country. There is a wire-drawing and cable plant, Industrias de Cobre S.A., in Lima, and the extrusion plant, Fabrica de Aluminio y Metales, produces both copper and aluminium sections. The refinery at La Oroya, operated by Cerro de Pasco, produces copper wirebars and has recently added wiredrawing facilities. This is expected to lead to increased domestic consumption.

Lead and zinc

Total reserves of lead have been quoted at 3.3 million tons, of which 2.8 million tons are considered proved and probable. Zinc reserves are quoted at a total of 7.5 million tons with 5.8 million tons proved and probable. Lead content usually ranges from 2.5—10 per cent, zinc content from 4.5—16 per cent and copper from 0.15—3 per cent, but even higher-grade ores are sometimes encountered. All ores also contain copper, with silver, gold, antimony, arsenic, bismuth, cadmium, indium, tin, tungsten and other elements being

present and usually recovered as by-products from lead and zinc processing. With the recent discovery of new complex copper ores, which also contain lead and zinc, these figures are an obvious underestimate of the total reserves available.

The Southern Peru Copper Corporation does not process lead and zinc ores. Cerro de Pasco Corporation is the major producer of lead and zinc, although there are a number of smaller mines in production. In addition to those copper mines where lead and zinc are recovered, a number of mines produce lead and zinc-rich ores, which are listed in table 68. These are mainly sulphide ores containing 1–7 per cent lead and 4.5–12 per cent zinc; the complex copper-containing ores average 2 per cent lead 9.5 per cent zinc 1.5 per cent copper and about 170 g/ton silver. Ore-dressing plants vary in size from as small as 50 tons/day to nearly 2,000 tons/day, and the range of processing and degree of concentration undertaken also varies widely between different mines, depending upon many factors including ore characteristics and size of operation.

Table 68

OWNERSHIP, LOCATION AND MAIN ORE CONSTITUENTS OF LEAD ZINC MINES IN OPERATION IN PERU IN 1968

Company	*Ownership*	*Location*	*Main ore constituents*
Cerro de Pasco Corp.	United States	(See table 71)	
Aja – Cia Minera	Peru	Huancapeti, Ancash	Pb, Ag
Alianga – Cia Minera	60%, Peru 40%, United States	Ticapampa, Ancash	Pb, Zn, Ag
Chavin Mines Corp.	Peru	Santa Beatriz, Huancavelica	Pb, Zn
El Brocal S.A.	Peru	Colquijirca, Pasco	Pb, Zn, Ag, Cu, Hg
El Pilar – Cia Minera	Peru	Estrella, Pasco	Pb, Zn, Ag
Gran Bretaña No. 9 Soc. R	Peru	Gran Bretaña, Junin	Zn, Mn
Heraldos Negros – Cia Minera	Peru	Heraldos Negros, Lima	Pb, Zn
Huanca – Cia Minera	Peru	San Antonio, Huancavelica	Pb, Zn
Huaron – Cia de Minas	France	Huaron, Pasco	Pb, Zn, Cu
Huampar – Cia Minera	Peru	Colqui, Lima	Pb, Ag, Zn, Cu
Jecanca – Cia Minera	Peru	Huancapeti, Ancash	Pb, Zn
Raura S.A. – Cia Minera	60%, United States 40%, Peru	Raura, Huanco	Pb, Zn, Cu
Ria Pallango – Sind. Minero	Peru	Alpamarca, Junin	Pb, Zn
		Carhuacayan, Junin	Pb, Zn
San Ignacio de Morococha S.A.	Peru	San Ignacio, Junin	Pb, Zn
Santo Toribo S.A.	Peru	Santo Toribo, Ancash	Pb, Zn
Vinchos Emp. Explotodoca	Peru	Vinchos, Pasco	Pb, Zn, Ag
Volcan Mines Co.	Peru	La Victoria, Lima	Pb, Zn, Ag
Yauli Soc. Min.	Peru	Alpamina, Junin	Pb, Zn

Somewhat more than half of the lead ores and concentrates produced are turned into primary metal at La Oroya. A major customer for the concentrates is the Federal Republic of Germany. Only about one quarter of the zinc concentrates are refined domestically, but plans are being implemented for a 30,000 tons/year plant at Arecón Colyao. The rest of the concentrates are exported, mainly to the Federal Republic of Germany, France, Japan and the United States. In addition to these metals many minor metals are produced, as well as a wide range of chemicals. The lead refinery has an annual capacity of around 100,000 tons/annum, and the zinc plant, which operates by the electrolytic process, has a capacity in the region of 85,000 tons/annum.

Data on the production, consumption, exports and imports of lead and zinc in various forms are summarized in table 69. There are no plants in Peru known to be engaged in the semi-fabrication of lead and zinc and their alloys.

Table 69

PRODUCTION, CONSUMPTION, EXPORTS AND IMPORTS OF LEAD AND ZINC IN VARIOUS FORMS — PERU

(Thousand tons)

	1959	*1965*	*1966*	*1967*	*1968*	*1969*
Lead						
Mine production	121.0	154.3	144.8	163.2	164.9	145.8
Lead concentrates exports	59.9	61.3	65.9	43.2	75.4	81.5
Primary lead production	57.0	86.8	88.8	81.8	86.4	77.5
Primary lead exports	56.0	85.4	85.8	77.3	79.4	74.7
Primary lead consumption	1.7	5.5	6.0	3.7	3.6	3.8
Zinc						
Mine production	121.0	254.5	258.0	329.0	303.0	315.0
Zinc concentrates exports	131.0	212.0	225.0	241.0	249.0	253.1
Primary zinc production	26.0	62.9	63.5	63.4	67.3	64.0
Primary zinc exports	26.0	56.5	55.6	60.8	55.0	57.7
Primary zinc consumption	1.2	4.5	5.0	3.8	3.8	4.0
Semi-fabricated zinc imports	0.2	0.2	0.2	0.1	0.1	...

Tin

Small quantities of tin are mined at San Rafael, Puno, in conjunction with gold and copper, and are turned into concentrates. Small amounts are also recovered in the processing of lead concentrates from the Cerro de Pasco deposits. Output, export and import data are given in table 70.

Table 70

PRODUCTION AND EXPORTS OF TIN CONCENTRATES AND IMPORTS OF REFINED TIN — PERU

(Tons)

	1959	*1965*	*1966*	*1967*	*1968*	*1969*
Concentrates production	25	50	40	40	60	100
Concentrates exports	25	50	67	74	...	...
Primary tin imports	30	60	20	20	20	...

Surinam

This country of 383,000 people, with an area of 126,000 km², is situated in the north-east corner of South America. It has a northern coastline on the Atlantic; French Guiana lies to the east, Brazil to the south, and Guyana to the west. Most of the country is of low elevation, although hills rise to 300 — 500 m in the south and south-east. The climate is tropical — hot, humid and equable with annual rainfall in the range of 100 — 150 cm. The major drainage system is that associated with the Suriname river, which is about 600 km in length, includes two lakes, and is navigable for part of the distance.

A short railway line of 219 km runs from Brownsweg to Paramaribo. The road network is mainly near the coast and totals 846 km. Connections with international air services are provided by the airport at Paramaribo.

There are no known reserves of coal or crude oil. Production of electricity amounted to 681 million kWh in 1966 of which 464 million kWh were produced from hydroelectric sources. With the recent establishment of an aluminium smelter, total power production has been considerably increased.

The economy is still largely based on agriculture, but bauxite mining, alumina and aluminium production have risen substantially over the past decade. Deposits of beryllium, tungsten and manganese have been reported, as well as diamonds, but none of these are exploited commercially.

Aluminium

There are considerable bauxite reserves known to exist in the country. Estimates published suggest that these amount to at least 2,000 million tons of which 470 million tons are reported as proven. The Al_2O_3 content of these deposits ranges from 45—55 per cent. The main deposits being exploited currently are in the east of the country near the mouth of the Suriname river not far from Paranam. The largest known reserves are those in the west in the Bakhuis deposits. Other reserves are known in the neighbourhood of Wintiwaai, Hokahin, Lely and Stofbroekoe. Integrated bauxite mining, alumina production and aluminium reduction are conducted by Suriname Aluminum Co., a subsidiary of the Aluminum Company of America at Paranam. Bauxite mining is also carried out by N. V. Billiton Maatschappij at Onverdacht. Both companies have an output of approximately 2 million tons/year. Data on production and exports of bauxite, alumina and primary aluminium are contained in table 71.

Agreement is reported to have been reached in principle between the Surinam Government and a consortium consisting of Suriname Aluminum Co., Alcan Aluminium Ltd, N. V. Billiton and Ormet Corporation for the development of the bauxite deposits in the west of the country, which will also involve construction of an alumina plant to convert 75 per cent of the bauxite produced into alumina. Kaiser, Reynolds and Pechiney are also understood to be interested in the western Surinam deposits. The Government has also been involved in discussions with the Japanese company, Nippon Light Metal Co., and with a consortium of American interests on the possible

development of bauxite mining in the Bakhuis-Bergen area, including the erection of an alumina plant.

There are no semi-fabricating facilities in Surinam

Table 71

PRODUCTION AND EXPORTS OF BAUXITE, ALUMINA AND PRIMARY ALUMINIUM, SURINAM

(Thousand tons)

	1959	*1965*	*1966*	*1967*	*1968*	*1969*
Bauxite—production	3,430	4,360.0	5,563	5,466	5,660	6,236
Bauxite—exports	3,338	4,230.0	4,512	3,804	3,100	...
Alumina—production	—	130.0	430	684	892	960
Alumina—exports	—	275.0	349	684	893	...
Aluminium—production	—	3.5	27	31	44	53
Aluminium—exports	—	—	26	31	43	...

Lead, tin and zinc

No deposits of these metals have been reported and there are no plants concerned with their reduction or semi-fabrication.

Uruguay

Uruguay is situated on the east coast of South America with Brazil as its neighbour on the north-east; it shares the rest of its frontier with Argentina. The country, which has a population of 2.82 million (1968 estimate), is one of the smaller South American Republics. Despite the importance of agriculture and livestock rearing to its economy, over 40 per cent of the population live in towns of more than 100,000 inhabitants.

The terrain consists of well-watered undulating plains, particularly in the south and west, with some hills—the Cuchilla de Haedo which are in the north of the country and continue into Brazil, and the Cuchilla Grande in the south-east. These do not rise above 600 m. The main river is the Rio Negro which flows into the Rio Uruguay. The Rio Uruguay is navigable for about 320 km north and the Rio Negro is also navigable for a short distance. The climate is temperate, with warm summers tempered by Atlantic breezes, and mild winters with cold spells during June–August. Rainfall is moderate and regular but with occasional short droughts.

The country is relatively well provided with roads, of which 5,000 km are paved and 2,820 km are all-weather; a further 33,800 km of unpaved roads are not always usable throughout the year. There are four separate railway systems totalling 2,398 km of standard-gauge track. International airline services operate from the airport at Carrasco, 22 km from Montevideo, the capital, and there are also internal airlines. Montevideo is also the chief port of the country.

Uruguay has no domestic fuel resources. There is an oil refinery on the outskirts of Montevideo, but it is not producing. The country is dependent

on imported fuels for power generation. Electrical power generation in 1964 totalled 1,387 million kWh.

Cattle rearing, mainly beef and mutton, production of cereals, oilseed crops, rice and fruit are major activities. Steel re-rolling mills, textiles, glass, light engineering, consumer goods and food processing are the main industrial sectors of the economy.

Aluminium

There are no known bauxite deposits in the country and no alumina or aluminium reduction facilities. Semi-fabricating activities are carried out in three plants, the largest of which is Alcan Aluminio del Uruguay S.A. (owned by Alcan Aluminium Ltd, Canada), which has sheet- and foil-rolling facilities, an extrusion plant and wiredrawing equipment, and operates in Montevideo. Two other small rolling mills, Arricar Lobat-Odone S.A. and Helguera and Morixe S.A.C. e I., are also situated in Montevideo; these also fabricate copper and its alloys. There is also a small secondary metal plant producing ingots, for foundry use, in aluminium and other non-ferrous metals.

Statistics on imports of primary aluminium and production of semi-fabricated products in Uruguay are given in table 72. Imports of semi-fabricated products are believed to amount to around 150 tons/year.

Table 72

IMPORTS OF PRIMARY ALUMINIUM AND PRODUCTION OF SEMI-FABRICATED PRODUCTS – URUGUAY

(Tons)

	1959	*1965*	*1966*	*1967*	*1968*	*1969*
Primary aluminium – imports[a]	1,117	331	1,696	1,259	1,127	1,168
Semi-fabricated aluminium production .	...	1,035	1,126	1,750	1,400	...

[a] Based on statistics of exporting countries.

Copper

Two small rolling mills for producing copper and copper alloy sheet, strip etc., Arricar Lobat-Odone S.A. (Alosa) and Helguera and Morixe S.A.C. e I., operate in Montevideo. Total imports of copper in all forms amounted to 866 tons in 1967.

There are no reports of copper-bearing ores in the country, and no industry exists that is engaged in their processing or refining.

Lead, zinc and tin

Imports in 1967 of lead in all forms amounted to 1,110 tons, and zinc to 881 tons, with 24 tons of tin and tin alloy (unwrought). There are no reports of the existence of ores of these metals, and there is no industry associated with their processing or refining.

Venezuela

The Republic of Venezuela is situated on the north of the South American land mass with a coastline on the Caribbean Sea. Guyana is its eastern neighbour. Brazil lies to the south and south-east, and it has an irregular frontier with Colombia in the west and south-west. Venezuela has three regions of main relief: the Cordillera ridge in the north and north-west, the Orinoco lowland in the centre, and the Guyana uplands which are dissected by a number of major rivers in the south. Most of its 9.35 million population (1968 estimate) live in the central lowlands. The total land area is estimated at 912,000 km^2. The climate is tropical, with high temperatures throughout the year and two rainy seasons. Seasonal rains result in flooding of the rivers, but there is a sharp decrease in their volume in the dry seasons.

The railway system of 1,400 km is entirely concentrated along the northern coast and in the vicinity of Lake Maracaibo. The road network of 10,000 km is mainly located in the lowland areas. The highway connecting Caracas (the capital) with Bogotá (in Colombia) forms part of the Pan-American highway. The major drainage system is provided by the Orinoco river and its tributaries; the Orinoco is also navigable for virtually its entire length. International airport facilities are provided in Caracas, and there are other airports and landing strips used by internal services.

The country is a major oil producer, second only to the United States, with an output of 188.7 million tons, of which 30 per cent is refined in the country and is a major factor in the Venezuelan economy. Natural gas output amounted to 6.8 billion m^3, and coal production amounted to 34,000 tons in 1966. Electrical power generation in 1966 amounted to 8,735 million kWh, of which 1,405 million kWh were generated by hydroelectric stations.

Deposits of copper, nickel, gold, silver, diamonds, tin, uranium and thorium have been noted, but so far these have not been commercially significant. There are significant reserves of lateritic bauxite in the remoter parts of the country.

Aluminium

The main bauxite deposits occur in the remoter mountainous regions in the Guyana province, in the Nuria area (plateau) of the Amareuro river, and near Upata and the highlands of the Gran Sabana. The deposits have an average Al_2O_3 content of 40 per cent. The difficulties of access to these deposits and of the terrain diminish its potential for development.

An aluminium smelter came into operation in 1967; it is owned by Aluminio del Caroni S.A., a joint venture of Reynolds Metals Company and the Venezuelan Government financial institution, Corporacion Venezolana de Guayana. The smelter has a capacity of 20,000 tons/annum, which is planned to be expanded in the future to reach in stages a capacity of 50,000 tons. It is located at Mantanzas Santa Tomé de Guayana, Bolivar State, and is supplied with hydroelectric power generated nearby.

Associated with the smelter is a rolling mill and a Properzi wire plant. At Maracaibo a cold-rolling mill and foil plant and extrusion facility is operated by Aluminio Reynolds de Venezuela S.A., a wholly owned subsidiary of Reynolds Metals Company. An aluminium extrusion plant, Corporacion Venezolana de Aluminio S.A., is located in Mariara. This company is jointly owned by Venezuelan interests, Alcoa and Montecatini Edison. A foil and foil-products plant, Aluminio Nacional S.A., a Kaiser Aluminium and Chemical Corporation subsidiary, is based at Guacara. Two small extrusion plants are also understood to be in production—Aluminio Nacional S.A. at Guacara and Envases Nacionales de Aluminio C.A. in Valencia. Data on primary aluminium production and imports of ingot and semi-fabricated products are contained in table 73.

Table 73

PRODUCTION OF PRIMARY ALUMINIUM AND IMPORTS OF INGOT AND SEMI-FABRICATED PRODUCTS – VENEZUELA

(Thousand tons)

	1959	*1965*	*1966*	*1967*	*1968*	*1969*
Aluminium ingot – production ..	—	—	—	3.1	11.2	17.2
Aluminium ingot – imports	0.8	2.4	2.2	1.8	1.1	0.4

Copper, lead, zinc and tin

Prospecting has been carried out in recent years with assistance from the United Nations Special Fund, and the presence of copper and zinc ore deposits is understood to have been established at several locations. No information has been published, however, to indicate whether these are likely to be of commercial value. There are no reports of the presence of lead and tin. The country does not possess any installations for refining or semi-fabrication of any of these non-ferrous metals.

ASIA

SOUTHERN AND SOUTH-EASTERN ASIA

Afghanistan

The Kingdom of Afghanistan lies to the east of Iran. Pakistan is its neighbour to the south and south-east, and the Soviet Union lies to the north. The country as a whole is very mountainous with a series of high ridges running in a general south westerly-north-easterly direction, broken by a series of deep ravines. Some of the highest peaks in the east rise to 8,000 m, and most of the system ranges from 3,500 to 5,000 m elevation. The land area totals 647,500 km^2; the main habitable areas are situated around the four major river systems—the Amu Darya in the north, the Hari Rud in the west, the Helmand and Arghandab in the south-west and

the Kabul in the centre and east. These valleys have an elevation of around 1,500 m. The climate is characterized by extremes of temperature, both seasonal and diurnal, and by high winds and dryness, being primarily influenced by the elevation. Summer temperatures have been known to reach 40 – 45 °C while in the winter the temperatures in some areas have fallen as low as – 5 °C.

The population numbers 16.1 million (1968 estimate). Afghanistan is primarily a pastoral country with not more than about 13 per cent of the land under cultivation. Sheep raising predominates, but horses, donkeys, camels and goats are also widely reared. Crops are mainly wheat, barley, rice, millet and maize.

The main centres are linked by 2,000 km of asphalted roads, which have been constructed over difficult terrain with assistance from the United States and the Soviet Union. A widespread network of minor roads is not all-weather standard. There are no railways in the country, but there is an agreement with Pakistan to extend its railway system into Afghanistan from Tor-Kham or Chaman. The airport at Kandahar provides international services and there is an internal air network.

The main industry is associated with agriculture and also includes textiles, leather and footwear, furniture, glass, plastics components, bicycles, and one plant producing factory-made houses.

Deposits of copper, lead and zinc as well as of beryl, chromite and iron ore are known to exist. The Government is encouraging feasibility studies with foreign assistance. Transport difficulties and shortage of local capital are the major problems to be faced in development.

Aluminium

There are no known bauxite or other high-aluminous ores in the country and no reduction or semi-fabricating activities.

Copper

There are twelve known occurrences of copper in nine provinces, Bamyan, Wardak, Urizgan, Ghazni, Zabul, Farah, Kandahar, Logar and Parwan, and they are still in the preliminary study stage. The Kundalon deposit in Zabul Province has advanced to the ore-development stage, as a result of work done by a team of geologists from the Soviet Union in co-operation with the Ministry of Mines and Industry. After completing surface studies in 1968, the team initiated a drilling programme designed to locate copper ores at depth. The first "ore zone" drilled at Kundalon revealed chalcopyrite mineralization to a depth of at least 200 m. Details are lacking but the copper level is considered to be such as to justify a comprehensive development programme. Logar, Wardak and Bamyan provinces are also considered favourable for early study.

***Lead** and zinc*

Studies of lead and zinc deposits in northern Afghanistan have been made by the Ministry of Mines and Interior in conjunction with the German

Federal Republic firm, Bergbau Planung GmbH. In all, seven occurrences have been reported of lead zinc ores. The location and details of these deposits are indicated in table 74.

Table 74

LOCATION AND DETAILS OF LEAD-ZINC ORE DEPOSITS IN AFGHANISTAN

Nearest town	*Province*	*Details reported*
Feranjal	Parwan	Mainly Pb-Zn with baryte (1 – 3 per cent Pb and 3 – 5 per cent Zn)
Jalraiz	Wardak	Field exploration completed
Kakhriz-Dahla	Kandehor	Field exploration completed
Nalbandal-Serghol	Ghor	Mineralized belt approximately 16 km long being mapped Underground work started
Saheb Khan	Badghis	None
Two unnamed places	Ghor	None

Tin

There are no reports of tin-bearing ore deposits in the country.

Burma

Burma, which became independent in 1948, is the westernmost country of the Indo-Chinese peninsula of South-East Asia. To the north-west it borders on India and Pakistan, to the north-east on China; it has a short frontier with Laos and a long irregular boundary with Thailand to the south-east. It has a long coastline on the west and south-west on the Bay of Bengal and the Andaman Sea. Its land area totals 678,000 km².

The distribution of population (27 million, 1969 estimate) is governed by the physical geography of the country, which is mountainous over more than half the area. The extensive river valleys are the main centres of population and are important as a means of transport. The country lies in the tropical monsoon climatic zone.

The railway network of Burma covers 4,300 km. The main line runs from Myitkyina in the north via Mandalay, where it splits into two branches which rejoin at the port of Rangoon. There is a well-developed road network amounting to 25,000 km, of which 15,000 km are macadam. The rivers carry a high proportion of the export traffic. The main ports are Rangoon, Moulmein Akyab and Bassein. International airport facilities are provided by Rangoon Airport. The country possesses only modest fuel resources. Coal production amounted to 10,000 tons in 1966; oil production was 740,000 tons in 1968; and an important quantity of natural gas is available.

The country possesses deposits of copper, lead, nickel, silver, tin, tungsten and zinc.

Aluminium

There are no known bauxite deposits in the country and there is no semi-fabricating industry.

Copper

The main production of copper concentrates derives from the lead-zinc ore production based on the plant at Bawdwin. Porphyritic copper ores have been found in the Monywa district; the reserves are estimated to amount in all to 400 million tons of ore with a copper content up to 1.5 per cent. Exploration of the extent and quality of these deposits is incomplete. Total reserves of copper, excluding these deposits, are estimated as approximately 3 million tons, but only 34,000 tons of ore are proved and probable. Output of copper matte in 1969 was 170 tons.

Lead and zinc

The total reserves of lead and zinc ores at the Bawdwin mine are appreciable, according to a survey by United Nations experts in 1964—1965. They amount to 6.3 million tons of ore, containing on the average 14.8 per cent lead, 8.2 per cent zinc and 0.53 per cent copper and small amounts of silver, of which two thirds are considered proved. There are at least twenty areas where lead-zinc deposits or manifestations of them are known, but they have been little investigated.

The Bawdwin plant produces zinc concentrates, refined lead, some refined antimonial lead, and small amounts of copper matte, nickel speiss and fine silver. All the production is exported. There are a few other deposits being mined on a very small scale. Details of production and exports are given in table 75.

Table 75

PRODUCTION AND EXPORTS OF LEAD AND ZINC IN VARIOUS FORMS — BURMA

(Thousand tons)

	1959	*1965*	*1966*	*1967*	*1968*	*1969*
Lead — mine production	19.3	20.0	18.5	15.0	9.5	10.0
Lead concentrates — exports ...	0.7	0.2	...	...	...	...
Primary lead — production	20.2	17.8	14.8	13.4	9.0	8.5
Primary lead — exports	0.8	0.2	...	...	...	...
Zinc — mine production	11.0	7.8	6.3	4.7	4.1	4.5
Zinc concentrates — exports	...	15.0	...	...	...	...

The present low output has been due to internal problems, but given reconstruction of the plant and prospecting nearby, the output could be considerably increased. Further surveying of the western part of the Shan plateau is considered likely to reveal more deposits meriting commercial exploitation.

Tin

Deposits of tin, tin-tungsten (and tungsten) ore are found in a belt extending northwards for 4,200 km from the southern extremity defined by Victoria Point and the southern end of the Shan plateau, and in the east running up to the high-grade tin and tungsten deposits of Thailand. The prospecting of these deposits is very incomplete, and their total reserves are believed to greatly exceed the over-all reserves; these reserves are estimated at 0.3 million tons of ore, of which 0.1 million tons are proved and probable.

Prior to 1939 there were nearly 600 different sites being worked, mainly by very simple hand tools and equipment; of these, 47 mines were responsible for 88 per cent of the total output. The highest output was 5,440 tons in 1939. Only the Mochi mine in Karenni State produced tungsten trioxide. Operation at that mine ceased, however, although the deposit was by no means worked out. Reopening of this mine might be economically justified but would require careful assessment.

The main mine in current operation is the Heynda mine in the Tovoy district, working placer deposits with proved reserves amounting to 9,000 tons of tin in sands averaging 700 g/m³. The production in 1939 was 400 tons. No published data is known of the output of mines currently producing, but over-all output has fallen consistently over the past decade, as indicated in table 76.

Table 76

PRODUCTION AND EXPORTS OF TIN CONCENTRATES - BURMA

(Tons)

	1965	*1966*	*1967*	*1968*	*1969*
Tin concentrates - production	464	370	259	300	300
Tin concentrates - exports	300	100	60	107	...

Tin concentrates are exported mainly to Malaysia, Singapore and the Netherlands for further processing.

Ceylon

Ceylon lies off the southern tip of the Indian subcontinent from which it is separated by the Palk Strait. It is approximately 450 km maximum length north-south and 230 km width east-west, being roughly pear-shaped and having an area of 65,607 km². Much of the south-central area is mountainous—1,000—1,200 m elevation with peaks up to 2,750 m—and is surrounded by an upland belt and a coastal plain. Forest jungle and scrub cover a large part of the land surface. Most of the population of 12 million (1968 estimate) live in the lower elevations and on the coast; the urban population amounts to 19 per cent of the total. The country became an independent state in 1948.

The climate is warm and humid as would be expected from its location within the tropics, the temperature averaging 27° C in the lowlands and

diminishing to 15° C in the hills. There is little temperature variation over the year. Rainfall is heavy, reaching up to 650 cm/annum on the south-western slopes of the Central Highlands, the maximum for the country. Being on the edge of the South-East Asian monsoon belt, Ceylon suffers from cyclonic activity in the October-December monsoon season.

The country has 1,565 km of railways, of which 420 km are 5 ft-6 in-gauge and 130 km are 2 ft-6 in-gauge; the longer line runs down the west coast and the short line down the east coast. The road system totals 21,560 km, of which 3,680 km are bituminized. There were 29,484 trucks and 84,678 private cars registered in the country in 1968. Scheduled international air services operate via Colombo and there are limited internal services. The capital, Colombo, is also the main port.

The economy is mainly agricultural, with tea, rice, rubber and coconuts featuring prominently; much of the production is carried out on large estates. Processing industries for food and chemicals associated with these crops also exist. There is a steel re-rolling mill and an iron foundry.

The main mineral resources of the island are graphite, which is mined; semi-precious stones and ilmenite are also produced. Deposits of kaolin and iron ore are known but are not worked. Much of the country has been very incompletely surveyed for metallic minerals, owing to the difficult terrain.

Aluminium

There are no reports published of the existence of bauxite deposits in the country, and there is no alumina or aluminium reduction industry. A foil-rolling plant, Acme Aluminium Ltd, operates in Colombo and is a subsidiary of India Foils Ltd, which is in turn a subsidiary of the British Aluminium Co. Ltd. Imports of aluminium (in all forms) amounted to 2,100 tons in 1967.

Other non-ferrous metals

There are no known deposits of non-ferrous metal ores in Ceylon nor industries associated with their refining or fabrication. Imports for 1967 were: copper, 1,300 tons; lead, 569 tons; tin, 48 tons; and zinc, 640 tons.

India

India became independent in 1947 and was proclaimed a republic in January 1950. In the north its borders are with China and Nepal, in the east with East Pakistan and Burma, and in the north-west with Afghanistan and West Pakistan. In the north its boundaries are formed by the Himalayas, in the south-east by the Bay of Bengal, in the south by the Indian Ocean and in the south-west by the Arabian Sea. The most important rivers are the Ganges, Brahmaputra, Narmada, Godarwari and Krishna. The population is estimated to be 511 million (1968) and the total land area is 3,162 million km². The total length of the railway lines is 56,500 km, of which 55,800 km belong to the state; 1,400 km are electrified. The total length of the road system is 675,000 km.

The country has a widely varied climate ranging from tropical in the south to semi-tropical, with large parts having a continental climate of warm summers and cold winters, as well as characteristic monsoon periods.

India is well endowed with fuel reserves which are still being developed. The proved reserves of coal are equal to 50,000 million tons, those of brown coal 210 million tons, and oil 222 million tons. Total reserves of natural gas are estimated to be 42,500 million m^3. Production of coal in 1967 amounted to 70 million tons, of lignite to 2.8 million tons, and of oil to 5.5 million tons.

Table 77

LOCATION, ESTIMATED RESERVES AND COMPOSITION OF BAUXITE DEPOSITS IN INDIA

(Million tons)

Location	*Estimated reserves*		*Composition*
	Total	*Proved*	
Bihar State			
Ranchi – Palamau districts[a]	...	10.0	50% Al_2O_3
Kharagpur Hills – Monghyr district		1.5	35 – 40% Al_2O_3
Goa State[a]	1.0	...	...
Gujarat State			
Kutch – Saurashtra district	...	11.0	50% Al_2O_3
Kashmir State			
Riasi – Jammu province	...	2.0	75 – 82% Al_2O_3
Riasi – Jammu province	...	10.0	65 – 75% Al_2O_3
Panch	...	0.8	...
Kerala State			
Cannanore – Malabar district	...	...	...
Pallippuram, near Trivandrum	...	...	...
Madhya Pradesh State			
Shivpuri, Guna, Bhilsa, Pajgarh, Shajapur, Mandasor, Bhopal	...	...	...
Jabalpur	...	...	55 – 70% Al_2O_3
Amarkantak, Baihar and Mandla[a]	...	18.0	...
Madras State			
Shevaroy Hills Salem district[a]	...	7.0	50% Al_2O_3
Kotagiri	...	3.0	...
Maharashtra State			
Kolhapur, Amravati district[a]	...	6.7	55% Al_2O_3
Kolaba, Kaira (near Bombay)	31.0	0.3	Low grade
Mysore State			
Bhatkal, Bababudan Hills	8.0	0.5	Variable
Belgaum district	...	0.7	...
Orissa State			
Kuralapat, Kashmir, Mahulpatna, Zamindaries/Kolahandi district	...	...	...
Khariar Hills – Sambalpur district	2.5	...	...
Uttar Pradesh			
Allahabad – Banda area[a]	10.0	...	...
Total	190.0	70.0	

[a] Deposits being worked.

Table 78

LOCATION OF BAUXITE MINING, ALUMINA PRODUCTION, ALUMINIUM REDUCTION AND SEMI-FABRICATING OPERATIONS OF MAJOR COMPANIES IN INDIA

	Bauxite mining	*Alumina production*	*Aluminium reduction*	*Semi-fabrication*
Aluminium Corporation of India Ltd	Lohardaga, Bihar	Jaykaynagar, W. Bengal	Jaykaynagar, W. Bengal	Jaykaynagar, W. Bengal (Rolling, extrusion, wire manufacture)
Bharat Aluminium Co.	Amarkantak, Madhya Pradesh Mandla, Madhya Pradesh Ratnagiri, Maharashtra	Konya, Maharashtra Korba, Madhya Pradesh	Koyna, Maharashtra Korba, Madhya Pradesh	Thana, Maharashtra (Wire manufacture)
Hindustan Aluminium Corporation	Lohardaga, Bihar Amarkantak, Madhya Pradesh	Renukoot, Uttar Pradesh	Renukoot, Uttar Pradesh	Renukoot, Uttar Pradesh (Rolling, extrusion, wire manufacture)
Indian Aluminium Co. Ltd	Lohardaga, Bihar	Muri, Bihar	Alupuram, Kerala Hirakud, Orissa Belgaum, Mysore	Alupuram, Kerala Belur, W. Bengal (Rolling, extrusion, wire manufacture)
Madras Aluminium Co.	Salem, Tamil Nadu	Coimbatore, Tamil Nadu	Mettur, Tamil Nadu	Mettur, Tamil Nadu (Rolling, extrusion, wire manufacture)

The output of natural gas in that year was 300 million m^3. Electricity production in 1966 amounted to 15,405 million kWh.

Aluminium

The country has large and widely distributed deposits of bauxite, mainly of the diaspore type. Total bauxite reserves are estimated to be equal to 190 million tons, of which 70 million tons are considered to be proved and probable. The bauxites contain from 35 per cent to over 75 per cent aluminium oxide, varying from deposit to deposit. About 75 million tons of bauxite reserves, of which the greatest portion is considered to be proved or probable, contain more than 50 per cent of Al_2O_3. Bauxites of a high quality usually contain 3—5 per cent SiO_2 and 5—8 per cent Fe_2O_3. Data summarizing the available information on these deposits are contained in table 77.

The logistics of aluminium production in India tend to result in the location of alumina plants close to the bauxite mines. Smelter locations depend upon a combination of factors, which include availability of adequate power resources (hydroelectric or thermal), cost of haulage of alumina, and distance of smelters from the main markets. Recent projects, however, have shown a preference for complete integration of all stages at the same site. The available data on the location and the operations of the main producers in India are summarized in table 78, which also indicates the extent of the proposed expansion of present plants and the establishment of new facilities.

The country also has a number of semi-fabricating works. The three principal producers, Hindustan Aluminium Co. Ltd, Indian Aluminium Ltd and Madras Aluminium Co., have semi-fabricating plants, and there are a number of smaller rolling mills, extrusion and wiredrawing plants, as well as two plants producing foil. Most of the semi-fabricating industry is based in the larger towns distributed around the coast of India. Data on production, imports, exports and consumption of aluminium in various forms are given in table 79.

Table 79

PRODUCTION, IMPORTS, EXPORTS AND CONSUMPTION OF ALUMINIUM IN VARIOUS FORMS—INDIA

(Thousand tons)

	1959	*1965*	*1966*	*1967*	*1968*	*1969*
Bauxite production	28.0	706.0	750.0	789.0	936	1,012
Exports of bauxite	23.0	63.0	80.0	53.5	99	...
Alumina production	26.0	145.0	167.0	170.0	200	240
Imports of alumina	12.0	0.8	16.1	—	6	—
Production of primary aluminium	56.0	64.0	84.0	96.0	120	132
Imports of semi-fabricated aluminium	13.0	17.0	11.0	18.0	13	...
Production of secondary aluminium	6.3	8.0	8.0	11.0	11	...
Consumption of primary aluminium	24.0	71.0	93.0	119.0	128	115

Copper

Total copper reserves of India are estimated to equal 1 million tons, of which 0.3 million tons are proved and probable. Mean copper content of the estimated reserves is about 1 per cent. It varies from 0.8 to 2.37 per cent from one area to another. For the past few years a number of new ore deposits have been discovered and are partly evaluated. These new deposits are not taken into account by the official statistics. As far as can be judged from reports, the new reserves exceed those already estimated, so that the total reserves of copper ores in India may be approximately estimated as being 2.2—2.5 million tons (the mean copper content being the same).

Production and imports of copper in various forms are given in table 80.

Table 80

PRODUCTION AND IMPORTS OF COPPER IN VARIOUS FORMS — INDIA

(Thousand tons)

	1959	*1965*	*1966*	*1967*	*1968*	*1969*
Mine production	8	9	10	9	10	10
Production of primary blister copper	7	10	10	8	9	9
Production of refined copper	8	9	9	9	9	10
Imports of blister and refined copper	36	50	20	33	31	34
Imports of secondary raw material and copper alloys	3	1	0.4	0.7	0.7	0.7
Consumption of refined copper	54	64	33	45	45	46
Imports of semi-fabricated products of copper and copper alloys	2	3	4	2	1	1
Production of semi-fabricated products of copper	...	14	14	20	24	...
Production of semi-fabricated products of copper alloys	...	18	10	14	18	...

At present copper production and processing in India are carried out at the Maubhandar copper complex belonging to the Indian Copper Corporation. The complex includes mines, concentrator and plants for copper smelting and electrolytic refining. Output of the complex is just over 9,000 tons/annum.

Measures are being taken for increasing ore production and expanding processing facilities of the complex up to 16,000 tons of copper per year. The reverberatory smelting will be replaced by fluidized bed-flash smelting with a preheated air blast (Outukumpu Oy process). The smelting method will enable the output of concentrates to be increased to 80,000 tons per year. The sulphurous exhaust gases will be utilized for production of sulphuric acid.

Construction of a big copper-producing complex has been started at Khetri. The concentrator of this complex will process 9,600 tons of ore per day. The plant is designed for processing ore containing about 1 per cent of copper. The technique employed is as follows: copper concentrate containing 24 per cent of copper and 16 per cent of moisture will be dried in a rotary furnace until 1 per cent of the moisture is left; the concentrate will

then be fed into the furnace for blast-smelting in a fluidized bed with a pre-heated blast (Outokumpu Oy) technique. The furnace output is 700 tons per day.

The output of the complex is as follows:

Electrolytic copper	31,000 tons/year
Sulphuric acid	600 tons/day
Superphosphate	214,400 tons/year
Gold	250 kg/year (approximately)
Silver	1.9 tons/year

There are about 36 plants in the country producing semi-fabricated copper and its alloys. The majority of them are concentrated in the vicinity of cities such as Calcutta, Bombay and Madras (80 per cent), locations picked both for their commercial importance and ease of importing raw materials. In addition to these plants are factories for producing secondary metal ingots, as well as a number of foundries, both small and large.

The annual requirements of the Indian economy for semi-fabricated copper and its alloys is expected to increase to 180,000 tons by the end of the current five-year plan, or an amount four times greater than that being produced at present. Consumption of copper was 45,000 tons in 1967.

Lead and zinc

Lead-zinc deposits are found mainly in Rajasthan State. The existence of large deposits in Rajasthan capable of producing about 1 million tons of zinc and 50,000 tons of lead have been reported. Reserves are estimated at 137.5 million tons, of which 42.5 million tons are proved and 95 million tons are probable. Generally, the ore of Zawar area contains about 3.5 - 4 per cent of zinc and 2.15 - 3.50 per cent of lead. In certain parts of the deposits this percentage is higher, up to 7.5 - 8 per cent. Intensive geological surveying has been in progress over recent years.

Data on the production, imports, exports and consumption of lead and zinc in various forms are given in table 81.

Table 81

PRODUCTION, IMPORTS, EXPORTS AND CONSUMPTION OF LEAD AND ZINC IN VARIOUS FORMS—INDIA

(Thousand tons)

	1959	*1965*	*1966*	*1967*	*1968*	*1969*
Lead—mine production	5	4	4	4	4	3
Primary lead—production	4	3	2	2	2	2
Primary lead—consumption	26	32	40	37	36	45
Primary lead—imports	25	38	44	41	35	26
Zinc—mine production	5	5	5	6	10	10
Primary zinc—production	—	—	—	3	20	23
Primary zinc—consumption	47	70	50	75	82	78
Zinc concentrates—imports	7	1.5	20	19	...	...
Primary zinc—imports	68	92	49	74	102	...
Zinc concentrates—exports	5	3	—	—	—	—

Lead-zinc ores containing 1.5 per cent lead and 3.6 per cent zinc are subjected to beneficiation. The concentrates thus produced are then processed at the metallurgical plant of Hindustan Zinc Ltd in Tundoo near Dhankad. There are two zinc-producing plants and one lead-producing plant in India. The electrolytic zinc plants were put into operation in 1967–1968 and have an output of 38,000 tons/year. The zinc plants are Comenco Binani Zinc Ltd, at Edayar near Cochen (Bihar) and Hindustan Zinc Ltd at Udaipur, Rajasthan, which both use the electrolytic extraction process. It has been proposed to double the capacities of these plants by 1973–1974. The lead plant has a small capacity (5,000 tons/year); production is currently only about 2,000 tons/year. It is proposed to set up another zinc smelter at Vishakhapatnam based on imported zinc concentrates with a capacity of 30,000 tons/annum. The feasibility of setting up a zinc smelter in the Zawar Mines area based on the Imperial Smelting Process is also being studied.

Production of semi-fabricated lead and zinc is undertaken at several plants. Besides these plants, which utilize the primary metal, there are several plants producing secondary lead, lead alloys and solders. These also produce other secondary non-ferrous metals.

Tin

There are no known tin deposits nor ore-refining plants in India. Consumption of tin in India has been as follows: 1965—3,900 tons; 1966—2,600 tons; 1967—3,900 tons; 1968—4,200 tons; 1969—4,400 tons.

Indonesia

The Republic of Indonesia consists of a group of about 3,000 islands situated to the south and east of the Malay Archipelago; the largest are Sumatra, Java, Celebes and Kalimantan. The distribution of the population of 112 million (1969 estimate) is uneven, ranging from 74 persons/km² in Java to 2 persons/km² in West Irian. The climate is characteristic of the equatorial South-East Asian monsoon belt but modified by marine influences. The weather is humid throughout the year and no season is free of rainfall. Much of the country is flat, but there are a number of ridges where mountains rise to over 2,000 m. The total land area is estimated at 1,900 million km².

Before Indonesia achieved independence, its economy was based mainly on agriculture, with large foreign-owned estates producing commodities for export such as sugar, coffee, tea, rice, palm oil and natural rubber and crude oil. Since achieving independence, Indonesia has been concerned with widening its range of industries as part of its development programme. Initially it pursued a policy of nationalization and expropriation of foreign-owned enterprises, but current policy is directed towards finding acceptable arrangements for the participation of foreign capital in developing the resources of the country.

Reflecting the pre-1940 pattern of economic development, the main communications network has been developed on the islands of Java and Sumatra. A railway system, totalling 4,700 km, exists in Java, and in

Sumatra the system totals approximately 2,000 km. The country as a whole has a road network totalling 80,000 km, but this again is largely contained within the two main islands. Rivers are used for goods transport, and coastwise shipping is also important between the islands. A number of ports and harbours are in use, of which the main ones are Surabaja on Java, Palembang on Sumatra and Balikpapan on Kalimantan. International airport facilities exist at Djakarta, and airports and/or landing strips are provided on the main islands. These internal air services are of particular importance to future development.

Production of electricity in 1966 amounted to 1,520 million kWh, of which just under 20 per cent was from hydroelectric stations. The country has been through a period of serious power shortages, but over recent years this has been partially remedied by the modernization of older plants and the building of additional capacity. The country is a large producer of crude oil, which amounted to 23.9 million tons in 1966, and it has a refinery capacity of 13.9 million tons. Coal amounting to 0.32 million tons was produced in 1966 and the natural gas output in that year was 1.601 billion m^3.

The country has for some years been one of the larger producers of tin, and more recently has exported significant quantities of bauxite. Deposits of tungsten, nickel, mercury, copper, lead and zinc ores are known to exist, but data at present available indicate that only some of these are likely to be of commercial importance.

Aluminium

Bauxite deposits occur in several places within Indonesia. The major deposits being worked are those of P. N. Pertambangan Bauxit Indonesia (a state-owned concern), which is located on Bintan and the islands of the Riau Archipelago. The company also plans to develop deposits in the region of Singkuang in the south-west of Kalimantan. Small deposits of high-grade bauxite are also known to exist on the islands of Bangka and Batam, Belitung and others. The Aluminum Company of America has obtained bauxite mining rights in East Sumatra, West Kalimantan, South Celebes, Central Java and West Irian, and is proposing to invest $100 million in developing a 400,000 tons/annum output under a joint company with Indonesian interests.

The company P. N. Aneka Tampang, which is a Japanese consortium of Nippon Light Metal K. K., Sumitomo Chemical K. K. and Showa Denko K. K., also has bauxite mining facilities on Bintan, and is understood to be making a feasibility study of an alumina and aluminium reduction plant for development in conjunction with these facilities.

Data on bauxite production and exports are given in table 82.

Table 82

PRODUCTION AND EXPORTS OF BAUXITE FROM INDONESIA

(Thousand tons)

	1959	*1965*	*1966*	*1967*	*1968*	*1969*
Bauxite—production	598.5	688.3	701.2	920.2	879.3	927.0
Bauxite—exports	576.2	567.6	672.3	768.9	847.7	863.6

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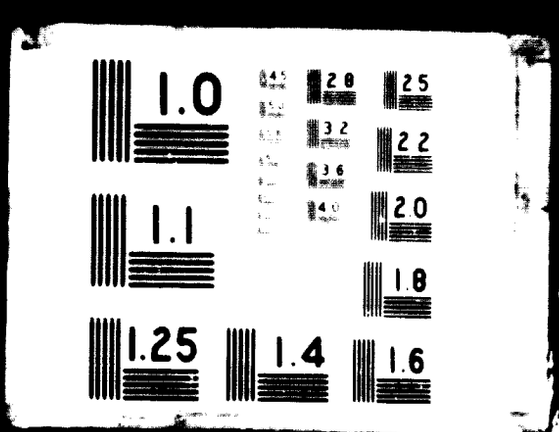


The country at present has no alumina or aluminium reduction plant, nor has it semi-fabricating facilities. A project has been under consideration for the establishment of a rolling mill with a planned output of 10,000 to 12,000 tons/annum, but the project is in abeyance until economic conditions are more favourable. No published statistics are available on the imports of semi-fabricated products.

Copper

Until recent years a small unworkable deposit was known, and there was also some copper that occurred in conjunction with small gold deposits that were mined. In the early 1960s two copper ore bodies were located that appeared to be of commercial significance. The first of these was the Sancoroly deposit in the south of Celebes island, on which there is, however, no published information as to its extent or copper content.

The second deposit is located at Erstberg, West Irian, which has been traced to a depth of 180 metres, and which contains an average of 3 per cent copper content and 38 per cent iron (magnetite), with silver and gold also present. The estimated ore reserves that are considered suitable for open-cast mining amount to 30 million tons. The American company, Freeport Sulphur Company, has made a feasibility study of the deposit and expects to develop the mine for operation by 1973, with a capacity for ore having 40,000 tons/annum of copper content when fully developed in the first stage.

The country has no semi-fabricating industry and the imports of semi-fabricated copper are believed to total only about 100 tons/annum.

Tin

The country is the third largest tin producer in the world. The main deposits are found on three islands to the north of Sumatra, Bangka, Billiton and Singkep, the first two having the largest reserves. Small alluvial deposits are known on Sumatra, Karimun, Kundur, Riau and the Lingga Archipelago. The richest deposits are located at the northern and north-eastern end of Bangka island, with a typical cassiterite content of 0.5 - 1.2 kg/m³. In other areas the deposits have a lower average tin content. The deposits in this area are characteristically alluvial layers deposited in valleys which in earlier geological time were below sea level. They usually consist of lodes of about one metre in depth, about 20 km from the beach and 40 m below the surface. There are a number of primary tin deposits, containing 0.4 - 1 per cent tin, but these have not been explored and they are not included in the estimates of the over-all deposits. The total tin reserves are estimated to amount to 0.8 million tons, of which 0.55 million tons are considered proved and probable. These figures are based on an assumption that the sands average 0.5 kg/m³.

Primary dressing is carried out at or near the mining sites and then sent to the final dressing and concentrates' plants. The metal content of the concentrates after final dressing is normally around 70 - 75 per cent. In the mid-1960s a modernization programme was carried out with the help of British, Dutch and German Federal Republic companies. The Indonesian

Government has been encouraging further prospecting for tin. In July 1968 the Government signed a 40-year contract with N. V. Billiton to carry out offshore prospecting. Rio Tinto Zinc Ltd, Bethlehem Steel Company and Simon Lobniz Co. are also negotiating with the Indonesian Government for prospecting rights on the islands of Karimun and Kundur. As part of the policy of encouraging mining development since 1968, mining companies can retain 86 per cent of their total net revenues in foreign currency, obtained from export shipments. This was intended to facilitate an increased production of concentrates to 35,000 tons/annum in 1970, but the target appears to have been set at a too optimistic level.

The output of refined tin in Indonesia was for many years restricted to a single smelter with a nominal 2,000 tons/year capacity, at the Muntok mines on Bangka island. In 1967 a new smelter went into operation and is planned to have an ultimate capacity of 25,000 tons/annum. Various delays and problems have limited its development, however, and output throughout 1969 ran at only 380 tons/month (4,560 tons/annum) in total from the two smelters. Data on production and exports of tin concentrates and refined tin and consumption of refined tin are given in table 83.

Table 83

PRODUCTION AND EXPORTS OF TIN CONCENTRATES AND PRIMARY TIN AND CONSUMPTION OF REFINED TIN — INDONESIA

(Thousand tons)

	1959	*1965*	*1966*	*1967*	*1968*	*1969*
Tin concentrates—production ...	21.9	14.7	12.5	13.6	16.9	16.5
Tin concentrates—exports	18.7	13.0	10.0	12.5	16.2	10.8
Primary tin—production	0.3	1.2	0.8	1.5	4.6	4.6
Primary tin—exports	0.3	0.5	0.5	0.75	4.0	7.3
Primary tin—consumption	0.5	0.7	0.4	0.1	0.2	0.3

Indonesia is well placed to foster the further development of its tin industry given the creation of appropriate conditions. The expansion of tin production would have useful effects on the economy, depending partly on political factors and the ability to attract foreign capital, as well as on a programme of exploration and development linked with a general modernization of mining and ore-processing facilities.

The Khmer Republic

The Khmer Republic (formerly Cambodia) attained independence in 1955, adopting a constitutional monarchy with main political power exercised by the head of state and not by the monarch. The monarchy was overthrown by a military coup in 1970. The country is situated in South-East Asia with a long coastline on the Gulf of Siam. To the west and north it adjoins Thailand and Laos, and the Republic of Viet-Nam lies to the east and south-east.

The population is estimated at 7 million (1969) and occupies an area of about 180,000 km², of which approximately half is covered with forests. The country lies in the South-East Asia tropical monsoon belt with a rainy season from May to October. The land is generally of moderate elevation with the river valleys being of particular economic importance for rice growing and other agricultural products, as well as for fishing and transport routes. Forestry also provides an important sector of the economy.

A 385 km-long railway line of one metre gauge connects the capital, Phnom Penh, to Poipet in Thailand. A line from Phnom Penh to Kampot has been completed recently and is planned to be extended to Sihanoukville. The country has approximately 5,000 km of roads, of which about one half are hard-surfaced and passable in the rainy season. Pochentong airport, 10 km from Phnom Penh, will accommodate large modern jets and provides connexions with international services. Royal Air Cambodge provides services to other South-East Asian countries. The airport at Siem Reap can take DC 6 aircraft, and there are a number of fair-weather landing strips for light aircraft in various parts of the country. The capital, Phnom Penh, lies on the Mekong river and vessels of 3,000—4,000 tons can reach it via the Republic of Viet-Nam. A new port has been built at Sihanoukville (Kompong Som) on the Gulf of Siamand is being increasingly used by long-distance shipping.

Although predominantly agricultural, the country has been developing light industry, including a motor vehicle assembly plant, three cigarette factories, a match factory and light engineering, as well as pressed metal parts, pottery, glassware, cement, textiles and foodstuffs processing. Phosphates are mined and iron-ore deposits exist in the north but are not being exploited. There are no known coal deposits nor oilfields in the country.

Aluminium

There appears to be little published information other than the fact that some deposits of bauxite were located during the 1967 survey carried out by geologists from France, the People's Republic of China and the United Nations. There is no semi-fabricating industry in the country and imports of aluminium are few.

Copper

Surveys in 1965 of the Kompong Thom area revealed the presence of copper-bearing minerals, but much further work was considered to be needed before their commercial potential could be evaluated.

Lead and zinc

Deposits containing lead and zinc minerals were found during the 1967 survey but details have not appeared. It seems likely that further work is necessary to evaluate these sources.

Laos

The kingdom of Laos, which became independent in 1954, forms part of the peninsula of Indo-China. In contrast to its neighbours, Viet-Nam

to the east, the Khmer Republic to the south, Thailand and Burma to the west, and the People's Republic of China to the north, it is a completely landlocked country. The climate is that associated with the tropical monsoon zone of South-East Asia.

It is a mountainous country, except in the south, and some mountains rise to over 2,000 m. The terrain is broken, however, by a number of river valleys. The most important of these are those of the various tributaries to the Mekong river, which for some distance provides the frontier with Thailand. The population of 2.5 million tends to be concentrated in the river valleys and towards the southern part of the country. The country has substantial communications problems, having no railways, and only about one-half of its 4,000 km of roads are all-weather roads.

Aluminium and copper

No occurrences of ores of these metals have been reported, although geological surveying of the country is very incomplete. There are no plants engaged in the production of primary metals nor in the production of semi-fabricated products.

Lead and zinc

There are a number of veins of lead-zinc ores, in which small amounts of gold are sometimes present. These deposits are reported to be centred in three regions, Capaban, Chepon and Vientiane, but no data are available on amounts of ore and its composition. More recently, new deposits of lead ores have been reported near Chepon, in which some zinc and silver are present. The Laotian Government hopes to develop rail, river and air transport facilities as a preliminary to making it possible to exploit these deposits.

Tin

Tin ores are known to occur in the country, and present estimates are of 60,000 tons, proved and probable, with an average tin content of approximately 0.5 per cent and rarely exceeding 1 per cent. These figures should be treated with caution because of the limited surveying so far carried out; the real reserves may well be much larger.

In recent years the output of the country has been about 300—400 tons of tin (as concentrates). The main mining company, Société d'Etudes et d'Exploitations Minières de l'Indochine, operates a deposit in the Phon Tiou region about 80 km north of Thakhek. The ore body is worked by open-cast mining and about 30,000 tons/annum of crude ore is mined. The associated mill produces tin concentrates having a 60 per cent tin content and can produce up to 1,800 tons/annum of concentrates. There have been reports of resumption of tin mining in the Boneng district with an estimated production of 100 tons/annum of tin concentrates. There have also been reports that the Japanese firm, Mitsubishi Mining and Smelting K.K., is interested in the possibility of erecting a smelter in Laos.

Statistics for the production and exports of tin concentrates are given in table 84.

Table 84
PRODUCTION AND EXPORTS OF TIN CONCENTRATES - LAOS
(Thousand tons)

	1959	1965	1966	1967	1968	1969
Production of concentrates	0.3	0.28	0.40	0.35	0.50	1.05
Exports of concentrates	0.4	0.36	0.46	0.41	0.53	...

Malaysia

The Federation of Malaysia came into existence in 1963. In addition to the "Malay States" at the southernmost tip of the Malay Peninsula (excluding Singapore which became independent in 1965), the Federation includes Sarawak and Sabah in the north and western part of the island of Borneo. The total land area is 132,000 km².

The Malay Peninsula is mountainous; mountains rise to over 2,000 m and cover nearly 60 per cent of the territory. The southern part of the country is less mountainous than the north, and the plains have well-marked river valleys. The longest rivers are the Sungei Pahang and the Sungei Perak. Apart from the coastal fringe, Sabah is mountainous. Sarawak has a coastal plain, broader river valleys and is less mountainous.

The territory of Malaysia lies slightly to the north of the equator and is within the South-East Asia monsoon belt. The population of 10.4 million (1969 estimate) is largely centred in the river valleys and the lower-lying parts of the country. Much of the interior is dense jungle, which makes communications difficult.

The railway system of the Malay States totals 2,000 km, based primarily on a twin north-south line running from Thailand; one main branch runs via Tana Merah to Singapore, and the other runs down the west coast via Taiping and Seremban to Singapore. There are various small branch lines connecting to rubber and tin-producing areas. There is a well-developed road system totalling 17,000 km, of which 12,600 km are bituminous metalled. Coastal sea traffic is also of importance. International airport facilities are provided at Kuala Lumpur, and the country has domestic air services and landing strips.

The Malay States have modest resources of low-grade coal and these have been mined on a small scale. There has also been a long history of coal mining on a modest scale in Sarawak where recent investigations have indicated probable reserves of 50 million tons of coking coal at Silantek. Oil has not been found in the Malay States. Production has been in progress in Sarawak, however, since the late 1920s but is declining and was only around 50,000 tons/annum in 1967. A refinery in Lutong used imported crude oil and has a capacity of 3.15 million tons/annum. Electricity generation amounted to 2,522 million kWh.

The country has important deposits of tin ores and bauxite and small resources of copper. Wolfram, columbite, gold, iron ore and some uranium-bearing deposits are also known.

Aluminium

Bauxite deposits of the lateritic type occur in the Malay States, Sabah and Sarawak. Data on the location of these deposits, their quality and extent of reserves are given in table 85.

Table 85

DATA ON BAUXITE RESERVES IN MALAYSIA

	Composition	Production 1967 (tons)	Estimated reserves	
			Total (million tons)	Proved
Malay States				
Rantuna Bauxite Ltd		899,580		
Telok Rantuna, Johore	52 – 56% Al_2O_3	385,574		
Johore Mining and Stevedoring Co.				
Pengarang, Johore	56 – 58% Al_2O_3	514,026	40	10
Occurrences also in:				
Selangor		—		
Pahang	Good quality	—		
Trengganu		—		
Sarawak				
Mungu Behan, Sematan	56% Al_2O_3		...	5
Bukit Belong	47 – 52% Al_2O_3			
Sabah				
Kaibu	Medium quality		...	...
Darvel Bay	Inferior to Kaibu (higher Fe content)			

The data on these reserves should be treated with some caution since the extent of geological surveying has been limited. It seems highly probable that with systematic exploration and the use of improved beneficiation methods the total reserves may prove to be considerably higher. At present there are no facilities for alumina production in Malaysia, but discussions are taking place between the Malaysian Government and Alcan Malayan Aluminium Ltd, which owns Johore Mining and Stevedoring Co. Ltd, on the possibility of developing alumina facilities in conjunction with an aluminium smelter.

The country also has a semi-fabricating company, Alcan Malayan Aluminium Ltd, located at Petaling Jaya, Selangor, which operates a hot and cold rolling mill that produces sheet and strip, including corrugated roofing sheet. A plant for aluminium cables, Malayan Cables Ltd, is planned to be built nearby. The Alcan plant has a nominal capacity of 3,000 tons/annum. The proposed erection of an aluminium cable plant by Oregon Industries Far East Ltd has been announced, involving an investment of Malayan $10 million.

Data on bauxite production and exports, and imports of aluminium ingot and semi-fabricated products are given in table 86.

Table 86

BAUXITE PRODUCTION AND EXPORTS, AND IMPORTS OF ALUMINIUM INGOT AND SEMI-FABRICATED PRODUCTS — MALAYSIA

(Thousand tons)

	1959 [a]	1965	1966	1967	1968
Bauxite production	597.0	994.0	955.0	900	799
Bauxite exports	576.0	835.0	1,007.0	852	...
Aluminium ingot imports	0.3	0.6	1.6	45	...
Semi-fabricated products imports	2.7	3.3	3.0		...

[a] Excludes production from Sarawak.

Copper

At present there is no production of copper ores in Malaysia, although some copper is recovered as a by-product of tin smelting, mainly at the Sungei Lembing mine in Penang State. In the early 1960s copper-containing ores were found on the eastern slope of Mount Kinabulu during a United Nations Geochemical survey in the Labuk Valley of Sabah State. A prospecting licence was issued by the State Government to the Japanese Overseas Mineral Resources Development Co. Ltd. in which the Japanese Government has a financial holding. Drilling commenced in July 1968 and is continuing, and reserves are estimated to total over 880 million tons of ore containing 0.63 per cent copper. The company is going ahead with plans to develop a mine; a mining lease has been drawn up covering 8,900 acres, and a copper concentrates plant is planned with an output of 45,000 tons/annum.

There is no copper semi-fabricating industry in Malaysia. Imports of semi-fabricated products, however, are estimated to amount to abo. 2,000 tons/year.

Tin

Malaysia is a major producer of tin, accounting for over 40 per cent of the world output. At the end of 1967 there were over 1,000 mining sites. Figures of ore reserves need to be treated with caution, however, since they can be wrongly interpreted. Estimates have been made of 1.2 million tons (metal) total reserves, of which 0.6 million tons (metal) are considered proved. At current production levels of over 70,000 tons/annum, this would imply the exhaustion of proved reserves in under ten years. It seems extremely unlikely that these estimates represent the actual extent of the reserves, and they must be regarded as data obtained to support forward commercial planning. A further potential increase in available reserves is indicated by the discovery of ore in new areas, and the likely existence of offshore deposits. Approval has been given in principle to three foreign companies to explore for tin deposits in the offshore areas. The companies are Conzinc Rio-Tinto Ltd, N. V. Billiton and Ocean Mining Co. Ltd.

The production of tin in Malaysia has increased quite substantially over the past decade; the data are given in table 87. The pattern of mining operations has been influenced by complex economic factors, including the international selling prices of tin and cost factors associated with various methods of mining, particularly those that operate on the economic margin at a given level of tin prices. These factors were particularly significant during the period of high prices in 1965. Over recent years there has been an increase in the use of gravel pumps, which require only a small capital investment and can be used on deposits too small for dredging operations. The ore of these pumps reflects an opening up of some marginal mines under the stimulus of high prices. Most of the ores mined are alluvial deposits. The largest mine employing underground mining of primary deposits is the Sungei Lembing mine (Penang State) which produces 200,000—250,000 tons/annum of ore having approximately 1.5 per cent tin content. The deposits at Kaki Bukit are mined by a technique known as "cave mining" since they occur in subterranean limestone caves. Data on changes in the proportions of tin output by the various methods of tin mining used in Malaysia over the period 1960—1967 are given in table 88.

Table 87

PRODUCTION, CONSUMPTION AND TRADE IN TIN ORE, CONCENTRATES AND PRIMARY METAL — MALAYSIA

(Thousand tons)

	1959	*1965*	*1966*	*1967*	*1968*	*1969*
Tin-in-concentrates—production	38.1	64.7	70.0	73.3	76.3	73.3
Tin ore and concentrates—imports ...	8.7	7.2	0.6	2.2	13.7	...
Primary tin—production	46.5	73.6	72.2	77.6	86.0	87.1
Primary tin—exports	45.4	74.6	72.8	74.7	87.4	89.9
Primary tin—consumption	0.1	0.04	0.06	0.09	0.10	...

Table 88

CHANGES IN PROPORTIONS OF TIN OUTPUT BY VARIOUS MINING METHODS — MALAYSIA 1960—1967

Mining method	*1960*		*1967*	
	No. of mine units	*Production of Sn concentrates (thousand tons)*	*No. of mine units*	*Production of Sn concentrates (thousand tons)*
Dredging	69	28.5	66	24.2
Gravel pumps	470	18.1	960	40.7
Hydraulics	11	1.2	2	0.2
Open-cast mining	3	0.9	6	2.3
Underground mining	20	2.3	25	2.0
Dulang washing, panning and other small workings	18	1.8	13	3.9

Beneficiation is carried out in a variety of ways depending upon the characteristics of the deposit being worked. Preliminary treatment is usually done near the site of mining operations, with further processing by washing, concentration tables, magnetic separators and allied facilities being undertaken at plants serving a number of mines. After such treatment the concentrates produced are of high quality (up to 75 per cent tin) and are ready for further processing at the smelters.

The capacity of Malaysian smelters is estimated to be around 120,000 tons/annum, although actual output is smaller. The largest plant is that of Eastern Smelting Co. at Penang with a capacity of over 60,000 tons/annum. In addition to concentrates from Malaysian plants concentrates from Burma, Laos and the United Republic of Tanzania are also processed. The Straits Trading Co. operates a plant at Butterworth, Penang State, and also one in Singapore; it also processes concentrates from Indonesia. The third plant is that of Oriental Tin Smelters at Port Swettenham, which commenced operations in 1964 and processes concentrates mainly from the areas of Perak and Kuala Lumpur. The plant is owned jointly by Malayan National Investment and Ishihara Sangio Kasha K. K. of Japan. Most of the mines and concentrates plants and the two main smelters are owned by foreign companies. A secondary metal refinery on Penang handles tin, lead and zinc and produces refined tin and lead alloys, including solders.

Pakistan

Pakistan obtained independence in 1947 and proclaimed itself a republic in 1956. It has a population of 107 million (1968 estimate), a total area of 936,720 km², and is divided geographically into two parts, West Pakistan and East Pakistan. The two parts have a common frontier and are separated by India. The western frontier of West Pakistan is with Iran and the north-west frontier borders Afghanistan. East Pakistan has an irregular, indented frontier. Except for a short boundary with Burma in the south, it is entirely surrounded on the landward side by India. Both West and East Pakistan have important coastlines with a number of ports, of which Karachi and Chittagong are the major ones. The climate is mainly subtropical, approaching tropical in the south, with the annual monsoon season providing heavy rainfall. The geography of the country is dominated by broad flat valleys through which flow complex river systems associated with the Indus and its tributaries in West Pakistan and the Ganges in East Pakistan. In the West, towards the west and north-west border, the country is 500 m or more in elevation, with ridges rising to as much as 2,000 m in height.

The country has a road network and also 17,300 km of railway, of which 75 per cent is in West Pakistan. In East Pakistan the river system is particularly important as a means of transport.

The country is highly dependent on imported fuel; coal is imported from India and oil from Iran. Domestic production of coal in 1966 amounted to 1.2 million tons, and of oil to 508,000 tons. Total power generated in 1966

was 3,903 million kWh. of which 1,753 million kWh were from hydroelectric stations.

Aluminium

Bauxite deposits totalling approximately 15 million tons are known to exist and are spread over various parts of West Pakistan. They are found at the following locations: Ziarat (Quetta), Sargodha and Miyanwali, Campbellpore and the Margali Hills (Rawalpindi), Abbottabad, Bezirk Hazara (Peshawar), Lakhra (Hyderabad), Muzaffarabad and Kotli Tehsil (Kashmir). These deposits are not of high quality, the composition varying from 25.4—50.6 per cent Al_2O_3, 12.2—32 per cent SiO_2, 3—36.9 per cent Fe_2O_3, and 1.7—2.5 per cent TiO_2. Most of the bauxite deposits contain not more than 45 per cent Al_2O_3. There is no mining of bauxite or aluminium production, but the country does participate in the Iranian smelter project. Such aluminium as is used domestically is provided by imports, mainly from Canada and the United States.

A modest semi-fabricating industry exists in Pakistan. A rolling mill in Karachi, operated by Pakistan Aluminium and Industrial Works Ltd, has a capacity of 600 tons, and a rolling mill is also operated by Pakistan Metal Industries producing sheet (including corrugated sheet) and foil; it also produces copper and brass sheet. Its capacity for aluminium sheet is believed to be 600 tons/annum. Facilities for producing extruded sections are available at the works of Kruddson Ltd. Facilities for producing stranded aluminium cables are provided by Pakistan Cables Ltd (associated with British Insulated Callender's Cables Ltd).

The import of aluminium ingot into Pakistan during 1966 was 3,892 tons; semi-fabricated aluminium imports amounted to 1,427 tons.

Copper

There is no mining of copper ores in Pakistan but deposits of the ore are known. The main ore body considered to have possible commercial significance is the Bondagen deposit (near Chagai) and it is currently being surveyed. A preliminary survey in 1961 indicated the presence of some ore near Fort Sandeman with as high as 10 per cent copper content but there are no estimates of reserves. The shortage of water in this area presents problems for its exploitation, and it is remote from the nearest railway line. Copper ore deposits are also known to occur in the mountains near Pa'es-Koh in the north of West Pakistan near the Afghanistan border. The area generally has been poorly surveyed.

Domestic requirements are met by imports of copper ingot. Semi-fabricating facilities are provided by several small plants, mainly situated in and around Karachi. The main consumption is of wire for cables. Copper consumption is estimated to be about 3,000—5,000 tons/annum.

Lead and zinc

Lead-zinc ores are known to exist in the Ushu River valley in Swat, and also in the Chagai area. Worked-out lead mines are located in Kalat

province. In Swat, near Peshawar, small veins of lead ore are mined in the summer season, since the area is not readily accessible in winter, with 100–300 tons/annum of ore being extracted. All known deposits are small, of the vein type; they are located in the remoter mountainous regions and are poorly surveyed. Some attention is now being given to improving concentration techniques for the deposits currently exploited. There is no industry engaged in refining lead and zinc ores. Consumption of zinc (1968) was estimated as 18,000 tons, mainly for galvanizing steel, and consumption of lead (1968) is believed to have been approximately 6,000 tons, mainly for batteries.

Tin

There are no deposits of tin known in Pakistan and domestic consumption is very small.

The Philippines

The Republic of the Philippines, which became independent in 1946, consists of an archipelago containing more than 7,000 islands, of which the largest are Luzon and Mindanao. The country lies to the east of Viet-Nam and to the north of Indonesia. It has a population of 56 million (1969 estimate), which is concentrated primarily in the main islands. The Philippines is a mountainous country with more than 75 per cent of its area of 300,000 km² covered by mountains; it is dissected by deep gorges and high plateaux, with rapidly flowing rivers supplied by abundant rain, which varies from heavy in the monsoon season to light to moderate. The rivers provide a potential for the further development of hydroelectric power generation.

The country has a railway network on the island of Luzon amounting to 1,167 km. The main islands have a well-developed road network totalling 55,800 km. As would be expected from the country's geography, coastwise and international shipping is of great importance to the economy. The main port is Manila, which handles 90 per cent of the imports; it is also the site of an international airport. Airstrips are also provided on a number of the islands.

Power generation in 1966 amounted to 5,567 million kWh, of which 1,479 million kWh were generated by hydroelectric stations. Coal is mined on Cebu, mainly from government-owned mines, and production is believed to be in the range of 100,000–200,000 tons/annum. The country has no resources of crude oil but has a refinery which produced 5.15 million tons in 1966 and imported 1.74 million tons of refined products. The Republic has important reserves of copper ores and produces small amounts of mercury, silver, molybdenum, gold and cadmium.

Aluminium

Lateritic deposits are widely found in the Philippines, the lateritic mantle varying from 1–17 m, with an average thickness of 8 m. Although there are small local areas in which the Al_2O_3 content is as high as 58.8 per cent, most of the deposits are low in alumina and high in iron. On Nonoc Island

the Al_2O_3 content ranges from 16.6–22.1 per cent with 38.8–43 per cent Fe and .9–2.7 per cent SiO_2. On Bucas Grand Island there are small amounts of high alumina ores (40.8 per cent Al_2O_3), with the rest mainly low alumina, 22.4 per cent Al_2O_3, 42.5 per cent Fe and 2.6 per cent SiO_2. The total of these aluminous ores amounts to about 216 million tons (dry weight), of which only about 10 million tons are high aluminous ores of approximately 40 per cent Al_2O_3 content. The Philippines Bureau of Mines is conducting research with a view to developing a modified version of the Pederson process as a possible economical method of utilizing these ores.

The country has an established semi-fabricating industry. The two major plants are those of Reynolds Philippines Inc., which has a capacity of 5,000 tons/annum of sheet and 2,500 tons of extrusions, and Hooven Inc. (Philippines), which has a capacity of 2,500 tons/annum of extrusions, with a sheet mill of 5,500 tons/annum planned. Both companies plan to increase their capacity substantially in the near future. A third company, Jalwindor Manufacturers Inc., plans to build an extrusion plant at Quezon City with technical assistance from Comalco Industries Pty. Ltd of Australia.

Not all of the country's requirements are met by these plants, and semi-fabricated products are imported, mainly from Hong Kong and the United States, in addition to aluminium ingot. Data on these imports are summarized in table 89.

Table 89

IMPORTS OF ALUMINIUM INGOT AND SEMI-FABRICATED PRODUCTS INTO THE PHILIPPINES

(Tons)

	1965	*1966*	*1967*	*1968*
Aluminium ingot	4,263	5,954	7,909	9,887
Semi-fabricated products	1,118	1,482	1,475	2,031

A project for the erection of an aluminium reduction plant is at an advanced stage. This project, which is expected to save more than $20 million per year in imports, will be based on alumina imported from Australia, and will utilize the very considerable hydroelectric potential of the Maria Cristina station in Illigan City (Mindanao). The total investment is expected to amount to 150 million pesos, and the financial participation proposed is 40 per cent Republic Flour Mills Inc., 40 per cent Reynolds Philippines Inc., 7 per cent Hooven (Philippines) Inc. and 13 per cent financial institutions or the investing public.

Copper

There are considerable reserves of copper ores in the Philippines, estimated to amount in all to 383 million tons with an average content of 0.86 per cent copper but a range of from 0.60 per cent to 10 per cent. The largest reserves are the Toledo deposits on Cebu, totalling 150 million tons averaging 0.74 per cent copper; the Sipalay deposits on Negros Occidental, amounting to

73 million tons and averaging 0.82 per cent copper; and 40 million tons at Nevada on Santo Toma Island, averaging 0.75 per cent copper. Silver and gold are also found in small amounts in a number of these ore bodies, and the deposit on Nonoc Island also contains nickel.

There are no smelting facilities in the Philippines, but there are plants for the production of concentrates, which are shipped to virtually only two buyers, Japan (73 per cent) and the United States (27 per cent). Data on mine production of ore and exports of concentrates are contained in table 90. The ores mined are porphyritic with some sulphide ores. Economically recoverable amounts of silver and gold are contained in some of the deposits.

Table 90

MINE PRODUCTION OF COPPER ORE AND EXPORT OF COPPER CONCENTRATES - PHILIPPINES

(Thousand tons)

	1959	*1965*	*1966*	*1967*	*1968*	*1969*
Mine production	49.5	62.7	73.8	86.2	110.3	131.4
Export of concentrates	...	62.7	73.8	85.8	106.4	...

Expansion of output is still proceeding and a number of new mines and facilities are in the course of development or coming into production. Data on ore reserves, output from the principal mines and plans for expansion are given in table 91.

Table 91

LOCATION AND CHARACTERISTICS OF ORE RESERVES, MINE OUTPUT (1968) AND EXPANSION PLANS OF THE PRINCIPAL COPPER MINES IN THE PHILIPPINES

Company	*Location*	*Reported reserves (million tons)*	*Copper content (per cent)*	*Output 1968 (tons)*	*Expansion plans (tons)*
Atlas Consolidated Mining and Development Corporation	Toledo, Cebu Is.	177.20	0.74	42,218	53,000 (1971)
Copper Belt Mining Co.	Lobo, Batangas	0.18	2.16	184	35,000 (1970)
Lepanto Consolidated Mining Co.	Mankayon, Luzon	6.30	3.07	26,005	31,500 (1971)
Marcopper Mining Co.	Labo, Santa Cruz	51.70	0.85		30,000 (1970)
Marindique Mining and Industrial Corp.	Bagacay, Samar Is.	2.80	3.36	7,847	
	Sipalay, Negros Is.	81.30	0.81	15,415	35,000 (1971)
Philex Mining Corp.	Nevada, Santa Toma Is.	40.30	0.75	9,084	
	Tuba, Benguet	0.13	0.60	90	16,000

Other mining projects in the course of planning and development are Black Mountain, Surigas Consolidated (Mahayag), Samar Mining Co. Inc. (Hope), Itogon-Suyoc-Benong, Manila Mining (Masbate), Philex (Mindanao), White Eagle (Lobo), Acoje (Barlo) and Island Mines.

Atlas Consolidated has a concentrates' plant on Cebu Island which also processes ore from Lepanto Consolidated. Marcopper Mining Co. has a leaching plant virtually complete for handling ore from Labo, and concentrates' plants process the ore mined at the Bagacay and Sipalay deposits of Marindique Mining and Industrial Corporation. The latter company has entered into a ten-year contract with Nippon Mining Co. for the latter to buy the entire output.

A project has been put forward by Marindique Mining and Industrial Corporation to establish a copper smelter with a capacity of 30,000 tons/annum of ingots, wirebars and rods. The present internal market of the Philippines — about 11,500 tons in 1967 — will absorb only part of the output. It is intended to export the surplus in the form of wirebars to other countries in South-East Asia and to the United States. There are reservations in some quarters on the advisability of this project because of the possible low return on a high capital investment, freight costs of the finished product, and possible effect on the Japanese market for concentrates.

Lead

The only mine producing lead is that of Paracale Gumuas Mines, Benguet, where lead is a by-product of the company's gold-mining operations, which in 1967 amounted to only 89 tons of lead. Reserves of galena in the Philippines occur in the provinces of Camarines Norte and Batangas, but these total only 656,208 tons with an average of 0.96 per cent lead, representing 6,325 tons of lead in all.

Lead and lead products are imported for domestic use; imports totalled 6,369 tons in 1968 and were mainly lead sheet and pipes, battery grids and litharge. Projected future demand envisages an expansion of lead requirements to nearly 21,000 tons in 1974.

Zinc

Zinc occurs in association with other metals in the Philippines. The largest zinc deposit is that at Hinabangan where it occurs in combination with copper of the Bagacay mine, whose reserves are estimated to amount to 3 million tons with a zinc content of 5.6 per cent. Some zinc ores are also produced as a by-product of gold mining at Benguet where reserves are estimated at 0.13 million tons with 10.1 per cent zinc content. Two mines, one at Pañganiban and one at Paracale (Camarines Norte), closed down in 1956. The known deposits in Mountain Province and Camarines Norte are not considered sufficient to warrant investment in a zinc mine.

Data on zinc ore production and imports of refined zinc are summarized in table 92.

Table 92

PRODUCTION OF ZINC ORES AND IMPORTS OF REFINED ZINC — PHILIPPINES

(Thousand tons)

	1960	1965	1966	1967	1968
Mine production	5.0	2.1	1.1	1.5	1.5
Imports of refined zinc	9.3	15.9	16.6	18.1	21.6

The main users of zinc are six galvanizing plants, and a 50 per cent increase in zinc consumption is anticipated over the five years 1969—1974.

Tin

There are no reports of tin deposits in the Philippines. Domestic requirements for tin, mainly for solders etc., are met by imports, which amounted to 620 tons in 1968.

Singapore

The Republic of Singapore comprises the island of Singapore and adjacent small islands at the southern tip of the Malay Peninsula, with a land area of 534 km². Singapore has the same tropical monsoon climate of the peninsula generally. Its population of 1.9 million (1968 estimate) forms a compact, densely populated community that has traditionally occupied a strong position in the entrepôt trade of South-East Asia. Since achieving independence, Singapore has been rapidly expanding the manufacturing sector of its economy, and a large number of new factories have been built over the past five years.

Singapore is well placed for communications, being connected with Malaysia by a main railway line and a major international highway. It has an international airport and one of the best port facilities in South-East Asia, including a large dry-dock. Electricity power generation in 1966 amounted to 1,236 million kWh, based on imported fuels. It has a refinery with an output of 8.15 million tons (1968).

Aluminium

The country has no domestic bauxite resources and is badly placed for generating the large quantities of cheap power needed by an aluminium reduction plant. It possesses a rolling mill and extrusion press run by Pioneer Aluminium Ltd, which is a subsidiary of American Metal Climax Inc. Part of the output is consumed by the associated Kawneer Company's building-products plant, which is also in Singapore. Estimated output is approximately 2,000 tons/annum.

Copper, lead and zinc

There are no known ore deposits and no smelters for these metals nor is there production of semi-fabricated products.

Tin

The refinery of the Straits Trading Co. Ltd is located in Palau Brani and has an estimated output of 35,000 tons/annum of refined tin; it utilizes concentrates imported mainly from Malaysia, but also from Indonesia and Burma.

Thailand

The Kingdom of Thailand forms part of the Indo-China peninsula. It has a long coastline on the gulf of Siam, and a southern frontier with Malaysia on the Malay peninsula. It also has a long boundary to the west and north-west with Burma, to the north-east and east with Laos, and to the south-east its neighbour is the Khmer Republic. Thailand has an extensive river network providing the drainage pattern for the low-lying plains which occupy more than half of the country. The rest of the land area consists of hills and higher ground, some of which rise to over 1,000 m, with the total area being 514,000 km^2.

The country lies in the South-East Asia monsoon belt and has three main seasons: a warm, dry winter, a hot, dry intermediate season and a hot, rainy summer season that lasts for at least six months of the year. The extensive river network is of importance to the agricultural economy and also as a means of transport. The population of 32.7 million (1968 estimate) tends to be concentrated along the main river basins of the Mekong and its tributaries in the central and eastern parts of the country and the Ping, Wang, Nan and Yom rivers in the west, which unite as they flow south to become the Chao Phraya. There are also several lakes, the largest of which is the Nong Lahan in eastern Thailand.

Railways and rivers are of major importance in providing means of transport. The node of the railway system is Bangkok, which has lines connecting with Chiang Mai in the north, Tak (Rahaeng) in the north-west, Nong Khai in the north-east, Ubol in the east, with lines to Phnom Penh (in the Khmer Republic) to the south-east, and south to Malaysia. The total route covers 3,765 km. International airline connexions are provided at Bangkok airport. The road system totals 9,900 km of which 5,700 km are concrete or asphalt surfaced.

The country has modest reserves of brown coal and lignite in several different areas. At present lignite is being mined at Mae Mo and Krabi, which possess reserves totalling 120 million and 100 million tons respectively. Production from these two mines in 1968 totalled 305,336 tons. The output of electricity in 1965 amounted to 1,816 million kWh, of which approximately one quarter was generated by hydroelectric stations.

Aluminium

Deposits of lateritic bauxite, containing up to 60 per cent Al_2O_3, have been reported, but little information has been published on their location and occurrence.

The country has a small semi-fabricating industry. One fabricating plant, Alcan Thai Co. Ltd, is jointly owned by Alcan Aluminum Ltd and

the Thai company, P. Piya Co. Ltd. The plant has capacity for approximately 1,000 tons/annum of aluminium extrusions. Thai Metal Works Co. Ltd is jointly owned by Thai interests and Kaiser Aluminum and Chemical Corporation (United States). The plant has rolling-mill facilities, with an output that has been estimated at 1,000 tons/annum by one source and 1,800 tons/annum by another. It also produces aluminium hollowware and other finished products. Facilities for the production of aluminium cables is provided by Siam Electric Industries, which is owned 60 per cent by Thai interests and 40 per cent by Japanese participants. Capacity has been estimated at 1,800 tons/annum.

Statistics of imports of ingot and semi-fabricated products are given in table 93. There are no data on actual semi-fabricated production.

Table 93

IMPORTS OF ALUMINIUM INGOT AND SEMI-FABRICATED PRODUCTS INTO THAILAND

(Thousand tons)

	1965	*1966*	*1967*	*1968*
Aluminium ingot	1.8	3.9	...	...
Semi-fabricated products, ...	3.3	2.9	...	...
of which foil	1.0	1.0	...	...

Copper

In 1966, large porphyritic deposits were found in the province of Loei, in the north-east of Thailand. At present these deposits are being further explored. The initial survey indicated ore reserves amounting to 70 million tons with an average copper content of 0.7 per cent. Imports of semi-fabricated copper are estimated to amount to about 400 tons per year. There is a project for a cable plant to be built by Phelps Dodge Copper Corporation in conjunction with Thai interests. A small plant, Thai Metal Works Chong Nonori, produces sheet and extrusions, and Thai Yasaki Electric Wire Co., Bangkok, draws wire and produces the smaller sizes of cable.

Lead and zinc

Lead ores have been found at Kanchanaburi, Loei, Petchabun and Chiang Mai. Ore reserves at Kanchanaburi have been estimated at 140,000 tons, with 10—15 per cent lead content, and are being worked. More recently, a zinc deposit has been located at the Mae Sod in Tak province in the north, which has estimated ore reserves of 3.2 million tons with an average of 35 per cent zinc and some lead, but the deposit is not being worked.

Table 94 gives the statistics of production and exports of lead ore.

Table 94
PRODUCTION AND EXPORTS OF LEAD ORE, THAILAND
(Thousand tons)

	1965	1966	1967	1968	1969
Mine production	12.3	14.9	8.2	6.5	4.2
Exports of lead ore	11.9	12.9	9.9	6.8	...

The Netherlands is a major market for lead ores from Thailand.

Tin

Thailand is one of the major tin-producing countries, and tin is of major importance to the economy as a source of export earnings. The main tin deposits are found in the southern part of Thailand, but some are located in the north, west and central areas of the country. Primary tin deposits are usually found in association with tungsten ores, e.g. at Pilok in Kanchanaburi and at Mae Sariang in Mae Hong Son. These deposits vary widely in nature and size, but none have been studied or explored in detail. Production from primary tin deposits accounts for less than 10 per cent of the total tin production. The main known reserves are the secondary tin deposits—alluvial or placer—that are mainly located in southern Thailand. Production of tin concentrates in 1968 in the south amounted to 90.9 per cent of all output, with 7.3 per cent from the central area and 1.8 per cent from the north. There were 712 mining sites being operated in 1967, including 22 dredge mines.

A recent review of potential tin-bearing areas in Thailand identified the main existing and potential areas for tin mining. In the north of the country a number of mines are in operation around Wiang Pa Pao in Chiang Rai province and at Chae Son in Lumpang province, which lie within the Tern Triassic granite range of hills where further exploration is in progress. Also in the north the Doi Intanon hills provide a further producing area which is growing in importance, mainly based at Somerng in Chiang Mai province. A rich tin placer ground at Hang Dong has been discovered and is being mined. New tin prospects have been discovered at Chom Tong, south-west of Chiang Mai proper. To the west of the Tern range lies the small Mae Lama range of cretaceous granitic hills in which eluvial and vein-type tin deposits occur and tungsten is also found. The remoteness of the area from the main transport routes has retarded its exploitation.

The Tenasserim range further south contains productive deposits in many places, especially at Pilok, Song Khwae, Bong Ti and Lum Sai in Kanchanaburi province and Chom Bueong in Rat Buri province. The Thap Sakae range on the Burmese border is believed to have potential. The triassic granitic range of south-east Thailand contains tin deposits, and particularly around the coastal area of Rayong further deposits are anticipated subject to detailed prospecting.

In the main southern producing area the Ranong range is very productive and has considerable potential. The main mining centre is Pak

Song. The Taku Pa-Phangnga and Phuket ranges contain placer grounds terminating in Phuket island on the west coast, and these are being worked both onshore and offshore by dredge and gravel pumps. Small amounts of columbite and tantalite are found in association with the tin. On the opposite side of the country the islands of Kam Phangan and Kan Samai contain tin deposits, and also wolfram, which are being worked. These have not been fully explored but are considered to contain significant deposits as well as to have potential for offshore operations.

South of these islands and on the mainland lie the Surat Thani and Nakhon Si Thammarat ranges where there is a small amount of tin-mining activity. Continuing southwards the next tin-bearing area lies in the Thung-Song-Trang-Padang Besa granite range, which has been worked on a small scale for the tin and wolfram deposits it contains. The remaining four centres lie south-eastwards towards the Malayan border. They are the Songkhla range which contains placers and hydrothermal vein deposits that have not been developed; the Lam Paya-Pinyok-Betong range which contains eluvial and vein deposits and is worked mainly around Tam Talu and Pinyok; the Yala range which has only been explored to a limited extent but contains tin deposits; and the triassic Narathiwat range which contains sporadic tin occurrences and has not been seriously developed.

As easily accessible and high-grade tin deposits are rapidly exhausted on the one hand, and, on the other, as the price of tin on the "futures" market tends to fall under the influence of world market demands, the tin industry will tend to depend increasingly upon offshore dredging, which has the potential of being operated at relatively lower cost. Total reserves of tin are estimated to be 1 million tons of tin metal; these are considered enough to support the present level of production for at least twenty years, independent of any offshore dredging and new deposits that may be revealed by further prospecting.

Mining is undertaken by many small enterprises, but the major part of production is in the hands of a relatively small number of companies that have facilities for producing tin concentrates from the ore mined. Smelting of the concentrates is mainly carried out by Thailand Smelting and Refining Co. Ltd on Phuket Island, with an output capacity of around 30,000 tons/annum; this plant can handle the entire output from tin mines in Thailand.

Data on the production and exports of tin concentrates and metal, as well as on domestic consumption, are given in table 95.

Table 95

PRODUCTION, CONSUMPTION AND EXPORTS OF TIN CONCENTRATES AND METAL — THAILAND

(Thousand tons)

	1959	*1965*	*1966*	*1967*	*1968*	*1969*
Tin concentrates — production ...	9.50	19.00	22.60	22.50	23.60	21.20
Tin concentrates — exports	10.10	10.80	0.45	0.03	—	...
Primary tin — production	—	5.50	17.00	26.50	24.40	22.40
Primary tin — exports	—	4.90	17.30	26.60	23.50	...
Primary tin — consumption	0.06	0.10	0.12	0.12	0.15	0.16

West Asia

Cyprus

Cyprus is an island in the Eastern Mediterranean to the south of Turkey and to the west of Lebanon. It has a population of 636,000 (1969 estimate) inhabitants, mainly of Greek and Turkish origin. The total land area amounts to 9,251 km². The climate is characteristically Mediterranean, and the country has a mountainous interior rising to over 2,000 m. The road system totals 1,200 km, of which 200 km are asphalted. There are no railways in the country. There are rivers, although some are small and of irregular flow. There are sufficient perennial streams, however, to provide an important hydroelectric output. The main ports are Famagusta and Larnaca. Airport facilities are provided at Nicosia which link with the main European airlines.

There are no known fuel resources, but prospecting is being carried out on the island and offshore for oil and natural gas. An oil refinery is to be built at Larnaca at an estimated cost of £4 million. Electricity generation in 1966 amounted to 399 million kWh, of which 349 million kWh were generated by hydroelectric stations. The Moni power station is being appreciably expanded at a cost of approximately £1·0 million. Minerals provide the cornerstone of the economy, with asbestos, chromite, iron pyrites and copper ores dominating. A survey was made in 1968 with United Nations assistance in which some 75 holes were drilled, and promising mineralization was found in a number of these.

Aluminium

There are no known bauxite deposits nor is there a domestic aluminium industry.

Copper

Total copper reserves are estimated at 170,000 tons, of which 90,000 tons are considered proved and probable. The copper content of these deposits varies between 0.8 per cent and 1.4 per cent, although some local ore bodies contain as much as 5—6 per cent. The major centre of mining is around Skouriotissa, where over 500,000 tons/annum of ore from the surface mine and over 150,000 tons/annum from the Mavrouvouni underground mine are produced. The Limni mine produces over 500,000 tons/annum, and the Kalavasos underground mine over 150,000 tons/annum. New deposits are being opened up at Lefkere and Apliki. The two main companies operating are Cyprus Mines Corporation (American) and Cyprus Copper and Sulphur Company (British), with the Hellenic Mining Company (Greek) being the smallest producer. Ore-concentration facilities exist at Xeros that process ores from the Skouriotissa mine, and at Limni, Mitsero-Agrokipia and Kalavasos. A large new concentrator with an annual capacity of 700,000 tons is being built in the region of Tomasos. Data on mine production and exports of copper in various forms are summarized in table 96.

Table 96

PRODUCTION AND EXPORTS OF COPPER IN VARIOUS FORMS CYPRUS

(Thousand tons)

	1959	1965	1966	1967	1968	1969
Mine production	36.3	24.8	21.8	21.5	19.4	20.8
Export of concentrates	35.7	19.0	25.0	18.0	26.0	20.6

Lead, zinc and tin

There are no known deposits of ores of these metals and no domestic industry based on them or their fabricated forms exists.

Iran

Iran borders on the Soviet Union and the Caspian Sea in the north; its eastern neighbours are Afghanistan and Pakistan. To the south and south-west are the Arabian Sea and Persian Gulf, and its western frontiers are with Iraq and Turkey. A major part of its population of 26.7 million (1968 estimate) live in the western part of the country. Much of the country, whose area totals 1.622 million km², is semi-desert. Apart from a small area at the north of the Persian Gulf, and a narrow zone along the coasts, the country generally lies at an altitude of 500—2,000 m, with mountain ridges running in a north-west to south-easterly direction. The climate is sub-tropical with strong continental influences producing dry, hot summers and cold winters, which bring winds varying from moderate to strong. Rainfall amounts to 20—50 cm/annum, and the country generally has problems with securing adequate water. There are a number of short, fast-flowing rivers, some of which empty into swampy depressions that frequently dry up in the summer. The only navigable river is the Karun.

There are approximately 4,000 km of railways providing a through route from the Soviet Union and the Caspian Sea to the Persian Gulf, with a connexion with the Turkish railway system. The capital, Tehran, is connected with the main towns of Ahadan, Esfahan, Jolfa Khorramishar, Masshad, Shiraz and Tabriz. Road transport is a major factor in the communications and transport system with Tehran as the hub. The road system consists of 34,000 km, of which approximately 10,000 km are asphalted. The main ports are Bandar Abbas, Bandar Shahpur and Khorramshahr on the Arabian sea, Bandar-e Shah and Bandar-e Pahlavi on the Caspian Sea. Internal air transport services provide a means of quick communication within the country, and international airport facilities exist at Tehran.

The country is a large producer of crude and refined oil and natural gas; it also produces a useful amount of hard coal (195,000 tons in 1966). The total electricity generation in 1968—1969 amounted to an estimated 2,430 million kWh. The power distribution facilities are unevenly developed and the mines and ore-dressing plants frequently have to supplement the supply system with their own generating plants, or even provide all the

generating capacity they require. Private power generation accounts for an estimated additional 5—7 per cent.

The country produces and exports around 130,000 tons/annum of chromite, in addition to the non-ferrous ores mentioned below.

Aluminium

Several bauxite deposits have been located in the northern, central and southern parts of the country and are currently under investigation. The 1963 survey estimated that there were 7 million tons of commercial ores and 16 million tons of low-grade ores. The existence of new deposits of diasporic bauxites and high-alumina clays was reported in 1968. There is some doubt, however, as to the reliability of the 1963 estimates, and no commercial deposits have been proved.

The building is under way of an aluminium reduction plant at Arák in Central Iran which is scheduled to be in production by 1972. The initial capacity planned is 20,000 tons/annum, which can be readily expanded to 45,000 tons/annum as soon as the demand justifies this. The power will be provided by hydroelectric generation, using the resources of a nearby lake and river. The scheme has been promoted under the auspices of the Regional Co-operation for Development (RCD) organization and will be financed 75 per cent by Iranian interests, 5 per cent by Pakistan and the balance by Reynold Metals Company. Total investment is estimated at $46 million. It is hoped that eventually domestic consumption in Iran will account for 35,000 tons and Pakistan will take 10,000 tons.

In conjunction with this project, it was proposed to build a rolling mill, extrusion and wiredrawing facilities, but at the moment of compiling this study Pakistan had not given its firm acceptance to the offer of participation. There is a small extrusion plant, Sherkat Sanaye Pars Va America, which is believed to have a capacity of about 500 tons/annum. Imports of ingot aluminium in 1966 amounted to 508 tons and of semi-fabricated aluminium to 288 tons.

Data on imports and exports of aluminium in various forms are summarized in table 97.

Table 97

IMPORTS AND EXPORTS OF ALUMINIUM IN VARIOUS FORMS, IRAN

(Tons)

	1966—1967 [a]	*1967—1968* [a]	*1968—1969* [a]
Ingot aluminium—imports	5,423	3,992	4,970
Ingot aluminium—exports	2,030		165
Aluminium scrap—imports	723	628	813
Aluminium scrap—exports	100	1,067	
Semi-fabricated aluminium—imports	2,707	1,854	3,527
Semi-fabricated aluminium—exports	7	168	10
Aluminium manufactures—imports	10,828	13,841	17,741
Aluminium manufactures—exports	100	97	125

[a] The Iranian calendar year commences on 22 March.

Copper

Copper ore deposits are known to exist in the north-west, east and south of the country. A deposit estimated to amount to 350 million tons of ore containing 1.15 per cent copper has been discovered on Sar-Cheshmeh which Iranian Selection Trust has begun to develop with a view to producing 52,000 tons/annum of copper at an estimated cost of $50 million. Copper ore is being mined in quantity at Mazra'eh, and there is a limited output from Rashidabad and a number of smaller mines. A processing plant at Zandjan converts ore into matte, which is turned into metal at the Ganniabad smelter (near Tehran), with an output of about 1,000 tons per annum. The copper is converted into sheet and sections of copper and copper alloys. The extrusion plant of Sherkat Sanaye Pars Va America also produces copper and copper-alloy extrusions.

Table 98

ESTIMATES OF LEAD AND ZINC ORE RESERVES IN IRAN (1965)

(Thousand tons)

Mine (and operating company)	*Minerals (in order of importance)*	*Estimated reserves*			*Average metal content*	
		Proven	*Probable*	*Inferred*	*Lead (per cent.)*	*Zinc (per cent)*
Angouran (Simiran)	Smithsonite, Cerussite, Sphalerite, Galena	4,250	3,000	1,000	10.0	30.0
Kuchke (Simiran)	Sphalerite, Galena	5,000	4,000	...	2.5	10.5
Shah kuh (Bama)	Smithsonite, Cerussite, Sphalerite, Galena	500	1,000	...	6 0	28.0
Mehdiabad	Smithsonite, Cerussite	...	...	18,000	2.9	7.1
Mehdiabad	Sphalerite, Galena	...	...	6,000	2.9	3.8
Ozbakuh (Maaden Lute)	Galena	10	...	...	12.0	2.0
Zahbad (Minak)	Sphalerite, Galena	200	1,000	...	4.5	6.5
Ravange (Ravere)	Galena, Cerussite	700	—	...	6.0	—
Nakhlak (Iran Mining and Metal)	Galena	500	2,500		10.0	—
Chah Sorb (Khuhestan)	Galena	150	250		15.0	—
Nieband (Khuhestan)	Sphalerite, Galena	400	800		3.0	6.0

Lead and zinc

Iran has quite large reserves of lead and zinc ores. Over 150 lead, 40 lead-zinc and 5 zinc deposits are known; they are located in various parts of the country ranging over the north-west, east, south-west and central regions. Of these, 45 deposits are being worked currently. The data on estimated reserves for the larger deposits are summarized in table 98.

A number of the mines have ore-dressing facilities. The lead ore is mainly floated or hand-sorted, and the oxidized zinc ores are hand sorted and calcined. Table 99 summarizes available information on the beneficiation plants for lead and zinc ores, including estimates of annual capacity. Data on output of concentrates, which are all exported, and imports of refined metal are given in table 100.

Table 99

CHARACTERISTICS OF BENEFICIATION PLANTS FOR LEAD AND ZINC ORES — IRAN

Mine	*Type of Plant*	*Capacity (tons per annum)*
Anguran	Calcining	...
Kuchk	Flotation	135,000
Shah-kuh	Flotation	24,000
Ozbak-Kuh	Flotation	30,000
Zeh-Abad	Flotation	3,000
Ravanj	Flotation	105,000
Nakhlak	Flotation	60,000
Chah-Sorlu	Table, jig and flotation	15,000
Neiband	Flotation	15,000
Ardakan	Flotation	15,000
Lakan	Flotation	90,000
Total		525,000

Table 100

EXPORTS OF LEAD AND ZINC CONCENTRATES AND IMPORTS OF REFINED METAL — IRAN

(Tons)

	1966 – 1967 [a]	*1967 – 1968* [a]	*1968 – 1969* [a]
Zinc concentrates[b] — exports	77,547	51,112	40,122
Refined zinc — imports	1,031	3,777	3,765
Lead concentrates[c] — exports	44,935	36,177	47,485
Refined lead — imports	2,742	3,905	3,619

[a] The Iranian calendar year commences on 22 March.
[b] 40 – 45 per cent zinc.
[c] 40 – 50 per cent lead.

Most of the mining enterprises are privately owned, some jointly with foreign companies. A small number of mines are state-owned, including the Nakhlak and Ghanat-Marvan undertakings. Geological conditions indicate

the probable existence of other deposits of lead-zinc ores, and the possibility exists of appreciably expanding the output of existing mines and of developing new ones as part of the industrialization of the country.

Tin

There are no known deposits of tin in the country and domestic consumption of tin in all forms is very small.

Iraq

There are no reports so far as can be ascertained of occurrences of non-ferrous ore deposits in the country nor of semi-fabricating plants.

Jordan

The Kingdom of Jordan lies between Saudi Arabia, Iraq, the Syrian Arab Republic and Israel, with a small outlet to the sea through the port of Aqaba on the Red Sea. Its population of 1,935,000 (1968 estimate) is unevenly distributed over an area of 97,700 km², with most living in the western half of the country, particularly in the larger cities of Amman, Zarqa, Irbid and Nablus. Much of the country is desert or semi-desert; the western half is fertile but suffers from soil erosion, and much of the eastern part is a limestone plateau, broken up by arid steppe country. The climate is subtropical with dry summers and continental influences. Rainfall is low, and the streams are often seasonal and come into flood during the winter rains. The main river, the River Jordan, and its tributary, the Yarmuk, are perennial and flow into the Dead Sea.

A railway line runs from Damascus in the Syrian Arab Republic via Amman to Qatrana and terminates at Naqb Ashtar in the south; an extension is planned into Saudi Arabia. The road network with asphalt surface links the capital, Amman, with the principal towns and the port of Aqaba, as well as with its neighbours, the Syrian Arab Republic and Iraq. It totals 2,116 km. There is also a wide network of unmetalled roads. Royal Jordan Airlines operates services from the international airport at Damascus. There are no known domestic fuel resources, and oil prospecting has so far produced negative results. Agriculture dominates the economy, with wheat, barley and fruit as the main crops, irrigation is essential to any significant expansion in this sector.

Aluminium

There are no known bauxite or high-aluminous ore deposits in the country and no domestic aluminium semi-fabricating industry exists. Imports of semi-fabricated products amount to only a few hundred tons per annum.

Copper

Copper sandstone deposits have been found in Uddi-el-Aravo near the border with Israel and are believed to be an extension of the deposits in Israel. These have been estimated at 22 million tons of ore, containing an average of 1.25 per cent copper.

Exploitation of deposits at Wadi Khursheibeh indicates the existence of 4 million tons, containing 0.67 - 0.70 per cent copper. These deposits were considered to be only secondary mineralization on the surface; there have been no reports confirming primary mineralization at depth. Manganese-bearing copper deposits at Wadi Dana, 180 km south-west of Amman, have been reported to be under investigation, but no details have been published. More recently, the existence of about 455 million tons of white sand mixed with copper ore, which contains 8 - 10 per cent copper, have been discovered in the Wadi Araba region, the main deposits being near Kherbet Saloum, Oum, Ommad and Wadi Kheila. These deposits are being evaluated.

There is no semi-fabricating industry in the country and imports of copper in all forms amount to only around 200/300 tons per annum.

Lead, tin and zinc

There are no reports of occurrences of these metals and there is no industry associated with their manufacture or fabrication.

Lebanon

The existence of Lebanon as an independent state dates from 1941 when it ceased to be a French mandate. Situated at the eastern extremity of the Mediterranean, with the Syrian Arab Republic to the north and east and Israel to the south, it forms a strip of approximately 180 km in length and around 50—60 km in width. The coastal area and slope of the mountains, which cover most of the country, has a Mediterranean climate and vegetation, while the inland mountain range has the characteristics of a steppe. The total land area amounts to approximately 9,400 km².

Traditionally, the Lebanese have been traders, and the ports of Beirut and Tripoli have an active entrepôt trade. There are three railway lines, which are state-owned: Nakoura-Beirut-Tripoli (standard gauge), of which the Nakoura-Saida section is not currently operated; a narrow-gauge line from Beirut to Riyaq and thence to Damascus (Syria); and a standard-gauge line from Tripoli to Homs and Aleppo (Syria), with a branch from Homs turning south, re-entering Lebanon and terminating at Riyaq. There is a good road system with a surface normally of asphalt and a good network of main arterial and secondary routes. The registration of commercial vehicles in 1967 totalled over 12,000. The international airport at Beirut lies on the main routes east and is widely used by international airlines.

The service industries associated with commerce and agriculture account for a large part of employment. The industrial sector is expanding but remains relatively small. The main activities are associated with textiles, food processing, tobacco, soap, leather, perfumes, paint and matches. There is an oil refinery at Tripoli with a capacity of 3 million tons per year. Electricity consumption is in the region of 350 million kWh per annum.

Aluminium

There are no indications of the presence of bauxite or other high-aluminous deposits in the country and no aluminium reduction industry. There are two semi-fabricating plants, one of which produces extrusions and is operated by Société pour le Commerce et l'Industrie d'Aluminium et des Enterprises (SCIALE) (in which Reynolds Metals Company, United States, has a minority interest). The other, Société pour l'Industrie des Métaux (SIDEM), in which Pechiney S.A. (France) has a minority interest, operates a rolling mill and extrusion press.

Recent statistics available relating to the aluminium industry are given in table 101.

Table 101

IMPORTS OF ALUMINIUM INGOT AND IMPORTS AND EXPORTS OF SEMI-FABRICATED ALUMINIUM — LEBANON

(Tons)

	1965	1966	1967
Imports of aluminium ingot	1,429	3,921	4,236
Imports of semi-fabricated aluminium	578	583	
Exports of semi-fabricated aluminium	2,373	3,634	2,570

Copper

There are no known deposits of copper ores in the country nor is there a refining industry. In Beirut there is a small fabricating works, Boghos Najjarian, and a wiredrawing and cable plant, Cablèries Réunies. Recent statistics relating to copper are given in table 102.

Table 102

IMPORTS OF UNWROUGHT AND SEMI-FABRICATED COPPER — LEBANON

(Tons)

	1965	1966	1967
Imports of unwrought copper	666	969	1,326
Imports of semi-fabricated copper	537	489	

Lead, tin and zinc

Surveys so far made have not revealed the presence of these metals. Imports of lead in all forms amounted to 1,326 tons in 1967 and of zinc, 504 tons.

Saudi Arabia

The kingdom of Saudi Arabia, which occupies the major part of the Arabian peninsula between the Persian Gulf and the Red Sea, has Iraq and Jordan as its neighbours in the north, Yemen, the People's Democratic

Republic of Yemen and Muscat and Oman to the south and south-east, and the various territories referred to collectively as the "Gulf States" to the north-east. It is estimated that about 50 per cent of the population of 7.1 million (1968 estimate) is nomadic. The territory has a land area of approximately 1.840 million km².

The main feature of its physical geography is the ancient "Arabian Shield" of igneous and metamorphic rocks, which occupies much of the belt running parallel to the Red Sea. The highest mountains rise to over 2,500 m and most of the country lies between 200 m and 1,000 m above sea level. The Asir mountains in the south-west are the only area receiving moderate rainfall; the rest of the country is desert. The summer heat is fierce, tempered by the aridity of the higher regions but aggrevated by the humidity along the coasts.

The country has a long coastline but few good natural harbours. The main ports are Ad Dammam on the Persian Gulf and Jiddah on the Red Sea. A railway from Riyadh via Dhahran, Abqaiq, Ithmaniya and Harad to Ad Dammam was completed in 1951. A line is being built from Medina to link with the line from Damascus to Ma'an in southern Jordan. Jiddah and Dhahran have airports constructed to international standards which connect with the main routes, and Riyadh airport is also of international standard. There are thirteen other internal airfields. The main asphalt roads connect Mecca with Jiddah and also with Riyadh and Dhahran; they total approximately 1,200 km. A programme for the construction of over 7,500 km of new roads is under way.

The economy of the country is dominated by the oil industry, which provides 80 per cent of the budget revenue and most of the foreign currency. The main commerce of the nomadic peoples lies in hides, wool, clarified butter and similar products. There is fishing in the Persian Gulf and Red Sea. There is some production of dates, wheat, barley, honey, fruit etc. by the settled communities, but there is little export trade in these products.

Aluminium

There are no reports of bauxite occurrences in the country and it is thought unlikely that these exist. There is no aluminium reduction or semi-fabricating industry.

Copper

In 1966, exploration for minerals was carried out in the western province, and a copper ore body was located on Mount Sayed about 100 m from the surface that is estimated to amount to 7 million tons; the copper content has not been revealed, but it is believed to be at a commercial level.

The Syrian Arab Republic

Situated at the eastern end of the Mediterranean Sea with a coastline of approximately 160 km, the Syrian Arab Republic is to the south of Turkey,

to the west of Iraq, to the north-east of Lebanon, and to the north of Israel and Jordan. The total land area is 184,500 km².

The coast and western mountains have essentially a Mediterranean climate, but further inland the climate becomes arid, with cooler winters and hotter summers in large areas of desert. The main drainage is provided by the Euphrates which runs south-east across the country, entering at Jerablus and leaving a little beyond Abu Kemal. The other main river is the Assi, which runs north and is about 30 km from the coast.

A standard-gauge railway line runs from Aleppo to Meidan-Ekbes on the Turkish frontier (110 km), and from Aleppo to Tel-Kotchek on the Iraq frontier (500 km); a narrow-gauge line runs from Damascus to Hama (200 km), and from Damascus to Deria on the Jordan boundary. Two further lines – Al Jezirah to Latakia and Damascus to Jordan with access to Saudi Arabia – are planned and under construction. There are approximately 5,000 km of asphalted all-weather roads and 10,000 km of secondary roads. The main port is Latakia, which is constructing a deep — water harbour. Damascus airport accommodates international airlines, and there are limited internal air services.

The country is essentially agricultural with the production of cereals and raising of cattle as the main activities. The main industries are food processing, textiles, tanning, tobacco, knitwear, glassware, hosiery, footwear and metalware. Syria does not produce oil but receives revenue from Iraq for the oil pipeline that crosses the country. Deposits of natural gas have been reported in the Jezirah.

Aluminium

There are no reports of bauxite occurrences in the country, and it is thought unlikely that these exist. There is no aluminium reduction or semi-fabricating industry.

Copper

There have been no reports noted that refer to the possible occurrence of copper-bearing ores in the country, nor is there a semi-fabricating industry.

Lead, zinc and tin

There are no reports of sitings of ores of these metals and there is no industry associated with their processing and refining.

Turkey

The major part of Turkey lies in the north-west corner of the region often referred to as Asia Minor, and it has a European enclave in the south-east corner of the Balkan peninsula. Its neighbours in south-east Europe are Bulgaria and Greece. The northern border of Turkey (in Asia) is provided by the Black Sea, and it has a frontier with the Soviet Union in the north-east and with Iran in the east. To the south are Iraq and the Syrian Arab Republic.

The population of 32.7 million (1968 estimate) is unevenly distributed, with a high proportion living in western Turkey, Turkey-in-Europe, and in the coastal towns. Most of the area of the peninsula is occupied by the Central Anatolian plateau, which rises from 500 to 1,500 m, with a number of mountain ranges on the periphery of the plateau and in the east of the country. The total land area amounts to 767,000 km². The climate is characterized by hot, dry summers with wide diurnal temperature variations and very cold winters.

Turkey provides the headwaters of the rivers Tigris and Euphrates which flow southwards into the Persian Gulf. Other large rivers, the Ceyhan and the Menderes, and the Gediz, flow south and west respectively into the Mediterranean. There are a number of smaller rivers flowing into both the Black Sea and the Mediterranean; many of them are fast-flowing and they have considerable undeveloped potential for hydroelectric power generation.

The country has a railway network of over 9,000 km connecting the main centres of population. The road system is poorly developed in the eastern part of the country; however, buses provide a widely used means of transport for both passengers and goods. For shorter distances pack mules and horse-drawn transport are used.

Production of electricity in 1966 amounted to 5,535 million kWh, of which 2,318 million kWh were produced from hydroelectric installations. An important new development nearing completion is the Keban hydro-electric scheme on the Euphrates, which will have an output of nearly 6,000 million kWh/annum.

Coal and lignite deposits are found in the country. High-quality coal is mined in the Zonguldak area and amounted to 4.9 million tons in 1966; in the same year lignite production amounted to 3.6 million tons. Oil has been discovered on the upper Tigris near Romandaga, and production amounted to 2 million tons in 1966.

Under the current development programme a substantial investment is being made to improve the economic infrastructure of the country.

Aluminium

Significant bauxite deposits exist and these have been mined near Akseki; another deposit is known at Kokasu, 3 km south of Zonguldak. As part of a new aluminium production project, the deposits at Seydisehir in western Turkey are being studied with a view to initiating large-scale development. Domestic mining of bauxite is believed to amount currently to around 35,000 tons per annum. The reserves are estimated at 18 million tons and have a 60 per cent Al_2O_3 content. Other smaller deposits are located at Sebilköy and Kan in the Taurus Mountains. Deposits of diaspore bauxite lie between Milas and Mugla in the south-west, and in Alanya on the south coast, Saimbeyli and Bolkardag (Central Taurus). Total reserves of all bauxites are estimated at 100 million tons, of which 30 million tons are proved.

An aluminium plant with associated alumina production facilities is under construction near Seydisehir, which will initially produce 25,000 tons/

annum of aluminium. A plant is planned with a capacity of 200,000 tons annum alumina and 60,000 tons/annum aluminium. It will be supplied by the Soviet Union, which is also providing financial and technical assistance, and the Turkish Etibank is the domestic partner.

Data on bauxite production and on imports of ingot aluminium and semi-fabricated products are summarized in table 103.

Table 103

PRODUCTION OF BAUXITE AND IMPORTS OF ALUMINIUM INGOT AND SEMI-FABRICATED PRODUCTS — TURKEY

(Thousand tons)

	1960	*1965*	*1966*	*1967*	*1968*
Bauxite production	—	10.3	32.3	35.0	35.0
Imports of aluminium ingot	0.3	5.6	8.2	9.3	13.1
Imports of semi-fabricated products	1.4	1.7	2.9	...	...
of which aluminium foil	...	0.9	1.9	...	...

In conjunction with the smelter project, an associated rolling mill and ancillary facilities are planned. Other semi-fabricating facilities already exist in Turkey, consisting of a wiredrawing and cable plant, Turkkablo A.O., a small rolling mill and extrusion plant at Derince near Izmit, Rabak Electrolitik Bakir ve Mamulieri A.S. in Istanbul, and a further extrusion plant, Makina ve Kimya Endustrisi Kurumu.

Copper

The main deposits of copper ores are all being exploited and are based in three centres. The deposit at Ergani (Elazig) is estimated to have reserves amounting to 2.5 million tons, averaging 5.5 per cent copper (excluding low-grade ores); it is operated by Etibank. Output is running at 350,000 tons/annum, which is being expanded to 500,000—600,000 tons/annum, and the output of the concentrator is also being expanded. Black Sea Copper Mines at Murgal (Artvin) has estimated reserves of 40 million tons of ore containing 1.2—1.8 per cent copper and small amounts of cobalt, gold and silver; its production is reported to be 8,000 tons/day of ore. It also produces copper concentrates, the output of which is being expanded. At Küre, Kastamonou, reserves of copper ore amounting to 11 million tons with a metal content of 1.3—6 per cent occur in conjunction with pyrites, and output is believed to be about 700 tons/day. Construction of a concentrates' plant is being undertaken.

Blister copper is produced at Murgul and Ergani, and electrolytic copper is produced at Kirrikkale and Istanbul. More than half of the blister copper produced is exported, the rest being converted to electrolytic copper for domestic consumption. Details of mine, smelter and refined copper production, exports and consumption are summarized in table 104.

Table 104

MINE, SMELTER AND REFINED COPPER PRODUCTION, EXPORTS AND CONSUMPTION. TURKEY

(Thousand tons)

	1959	1965	1966	1967	1968	1969
Mine production	27.7	33.6	32.0	32.0	31.3	30.6
Smelter production	25.0	26.1	26.7	25.4	23.3	19.3
Exports of blister copper	...	20.2	19.9	15.3	15.1	6.5
Refined copper production	9.2	6.5	6.0	8.1	8.0	11.8
Refined copper consumption	...	6.5	6.0	8.1	8.1	8.1

A new copper-smelting plant is being built at Hopa on the Black Sea coast and is designed for an annual output of 40,000 tons of blister copper, with an associated sulphuric acid plant of 200,000 tons/annum output. It will be supplied by concentrates from the Murgul. Completion of this plant in 1971 should enable Turkey to produce 55,000—60,000 tons/year of blister copper. The project is under the control of Etibank with the participation of American interests.

A small domestic fabricating industry consists of two plants, one at Kirikkale and the other near Istanbul, with facilities for producing copper and brass wire, extrusions and sheet.

Lead and zinc

There are a number of small lead-zinc ore deposits, containing 8—12 per cent lead and 5—15 per cent zinc; over 30 are distributed throughout the country, and the most important are around Keban, Madeni and Zumanti. Total proved and probable reserves are 40,000 tons of both lead and zinc. Small amounts of copper, silver, gold, cadmium and other elements are extracted as by-products. The presence of oxidized lead-zinc ores has been reported. These present some processing difficulties but a suitable concentrating method is being developed.

Data on production of lead and zinc, exports of concentrates and consumption of refined metal are summarized in table 105.

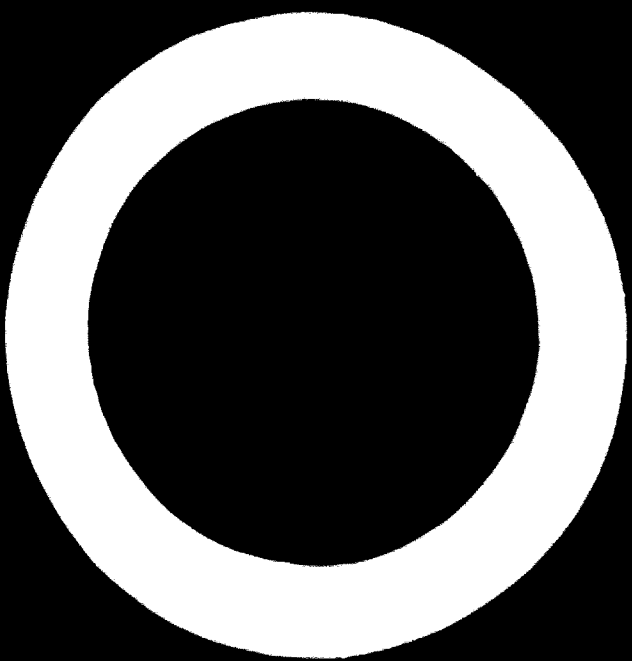
Table 105

LEAD AND ZINC PRODUCTION, EXPORTS AND CONSUMPTION IN VARIOUS FORMS. TURKEY

(Thousand tons)

	1959	1965	1966	1967	1968	1969
Lead—mine production	1.8	1.9	3.6	4.9	6.8	4.1
Zinc—mine production	3.6	1.8	6.1	3.4	14.0	10.7
Primary lead—production	1.8	0.9	0.5	1.2	1.6	1.2
Lead concentrates—exports	1.7	2.0	1.0	...	...	...
Zinc concentrates—exports	2.8	8.0	17.0	...	...	...
Refined lead—consumption	3.0	3.6	3.6	5.0	5.0	4.9
Refined zinc—consumption	...	2.4	2.4	3.0	3.3	8.0

These ores are mined underground at ten separate sites; the output of the largest mine does not exceed 40,000 tons/annum. The concentrates produced contain 68 per cent lead and 56 per cent zinc. Refined lead is produced at the smelter in Deneka. The lead concentrates not handled by the Deneka plant and all the zinc concentrates are exported. Refined metal is imported.



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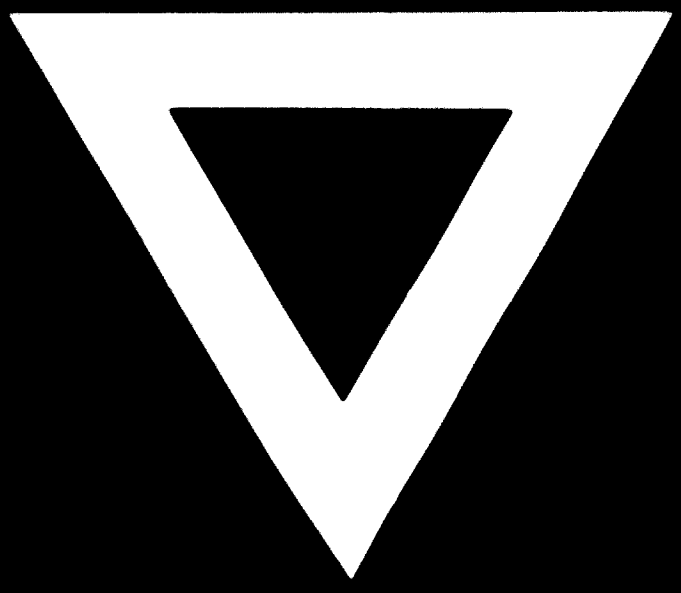

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