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of NON-FERROUS METALS

ALUMINIUM, COPPER, LEAD, ZINC AND TIN
INDUSTRIES IN THE DEVELOPING
COUNTRIES

p. 503

The survey prepared by the Institute Tsvetmetinformatsiya (USSR) for the Industrial Technology Devision of the Secretariate of UNIDO on the contract NIT-69/I dated 22 april 1969

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The Survey is prepared by a research group of the Institute "Tsvetmeminformatsiya" under the quidance of M.Dorochov, V.Michailov, M.Umanskaya

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PREFACE

This study "Aluminium, copper, lead, zinc and tin industries in the developing countries" has been carried out by the Scientific Research Institute of Information and Technical-Economical Studies of Non-Ferrous metallurgy of the USSR (Tsvetmetinformatsiya) on the contract with the Industrial Sectors' Development Section of UNIDO.

The study has been composed in the form of a survey of the five main non-ferrous metals mentioned above which are mined and consumed in the developing countries, and consists of two main sections.

The first section includes the general problems of the aluminium, copper, lead, zinc and tin industries in the developing countries; the second section considers the problems of the development of those fields in separate developing countries.

The survey includes materials on the following developing countries: in Africa: Algeria, Morocco, Tunisia, the UAR; Ghana, Guinea, the Cameroons, Sierra-Leone; Zambia, Congo (Kinshasa), Congo (Brazzaville), Mauritania, Uganda, Kenya, the Sudan, Botswana, Tanzania; Nigeria, Niger, Burundi, Rwanda, Swasiland; South-West Africa; in Asia: Burma, India, Iran, Jordan, Cyprus, Pakistan, Turkey; Indonesia, Malaysia, Thailand, Laos, Singapore; in Latin America: Mexico; Bolivia; Venezuela, Guiana, Haiti, Surinam, Jamaica, the Dominican Republic; Argentina, Brazil, Peru, Chile; Honduras, Guatemala, Colombia, Ecuador.

The information is based on the published sources given in the references.

SECTION I

GENERAL CHARACTERICTICS OF THE ALUMINIUM, COPPER, LEAD, ZINC AND TIN INDUSTRIES IN THE DEVELOPING COUNTRIES

§ 1. Mining of Ores. Production and Consumption of Metals

Independence gained by many developing countries gave an impact to a rapid growth of their economy.

Whereas for the industry of the developed countries as a whole the index numbers of industrial production has grown 4.1 times from 1938 to 1967 and 1.8 times since 1955, for the developing countries this index was considerably higher and amounted to 5.1 and 2.4 times, respectively. The mining industry of the developing countries also had been growing during these years at a more rapid pace compared with the developed countries.

Industrial progress in the developing countries is characterized by the rapid growth of not only quantitative, but also qualitative indices. To the latter belongs the amount of electric energy per worker.

Thus, over the 1953-1966 period this amount has grown more than three times in Ecuador, Gabon, Haiti, Lebanon, Liberia and others; and 2.5 times in Brazil, India, Ethiopia, Columbia, Congo (Kinshasa) and others.

The highest level of power supply per worker (in kilowatts of installed capacity) has been attained mainly in the countries of Latin America: Bolivia - 9.91; Chile - 5.51; Mexico - 5.42; Brazil - 5.32. Of the young developing countries the highest figure (5.66 kwt) is for Nigeria.

Thus, progressive changes in the pattern of industry of the developing countries were sufficiently marked. Nevertheless in their overwhelming majority these countries continue as yet to remain industrially backward.

The share of industry in the gross national product in developed countries is, as a rule, 30-40 per cent, whereas in developing countries it is at the level of about 20 per cent. In developed countries the proportion of industry exceeds several times that of agriculture, while the reverse is true of developing countries.

One of the main problems which determine further rise of national economy of developing countries is the problem of creation of trained personnel. At present the number of hired workers in developing countries is growing, especially in industry.

For example, in the processing industry of Ghana employment has increased more than 2.5 times during the 1953 to 1966 period, in the industries of Columbia and Kenya, - 1.5 times. Nevertheless the absolute employment of population in developing countries is low. This can be seen, for example, from the ratio of the number of employed persons to the total number of self-supporting population. Whereas for the developed countries this ratio is less than 80%, for the developing countries it varies from a few units per cent (the Upper Volta, Niger, Nigeria, Togo) to 35-40% (United Arab Republic, Algeria, Zambia). This is particularly true for manufacturing. Suffice it to say that the working class of the developing countries comprises only 20 per cent of all employed persons, and for the countries of South and South-East Asia this figure is still lower.

A further growth of employment is only possible with an increase in the number of operating enterprises, which, apart from a number of other reasons, is greatly handicapped by the lack of trained personnel. This results in a much greater proportion of the unemployed, than in the developed countries.

It should be admitted, that a further growth of national economy in developing countries depends also to a considerable extent on the raising of the level of general education of the population and setting up of a mass network of schools for professional training.

Non-ferrous metallurgy of the developing countries is an important part of the world industry of non-ferrous metals.

Table I

Proven and Probable Reserves of the Five
Basic Non-Ferrous Metals in Developing Countries
(designated DC in the Table)

Metals	1 9 5 8			1 9 6 7			Average growth of reserves,% per annum (1959-1967)	
	World reserves[1] million tons	DC, million tons	Share of DC in world reserves,%	World, million tons	DC, million tons	Share of DC in world reserves, %	World	DC
Aluminium (Bauxites)	428	320	74.8	2551	1428	56.0	22	18
Copper	86	54	62.8	163	104	64.4	7.4	7.6
Lead	20	3.7	19.1	49	12	25.1	10.7	14.1
Zinc	37	4.8	12.8	71	17	23.6	7.5	14.9
Tin	1.44	1.26	87.1	2.9	2.6	90.9	8.1	8.6

[1] Here and further the Socialist countries are not included.

The developing countries have more than 90% of proved and probable reserves of tin, about 65% of copper, over 50% of bauxites and about 25% of lead and zinc reserves.

A reduction of the share of DC bauxite reserves in the world reserves in 1967 was caused by the discovery of large deposits of bauxites in Australia.

The share of lead and zinc reserves of developing countries increased in 1967 as compared to 1958 as a result of an increase in reserves of lead in Morocco, Mexico and Peru and zinc in Congo, Zambia, Mexico and Argentine.

The share of copper reserves of developing countries has changed little over the 1958-1967 period; the average annual rate of growth of copper reserves was the same for the developing countries and the world as a whole.

Comparative data on the mine production (metal content) in the world and the developing countries are given in Table II.

Particularly high is the share of the developing countries in the mining of tin ores (about 96%) and bauxites (about 70%). A reduction in the proportion of developing countries in the mining of bauxites is to be expected in connection with the development of deposits in Australia, discovered in recent years.

The average annual rate of growth of bauxite and copper mine production in developing countries is higher than the world rate. A different picture is seen for lead and zinc: the share of ores of these metals mined in developing countries is falling; the average annual growth rate of mining of lead and zinc ores is lower than that in the world.

The data characterizing the share of the developing countries in production of the five metals reflect the changed status of these countries, where new plants are being built and the smelting of metals is sharply increasing (see Table III).

Very low as yet, though growing, is the consumption of non-ferrous metals in the developing countries (see Table IV).

A summary of data on the share of the developing countries in the world reserves, mine production , smelter production and consumption of the five non-ferrous metals is given in Table V.

Table II

Mine production of the Five Non-Ferrous Metals

in the Developing Countries (designated DC in the Table)

Metals	1955			1967			Average growth of mine production, % per annum	
	World, thou. tons	DC, thou. tons	Share of DC in world production,%	World, thou. tons	DC, thou. tons	Share of DC in world production,%	World	DC
Bauxites	13774	9865	71.6	36377	25916	71.2	8.4	9.2
Copper in ore	2681	1223	45.7	3976	2129	53.5	3.3	4.7
Lead in ore	1691	636	37.5	2079	647	31.0	1.75	0.2
Zinc in ore	2245	695	30.9	3743	844	22.5	4.0	1.7
Tin in concentrates	170	162	94.3	168	161	95.8	-	-

Table III

Production of Primary Non-Ferrous Metals in the Developing Countries

Metals	1955 World production, thou. tons	1955 DC, thou. tons	1955 Share of DC in world production, %	1967 World production, thou. tons	1967 DC, thou in tons	1967 Share of DC world production, %	Average annual growth rates, (1956-1967), % World	Average annual growth rates, (1956-1967), % DC
Aluminium	2577	9	0.3	6121	283	4.6	7.5	-
Blister copper	2685	1113	41.5	3935	1885	48.0	3.25	4.5
Primary refined copper	2716	616	22.7	3768	1233	32.8	2.75	6.0
Lead	1632	383	23.3	1960	439	22.4	1.5	1.1
Zinc	2223	149	6.7	3059	269	8.8	2.7	5.0
Tin	172.0	78.3	45.5	176.8	121.4	68.6	0.2	3.7

Table II

The Share of DC in World Consumption of Five

(Primary) Non-Ferrous Metals

Metal	1955			1967			Average annual growth rates (1956-1967), %	
	World consumption, thou. tons	Consumption in DC, thou. tons	Share of DC in world consumption,%	World consumption, thou.of tons	Consumption in DC,thou. of tons	Share of DC in world consumption,%	World	DC
Aluminium	2562	43	1.6	5908	314	5.3	7.2	18.0
Refined copper	2609	93	3.6	3943	180	4.6	3.5	5.7
Lead	1757	93	53	2109	243	11.5	1.5	8.3
Zinc	2250	104	4.6	3222	307	9.5	3.0	9.4
Tin	145	12.9	8.9	164	14.6	8.9	1.0	1.0

Table V

Share of the Developing Countries in the World Reserves, Mine Production, Metal Production and Consumption of Basic Non-Ferrous Metals, %

	1955				1967			
	Reserves	Mine production	Metal production	Consumption	Reserves	Mine production	Metal production	Consumption
Aluminium	74.8[1]	71.6[1]	0.3	1.6	56.0[1]	71,2[1]	4.6	5.3
Refined copper	62.8[2]	45.7[2]	22.7	3.6	64.4[2]	53.5[2]	32.8	4.6
Lead	19.1	37.5	23.3	5.3	25.1	31.0	22.4	11.5
Zinc	12.8	30.9	6.7	4.6	23.6	22.5	8.8	9.4
Tin	87.1	94.3	45.5	8.9	90.9	95.8	68.6	8.9

1) Bauxites

2) Copper in ore

Charcteristic of non-ferrous metallurgy in developing countries is the gap between the share of these countries in the world mine production and their proportion in the world metal production and, particularly, the world consumption of metals.

These ratios are different for individual metals. Particularly sharp contrast can be seen for aluminium, where the proportion of the developing countries in the world mining of bauxites was 70% in 1967 against 4.6% in production, and 5.3% in consumption of aluminium.

It should be pointed out, that the above-mentioned gap has somewhat diminished for the five metals during the 1955-1967 period. As substantial may be regarded the change in the pattern of copper production : with an unaltered proportion of the developing countries in the world reserves, their proportion in the mine production of copper has increased from 46 to 54% and in production of refined copper from 23 to 33%.

The proportion of developing countries in the world production of tin has also increased from 45.5% in 1955 to 68.6% in 1967.

During the 1955-1967 period there has been a marked increase of the developing countries share in the world consumption of some metals. For example, the share of aluminium consumption has increased from 1.6% in 1955 to 5.3% in 1967, share of lead, consumption from 5.3% in 1955 to 11.5% in 1967.

§ 2. The Exports, Imports Pricos

Tho gap between tho mine production of metals, and thoir metal production and consumption predetermines very large exports of raw materials and metals from developing countries (see Table VI).

Table VI

Exports of Non-Ferrous Metals and their Raw materials from the Developing Countries (designated DC in the Table)

	1955			1967		
	World export[1)] thou. tons	DC export, thou. tons	Share of DC in world exports, %	World exports[1)] thou. tons	DC export, thou. tons	Share of DC in world export, %
1	2	3	4	5	6	7
Bauxites	8970	8128	90.6	18900	16877	89.4
Alumina	416	187	45.0	3047	2344	76.9
Aluminium	616	-	-	1582	106	6.7
Copper in concentrates	155	114	73.5	340	199	58.5
Blister cop-por	598	514	86.0	724	587	81.1
Refined cop-per	1046	538	51.4	2153	1166	54.2
Lead in con-centrates	263	172	65.4	366	196	53.6
Lead	723	145	20.1	815	189	23.2

1) Estimate

Continued

1	2	3	4	5	6	7
Zinc in concentrates	973	523	53.8	1364	668	49.0
Zinc	712	148	20.8	774	14.9	19.3
Tin in concentrates	94	94	100	46	44	95.7
Tin	124	76	61.3	144	115	79.8

Over the 1955-1967 period there have been some changes in the pattern of exports of the developing countries. These relate mainly to the copper and aluminium industries.

There has been a considerable increase in the proportion of alumina exports from the developing countries in the world exports; for the first time aluminium has begun to be exported from these countries.

The developing countries are large suppliers of bauxites, especially to the USA, Canada and Japan. The countries of the Caribbean Sea area - Jamaica, Surinam, Guiana, the San Dominican Republic and Haiti occupy a leading position in bauxite exports. Less than 25% of bauxites mined is processed into alumina in these countries.

The proportion of alumina exported by the developing countries in the world total has grown up to 77%. The leading exporting countries of alumina are Jamaica, Surinam, [illegible], Guiana and Guinea. Only Surinam is partly processing her alumina into aluminium, being also an exporter of some quantity of aluminium. Guinea is exporting the whole of alumina produced to Cameroon, France and Norway.

In 1967 the proportion of such developing countries as Ghana, Cameroon and Surinam in the exports of primary aluminium was 6.7% of the world exports.

Aluminium-processing plants is Algeria, Argentina, Congo (Kinshasa), Iran, Iraq, Indonesia and Turkey work on imported aluminium.

There have been some changes in the pattern of exports of copper from developing countries during the years 1955 to 1967. The proportion of exports of copper in concentrates and blister copper from these countries in the world export has dropped and the proportion of refined copper has risen (Table VI).

The exports of copper in concentrates from these countries were about 200 thou.tons in 1967. Among these the Philippines accounted for 86 thou.tons (mainly to Japan and USA); Chile, 30 thou.tons; Peru, 23 thou.tons; Cyprus, 18 thou. tons. The exports of blister copper were more significant and amounted to 587 thou.tons distributed as follows: from Chile-241 thou.tons (mainly to USA); Peru - 123 thou.tons (more than a half to USA); Zambia and Congo, 80 thou.tons.

The exports of refined copper from developing countries were high - 1166 thou.tons, including 527 thou.tons from Zambia (about 200 thou.tons to Great Britain, 40-50 thou. tons each to France, F.R. of Germany and Italy, and about 80 thou.tons to Japan); 361 thou.tons from Chile (including 85 thou.tons to F.R. of Germany, 67 thou.tons to Great Britain, 54 thou.tons to Italy and 38 thou.tons to France);

241 thou.tons from Congo (mainly to Belgium).

On the other hand, the imports of copper into developing countries were not high: for 1967, data are available only on the imports of copper into Argentine (20 thou.tons), India (33 thou.tons).

There have been some changes in foreign trade in lead. The share of exports of lead concentrates from developing countries in the world exports has decreased (from 65% to 54%), and the share of exports of lead has increased correspondingly, from 20 to 23%. Lead concentrates are totally exported by Algeria, Congo (Brazzaville), Bolivia and Iran. The exports of lead concentrates from South-West Africa have decreased sharply in connection with the start of operations at the Tsumeb lead plant.

A considerable portion of lead metal produced in developing countries is exported. In 1955 these countries exported 38% of the lead produced, and in 1967 43%.

Considerable quantities of metal were exported in 1967 by South-West Africa (63 thou. tons); Mexico (86 thou.tons); Peru (77 thou.tons); and Morocco (20 thou.tons). The exports of lead from Mexico have declined (in 1955 the country exported 180 thou.tons) due to the growth of domestic consumption.

The imports of lead in developing countries are not great. Among importers of lead may be mentioned India (with 34 thou.tons imported in 1967) and Brazil (9 thou.tons).

The exports of zinc in concentrates in 1967 were [illegible] thou. tons (against the world total of 1,365 thou.tons).

The main exporters of zinc in concentrates among the developing countries in 1967 were: Mexico (160 thou.tons), Peru (247 thou.tons), Congo (Kinshasa) (about 40 thou.tons), and Iran (about 77 thou.tons).

The developing countries exported mainly zinc concentrates. The exports of metallic zinc were smaller. It amounted in 1967 to 149 thou.tons or 19.3% of the world exports. Metal was exported by: Peru (61 thou. tons), Mexico (38 thou.tons), Congo (30 thou.tons) and Zambia (40 thou.tons).

The imports of zinc in 1967 amounted to 87 thou.tons, with India importing 57 thou.tons and Thailand 12 thou.tons.

Of particular importance were the exports of tin in concentrates because tin is exported mainly from developing countries (95.7%). The exports of metallic tin were 80% of the world total. Over the 1955-1967 period the exports of tin concentrates have dropped more than twice, while the exports of metallic tin have increased by 51%. One of the reason for this was putting in operation of the tin smelting plant in Thailand in the Phuket island.

Very considerable exports of non-ferrous metals and their ores are a most important factor in the developing countries' economy. The revenues from non-ferrous metals industry (taxes, royalties, export duties, etc.) constitute a considerable share of the income budget of a number of countries, for example, Chile, Peru, Zambia and Congo. Since such payments depend in most cases on the income coming from sales , the prices of metals and raw materials are of utmost importance for developing countries.

There are no uniform world prices for non-ferrous metals at the present time. There are several main kinds of prices, which serve as a guide in non-ferrous metals trade. The variations of these prices over a years are given in Table VII.

The prices of aluminium are the most stable among non-ferrous metals.

Table VIII gives data on the average value of bauxite imported into the USA.

Table VII

Annual Average Metal Prices , dollars/ton

Year	Aluminium		Copper			Lead		Zinc			Tin	
Kinds of prices	Unalloyed ingot a	Virgin ingots 99.5%	Domestic refinery a	LME wirebar-prompt b	Cif.European ports a	Common a	LME prompt b	Prime Western East St. Louis a	LME prompt b	GOB producer basis a	Straits a	LME, prompt b
1955	483	...	827	972	-	333	291	289	250	-	2089	2070
1956	529	...	922	902	-	353	319	308	268	-	2236	2171
1957	560	...	652	607	-	324	267	262	226	-	2122	2030
1958	547	508	568	546	-	267	201	238	182	-	2096	2025
1959	545	496	687	655	-	269	195	264	226	-	2250	2165
1960	573	513	707	679	-	262	199	296	246	-	2235	2199
1961	562	513	660	635	-	240	177	266	215	-	2497	2449
1962	527	498	675	645	-	212	155	267	186	-	2527	2471
1963	498	498	683	646	646	246	175	276	211	-	2571	2507
1964	523	521	713	966	696	300	279	299	324	-	3477	3416
1965	540	540	772	1285	797	353	317	320	311	303	[illegible]	3899
1966	540	540	797	1520	1194	333	262	320	281	286	3517	3556
1967	551	540	843 1)	1130	1097	309	227	304	272	276	3382	3307
1968	564	548	923	1237	1133	291	240	298	262	271	[illegible]	3385

1) Average for 8 months:
a) New York [illegible]
[illegible] Exchange

Table VIII

Average value of United States imports of bauxite, dollars/ton

	Years						
	1960	1961	1962	1963	1964	1965	1966
Guiana	6.8	7.1	9.0	8.8	8.7	10.0	9.7
Dominican Republic	12.4	13.0	12.2	12.7	14.11	12.2	12.3
Haiti	8.8	9.3	9.2	9.4	14.0	9.3	9.3
Jamaica	9.3	9.3	12.4	13.6	13.8	12.4	12.3
Surinam	7.6	9.2	9.7	10.1	9.6	9.3	9.5
Brazil	-	12.3	-	-	-	-	17.7
Trinidad and Tobago	-	9.1	-	-	-	-	10.5
Average	9.8	9.5	11.4	12.2	12.4	11.3	11.4

Attention should be given to the following circumstance. The prices of aluminium have increased by 8.4% over the years 1963 to 1966, while the average cost of bauxite per ton, exported from developing countries to the USA, has not increased. Over the years 1960 to 1968 there has been almost no change in the price of alumina - 116.8 dollars per ton.

There has been no uniform price for copper on the world market in recent years. When deals were concluded, the partners used three kinds of prices as a guide: (1) the producer price in the USA; (2) the producer price as accepted in deals in Europe; (3) the price of copper on the London Metal Exchange. In the early sixties, as a result of co-ordinated measures by the monopolies to regulate the market, these three prices approached each other and were stable. This pattern of prices, however, changed in 1964. Owing to a deficit of copper, the prices on the London Metal Exchange rose sharply and were subject to considerable fluctuations during the subsequent period. The producer prices in New York rose more rapidly and were comparatively stable. The producer prices of c.i.f. Europe (at which the copper of developing countries was sold) during 1964*1965 approached the producer prices in New York, but were much lower than those on the London Metal Exchange. For example, in December 1965 the price of copper on the London Metal Exchange was 1516 dollars per ton, whereas the producer price in New York was 791 dollars per ton, and producer price c.i.f. Europe - 865 dollars per ton. In April 1966 the gap became still greater: the copper producer price in New York was equal to 79[illegible] dollars per ton, price c.i.f. Europe - 964 dollars per ton, whereas that on the London Metal Exchange was 1866 dollars per ton.

This gap caused great financial losses to developing countries, since the copper exported by them was being sold at the prices c.i.f. Europe.

In 1967 the governments of the developing countries which are large producers of copper, viz. Chile, Peru, Zambia and Congo, began selling copper in accordance with the London Metal Exchange quotations.

During recent years the importance of the London Metal Exchange quotations has increased; since 1966 most of the copper outside the USA has been sold at these prices.

In June 1967 the representatives of four developing countries - Zambia, Congo, Chile, and Peru - met at a conference in Lusaka for the purpose of strengthening the influence of their countries on the copper market. These countries account for about 44% of the world production of primary copper, and their share in exports of blister and refined copper together is about 65%. The conference decided to set up the Inter-Governmental Council of the countries-exporters of copper (CIPEC) which is located in Paris.

Thus, it may be stated that the influence of the developing countries on the price of copper has strengthened in recent years.

There exist no uniform world prices of lead and zinc at the present time. Of great importance are the prices in New York, at which lead and zinc are supplied to the USA's domestic market, and also the prices on the London Metal

Exchange which serve as a guide in deals in lead outside the USA. Most of deals in zinc outside the USA are concluded using the producer prices.

The prices of lead and zinc in New York are comparatively stable; their level changes rarely and there are no sharp fluctuations from the level. For example, the price of zinc in New York remained constant during 1965, 1966 and 1967.

The level of prices in London, mostly used as a guide in deals for lead outside the USA, is usually lower than that in New York. The difference depends on the import duties in the USA, transport costs and market fluctuations.

The prices of lead and zinc on the London Metal Exchange vary widely from month to month or even from day, to day which makes these metals less competitive relative to substitute materials. The following example may illustrate this. Over the 1965-68 period, the average monthly prices of zinc on the London Metal Market have changed at least [illegible] times, while the fixed prices only three times.

In 1964 large producers of zinc agreed on the sale of zinc at a fixed price; since then most of the deals outside the USA have been done using this price.

Of interest are prices of lead and zinc concentrates, since these constitute the main item of exports of the developing countries.

These prices are calculated, as a rule, according to the following formula:

$$X = \frac{P\ (T - A)}{100} - Rc$$

where P = current market price of metal

T = metal content of concentrate , %

A = losses of metal in processing, %

Rc = refining charges, either determined on agreement basis, considering the change of metal price, or borrowed from special literature, where its reference level is regularly published.

The cost of processing in Europe: 18-20 dollars per ton of lead concentrate containing about 70 to 80% Pb, 44-48 dollars per ton of sulphide zinc concentrate containing about 52-55% Zn.

Since the cost of processing has the tendency to remain at the same level, prices of concentrate depend to a large extent on the level of the price of metal (considering that losses of metal are nearly always the same).

Accordingly, changes in metal price affect mainly producers of concentrates, whereas payment received for processing of concentrates into metal varies less frequently and within narrower limits.

The market of tin is regulated at the level of the International Tin Agreement.

The Agreement now in effect is signed by six developing countries - producers of tin - Bolivia, Indonesia, Congo, Malaysia, Nigeria and Thailand - and 18 consumer-countries. The producer-countries and the consumer-countries have equal numbers of votes.

The International Tin Council is the executive body of the Agreement. To influence the market and prices the Council uses export control (in fact, production control) and manoeuvring with the so-called. "Buffer Stock".

During 1968 the prices in dollars per ton of tin on the London Metal Exchange were:

I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
3125	3110	3112	3106	3084	3059	3075	3050	3058	3098	3306	3245

On September 18-th 1968 there was 11,500 tons of tin stored in the Buffer Stock.

One of the main features of economics of non-ferrous metallurgy in the developing countries over the 1955-1967 period has been the tendency towards diminishing of their dependence on the control of monopolies.

By the beginning of this period only the tin industry of Bolivia had been nationalized. The non-ferrous metallurgy of other developing countries was de jure and de facto completely under unrestricted control of powerful capitalist monopolies.

At the present time, the situation has substantially changed, particularly in the copper and tin industries. A few examples will be given here. The copper industry of Congo has been nationalized. Control over the copper industry of Chile has passed to a considerable extent (at some enterprises by more than 50%) into the hands of the Chilean Government. In Mexico most of the shares of the mining and metallurgical companies belong to the Mexican capital.

The tin industry of Indonesia also has been nationalized during this period.

§ 3. General survey of aluminium industry

The production of aluminium in the developing countries has essentially started to grow only for the last 11-15 years despite the availability of large reserves of bauxites and the leading part of these countries in the world production of bauxites. 56% of the world reserves of bauxites and 71.2% of the world production fall on the share of the countries. High quality bauxites, containing more than 50% Al_2O_3 are mined in these countries. The bauxites have a low silicon modulus.

In 1958-1968 the capacities of alumina plants have increased from 549 to 2750 thousand tons, i.e. five-fold and those of aluminium plants increased from 39 to 422 thousand tons, i.e. eleven times. This increase mainly resulted from the construction of new plants in the developing countries though the share of these countries in the world production of aluminium is still insufficient. Up to now the developing countries are continued to be the leading exporters of bauxites and alumina.

The production of bauxites has a number of specific feature, therefore the mining essentially differs from that of in lead and copper industries.

The deposits occur under sand and clay layers whose thickness ranges from several to scores of meters. The average thickness of stratified bauxite deposits is in the range of 2-3 to 6-9 m.

Main method of working bauxite deposits is the open-pit mining with the application of various systems of picking up and handling ore: e.g. simple and complex systems of open-pit mining with the application of other-than by-vehicles systems of ore transportation; open-pit mining with transporting ore by vehicles; special and combined (hydraulicking) methods of open-pit mining.

Most developed is the mining in Jamaica where 9.4 million tons of bauxites are produced, in Surinam - 3.5 million tons, in Guiana - 3.4 million tons, in Guinea - 2.7 million tons.

Due to the growth of production and mining out of deposits with favourable modes of occurence, the depth of works and the stripping ratios increase which necessitates the use of more powerful stripping equipment. For instance, in the fifties the capacity of dragline stripper buckets did not exceed 3-4 m^3 whereas it has grown recently to 6-9 and in some cases to 16 m^3.

The increase in the depth of stripping did not only entail the use of draglines of large dimensions but resulted in a more complicated nature of those systems of mining which provide for other-than-by vehicles ore handling methods. This complication concerns the arrangement of works so that overburden is first transferred to a temporary dump (pre-dump) and then to a permanent one. The conveyance of overburden rock from the pre-dump to the permanent dump is in most cases effected by the dame dragline.

The organization of works according to this complicated system makes it possible to excavate overburden rocks whose thickness comes up to 30-35 m. With greater thickness the necessity arises to use combined systems of ore transportation:

handling by vehicles at the upper steps and without vehicles at the lower steps of the quarry.

For excavating the upper slices of overburden at deposits in Guiana and Surinam stripping facilities of 800-2000 tns/hr capacity are widely used, which include rotary bucket excavators with a bucket capacity of 200 and 400 l, systems of belt conveyers with belts 900-1200 mm wide and 2-2.5 km long, elevating conveyers and dumpers.

The availability of a self-propelled elevating conveyer makes it possible to strip the upper part of overburden 37-40m thick in three substeps.

A high-efficient operation of rotary bucket excavators leads to a gradual ousting by them of other mechanization means, in particular draglines and hydraulicking.

Excavation of bauxites at most deposits is carried out by diesel powered excavators with mechanical shovel or by draglines of various types with bucket capacities 1.2 to 3.8 m^3 operating jointly with bulldozers. Scraper and rotary bucket excavators are used more rarely.

The use of heavy-duty equipment for mining is limited in particular by a low carrying capacity of rock.

When bauxites are too hard and are difficult to [illegible] by excavators, they are subjected to a preliminary [illegible] by means of drilling and blasting.

Rotary drilling auger machines are successfully used for boring holes.

Transportation of bauxites from quarries to [illegible] is done by means of dump trucks of a 27-35 tons loading capacity. Aluminium alloy bodies of light-duty design are successfully used for these dump trucks. For transportation of bauxites cable ways and sometimes belt conveyers are also used.

Thus the working of bauxite deposits in the developing countries is characterized by the use of various earth digging equipment: draglines, rotary bucket excavator complexes, scrappers, bulldozers, mechanical shovels and hydraulicking.

When working these deposits, the main tendency that accompanies the deterioration of mining and geological conditions consists in introducing more powerful mining and transportation equipment making it possible to fulfil over growing scopes of stripping work at the least possible cost.

Production of alumina and aluminium. The developing countries produce 20% of alumina and only 6.4% of aluminium of the total world production. Out of 119 plants producing alumina and aluminium in the capitalist countries only 17 plants are located in the developing countries.

The following developing countries have alumina industry: Guinea in Africa, India in Asia, Jamaica, Surinam, Guiana and Brazil in Latin America.

By 1/1-1968 the developing countries had a total capacity of 2.75 M. tons of alumina and 422 thousand tons of aluminium.

According to the expansion programmes the capacity of alumina plants in these countries will increase by 197[illegible] up to 5.3 M. tons and that of aluminium plants up to 815 thousand tons.

Data showing the productivite capacities of alumina and aluminium plants in the developing countries are given in Table 1.

Table 1

Production capacities of alumina and aluminium plants (thou. tons)

Countries	Alumina			Aluminium		
	By data on I.I.58	Growth of capacity for 10 years	By data on I.I.68	By data on I.L58	Growth of capacity for 10 years	By data on 1.I.68
1	2	3	4	5	6	7
AMERICA						
Mexico	-	-	-	-	20	20
Brazil	39	40	79	12	47	59
Guiana	-	349	349	-	-	-
Jamaica	500	340	840	-	-	-
Surinam	-	800	800	-	60	60
Venezuela	-	-	-	-	11	11
ASIA						
India	10	142	152	9	105	114
AFRICA						
Ghana	-	-	-	-	105	105
Guinea	-	530	530			
Cameroon	-	-	-	18	35	53
Total for the developing countries	549	2201	2750	39	383	422

1	2	3	4	5	6	7
The world production capacities (excluding socialist countries)	6002	7587	13589	3123	3494	6617
Share of the developing countries in the world production,%	9.1	29.0	20.2	1.2	11.0	6.4

The major part of the reserves of bauxites and a considerable part of potential water resources are located in the developing countries. In the majority of these countries there are favourable natural conditions for the development of alumina and aluminium industries.

Bauxites produced in the developing countries are as a rule of a high quality, therefore they are processed everywhere with the help of the classical Bayer process. Depending on the mineralogical characteristic of bauxites (tri - or monohydric), modified variants of the Bayer process were developed and introduced for their processing, which were called American and European. The only difference between them lies in the temperature of the leaching process and in the concentration of the alkali solution. Trihydric bauxites of Guinea, Surinam, Brazil and other countries are leached at the atmospheric pressure, at a temperature of 105-110° and with a concentration of the return solution of [illegible] of Na_2O_k. In India monohydric bauxites are processed which are difficult to treat than trihydric bauxites, therefore they are leached in autoclaves at 175°C and with a concentration of the return solution of 300-350 gr/l of Na_2O_k. Alumina extraction is high in both cases: 85-88 per cent.

Among modern trends of further improvement of the Bayer process it is necessary to mention continuous leaching at high temperatures (up to 250°C).

For crushing bauxites, ball mills of 3x10 m size are used. Bauxites are leached in 3 m dia autoclaves having 30 m height. For the settling of the red mud single-chamber 35-40 m dia thickeners are used and for the filtration of the red mud-drum filters of continuous action and large-size press filters (up to 250 m^2) are employed. Improvement of the process of decomposition of the aluminate solution has led to an increase in the unit capacity of decomposers (2-3 thous. m^3), to the continuity of the process and application of the air-lift agitation with low power consumption. With regard to the process of evaporation a marked tendency can be noted of increasing the size of the equipment up to 1400 m^2 in every shop, of using mixed or countercurrent vapour-liquid flows with the purpose of reducing the formation of scale and a more effective utilization of heat. For calcining aluminium hydroxide, kilns from 75 to 110 m long and 4-5 m in diameter are employed.

As a result of improvement of the equipment, automation and employment of computers for process regulation, there has been achieved a considerable reduction of power and labour consumption as well as a reduction of unit capital investments. For the last 10 years the specific steam consumption in developed capitalist countries has been decreased 3-4 times (from 8-10 tons to 2-3 tons per one ton of alumina), the consumption of caustic soda decreased 2 times (from 240 to 120 kgs), of fuel - by 30%. Alumina extraction has been raised up to 86-88%.

Aluminium industry in the developing countries has started to develop rather recently , excluding India, where the first aluminium plant was commissioned in 1942. Shown below are dates of commissioning aluminium plants in other developing countries: Brazil - 1951, Cameroon - 1957, Mexico - 1963, Venezuela and Ghana - 1967. The plants, commissioned before are equipped with electrolytic cells of small capacity with side and upper current feeding, the amperage being 30-50 ka. The plants, commissioned for the last 5 years, are equipped with powerful cells with upper current feeding, the amperage being 100 ka (Mexico, Cameroon) and cells with prebaked anodes, the amperage being 140 ka (Ghana) (Table 3), which conforms to the modern trends prevailing in aluminium industry in developed capitalist countries.

Table 3

Brief characteristic of aluminium plants

of the developing countries

Country, plant	Date of commissioning	Capacity, thou. tons as on I.I.1968	Characteristics of cells: amperage, kA	Characteristics of cells: type of current feeding	Typo of anodo
Brazil					
Sorokaba	1955	36	30	upper	Round electrolyzers of Soderberg-Montecatini type
Satamenia	1951	23	"	"	
Venezuela					
Curi (Caroni)	1967	11	58	-	Prebaked anodes
Ghana					
Tema	1967	105	140	-	Prebaked anodes
India					
[illegible]kud	1959	20	50	Sido	Self-baking anodes
Alupuram	1942	16	25 50	Side Upper	-"- -"-
Renukut	1962	60	70	-	Prebaked anodes
Mettur	1965	10	80	...	...
Asansol	1943	7.5	24	Sido	Self-baking [illegible]
			50	Upper	-"-
Cameroon					
Edea	1957	53	100	Upper	-"-
Mexico					
Verakrus	1963	20	100	...	...

During the last years it has become an accepted world-wide practice to construct aluminium plants of large capacities - over 100 thousand tons of aluminium per year.

Aluminium production at plants, equipped with powerful electrolytic cells, amounts to about 40% of the total world production. Cells with pre-baked anodes are coming into an extensive use. Around 50% of the produced aluminium is yieldod by cells of medium and large capacities with pre-baked anodes.

At many plants the complex mechanization of cells maintenance has been introduced which contributes to achieving high labour productivity.

Cast aluminium busbars of large cross sections (and sometimes of various profiles) are being brought into a wido use in electrolyzers, these busbars being employed not only for current feeding but also as bearing structures; steel-aluminium composite rods are widely employed in cells with self-baking anodes and upper current feeding.

In a number of cases new refractory materials are employed for colls wall lining. Thus the wall lining of silicon carbide with nitride joint and of other (non-carbon) refractories is used at 15 aluminium plants of the developed countries. Hard pitch with a softening point of 85-90°C and sulphur-free petroleum coke of high grades are used for manufacturing the anode mix and anodes.

The voltage of rectifying units at some plants comes to 950-1000 v, which leads to the increase in the number of cells in a series and to a sharp reduction of the number of rectifiers.

The lowest specific consumption of [illegible] current electric power (13200-13900 kwhr per one ton of aluminium) is achieved at those plants where cells are equipped with pre-baked anodes (Bellingham - USA, Fusina - Italy).

As mentioned above, the aluminium industry of the developing countries is mainly based on the processing of bauxites, with a high alumina content in a number of cases.

In some countries however there are and may be discovered other kinds of aluminium raw materials as well. It should be mentioned here that the method of processing nepheline concentrates into alumina soda products and cement has been stiudied and successfully introduced in the USSR.

This method provides for producing 1 t. of alumina, about 750 kg of soda and 280 kg. of potash by processing 4 t. of concentrate (containing Al_2O_3 about 29.0%; Na_2O + K_2O about 17-19%; and SiO_2 about [illegible]) and 7.6 t of limestone. Nepheline sludge (6t in this particular case) is used for the production of portland cement (600 kg of sludge and 450 kg of limestone for the production of 1 t. of cement).

A method has also been worked out of obtaining alumina and chemical products from nepheline syenites, the consumption of which includes up to 21.7% of Al_2O_3, up to 12% of alkali lye and up to 60% of silica.

With the consumption of 5.5 t. of Syenites, [illegible] limestone and 0.3 t. of lime one can obtain [illegible] various chemical products (metasilicate of sodium, of [illegible]um, Yerevanite etc.), up to 0.29 t. of potash also nepheline sludge per one ton of alumina oxide.

The mentioned processes could apparently be applied in those cases when the developing countries are in possession of the necessary raw materials.

DATA ON ALUMINIUM PRODUCTION IN THE DEVELOPING COUNTRIES

Countries	Bauxite Reserves, M.t[1])		Mine production of bauxite, thoust.	Production thous.t.		Primary aluminium consumption thous.t.	Exports, thous.t.			Imports, thous.t.			
	TOTAL	proved and probable		ALUmina	primary aluminium		BAUxite	alumina	aluminium	bauxite[2])	alumina	aluminium	[illegible]
I	2	3	4	5	6	7	8	9	I0	II	I2	I3	I4
Total for the developing countries 1955	I202-I232	320	9865	200	9	43	8I28	I87	-	2,7	2,I	37,I	I4,I
1967	5269	I428	259I6	2426	283	3I4	I6877	2344	I05,8	62,5	I48,5	I47,2	20,5
AFRICA													
Ghana - I955	200-230	46	II8	-	-	-	II8	-	-	-	-	-	I,I
1967	250	45	353	-	49	-	3II[3])	-	25,2	-	...	-	7,2[3])
Guinea - I955	I00	6	493	-	-	-	...	-	-	-	-	-	-
1967	I500	600	2722	530	-	-	244[3])	520[3])	-	-	-	-	-
Cameroon - I955	-	..	-	-	-	-	-	-	-	-	-	-	-
1967	I000	50	-	-	48	-	-	..	49,6	-	85[4])	-	-
Morocco 1955	20	.	-	-	-	-	-	-	-	-	-	-	[illegible]
1967	20	..	-	-	-	-	-	-	-	-	..	..	1,8[illegible]
Sierra Leone 1955	-	-	-	-	-	-	-	-	-	..	-	-	-
1967	...	...	342	-	-	-	244[3])	-	-	..	-	-	-
Total for Africa 1955	340-370	72	6II	-	-	I	II8	-	-	.	.	..	1,1
1967	3230	715	34I7	530	97	I2	799[3])	520[3])	74,8	2	85[4])	-	8,8[5])

I		2	3	4	5	6	7	8	9	10	11	12	13	14
LATIN AMERICA														
Argentina	1955	-	-	-	-	-	...	-	-	-	2.7	-	14.8	-
	1967	-	-	-	-	-	25	-	-	-	43.6	-	36.9[3)]	-
Brazil	1955	140	20	45	...	2	8.2	3.3	-	-	-	-	6.4	0.3
	1967	300	40	261	74	36	78	2.2	-	-	-	-	28.0	1.4[3)]
Venezuela	1955	-	-	-	-	-	...	-	-	-	-	-	...	...
	1967	105	10	-	-	2	...	-	-	...	-	...	...	...
Haiti	1955	20	1	-	-	-	-	-	-	-	-	-	-	-
	1967	23	23	376	-	-	=	333[3)]	-	-	-	-	-	-
Guiana	1955	50	50	2474	-	-	-	2204[3)]	-	-	-	-	-	-
	1967	150	50	3381	300[3)]	-	-	2055[3)]	302[3)]	-	-	-	-	-
Dominica	1955	8	...	-	-	-	-	-	-	-	-	-	-	-
	1967	85	60	983	-	-	-	806[3)]	-	-	-	-	-	-
Colombia	1955	-	-	-	-	-	...	-	-	-	-	-	...	2.3
	1967	-	-	-	-	-	...	-	-	-	9.0[3)]	-	8.6	1.2
Mexico	1955	-	-	-	-	-	8.0	-	-	-	-	2.1	8.0	3.1
	1967	-	-	-	-	21	20	-	-	-	9.9[3)]	47.5[3)]	0.1[3)]	1.2[3)]
Surinam	1955	50	45	3123	-	-	-	3060	-	-	-	..	-	-
	1967	300	200	5466	684	31	-	3866	684	31	-	..	-	-
Jamaica	1955	300	70	3040[5)]	187	-	..	2207[5)]	187	-	-	-	-	-
	1967	600	200	9395[5)]	838	-	..	7255[5)]	838	-	-	-	-	-
Total for Latin America	1955	568	186	8682	187	2	16.2	7474	187	-	2.7	2.1	29.2	5.7
	1967	[illegible]	[illegible]	19363	1896	90	123	14318	1824	31	62.5	47.5[3)]	73.6	3.8

8.3. I		2	3	4	5	6	7	8	9	I0	II	I2	I3	I4
ASIA														
India	I955	250	34	82	I3	7	II	9	–	–	–	–	7	...
	I967	276	75	789	...	96	II9	53.5	–	–	–	I6.I 3)	48.4	...
Indonesia	I955	30	I7	264	–	–	–	263 3)	–	–	–	–	–	2.4
	I967	25	I5	9I2	–	–	–	683 3)	–	–	–	–	–	...
Iran	I955	–	–	–	–	–	–	–	–	–	–	–	...	...
	I967	–	–	–	–	–	–	–	–	–	–	–	6.I	2.0
Malaysia	I955	8	5	226	–	–	–	264 3)	–	–	–	–	–	2.7 3)
	I967	40	I0	900	–	–	–	I023 3)	–	–	–	–	I.6 3)	3.0 3)
Pakistan	I955	–	–	–	–	–	–	–	–	–	–	–	0.9	I.0
	I967	8	...	–	–	–	–	–	–	–	–	–	8.3	...
Turkey	I955	5.5	5.5	–	–	–	–	–	–	–	–	–	–	[illegible]
	I967	[illegible]	[illegible]	[illegible]	–	–	–	...	–	–	–	–	[illegible]	[illegible]
Total for Asian countries	I955	293.5	6I.5	572	I3	7	II	536	–	–	–	–	7.9	7.3
	I967	4I6	I30	2636	...	96	II9	I759.5	–	–	–	I6.I 3)	73.6	7.9

I) By data on I958 and I967

2) Bauxite imported for other than aluminium production.

3) By data on I966.

4) By data on I965.

5) By dry bauxite.

§ 4. General Survey of Copper Industry

The copper industry of the developing countries occupies a prominent place in the world's copper production. Thus in 1967 the copper reserves, mine production and the production of blister copper in the developing countries amounted to 64 per cent (104 million tons), 54% (2129 thou.tons) and 48 per cent of the total world figures respectively.

Among the developing countries are the world's largest copper producers - Zambia, Congo, Chile and Peru. In these countries the copper industry has attained a very high stage of development. The technical level of their copper production is in many cases equal to that of the most developed countries.

The copper content in the mined ores varies over a wide range i.e. from 0.7-0.8 per cent at the porphyry copper deposits, mined by open-pit methods, to 5-6 per cent and higher in relatively shallow underground mines. In most countries the copper content of the ores averages from 1 to 2 per cent.

Copper mining in some of the developing countries (Chile, Peru, Zambia and Congo*) is characterized by a high concentration of production and large scale mining operations. This is due to the availability of extensive porphyry copper deposits and copper sandtones. These deposits are mined mainly by the open pit method, which accounts for more than 70 per cent of the ores produced. Of the 56 currently operating mines with

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* If not mentioned otherwise data in this section refer to Congo with the capital of Kinshasa.

an annual output over 135,000 tons, 27 use the open-pit method, 25 are worked underground and 4 use both methods.

The enterprises using open-pit mining include such large quarries as Chuquicamata and Exsotica in Chile with an annual ore production of 8 and 7.8 million tons respectively; Toquepala (Peru) - 9.4 mill.tons; Cananea (Mexico) - over 3 mill. tons; Mousonoi and Kamoto-Congo (Kinshasa) and Chingola Zambia) - over 3 mill.tons p.a. each and others.

The large underground mines are: El Salvador (over 6.9 mill.tons p.a.) and El Teniente (10 mill.tons) in Chile; Kipouchi (about 3 mill.tons) in Congo; Rhocana and Luanshya (over 3 mill.tons p.a. each) and Mufulira (7.2 mill.tons) in Zambia, and Lepanto (about 2 mill.tons p.a.) in the Philippines.

The enterprises using both methods of mining include Toledo (Philippines) and Nchanga (Zambia) producing about 5 mill.tons p.a. each, and Kambove (Congo) producing 3 mill. tons p.a.

In open-pit mining drilling of the medium-hard and hard rock is mainly done by the roller boring method. The most widely used machines are manufactured for this purpose by Bucyrus Erie, Joy and Reichsdrill companies. They have a high drilling capacity (up to 150 metres per shift) with hole diameters from 229 to 311 (sometimes up to 380) millimetres.

Air percussion drilling machines mounted on caterpillars, wheels or special tripods, have found widespread use on quarries with a lower output. They are used also for drillin extra-hard rock. The operation of such units, capable of boring holes from 110 to 180 mm in diameter, guarantees good breaking of hard rocks and helps to increase the productivity of shovels in addition to a relatively low cost of drilling.

In blasting operations special attention is payed to the use of high density explosives. The less complex explosives, based on ammonium nitrate - fuel oil (AN/FO) mixtures find widepread use for breaking lower-medium and medium-hard rock. For hard and watered rock it is a common Practice to use metallized and waterfilled materials or composite charges of waterfilled explosives (in the lower part of the hole) and simple mixtures of the AN/FO type. Using such explosives guarantees good fragmentation of the rock and attaining optimal parameters of the blasthole set. In addition, charging the holes can be completely mechanized with the aid of special charging machines and systems.

Excavators of the mechanical shovel type with bucket capacities from 2-4 to 11.4 cu.m are the prevailing equipment used for mechanized removal and loading of the ore at open--pit mines.

During the recent years at the copper quarries of the developed countries there was a trend to increase the bucket capacity of power shovels to 19-23 cu m. This seems to be Promising for the developing countries as well.

Motor vehicles are the main type of transportation facilities used at open pit copper mines of the developing (and other) countries. Most quarries widely employ dump trucks of American, English and French manufacture with a load capacities from 27-35 to 65-85 tons.

The developed countries have started to use dump trucks and tractor-drawn semitrailers with load capacities up to 150-200 tons. Electronic computers, radio and television are widely used to control the operation of quarries and the work of their motor transport in particular.

Typical for underground mining of copper ores is the prevailing use of highly efficient block caving systems, as well as open stoping methods. The introducing of such systems is accompanied by increased losses and dilution of the ore. However a distinguishing feature of the developing countries is the use of caving systems for mining more valuable ores, than in the developed countries. (As an example a caving systems is used at San Manuel mine, USA, for mining ore with a copper content of 0.8 per cent and at El Teniente, Chile, for ore containing 1.61-1.81 per cent Cu).

Various modifications of the filling systems are in use for mining deposits of high-grade ores.

The level of mechanization on most mines is not high and consequently their technical and economic performance figures are low.

For drilling operations the developed countries widely use self-propelled carriages with two or three remote-controlled perforators and fully mechanized auxiliary equipment. Self-propelled drill carriages may be used not only in developing, but also for stripping operations, including horizontal layer-and-fill systems. Borehole b[illegible] is success- fully used in mining steep dipping deposits. [illegible] 38-[illegible] mm in diameter are drilled both in the upward and downward directions. Good quality uniform fragmentation is achieved by careful maintaining the proper orientation of the boreholes.

Low-strength explosives, a wide range of initiating means and machinery for charging the holes are extensively used in blasting operations.

The handling of ore at the majority of mines in the developing countries is accomplished with the [illegible] sluchores and small capacity buckets.

The world's leading mines also use scraper hoists in similar conditions, but their engine power is considerably higher and reaches 100-125 kW. They are remote-controlled and have hinged folding buckets of 1.0 to [illegible] cu.m capacity.

During the last decade the loading and hauling operations have been largely mechanized by the use of mobile machinery. Special loading and hauling machines - the transloaders-are successfully used on short distances. They have pneumatic or Diesel-engine drives and are equipped with buckets of 0.8 to 4.8 cu.m capacity.

Spreading the experience, gained in the developed countries and the practical introduction of progressive tech- nical innovations will contribute to more efficient mining of the ore deposits with a moderate copper content by both the open-pit and underground methods. This will enable to exploit a large number of new deposits and expand the pro- duction of the currently operating enterprises.

Coppor ores dressing has attained the highest stage of development in Chile and Zambia (which occupy the second and third place in the world's production and treating of copper ores), Congo (Kinshasa), Peru, Turkey and Philippines.

The copper-sulphide ores are the main source of the copper concentrates produced. In some countries (Zambia, Chile, Philippines) the practice of treating oxidized-sulphide and copper-oxide ores is being expanded. In small quantities copper concentrates are obtained as a result of processing complex ores, particularly in South-West Africa, Mexico, Kenya and Congo (Brazzaville).

Copper ores dressing is carried out in mills with a high production capacity: Chuquicamata 43,900 tons; Braden - 34,000 tons; and Salvador (24,000 tons) in Chile; Mufulira (25,000 tons), Nchanga (25,000 tons) and Nkana (15,000 tons) in Zambia; Colvezi (12,000 tons) in Congo - Kinshasa; Toccpala -36,500 tons) in Peru; Atlas (12,000 tons) in the Philippines; several mills, operating in Turkey, are being expanded to increase their throughput capacity to 3,000-8,000 tons of ore per day.

However in many countries (Marocco, South-West Africa, Uganda and others) copper ores are concentrated at small mills with capacities ranging from 100-500 to 2,000 tons of ore per day.

The copper content of the treated ores varies over a wide range. Thus Chile, Zambia, and Congo (Kinshasa) process mainly the rich ores, containing from 1.6 to 2.5-4.0

and in some cases 5.0-8.0 per cent of copper. Yet in many countries it is common practice to concentrate low-grade ores with a copper content 0.5 to 0.75 per cent.

From the point of view of technology, equipment and attained efficiency , the copper mills of the developing countries roughly can be compared with those in the world's leading countries.

The concentration of copper ores is carried out according to branched complicated floatation flowsheets with post comminution and recleaning the primary rough concentrate and midlings. The mills in Zambia, Congo and other countries widely use the practice of treating the ores in accordance to their commercial grades in independent sections of the mill. Ore blending is widely used also.

The methods of concentrating ores with a high slime content include preliminary washing of the ore and the disposal of slime by removing it to a dump or treating in a separate slime cycle. Flow-sheets including separation of the slime and sand fractions are used widely.

In the practice of treating copper-molybdenum ore, used by the mills in Chile and Peru, the cycles of separating the bulk copper-molybdenum concentrates have been greatly improved by the introduction of new efficient oxidizers; the Nokes reagent and others. In the bulk-floatation cycle, practiced at the Toquepala copper-molybdenum concentrating mill in Peru, a new reagent-allylic ether of amylxanthogenic ac acid is being used for the first time in the world. This reagent increases the recovery of molybdenum.

The concentration of oxidized copper-sulphide ores is practiced mainly in accordance with a flowsheet including separate floatation of sulphidic and oxidized copper minerals after their preliminary sulphidization.

The use of the LPF (leaching-precipitation-floatation) process for treating oxidized ores is at present limited to several plants only. Small LPF units are situated on the island of Cyprus. In Chile work is proceeding to introduce this process for treating oxidized copper ores. A 500 tons perc day plant for treating oxidized copper ores by the segregation - floatation method has been constructed in this country.

The following general achievements in the world's practice of treating copper ores are of interest.

Autogenous grinding methods are increasingly used in the preparation of copper ores for floatation. Their application sharply reduces the consumption of steel in balls and rods for grinding, and, in some cases increases the process efficiency.

Primary rough crushing methods are being used for dressing copper-sulphide and copper-molybdenum ores. As a result at some concentrating mills in USA and Canada the consumption of electric power has been sharply reduced.

The main trend in improving the technology of floatation is the development and introduction of new highly efficient reagents and in the first place the collectors and synthetic alcohol frothers. Coarse grain floatation in the world's practice is based on using selective reagents of the L-200 series.

Approximately 70 per cent of the mills in USA use synthetic alcohol frothers of the methylisobutylcarbonyl, Dowfroth-250, TEB.

The introduction of several efficient collectors and nontoxic frothing reagents for the floatation of copper ores has led to the increasing application of the so-called "hungry" or decreased reagent addition rate.

In processing copper-zinc ores there is a promising outlook for preliminary aeration of the pulp to oxidize pyrite and pyrrhotite, contained in the ore.

The hydrometallurgical - floatation process (LPF) is finding use in the world practice of dressing oxidized and oxidized copper-sulphide ores.

The practice of producing molybdenum concentrate is being introduced at porphyry-copper ores treating mills, which previously produced copper concentrates only.

A high degree of process automation is a characteristic feature of large copper plants, especially of those that were built in the recent years. Mills with centralized control, some of which use controlling computers, have been constructed.

The practice of using automatic analyzers to determine the content of basic metals in the ore and concentrates is spreading considerably. The automatic X-ray analyzers are most widely used at present by the Zambia mills.

On the whole the automation level of the mills in developing countries is not high, with the exception of mills in Zambia, Chile, Peru and some other countries.

Zambian mills have the most modern equipment. The largest in Central Africa gyratory crushers 1370x1370 mm with a capacity 1080 tons of ore per day are installed at the Nchanga mill. X-ray spectrographs are used to determine the metal content in the ore and concentration products.

Metallurgy of copper. The copper industry of the developing countries is represented by large copper smelters and electrolytic copper plants with an annual copper production exceeding 100,000 tons (in Chile, Zambia, Congo and Peru), and also by smaller plants (Turkey, India, South-West Africa, Uganda, Mexico).

The copper plants mainly use concentrates rich in copper and having a low impurity content: Chuquicamata (Chile) - 50% of copper; Potrerillos (Chile) - 48 to 50%); Mufulira (Zambia) - 51 to 52%; Luanshya (Zambia) and Nkana (Zambia) - 50%. The copper-zinc concentrates, containing 12% zinc, processed at the Lubumbashi plant, are an exception.

The plants in Peru, Turkey and Uganda treat concentrates containing about 30 per cent of copper.

The bin method of preparing the charge materials is predominantly used by the plants in the developing countries. The plants at Chuquicamata and Las-Ventanas, which use the ore bedding method, are an exception.

Copper smelting in reverberatory furnaces is the predominent pyrometallurgical process used in these countries.

At present there is a tendency to modernize the reverberatory furnaces. At the Potrerillos plant in Chile as a result of reconstruction of many elements of their reverberatory furnace its life has encreased up to 7 years.

This furnace was equipped with:

- watercooled copper-jacket belts in the slag bath zone,
- watercooled copper rings for the charging tubes,
- large magnesite blocks in the sidewalls.

At another Chilean plant (Chuquicamata) the furnace campaign is equal to 3 years.

A new powerful reverberatory furnace at the El Teniente plant is designed to operate 9 to 10 years without major repair.

However there are plants, where many known improvements of metallurgical units are not used. Thus the life of old furnaces at El Teniente was very short and averaged 4 months.

Both suspended chrome-magnesite and arch-type silica roofs are successfuly used in reverberatory furnaces. Practicaly the life of all furnaces with silica roof is increased by guniting.

The unit smelting rate of reverberatory furnaces is, as a rule, fairly low and does not exceed 2.5 tons/m^2 per day, and is only 1.6 to 1.8 tons/m^2 at the Chilean Government plant in Paipote.

In 1969 the first oxygen plant in Africa, capable of producing 600 tons of oxygen per day will start operation to increase the smelting rate and decrease fuel consumption at the Nkana copper smelter in Zambia. This is the second largest oxygen plant in the world.

The majority ofc copper plants in the developing countries (Potrerillos, Chuquicamata, Paipote, Mufulira, Nkana, and others) utilise the heat of waste gases. Boiler cleaning is mechanized and to a large extent automated. The waste heat boilers generate steam that may be used by power plants.

Chilean copper plants use fuel oil without air preheating, and in Zambia the plants operate on powdered coal with preheating the secondary air to 200°C.

The sulphurous gases are not utilized anywhere, with exception of the converters at El Teniente.
At all the plants converter tuyering is done manually.

Up to now almost none of the plants in developing countries use oxygen for process intensification.

In this respect the developing countries could successfully utilize the experience gained, for instance, in the Soviet Union, where oxygen is extensively used in the copper industry.

The application of methods, used in treating bulk copper - zinc and copper - lead - zinc concentrates, could also be of great importance for the developing countries. The production of bulk concentrates by the ore-dressing mills is generally accompanied by a considerable increase of metal recovery in comparison with processes, designed to produce selective concentrates.

The most promising method of processing bulk concentrates, containing copper, zinc and lead, is the "KIVCET" (oxygen-flash-cyclone-electrothermal) process, developed by Soviet engineers. In this process the smelting of fine material in a stream of blast (containing oxygen in the range from the usual content in air to 100 per cent) is combined with treating the produced melt by an electrothermal method.

During the process: a) the smelting of fine material proceeds in a stream of blast both in a suspended state as a straight flame and as a flame vortexed by a cyclone, b) the melt is treated in the electrothermal section of the unit. This section is either directly connected to the smelting chamber , or placed separately and connected with the smelting chamber by a launder for transferring the molten material.

When treating sulphidic raw material, containing over 20 per cent of sulphur, the roasting and smelting processes are carried out in an atmosphere of technical oxygen autogenuously without any fuel consumption, and gases, rich in sulphurous anhydride, are produced.

The smelting of oxidized or low-sulphide concentrates is carried out with the addition of gaseous, liquid or solid fuel.

The basic charge components, i.e. copper, zinc and lead, are distributed in the following manner:

Zinc in the smelting process passes into the melt and after being sublimated in the electrothermal section of the unit, is concentrated in a liquid state inside a condenser and as a commercial product.

Lead is partly sublimated in the smelting process and is concentrated in the sublimates. Partly it is driven off, condenses as crude lead together with zinc and is obtained mainly in the form of crude metal.

Copper (as well as cobalt and nickel) passes into the rich matte, which is periodically tapped from the electro-thermal section of the unit.

The advantages of the KIVCET process are listed below:

- the stages of pelletizing and sinter roasting are omitted;
- a small quantity of rich gases, containing 70 to 90 per cent of sulphurous anhydride, is generated and they can be efficiently utilized to produce cheap sulphuric acid, elemental sulphur or liquified sulphurous anhydride;
- the heat of oxidation, generated during the roasting and smelting of the charge, is utilized in the process to melt and overheat the charge constituents, and this considerably reduces the energy consumed in the whole process of treating the raw material (in comparison with many other processes);
- high-quality coke is not needed.

In a discussion on converter blowing practiced in the developing countries, one should mention the use of thermal diagrams at the Potrerillos plant. With the aid of such diagrams the completion of the copper smelting process can be determined automatically.

Nearly all converters are equipped with nozzles to prolong the service life of their lining.

As far as fire refining is concerned, it is interesting to mention the experience gained at the Potrerillos plant, where steam is used as an oxidizer, and solar oil as a reductant instead of wood.

The copper recovery at this plant is sufficiently high and reaches 97-98 per cent.

In addition to smelting in reverberatory furnaces the developing countries use shaft furnaces for smelting sinter and rich ores at Lumoumbachi (Congo) and Ergami - Maden (Turkey), and electric furnaces for smelting concentrates in Dginja (Uganda).

It is intended to introduce flash smelting of finely divided sulphide concentrates in preheated blast at two Indian plants (Moubhandor and Ketri)in 1969-1971.

Along with pyrometallurgical plants oxidized and oxide sulphide ores are successfully treated at hydrometallurgical plants. They include such large enterprices as Chuquicamata (130,000 tons of copper), Mantas-Blancos (25,000 tons), Yadotville- Shituru (150,000 tons), Luilu (100,000 tons), Chingola (100,000 tons), Chambishi (23,000 tons).

Of the new processes one should mention the successful application of the "Torco" process for treating refractory ores at the Nkana works in Zambia.

In relation to electrolytic refining of copper at the plants of developing countries the following may be noted:

The current density used has been somewhat increased. At the Mufulira and Nkana plants in Zambia the surface of the electrolyte is covered with polyolephiline balls 19,44,5 and 152 mm in diameter. The aim is to prevent the evolving of sulphuric-acid vapour from the bath. The use of such balls (which cover 90% of the free area) allow to decrease the evaporation of the electrolyte by 90% and the heat losses by 70%.

At these plants the cathode blocks are made by the galvanic method and the cathode is a cold-rolled copper blank. It is preheated by a mixture of Diesel fuel and a solution of beech tar in alcohol. This facilitates stripping the cathode base from the blank. The cost of 10,000 balls was payed for after two weeks of the electrolytic bath operation.

DATA ON COPPER PRODUCTION IN THE DEVELOPING COUNTRIES , thous.t.

COUNTRIES	Copper reserves: total	Copper reserves: proved and probable	Mine production (copper content)	Primary blister production	Refined Copper production	Copper consumption	Exports: concentrates (metal content)	Exports: primary blister copper	Exports: refined copper	Imports: refined copper
I	2	3	4	5	6	7	8	9	I0	II
Total for the developing countries 1955 I)	II5797	54I70	I223	III3	6I6	93	II4,I	5I4	538	44.3
1967	I76440	I03650	2I29	I885	I233	I80	I98.9	587	II66	I05.9
AFRICA										
Zambia I955	45000	23200	359	353	I80	---	–	I76	I72	–
1967	54000	27400	663	633	535	–	–	80	527	–
Congo Republic (Kinshasa) I955	27000	9000	235	235	II5	–	–	II8	II3	–
I967	36000	I8000	322	322	24I	–	–	8I	24I	–
Congo Republic (Brazzaville)										
1955	–	–	–	–	–	–	–	–	–	–
1967	40	40	–	–	–	–	–	–	–	–
Morocco I955	20	–	–	–	–		–	–	–	–
[illegible]	[illegible]	20	2	–	–		2	–	–	–
Mauritania I955	700	700	–	–	–		–	–	–	–
1967	590	590	–	–	–	–	–	–	–	–
UAR I955	–	–	–	–	–	0.I	–	–	–	–
1967	70	...	–	–	I 2)	I	–	–	–	–

I		2	3	4	5	6	7	8	9	I0	II
Sudan	I955	-	-	-	-	-	0.3	-	-	-	0.3
	I967	300	-	-	-	-	0.3	-	-	-	0.3
Uganda	I955	300	-	-	-	-	-	-	-	-	-
	I967	I80	I30	I5	I5	-	-	-	I5	-	-
South West Africa	I955	6I0	300	2I	-	-	-	2I	-	-	-
	I967	700	530	34	32	-	-	.2	32	-	-
Algeria	I955	-	-	0.I	-	-	-	0.I	-	-	-
	I967	50	I0	I	-	-	2	I	-	-	2
Total for Africa	I955	73630	33200	6I5.I	588	295	0.4	2I.I	294	285	0.3
	I967	9I970	46720	I037	I002	777	3.3	5.0	208	768	2.3
LATIN AMERICA											
Mexico	I955	340	I60	55	55	35	I4	9	29	I6	-
	I967	I000	680	63	50	47	34	6 3)	8 3)		-
Argentina	I955	-	-	0.5	-	-	6	-	-	-	I4
	I967	30	-	0.5	-	-	20	0.5	-	-	20
Bolivia	I955	38	24	3	-	-	-	3	-	-	-
	I967	700	50	6	-	-	-	6	-	-	-
Brazil	I955	220	I20	-	-	-	I5	-	-	-	I5
	I967	I000	280	3	3	3	39	-	-	-	35
Venezuela	I955	-	-	-	-	-	-	-	-	-	-
	I967	20	-	-	-	-	-	-	-	-	-
Haity	I955	-	-	-	-	-	-	-	-	-	-
	I967	90	90	3	-	-	-	3	-	-	-

I		2	3	4	5	6	7	8	9	IO	II
Nicaragua	I955	-	-	-	-	-	-	-	-	-	-
	I967	50	50	IO	-	-	-	IO	-	-	-
Peru	I955	IO800	3800	43	33	28	-	IO	4	27	-
	I967	I3000	IO900	I86	I66	36	-	23[3)]	I23	29	-
Chile	I955	28000	I5700	434	406	24I	34	26	I75	2IO	-
	I967	59000	42000	66I	630	353	I7	30	24I	36I	-
Total forLatin America	I955	39398	I9804	535.5	494	304	69	48	208	253	29
	I967	74890	54030	932.5	849	439	IIO	78.5	364	398	56
ASIA											
Burma	I955	20	20	-	-	-	-	-	-	-	-
	I967	3000	20	0.4	-	-	-	0.4	-	-	-
India	I955	76	76	7	7	7	22	-	-	-	I5
	I967	I000	300	9	9	9	45	-	-	-	33
Jordania	I955	-	-	-	-	-	-	-	-	-	-
	I967	260	-	-	-	-	0.3	-	-	-	0.3
Cyprus	I955	273	60	24	-	-	-	24	-	-	-
	I967	I70	90	22	-	-	-	I8	-	-	-
Turkey	I955	I600	480	24	24	IO	2	4	I2	-	-
	I967	I250	530	32	25	8	8	I	I5	-	0.3
Philippines	I955	700	530	I7	-	-	-	I7	-	-	-
	I967	3000	I600	86	-	-	4	86	-	-	4
Total for Asia	I955	2769	II66	72	3I	I7	24	45	I2	-	15

I	2	3	4	5	6	7	8	9	I0	II
I967	9580	2900	I59.4	34	I7	67.3	II5.4	I5	-	47.6

I) Data on I958
2) From secondary material
3) Data on I966.

§ 5. General Survey of the Lead and Zinc Industry

The estimated resources of lead and zinc in the developing countries in 1967 amounted to 25.1 and 23.6% of the world reserves. Mine production equaled 31.0% and 22.5% respectively. With the expection of Mexico, these countries exploit mainly the richer deposits with a total lead and zinc content 10% and higher.

Mine production of lead and zinc mines is generally low. Thus of the total number of the largest lead-zinc mines, sixteen have an annual ore output from 135,000 to 270,000 tons, fifteen - from 270,000 to 450,000, fourteen - from 450,000 to 1,000,000, and only three mines produce more than 900,000 - 1,000,000 tons p.a. Other several hundred mines are small enterprises with annual capacity of less than 135,000 tons.

A distinguishing feature is the predominant use of underground operations due to complex geological and mining conditions prevailing at the lead-zinc deposits and, particularly, due to considerable depth of their occurence.

Benefication of l[illegible]d-zinc ores. The main world's resources of lead and zinc concentrates are lead-zinc sulphide, lead, and complex copper-lead-zinc ores. There is also a small quantity, sulphide-oxide and oxidized ores.

In general only relatively rich ores are subjected to treatment by beneficating methods.

The processed ores contain from 1.0 to 10.0-20.0 %

lead and 2.0 to 16-30% zinc in Africa; from 1.0 to 17.0% lead and 2.0-30.0% zinc in Asian countries; and from 1.0 to 10.0% lead and 4.0-12% zinc in Latin America.

The benefication of lead-zinc ores is more developed in Morocco, Peru and Mexico. In Algeria, Iran and Turkey lead-zinc ore dressing is in a state of development - several new mills are being built and the old ones are undergoing reconstruction.

In Nigeria, Tansania, Congo (Brazzaville), UAR, Thailand, Argentina and BOlivia there are small mills with a capacity in the range of 100 to 300 tons per day.

The largest mills in Morocco are: Bou Beccire (4500 tons per day), Aouly (2400 tons), Toussite (1500 tons). Mibladen (1200 tons); in Peru: Cerro de Pasco (1700 tons), Juaron (700 tons); in Mexico: El-Potoci (2900 tons), San Francisco (2000 tons), Parral (1450 tons) and in South-West Africa: Tsumeb (2170 tons p.d.).

On the whole mills in Mexico , Morocco, Peru and South-West Africa approximately correspond by their technological level equipment and processing efficiency to the mills in the leading world countries. The mills in Morocco have mastered the technology of dressing complex sulphide-oxide ores. The ores are treated separately according to their grade in different sections of the mill. Separate floatation for the oxide and sulphide lead minerals is also practiced.

The mills in Morocco, Peru and Mexico practice preliminary treating of ores by the heavy-media process. Flowsheets including separate floatation of sands and slime, are now used for processing slimy ores. Some mills that process complex multimetal ores successfuly practice methods of separating bulk copper-lead concentrates.

The Tsumeb mill in South-West Africa efficiently processes copper-lead-zinc ore with a concominant extraction of a germanium-containing product.

However some mills, mainly in Iran, Algeria and other countries, use relatively simple processing methods. This is explained, to a large extent, by the composition of their ores.

At the Iran mills the ore is subjected, as a rule to primary hand sorting to produce cabbed ore, for further floatation or gravity concentration.

Depending on the properties of the treated ores the mills produce lead concentrates, containing 60 to 78% lead (40% minimum), and zinc concentrates, containing 48-62% zinc. Recovery ranges 80-90% lead and 75-80% zinc and is approximately equal to that attained by mills in other countries of the world.

The following achievements in the world's ore dressing practice may be of special interest to the developing countries.

A more wide use of the heavy-media process for preliminary ore concentration, which allows to increase the mill output and to decrease the cost of ore processing.

The use of preliminary washing for ores with a high slime content and oxidized zinc ores with further removing slime to a dump or treating it in a separate cycle.

Up to now autogenous grinding has not found a wide use in treating lead-zinc ores (it is practiced by approximately 4 per cent of the mills), but can be efficiently used in some cases.

Progress in the field of lead-zinc ore floation is mainly connected with the development and use of effective new reagents, and especially of collectors and frothers, that increase the process efficiency and allow their addition rate to be sharply reduced.

There is a promising outlook for the use of highly efficient nontoxic synthetic alcohol frothing agents in accordance to the experience of the world's leading concentrating mills.

It should be noted that, up to now, there was a trend in the world practice of processing lead-zinc ores to attain a most possible separation of lead and zinc.

However, in the recent years, a change in the direction of producing bulk concentrates is observed. This is related to the introduction of new methods of smelting concentrates (particularly in Imperial Smelting furnaces).

The automation level of mills in the developing countries is , as a rule, low. The experience, gained at the world's leading mills, is not used sufficiently. This pertains to the introduction of dispatcher-process control, the use of automatic analyzer for determining the metal content in ores and concentrates, etc.

Metallurgical processes. Only 14 of the developing countries have lead-and-zinc plants: Argentina, Burma, Brazil, Zambia, India, Columbia, Congo (Kinshasa), Morocco, Mexico, UAR, Peru, Tunisia, South-West Africa. All the plants, excluding Mexico, Peru and West Africa, have a small production capacity - from 5,000 to 30,000 tons of metal p.a. Argentina and Brazil have several small plants.

The lead industry mainly operates small size obsolete equipment and some plants in Argentina and Morocco still use ore-hearth smelting. Large Mexican lead plants that have been operating for more than 60 years, mostly also use low-capacity facilities. Practically no novel improvements are being introduced with the exception of a Mexican lead refining plant where the batch refining processes were replaced during 1945-1950 by the more modern continuous processes.

In the production of zinc most plants use the electrolytic method. Both electrolytic-zinc plants in India started operation in 1966-1967. Brasilian plants (including the new ones) operate under flowsheets, distinct from other plants, because their concentrates have a high silica content. With the exception of Peru and Congo (Kinshasa), all the plants are of low capacity (10 to 30,000 tons) and improvements are not introduced satisfactorily. A plant in Peru occupies the leading place in the world from the point of view of complex raw materials utilization.

A new plant using the horizontal-retort process started operation at Saltillo in Mexico in 1963. This old process was specially improved and automated for the new plant.

In connection with further expansion of lead and zinc metallurgy in the developing countries, some consideration about the possible technological courses are offered below.

<u>Choice of Principal methods in lead and zinc metallurgy</u>

Assuming that raw materials and other necessary resources (i.e. sufficient fuel, water, electric power and auxiliary materials) are available, the effective development of the lead-zinc industry in each developing country greatly depends upon the correct choice of a principal flowsheet and equipment for process the mined ores.

From the point of view of their mineralization characteristics and methods of processing the lead and zinc ores in the developing countries can be subdivided into the following groups:

a) oxidized complex lead-zinc ores with a total lead and zinc content 6-7% and higher. It is probably more economic to treat ores directly by the Waelz Process with out any preliminary treating by the conventional dressing methods. The mixed lead-zinc fume produced can be treated by one of the metallurgical methods, mentioned below.

b) oxidized or mixed oxidized-sulphide monometallic lead ores, containing over 15% lead. It is probably more economic to treat them directly by metallurgical methods (sintering and shaft smelting and other methods) in mixture with standard lead concentrates. If a metallurgical plant has not been built in a country, which possesses such ores, it is possible to sell them to other countries. Particularly this question may be considered by the USSR institutions;

c) oxidized monometallic zinc ores with a zinc content exceeding 6-7%. The ores may be treated by the Waelz process followed by additional redistillation of the Waelz - oxides to produce a commercial zinc white, or the oxides can be sent to zinc plants for processing;

d) monometallic and complex sulphide ores. As a rule it is practical to treat such ores by conventional floatation methods.

The technical progress of the lead-zinc industry in a developing country may be more efficient if technological development of mining, dressing and metallurgical processes is carried out according to a single development program characterised by the following two factors:

1. Where ever possible highly efficient bulk-mining systems should be widely practiced. They should be based on the use of high capacity mining equipment, that ensure the most economical cost of mining. Sometimes, when such highly efficient systems are used, there may be cases of a somewhat increased ore impoverishment as a result of the gangue being picked up in the mining operations.

To decrease the effect of impoverishment in the concentration stage, it is necessary to use such processes and apparatus, that allow the largest possible volume of gangue- to be removed at the beginning of the benefication process. This can be achieved by the use of heavy-media separation and by preliminary sorting of the ore with the aid of radiometric and photometric methods.

2. For dressing complex polymetallic ores it is necessary to use such methods, that allow the maximum possible recovery of the contained metals into clean and rich corresponding concentrates. The part of metals, that cannot be recovered into clean and rich corresponding concentrates, should be recovered into a bulk concentrate for subsequent processing by special metallurgical methods. Among such methods one can mention the Imperial Smelting process and a new method, the so called "KIVCET" process, developed in the USSR, and briefly described in Section 4 of this chapter.

At present only the pyrometallurgical production methods are mainly used in the metallurgy of lead . These methods include:

- reduction smelting in shaft furnaces, proceeded by sintering of the lead concentrates;
- shaft smelting by Imperial Smelting method;
- ore-hearth smelting of the unroasted concentrates;
- reaction smelting of lead sinter in electric furnaces;
- smelting sinter or rich partly roasted lead concentrate in short-rotary furnaces;
- precipitation smelting in electric furnaces.

Most widely used is the method of sintering lead concentrates with subsequent smelting of the sinter in shaft furnaces in the reduction atmosphere. In 1965-1967 about 87% of the smelted lead was produced by this method.

The Imperial Smelting method accounts for approximately

8.5% of the total lead production during the last 2 years

- production of lead by the ore hearth-smelting method amounts to approximately 3%;
- production by the precipitation smelting method is less than 0.1%.

Zinc is produced at present both by pyrometallurgical and hydrometallurgical methods. The pyrometallurgical methods include:

- zinc distillation in horizontal-retort furnaces;
- zinc distillation in vertical-retort furnaces
- various modifications of the electrothermic method,
- shaft smelting by the Imperial Smelting method.

The oldest (used since the beginning of 19-th century) and imperfect from modern point of view method , is the distillation of zinc in furnaces with horizontal retorts. This method is characterized by a number of defects, such as: low labour productivity, low zinc recovery and poor quality of the metal, high cost of zinc production, hard working conditions and batch character of the process.

Zinc distillation in vertical-retort furnaces is a more perfect method. In comparison with the previously mentioned process it has a number of advantages: continuity of the operation; higher labour productivity, higher zinc recovery and higher metal purity, better heat utilization, possibility of process mechanization and better working conditions, due to the units being hermeticaly sealed. The defects are: high cost and complexity of charge preparation, use of silicon carbide for making retorts (that increases capital investments).

In 1936 the electrothermic method of zinc production was first introduced. At present this method is used at the plants in USA, FRG, Peru, Argentina, Japan and the USSR. Advantages of the process include: high zinc recovery and high labour productivity, the possibility of building relatively large units and a better complex utilization of raw materials in comparison with the previous methods. A disadvantage is the engineering difficulty of selecting suitable slag-and zinc-vapour-resistant materials for the furnace bath and condenser. There is a definite promising outlook for the future development of this process, especially in countries with an abundant supply of cheap electric power.

In the pyrometallurgy of zinc the Imperial Smelting method is finding widespread use for smelting mixed lead-zinc concentrates with concurrent condensation of zinc vapour and liquid lead production.

The hydrometallurgical method at present occupies a predominant place in world's zinc production.

The hydroelectrometallurgical process has the following advantages: a high degree of zinc recovery (taking in account the processing of revert materials), high purity of the produced metal, a high degree of complex raw materials utilization, especially in the case of concomitant zinc and lead production; satisfactory working conditions. The [illegible]van-tages of the process are: a considerable reduction of [illegible]act-ion efficiency when using concentrates containing [illegible] amount of impurities (iron, silics, arsenic, antimony, cobalt, copper magnesium, nickel, germanium, chlorine) that need en-larged apparatus for treating the solutions; low labour pro-ductivity in electrolytic process (manual stripping of cathodes and the necessity of an additional operation for treatment of the rich in zinc cakes.

In spite of existing defects the hydroelectrometallurgi-cal method of zinc production will not probably loose its importance for processing rich and pure zinc concentrates in countries processing cheap electric power.

The choice of the right method for producing zinc depends on many factors of which the most important are: composition of raw materials, availability of electric power and [illegible] and pattern of future metal consumption.

In each case the choice should be based on technical and economical calculations. The decisive factor for developing countries is their ability to satisfy the demand for electric power and coke without which the production of lead and zinc cannot be established.

In improving the existing technological methods and de-veloping new and more perfect flowsheets for the production of lead, zinc and other heavy nonferrous metals, the Soviet specislists follow the line of widespread application of indus-trial oxygen and the use of electrothermic processes.

More than 80% of pig lead is produced in the Soviet Union with the usage of oxygen.

In the hydrometallurgy of zinc in the USSR oxygen is used to enrich the air for roasting concentrates in a fluidized bed. Enrichment of air to 28-30% oxygen increases the unit production rate of fluidized bed roasted by 60 to 70% increase the solubility of zinc in the calcine by 2.0 - - 2.5% and increase the concentration of sulphur dioxide in off gases. Another application of the industrial oxygen is the separation of iron impurities from Waelz- oxides leach solutions. As a result the filtration and settling of the pulp are improved, and the consumption of manganese ore reduced by 30 to 40 per cent.

Blast air is also enriched by oxygen for treating zinc cakes in a Waelz kiln.

The main advantages of using oxygen are: the intensification of production processes, the decrease of unit fuel consumption rate, improvement of process efficiency, increased metal recovery, increased concentration of sulphur dioxide in the waste gases. All this results in a decrease of the production cost.

Large work is being carried out in the Soviet Union in the field of developing and introducing electrothermic processes. In the lead metallurgy electric furnace devices are used in USSR for holding the liquid melt from the shaft furnaces and fuming furnaces during slag settling. The electrothermal process has been developed and applied for silver scum treatment with the resulting condensation of the liquid zinc. Furnaces are used also continuous dezincperising of lead.

Electrothermic processes are being widely introduced in the metallurgy of zinc.

In 1969 one of the Soviet lead smelters will start operating a 9000 KVA electrothermic furnace with liquid condensation of zinc for processing pelletized and calcined sublimates, containing zinc and lead.

Large-scale work is being done in the USSR with the aim of introducing the previously mentioned "KIVCET process". This experience may be considered in the development of the lead and zinc metallurgy by the developing countries.

The accompanying tables present some data concerning the lead and zinc industry in the developing countries.

Data on lead production in the developing countries

Countries		Reserves thous.t total	Reserves thous.t proved and probable	Mine production, thous t	Primary metal production, thous, t	Primary metal consumption, thous.t	Exports, thous. t raw material	Exports, thous. t metal	Imports, thous. t raw material	Imports, thous. t metal
I		2	3	4	5	6	7	8	9	IO
Total for the developing countries	1955	9285	373I	636.I	383	93	I72 2)	I45 2)	-	26 2)
	1967	2II95	I2237	647.I5	439.4	243	I96 2)	I89 2)	-	54 2)
Africa										
Morocco	I955	I000	500	89	27	-	96	26	-	-
	I967	I600	I200	75	20	-	62	20	-	-
Tunisia	I955	I60	I00	27	27	2 2)	-	25	-	-
	I967	I60	I60	I5	I5	3 2)	-	I2	-	-
Zambia	I955	484	276	I6	I6	...	-	I5	-	-
	I967	550	550	2I	2I	4	-	I7	-	-
South West Africa	I955	854	854	74	-	-	78	-	-	-
	I967	I030	I030	75	70	-	5	[illegible]	-	-
Algeria	I955	-	-	I0	-	-	I5	-	-	-
	I967	545	307	5	..	-	...			-
Congo Republic (Brazzaville)	I967	545	307		..	-	...	-		-
	I955	-	-	-	-	-	-	-	-	-

I		2	3	4	5	6	7	8	9	10
Tanzania	1955	-	-	4	-	-	4[2]	-	-	-
	1967	-	-	-	-	-	-	-	-	-
UAR	1955	-	-	-	-	-	-	-	-	-
	1967	30	...	-	-	-	-	- -	-	-
Total for Africa	1955	2498	1730	220	70	10	99[2]	46[2]	-	-
	1967	4415	3707	195	126	22	71[2]	72[2]	-	-
Latin America										
Mexico	1955	680	500	211	198	18	4	88[2]	-	-
	1967	6000	3000	168	164	63	...	86[2]	-	-
Argentina	1955	1170	440	23	18	25	-	-	-	-
	1967	1100	1100	31	36	30	...	-	-	-
Bolivia	1955	170	100	19	-	-	19	-	-	-
	1967	120	80	20	-	-	20	-	-	-
Brazil	1955	1145	40	4	4	14	-	-	-	13
	1967	3000	1100	19	16	26	-	-	-	13[2]
Guatemala	1955	-	-	5	-	-	5	-	-	-
	1967	160[2]	80[2]	-	-	-	-	-	-	-
[illegible]	[illegible]	-	.	.	-	-	-	-		.
	[illegible]	80[2]	80[2]	.		-	-	-	.	-

I	2	3	4	5	6	7	8	9		I0
Peru	I955	I265	II0	II9	6I	-	49	57	-	-
	I967	3000	2300	I65	82	6	74	[illegible]	-	-
Ecuador	I955	-	-	0,I	-	-	0.2	-	-	-
	I967	20	I0	0,I[3]	-	-	0,7[3]	-	-	-
Total for Latin America	I955	4430	II90	38I	28I	63	7I[2]	83[2]	-	I3[2]
	I967	I3480	7750	403	298	I49	95[2]	II6[5]	-	I3[2]
Asia										
India	I955	230	230	2	2	I4	-	-	-	I2
	I967	500	II0	5	2	34	-	-	-	34
Burma	I955	2000	498	I4	I4	-	2	I6	-	-
	I967	2I00	380	I5	I2	-	0,2[4]	I2[4]	-	-
Iran	I955	-	-	I4	I4	-	-	-	-	-
	I967	600	I50[2]	20	0,4[3]	-	45[3]	-	-	3[3]
Turkey	I955	70	70	3	2	-	-	-	-	0,6
	I967	40	40	2	I	-	I[3]	-	-	
Thailand	I955	48	4	5	-	-	...	-	-	-
	I967	50	50	7[4]	.	-	I[illegible][3]	-	-	[illegible]
Philippines	I955	9	9	2	.	.	-	-	..	-
	I967	I0	I0	0,0[illegible]	-	-	.	.	..	-

I		2	3	4	5	6	7	8	9	10
Total for Asia	1955	2357	811	40	32	20	2[2)]	16[2)]	-	13[2)]
	1967	3300	780	49	15	72	30[2)]	12[2)]	-	41[2)]

1) By Data on 1958 and 1967

2) Estimate

3) By data on 1966

4) By data on 1965

DATA ON ZINC PRODUCTION IN THE DEVELOPING COUNTRIES

COUNTRIES		Reserves, thous.t.		Mine production, thous. t.	Primary metal production, thous. t.	Primary metal consumption, thous. t.	Exports, thous.t		Imports, thous.t.	
		total	proved and probable				Raw material	Metal	raw material	metal
I		2	3	4	5	6	7	8	9	IO
Total for developing countries	1955	I3893	4757	695	I49	I04	523	I48	-	52
	1967	38709	I63I3	844	269	307	668	I69	20	87
AFRICA										
Algeria	I955	-	-	3I	-	-	65	-	-	-
	I967	I029	673	IO	-	-	...	-	-	-
Morocco	I955	800	650	43	-	-	90	-	-	-
	I967	800	680	46	-	-	45	-	-	-
Tunisia	I955	60	25	5	-	-	I3	-	-	-
	I967	60	60	3	-	-	7	-	-	-
UAR	I955	-	-	-	-	-	-	-	-	-
	I967	860	...	-	-	-	-	-	-	-
Zambia	I955	776	423	3I	28	-	-	26	-	-
	I967	II60	II60	53	45	-	-	40	-	-
[illegible] Republic ([illegible])	I955	2000	-	[illegible]	3[illegible]	..	I03	51	..	..
	I967	2000	I0[illegible]	[illegible]	62	..	[illegible]	30	-	..

I		2	3	4	5	6	7	8	9	IO
South West Africa	**I955**	340	340	I7	–	–	22	–	–	–
	I967	850	850	23	–	–	20	–	–	–
Total for Africa	**I955**	3976	I438	I95	62	–	I65	77	–	–
	I967	6759	4423	245	I07	28	I48	70	–	–
<u>LATIN AMERICA</u>										
Mexico	**I955**	950	890	269	56	I3	37I	49	–	–
	I967	I2000	3600	235	66	35	I60	38	–	–
Argentina	**I955**	I650	625	2I	I4	20	–	–	–	0.2
	I967	I500	I500	27	24	23	...	...	–	...
Bolivia	**I955**	I400	800	2I	–	–	2I	–	–	–
	I967	900	750	I0	–	–	I0	–	–	–
Brazil	**I955**	–	–	–	–	I4	–	–	–	I4
	I967	4000	II00	–	7 2)	35	–	–	–	I4
Guatemala	**I955**	–	–	9	–	–	–	–	–	–
	I967	I20 2)	60 2)	–	–	–	–	–	–	–
Honduras	I955	–	–	–	–	–	–	–	–	–
	I967	80 2)	80 2)	–	–	–	–	–	–	–
Peru	**I955**	3I60	250	I66	I7	–	I28	I9	–	–
	I967	6000	4000	290	65	5	247	6I	–	–
Total for Latin America	I955	7I60	2565	477	87	52	334	68	–	[illegible]
	I967	24600	II080	562	I62	I28	4I7	99	–	I4

I		2	3	4	5	6	7	8	9	IO
ASIA										
India	I955	390	390	3	-	48	5	-	-	32
	I967	I000	270	6	-	52	...	-	20[3]	57
Burma	I955	2275	308	8	-	-	4I	-	-	-
	I967	2700	240	5	-	-	I5[4]	-	-	-
Iran	I955	-	-	6	-	-	-	-	-	-
	I967	2200	I50	I7[3]	-	-	77[3]	-	-	0.8[3]
Turkey	I955	40	40	3	-	-	I	-	-	-
	I967	40	40	6	-	-	I7	-	-	3[3]
Thailand	I955	40	4	3	-	-	-	-	-	6
	I967	I340	40	2[3]	-	-	-	-	-	I2[3]
Philippines	I955	I2	I2	-	-	-	-	-	-	0.I
	I967	70	70	I[3]	-	-	...	-	-	...
Total for Asia	I955	2757	754	23	-	52	24	-	-	38
	I967	7350	8I0	37	-	I5I	I03	-	20	73

I) By data on I958 and I967

2) Estimate

3) By data on I966.

§ 6. General survey of tin industry

The tin-mining industry of developing countries plays the leading role in the world mining and production of tin. It is mainly concentrated in the developing countries of Asia (Malaysia, Indonesia, Thailand), Africa (Nigeria, Congo-Kinshasa) and Latin America (Bolivia, Brazil).

The share of the developing countries in the world tin-mining industry for 1967 is as follows: proven and probable reserves - 92%, tin production in concentrate - over 95%, tin metal - about 70%. The share of the countries in Asia is respectively the following : 62, 66 and 60%.

The most important producers of tin are: Malaysia (77.5 thou.tons in 1967) and Thailand (27 thou.tons in 1967). Along with this a number of countries, where tin mining is a matter of recent years, should be mentioned. These are Tanzania, Niger, Congo (Brazzaville), Swaziland etc.

Data on tin reserves, mining, production and exports are given in appendix V.

In the developing countries excluding Bolivia, this is mainly mined from alluvial deposits.

In 1967 it was mined from alluvial deposits of the developing countries in the amount of 67.6% of the world production and that of 23.6% from primary deposits including Bolivia.

Tin-bearing alluvial deposits are worked by the following methods depending on the aim: dredging, hydraulicing and the use of earth digging and transportation equipment. The considerable proportion of tin is mined by small owners and tributors using primitive mechanization and mannual labour.

Working of tin alluvial deposits over long period has brought to the fact that resources of the most accessible and rich deposits are being depleted while costs of production are rising.

The large tin-bearing alluvial deposits island as well as off-shore are mined by dredging. Working of sea bed alluvial deposits aquires still greater importance in the south-east Asia.

The necessity to work deposits lying near the surface and to check costs of production has brought of two main ways of effective dredging:

a) increase in depth of deposits working;

b) increase in capacity of dredges and buckets and speeding the movement of the bucket chain.

At present the depth of digging of multibucket dredges is up to 48 meters, the capacity of buckets is up to 566 liters. The further increasing of these parameters requires broad application of special steels, titanium alloys, light metal alloys and plastics. The appliance of such materials makes it possible to decrease the weight of some units and parts of the dredge to increase their strength and to reduce power consumption. It will provide technical feasibility and economic expediency of increasing digging depth and buckets capacity.

For the improvement of dredging methods automatic control by means of electronic computors as well as industrial television sets are of great importance.

The dredges operating off-shore should be of greater working depth capacity, (up to 25-50 meters) strength and stability.

In contrast to dredging by powerful dredges, hydraulicing is performed mainly by small capacity units.

Annual capacity of the majority of placers, where hydraulicing is used averages 100-150 thou cu.m of overall mined mass. There are only a few enterprises equipped with high-duty equipment.

Cost of tin at small plants is considerably higher which is a drawback when tin price at the world market decreased below the average level.

The effect of hydraulicing depends on availability of power sources. The main stimulating factors for the progress of hydraulicing are the sufficient amount of cheap electric power and the usage of high capacity equipment.

For alluvial deposits are worked by small interprises using earthdigging and transport means. The technical level is not high here.

Stripping is performed as a rule by draglines with the bucket capacity up to 5.4 cu.m and the sand is mined by small excavators with the bucket capacity sometimes up to 3.4 cu.m Sand mainly is transported by trucks.

It should be mentioned that in the tin-mining industry of the developing countries such hi-h capacity equipment as stirrers, bulldozers, scrapers and single-bucket loaders is very seldom used, however there is a tendency in recent time to apply modern equipment as well. So tin-bearing sand at a quarry in Malaysia is mined by rotary bucket excavators and transported by belt conveyors to the ore dressing plant.

In Nigeria, in stripping operations, loaders of Uklid company with the capacity of 400 cu.m per hour are used to load rock into dump trucks. However new equipment is being introduced rather slowly.

Many small tin producers, and tributors in particular, mine sand mannually.

Tin-bearing sands are dressed at modern dredges and washing plants with the aid of scrubbers, for preliminary desintegration and screening, hydrocyclones, jigs and concentration tables.

This process makes it possible to receive a course concentrate with recovery in the range of 90%. The concentrate is treated at special units equipped with screens, concentration tables and magnetic separators. As a result of the treatment a commercial concentrate of a rather high quality containing 70-75% of tin and minimum quantity of harmful admixture is obtained.

Unfortunately in some countries a large amount of sand (perhaps half of it) mined by small enterprises by means of gravel pumps and even by some dredges are washed, as in the beginning of the century, at sluices of Malayan type that is "palongers" and the like. Tin losses during washing are higher by 5-20%, compared with the process mentioned above.

The most heavy losses here are those of fine cassiteritet (-0,2) mm and finer fractions).

Course concentrates is often finally dressed at primitive units ("lanchutes" in the south-east Asia). This involves considerable manual labour and unjustified metal losses (up to 10 per cent and more) in particular when treating course concentrates with high content of heavy minerals.

Tin ore mining. Tin ores relatively seldom form bodies of great thickness, as in Congo for example, where Manono deposit is worked. The deposit is a pegmatite intrusion 5 km in length and 100-400 m in width. This and some other deposits of such kind are mined by open pit practice.

The ore mass is excavated from the weathered upper part. The ore mass of the lower semidecomposed pegmatite layers is drilled and exploded if necessary before the exavation.

Tin ore is mined from veins that are often rather small. The typical example are tin mines in Bolivia where the ore is mainly mined from small veins (less than 1 meter in thickness) by means of overhand step shrinkage systems with filling sometimes. At the areas where multiple thin veins from a thick ore zone, the productive block caving system instead of mining separate veins is used at present time (the Llallagya mine). This system allows to reduce tin losses in the mine, to encrease labour productivity by several times and to receive cheap ores.

However a considerable dilution of ore with barren rock picked up with lode mass takes place. The appliance of the block caving method in the mentioned geological conditions is commercially expedient due to beneficiation in dense suspensions which makes it possible to remove up to 50% of barren rock (from ore mass) after course and medium crushing.

Only some quantity of the remaind ore is treated by usual expensive dressing process, requiring much power and this considerably decrease the overall operating costs.

Tin ore dressing. A major quantity of tin concentrates of the developing countries is mined from alluvial deposits, about 20% from primary and insignificant quantity from complex columbite-cassiterite ores.

The production rate of tin ore dressing plants is different, and when dressing sands it is in the order of 400-1600 t per shift. The capacity of the most large dressing plants treating primary ores is: in Bolivia - Katavy - 4.5 thou tons, Kolquiry - 1 thou tons, Patino - 2 thou tons, in Congo - Géomine - 24 thou tons, in Tanzania - 1 thou tons, in South-West Africa - 2.5 thou tons per day.

In the other countries without large plants for tin ore mining and treatment the capacity the plants is 100-200 tons per day.

The large dressing plants have modern high production equipment and use modern flow-sheets.

The main method of tin ore treatment is gravity concentration at jigs, concentration tables, special type separators and sluices.

Course gravity concentrates is finally treated according to complicated schemes including magnetic separation at separators with high intensity of magnetic field, floatation and the floatation - gravity concentration.

Tin is recovered from slime product at special sections equipped with concentration tables, dumping automatic sluices and vanners.

When dressing of primary tin ores containing 0.1-1.5% tin the 25-70% tin. concentrates are produced with the recovery of 28-78%.

Among the improvements in the world practice of tin ore dressing technology the most promising one is preliminary ore dressing in dense suspensions which allows to encrease plants capacity and to reduce the costs of the ore treatment.

In recent years in connection with development of new reagents floatation concentration of tin ore received more attention in a number of countries (Australia, England, the German Democratic Republic), though at present only a relatively low-grade tin concentrate produced by this method. In this connection it is assumed that present floatation process should be combined with gravitation process for dressing of fine materials instead of substituting it.

In a number of developed countries (Australia, England, the German Democratic Republic) research work on cassiterite floatation conditions is being carried out, on the basis of which perspective reagent practice is developed.

Cassiterite floatation from slime products is done on an industrial scale in England at the plant of the South Crofty mine and in the German Democratic Republic.

In recent years the matter of interest is research work on the development of the so called spherical agglomaration for the dressing of low-grade tin ores.

The parameters and apparatus for the process are developed in Canada where they suppose to treat tin-bearing complex ores from one of the new deposits.

In a number of cases cassiterite floatation allows to produce only 8-12% tin concentrate the effective treatment of which by conventional pyrometallurgical methods is impossible. As shown by the experience of the plants in the Soviet Union such concentrates can be treated by the fuming process.

Tin metallurgy. The production capacity of tin smelters of the developing countries is given in table 1.

Up to the fifties tin concentrates produced by the developing countries were in the main exported into the developed capitalist countries. A number of developing countries (Malaysia, Thailand, Indonesia, Bolivia, Nigeria etc.)

in the post-war period and after the sixties, in particular, erected new tin smelters as a result of which some of the countries ceased or extremely limit the exports of tin concentrates.

At present the production capacity of tin smelters is twice as much and even more than the annual production of primary metal.

The majority of tin smelters of the developing countries use high-grade concentrates (65-75% of tin) with low impurity content. For its treatment reduction melting in reverberatory furnaces with a mixture of coal and flux is used, the resulted product being crude tin and high-grade slags. The crude tin is fire-refined and the slags are remelted to produce dump slags.

This process is promising for rich concentrates and it is successfully being developed in the direction of improvements in flow-sheets of plants with the aim of increasing recovery of tin and valuable by-components from the raw material. So at the Volta Redonda plant, as a result of treating raw materials in addition to tin, a number of other products (niobium and tantalum concentrates, alloys and solders) are produced.

At a new tin smelter in Muntok in Indonesia continuous melting of tin concentrates in large rotary furnaces is put into practice.

An important trend in the development of tin metallurgy of the developing countries is the development of a new effective technology for treating low-grade concentrates produced

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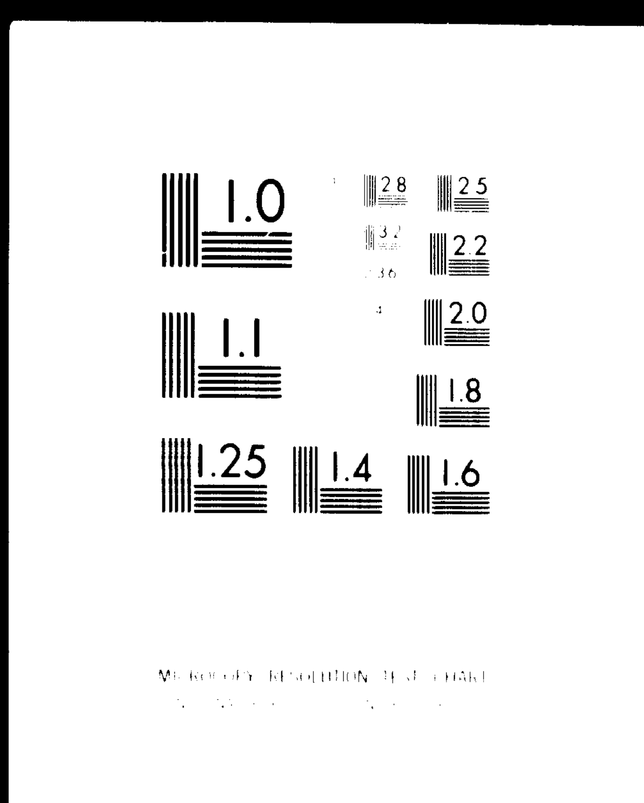

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from ores of complex ore deposits.

The Vinto tin smelter in Bolivia which is planned to be put into operation in 1969 will play an important role in tin metallurgy. The plant will treat concentrates of complex composition produced from primary deposits of the country.

Table 1

Production capacity of tin smelters (primary tin) in the developing countries

Country	Company	Plant and its location	Production capacity, thou tons per year (as for 1.I. 1967)	Actual production, thou tons per year (1967)
	Asia			
Indonesia	Banka Tin-Mines	Muntok	...	1.5
	Peltim Smelter	Muntok	[illegible]	
Malaysia	Eastern Smelting	Dato Kramat, isl.Penang	60-70	
	Oriental Tin Smelters	Clang, near Swettenham port	12	77.5
	Straits Trading	Butterworth	55	
Singapore	Straits Trading	Pulau Brani	...	...
Thailand	Thaisarco	Phuket, t.Pelin	33	27.0
	Africa			
Morocco	Société des Mines d'Etain d'Oulmes	Near t.Oulmes		0.012
Congo (Kinshasa)	Geomines	Manono	10	1.8

Country	Company	Plant and its location	Production capacity, thou tons per year (as for 1.I. 1967)	Actual production, thou tons per year (1967)
Nigeria	Makery Smelting	Makeri Jos	10-12	9.3
	Latin America			
Argentina		[illegible], Buenos Aires	1.5	0.1
Brazil	Estanifera do Brasil	Volta Redonda	6-7	2.1
		Sao Joao del Rei	1.0	
Bolivia	Fundicion de Estano	Oruro	5	
	Banco Minero de Bolivia	Oruro	1.5-2	1.1
Mexico	Estano Electro	Tlalnepantla	1.3	1.0

The development of tin mining industry in developing countries can take place with the most economic effect with coordination of mines, and smelters operation as a part of a general plan of technical development.

The main ways of improving alluvial tin deposits mining in developing countries are the following: unification of the dredge fleets, building dredges capable of working deposits including sea bed placers at the depth of 50- 60 m, construction of plants with hydraulic methods of mining on the basis of cheap electric power sources, the use of modern diggers, mechanization of preparing areas for mining (cutting and clearing of Jungles etc.).

In a number of cases pump dredges with mechanical and hydraulic loosing of the place can be used.

Some conclusions and proposals concerning the tin mining industry of developing countries are wholly based on the tin industry practice of the USSR.

Tin ores should be open mined wherever it is possible and underground mining should be used with the effective mining systems to receive cheap ore for the further dressing in heavy suspension; when dressing sands washing in sluices and final treatment at primitive units (lanchutes) should be replaced wherever it is possible by installations equipped by scrubbers, jiggers and concentration tables; the plants for final dressing should be equipped by all necessary facilities including magnetic separators. This measure would make it possible to reduce sharply (in many countries by 10-20%) losses of tin and valuable associated materials, when dressing sands, and to encrease operating efficiency.

Alongside the high-grade concentrate production it is expedient in many cases for the reduction of tin losses to arrange secondary treatment to get concentrates with 5-15% content of tin for special metallurgical treatment.

At dressing plants treating complex disseminated ores only, it is often sound practice to receive only such concentrates, which may be recovered without considerable tin losses in tails. These concentrates as a rule can be divided into the rich ones for conventional melting and the product of secondary treatment for special metallurgical processes.

In the Soviet Union concentrates are treated at special final dressing plants with complex treatment schemes, calcination, magnetic separation and leaching. The resulted high-grade concentrates are melted in electric furnaces that nearly completely have replaced the reverberatory furnace. Low-grade products of beneficiation, and metallurgical treatment containing less than 10% of tin are treated by fuming process to receive sublimate and slags containing 0.I-0.I2 % of tin.

Such a flow sheet being almost universal, after the proper experimental check up can be used successfully in many developing countries.

Data on tin production in the developing countries, thou. tons.

Countries		Tin reserves		Production		primary tin consumption	Exports		Imports	
		total	proved and probable	tin in concentrates	primary tin		tin in concentrares	primary tin	tin in concentrates	primary tin
I		2	3	4	5	6	7	8	9	IO
Total the developing countries	I955	3943	I260	I62.0	78.3	I2.9	93.5	76.2	I2.6	...
	I967	5488	2645	I6I.4	I2I.4	I4.6	43.6	II5.0	2.3	...
Asia										
Burma	I955	300	...	I.I	–	...	I.0	–	–	0.05
	I967	300	I00	0.3	–	...	0.06	–	–	...
Indonesia	I955	800	400	33.9	I.8	0.5	32.3	I.5	–	0.02
	I967	800	550	I3.8	I.5	0.I	I2.5	I.6	–	...
Laos	I955	30	...	0.3	–	...	–	–	–	...
	I967	60	60	0.3	–	...	0.4	–	–	–
Malaysia	I955	I000	300	62.0	7I.8	0.I	–	72.0	II.2	–
	I967	I200	600	73.3	77.5	0.I	–	75.0	2.2	–
Thailand	I955	700	I50	II.2	–	0.I	II.	–	–	0.7
	I967	I500	500	22.6	27.0	0.I	0.04	26.9	–	–

I		2	3	4	5	6	7	8	9	I0
India	I955	–	–	–	–	4.3	–	–	–	3.7
	I967	–	–	–	–	4.0	–	–	–	4.2
Turkey	I955	–	–	–	–	0.7	–	–	–	0.7
	I967	–	–	–	–	0.9	–	–	–	0.9
Other countries	I955	–	–	–	–	I.2	–	–	–	I.2
	I967	–	–	–	–	I.5	–	–	–	I.5
Total for Asia	I955	2830	850	I05.7	73.8	6.9	43.6	63.5	II.2	6.9
	I967	3860	I8I0	II0.5	I06.0	6.7	I3.0	I03.5	2.2	6.7
America										
Argentina	I955	...	....	0.09	0.I	I.6	–	–	–	2.3
	I967	I0	I0	2.I	0I	I.8	–	–	–	0.9
Bolivia	I955	400	300	28.4	0.I	–	28.0	0.I	–	–
	I967	850	440	27.3	I.I	0.06	26.0	I.I	–	–
Brasil	I955	5	...	0.I	I.2	I.3	–	–	I.4	0.0[illegible]
	I967	20	20	I.6	2.I	2.I	–	–	–	–
Mexico	I955	5	–	0.6	0.2	0.7	0.0I	–	–	0.05
	I967	28	20	0.6	I.0	I.6	–	0.002	0.I	0.2
Peru	I955	...	...	–	–	–	0.002	–	–	0.07
	I967	...	...	0.02	–	...	...	–	–	0.05

I		2	3	4	5	6	7	8	9	I0
Ghile	I955	-	-	-	-	0,4	-	-	-	0.4
	I967	-	-	-	-	0,6	-	-	-	...
Other countries	I955	-	-	-	-	I,0	-	-	-	...
	I967	-	-	-	-	0,5	-	-	-	...
Total for America	I955	4I0	300	42.2	I.6	5,0	28,0	0.I	I.4	...
	I967	908	490	3I,I	4.3	6.8	26.0	I.I	0.I	...
Africa										
Burindi	I955	-	-	...	-	...	...	...	-	...
	I967	-	-	0.I	...	...	...	...	-	...
Congo Republic (Kinshasa)	I955	500	...	I5,3[2]	3.I	...	I2.6[3]	2.6	-	0.0-
	I967	500	200	7.I	I.8	0.I5	3.6[4]	I,8	...	...
Congo Republic (Brazzaville)	I955	...	...	-	-	...	...	-	-	...
	I967	...	...	0.05	-	...	...	-	-	...
	I955	I00	I00	8.3	-	0,I	8.3	-	...	0.5
	I967	II0	II0	9.5	9.3	0.2	0.005	9.6	...	...
Niger	I955	...	...	...	-	...	...	-	-	...
	I967	...	...	0.06	-	...	0.03	-	-	...
Rwanda	I955	60	...	2.0	-	...	...	-	-	...
	I967	65	20	I.3	-	...	I.4	-	-	...

I		2	3	4	5	6	7	8	9	IO
Swaziland	I955	...	...	0,03	-	...	...	-	-	...
	I967	...	...	0,0I	-	...	...	-	-	...
Tanzania	I955	3	...	0,04	-	...	0,05	-	-	...
	I967	3	3	0,4	-	...	0,[illegible]	-	-	...
Uganda	I955	...	...	0,06	-	...	...	-	-	...
	I967	2	2	0,I	-	...	0,I	...	...	...
Other count-ries	I955	40	I0	0,4	-	0,9	...	-	-	...
	I967	40	I0	0,7	-	0,8	...	-	-	...
Total for Africa	I955	703	II0	26,7	3.I	I,0	20,9	2,6	...	...
	I967	720	345	I9,2	II.I	I,I	4,3	I0,4	...	...

I) By data on I958 and I967

2) Including Production of tin-in-concentrates in Ruanda-Urundi

3) Including exprots from Ruanda-Urundi

4) Estimate

§ 7. Non-ferrous metals processing

Total production of semis from aluminium and its alloys by the developing countries is estimated at 210,000-225,000 t and from copper and its alloys - 200,000-275,000 t a year.

The annual production of non-ferrous semis per capita of more than 1,2 billion population of the developing countries is 30-80 times less in comparison with the industrially developed countries and amounts to 0.17 kg per capita of aluminium rolled metal and 0.20 kg per capita of copper product. The production of semis throughout the developing countries is extremely uneven. In the countries of South and Central America the production per capita constitutes 0.60 kg of aluminium and 1.0 kg of copper rolled metal; in Africa 0.16 kg and 0.07-0.09 kg respectively; in Asian countries - 0.10 and 0.07-0.09 kg. The output per capita of the same products in the developed countries amounts to 3 and 15 kg.

Low level of economic development together with the shortage of currency and the absence of home non-ferrous metals production in the majority of the developing countries are the main factors causing the weakness of the non-ferrous semifabrication industry. Nevertheless the growing demand for non-ferrous semis caused the majority of these countries to import non-ferrous metals (mainly from the developped countries) with the aim of organising home production of semis.

The rate of the development of this industry is the highest in the countries of Latin America, where the total capacity of the non-ferrous processing plants increased threefold during the period from 1962 to 1967. Large volume of,the rolled products output in the form of sheet metal is used for the production of kitchen utensils and roofings. Another big share consists of pressed aluminium shapes used in building construction and aluminium foil for packaging of food, tee, cigarettes, etc.

In India and some Latin American countries part of the aluminium and copper rolled wire is used for the production of electric wire and cables.

In the majority of the developing countries, plants producing non-ferrous semis are under control of foreign capital. Thus in Asian and African countries these plants account for 50-70% and in Latin American countries for 70-100%.

Unlike the American and European non-ferrous metals processing plants, the plants in the developing countries are rather small with annual capacity - 4000-5000 t of aluminium semis and 10000-12000 t of copper semis. The exception are some big plants in Brazil (1), Venezuela (1), Chile (2) and India (3-4).

Annual capacity of modern plant in developed countries is in the range of over 100000 t for aluminium rolled products and 50000-100000 for copper ones.

The output of non-ferrous processing plants in the developing countries is only 40-50% of their designed capacity. Many enterprises use obsolete flowsheets.

Thus sheet metal is produced by labour consuming pack rolling on duo mills, operated manually. Some of the plants are equipped by obsolete rolling facilities demounted from the plants of the developed countries which strive for continuous development of technological methods of semi-fabrication to satisfy the growing demand for better quality of rolled products and to increase the profitability of the operations.

At modern non-ferrous metals processing plants great attention is payed to the development of continuous processes, which allow further mechanisation and automatisation and to the application of such methods of production which minimise further processing.

In strip and sheet metal production the above mentioned refers to continuous and semi-continuous ingot casting on automatic casting machines with the production capacity of 10 t/hr; hot rolling of big blocks of aluminium and aluminium alloys (up to 7 t) on four-high multistand rolling mills 2000 mm wide with a delivery speed of 150 m/min; hot rolling of big blocks of copper and copper alloys on two-high reversing mills of high capacity; cold rolling on four-high mills with preloaded stands to produce a strip with very narrow allowance (e.g. a 1300 mm wide and 0.25 mm thick sluminium strip with the allowances of ± 0.005 mm); finish rolling on precision twenty-high and twelve-high mills; rolling on mills with side-supported work rolls; continuous thermal treatment in non-oxidising atmosphere in special coveyor furnaces.

Continuous casting of thin sheet slabs is often used instead of a conventional ingot casting, heating and hot rolling procedure. Combining casting and rolling operations in one continuous process makes it possible to create conditions for complex mechanisation and automatisation of the whole process.

Complete descriptions of several methods used for casting thin aluminium slabs have been already published in literature. 5μ gauge aluminium foil is produced nowdays by rolling slabs 1700 mm wide and 6 mm thick . "Hazelett" method is widely applied for casting of zinc slabs. This method can also be successfully used for casting copper.

In Australia, USA and Canada continuous casting is used for the production of lead sheets with the gauge of 0.4-1.5 mm. For continuous casting of wire bars "Properzy" and "Spidem" machines are widely applied. "Dip-Forming" process recently brought into production permits the molten copper to built up on a thin wire, increasing threefold its cros-section.

Continuous horizontal and vertical casting machines are widely used for the production of bars for rods, shapes and tubes.

The production of strips is sometimes economically feasible by the method of continuous powder rolling, which eliminates many operations and consequently reduces production costs.

Modern measuring methods together with partial or complex automatisation are widely introduced by modern plants producing non-ferrous semis.

At several plants in the developing countries casting of aluminium wire bars is carried by means of "Properzi" conti nuous casting machines. There are 17 such units in the developing countries, including 9 in,India, 4 in Brazil, 1 in Argentina, 1 in Venezuela, 1 in Mexico.

During recent years aluminium foil rolling shops were built and commissioned at several plants in Argentina, Brazil, Mexico and India. These shops are equipped by modern 1180-1570 mm, high-speed, four-high foil rolling mills. All these facilities are owned by foreign companies.

In the Philippines there is a plant for the production of copper strip by powder rolling.

Most of the non-ferrous metals processing plants in the developing countries are located in capital and big cities.

In the countries with the sea exits these plants are situated in big sea ports for easier handling of imported materials and for supplying plants of major consumers which are also located in these ports.

One of the main trends of technical progress, further improvement and development of their non-ferrous processing industry in the developing countries, includes: maximum application of continuous methods of operation, which minimize further processing and production costs; continuous casting of aluminium and copper wire bars; continuous casting-rolling of thin aluminium, zinc and copper slabs for the production of strips and foil; continuous horizontal casting of bars for shapes and tubes with sizes close to the finish gauge, production of strips by powder rolling; continuous casting of lead sheets and strips by pouring the molten metal onto the water cooled rotating drum of the casting machine.

The application of the above-mentioned continuous processes eliminates hot rolling of flat and shaped bars, slabbing pressing and other operations which demand the application of hot rolling mills, hydraulic presses and other expensive equipment.

If the application of combined continuous processes for the production of sheet and other semis is difficult, the economical feasibility of rolling and finishing processes can be increased by rolling big blocks, produced by continuous or semi-continuous casting or by welding smaller pieces. In these cases usuage of high speed hot and cold rolling mills is found practicable.

SECTION II

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

§ I. The Democratic People's Republic of Algeria

The Democratic People's Republic of Algeria is situated in North-Western Africa.The country borders on Morocco and on Mauritania on the West, on the Republic of Mali and Niger on the South, and on Libya and Tunisia on the East. In the North Algeria is washed by the Mediterranean Sea. The independence of Algeria was proclaimed on the 5th of July in 1962.

Territory - 2,382 thousand sq.km.
Population - 12.5 million people
Population density - 5 persons per sq.km.
Capital - Algiers

Natural conditions in northern Algeria differ much from those of the South of Algeria.North Algeria is situated along the Mediterranean coast; mountainous regions are dissected by large plains. The climate in northern Algeria is subtropical, mediterranean; with dry, hot summers and mild, rainy winters.South Algeria is a vast area of Algerian Sahara (80% of the territory of the country).The climate is desert and dry. Water resources of the country are limited. Only in North Algeria there are rivers reaching the Mediterranean Sea.The rivers are not navigable, but they are used for irrigation.The largest river is Chelif (700 km). For the last few years constructing of dams to make water storage reserves has been started.The country possesses a dense network of railways and roads.The trunk-line from Marrakesh (Morocco) to Tunisia runs through the country along the coast.This trunk-line forks to the South,connecting the interior with sea-ports (Oran with Bechar, Algiers with Djelfa and Annaba with Touggourt). The network of railways amounts to 4,500 km, including 1,637 km of narrow gauge track. The country possesses more than 22,000 km of highways and more than 34,000 km of earth roads. Two highways, connecting the coast of the Mediterranean Sea with Sahara and the countries to the South of Sahara cross the country. Principal sea-ports are Algiers, Oran, Annaba. Algeria is connected by regular airlines with France, the U.S.A., the USSR, Switzerland, Tunisia and Morocco. International airlines pass via the country. Large airports are situated in Algiers, Oran, Annaba.

Algeria is rich in power resources. Algeria is especially rich in oil and gas. But the reserves of coal are rather modest, they are enough to supply with coal only one thermo-power station at Bechar (table I).

Table I

Fuel production

Fuel	1955	1960	1965	1966
Coal (thousand tons)	100	100	50	100
Oil (million tons)	...	8.5	26.0	32.0
Natural gas (billion m^3)	...	0.6	1.8	2.0

Oil and gas fields are concentrated in Algerian Sahara. The greatest in this region are oil fields in Hassi-Messaoud and Edjem and gas fields in Hassi-er-Rmel. From

Hassi-er-Rmel gas is pumped to Arzev (near Oran). Two pipe lines carry oil to the Algerian port Buojie and to the Tunisian port Behira. From the ports oil tankers carry it to West Europe.

In 1966 the third pipe line from Hassi-Messaoud to the Mediterranean was completed. In Arzev there is a plant condensing natural gas.

The bulk of electricity is generated by thermo-power stations, working on coal (in Bechar), on oil and gas (near Annaba and Buojie). The number of hydro-electric stations is rather small. Figures, illustrating electricity generation in the country and the installed capacity are given in table 2.

Table 2

Electricity generation in Algeria

	Years				
	1958	1963	1964	1965	1966
Installed capacity (thous kw)					
Total	433	434	363	500	...
Installed capacity of hydropower stations	186	134	138	228	...
Generation of electricity (M Kwhr)					
Total	1,123	1,088	1,099	1,096	1,1[illegible]
Generation of electricity by hydro-power stations	406	256	284	400	355

Aluminium industry is represented by plants, producing aluminium semi-finished products (table 3).Total annual output capacity of 5 plants, processing aluminium, is 4-5 thousand tons.Raw materials for the plants are supplied by France and other countries.

Table 3

Production of aluminium semi-finished products in Algeria (tons)

	Years			
	I960	I96I	I962	I96?
Total	1,560	2,089	571	606
including sheets, strips	421	583	141	210
pressed-drawn wears	666	1,243	205	51
cooking utensils	473	263	225	405

Copper industry.Proved and probable copper reserves amount to 63.5 million tons, possible reserves are estimated at 16-thousand tons.Small deposits, which mostly contain complex, copper-lead-zinc ores, occur in north-western part of the country, in the department of Constantine.

Now the Ain-Barbar and Cavallo deposits are of paramount importance.The total reserves of the Ain-Barbar deposit amount to more than 3 million tons of ore; 235 thousand tons are considered proved and probable.The content of copper is 2.8% , the content of zinc is 2.7% , of lead -

0.8%. Out of 17 ore-bearing veins, only 4 are exploited by underground mining. Average month output is 2,300 tons of ore. The designed output of the mine (50 thousand tons of ore a year) is not reached yet. Proved and probable reserves of the Cavallo deposit are estimated at 2 million tons. The ore contains 2.5% of copper, 5% of zinc, 5% of lead. The deposit is very promising. The annual output capacity of the mine, which is scheduled for construction on the basis of the deposit, will be 240 thousand tons of ore. Geology and mineral resources of the country are poorly surveyed.

Geological prerequisites make it possible to believe that considerable deposits of copper can be found in the northern part of the country. The Bureau Algérien de Recherches et d'Exploitations Minières scheduled a program of large scale prospecting work for copper. Figures illustrating copper output and copper foreign trade in Algeria are given in table 4.

Table 4

Mine production, consumption and trade
(Thousand tons)

	1955	1960	1965	1966	1967	1968
Mine production (copper content)	1	-	1	1	1	1
Exports of concentrates	1.0	0.4	3.7	1.6	...	...
Imports of refined copper	-	-	2	2	2	...
Consumption of refined copper	-	-	2	2	2	2

Copper mine production in the country is insignificant. Only Ain-Barbar deposit is exploited. The produced cupreous concentrates are exported to European countries; F.R.G. being especially important customer. Algeria consumes about 2 thousand tons of copper, which is imported by the country.

In Algeria there is only one plant processing copper, which is situated in Cuba. It belongs to "Laminoir Tréfilérie de l'Afrique" and produces wire and cable from copper and aluminium. The annual output capacity is 6.3 thousand tons of wire and cable. Earlier the plant had relation with the French company "Trefimetaux". The plant works on the ores, coming from France and other countries.

Lead-zinc industry. Algeria abounds in numerous small and middle deposits of lead and zinc. Total lead reserves in the country are estimated at 545 thousand tons (307 thousand tons are considered proved and probable, 238 thousand tons - possible).

Total zinc reserves are estimated at 1,029 thousand tons (676 thousand tons are considered proved and probable, 356 thousand tons - possible).

The content of lead in the ores varies from 0.15% to 10.0% (average content is 2.2%). The content of zinc varies from 0.7 to 17.3% (average content is 6.0%).

The content of copper varies from 0.8% to 3.0%

Besides, silver is found in the country - 250-300 g/t, in rare cases up to 900 g/t. In some areas there are workable deposits of mercury (Tagiet, Cudiat - Stah, Bir-Beni - Salah deposits). 72 deposits of lead and zinc are known in the northern part of the country.The most significant one is El-Abed, its reserves are estimated at 5,650 thousand tons of lead-zinc ore. The southern part of the country is not at all surveyed.Mineral resourses are poorly surveyed. Geological prerequisites make it possible to believe that the areas are rich in lead-zinc ores.For the exploration of new deposits it is necessary to carry out large-scale prospecting work in the areas abounding in deposits; near the frontier with Morocco, in the area of El-Abed and Wad-Zounder Mines, near Collo; between the cities of Setif and Batna; near Algero-Tunisian frontier, near Kef-Um-Tebul.The increase of the output of the existing mines, the exploitation of fresh capacities at existing deposits,construction of new mines will contribute to the development of mining industry in Algeria.

Recently a new zinc deposit was discovered near Ichmoul.

Figures, illustrating lead and zinc production and lead-zinc foreign trade, are given in table 5.

Table 5

Lead and zinc production and exports from Algeria
(thou . tons.)

	Years					
	1955	1960	1965	1966	1967	1968
Lead mine production (metal content)	10	10	10	3	5	4
Zinc mine production (metal content)	31	40	38	14	7	8
Exports of lead ore and concentrates	13	5.8	12.6	8.2	...	...
Exports of zinc ore and concentrates	65	66	68	...	...	...

Four lead-zinc underground mines account for the output of lead-zinc ores in Algeria. They are the following: El-Abed, Sidi-Kamber, Quarsenis and Ain Barbar.

The El-Abed mine is the largest lead-zinc mining plant in Algeria. At present 700-800 and up to 1000 tons of ore a day are mined at this plant. The mined ore is sent to a dressing mill in Morocco. The mine is supposed to be reconstructed with the aim to encrease its capacity up to 3000 tons of ore a day.

The Sidi-Kamber mine is working lead-zinc deposits having small ore reserves, which may be encreased in the future. The Buduk deposit may be used as potential raw material sources for this mine.

Quarsenis and Ain Barbar mines have limited ore reserves and this predetermines the necessity of considerable prospecting for new deposits.

The developing of a lead,barite deposit at Djebel Easchmool (60 km of Batana) and building of a mining-dressing plant with the capacity of 100 thou.tons of processed ore per year will be started in the nearest future.

The overall reserves are amounted to 1.2 M. tons of ore, 50 thou.tons of lead and 480 thou.tons of barite. There are definite perspectives for a further growth of reserves.

Ores are treated at three dressing mills: Sidi-Kamber, Quarsenis and Ain Barber.

A new dressing mill with the capacity of 2000 tons/day is under construction at the El-Abed deposit. Sulphide disseminated ores will be treated at this plant.

The dressing mills of Algeria produce lead concentrates, containing 65-78% of lead and zinc concentrates, containing 53-60% of zinc (Table 6).

Table 6

Production of lead-zinc concentrates of Algeria

Mill	Extracted tons of ore	Metal content in ore (%)			Concentrate produced (tons)			Metal content in concentrates (%)		
		Lead	Zinc	Copper	Lead	Zinc	Copper	Lead	Zinc	Copper
Quarsenis	34,000	2.00	12	-	634	3,134	-	63.0	53.0	-
Sidi Kamber	27,730	9.2	4.3	-	3258	1,975	-	78.8	57.66	-
Ain Barbar	23,885	o.7	1.4	4.1	358	682	2,900	44.0	49.0	26.78

In Algeria a number of new lead-zinc mills are scheduled for putting in operation in the nearest future. Expected production data of the mills are given in table 7. All produced concentrates are not processed in Algeria, they are exported to different countries. Lead concentrates are delivered to France, Tunisia, Morocco, Belgium, Italy, FRG and Japan.

Zinc concentrates are exported to France, Morocco, Belgium, Spain, the U.S.A., Great Britain, Italy, FRG, Japan. At the beginning of 1968 an agreement was signed between the government of Algeria and the government of Morocco. Under this agreement 300 thousand tons of lead-zinc ore coming from the El-Abed mine will be delivered annually to Morocco, to the Bou-Beker concentrator. Lead concentrates will be processed in Morocco at Wad- el - Heimer mill. Zinc concentrates will be reexported. The lead processing mill at Blida, belonging to the "Samabe", company, produced lead ingots, tubes and other products. The annual output capacity of the mill is 3.5 thousand tons. In 1963 the plant produced 1,400 tons of slabs and 409 tons of tubes.

<u>Tin industry</u> is not developed in the country. In Beni-Bel-Aid, in 65 km to the North-West from Constantine there are areas of tin-bearing greisens embedded in sericitie and clorite sla es. The thickness of the layers is up to 1 m, the extent seldom exceeds 200 m. Mineralization is presented by cassiterite and magnetite with insignificant impurities of columbate. Still only small number of above areas are found, but it is proved that cassiterite occurs in almost all rivers of the region.

Table 7.

Some data about concentrators which are scheduled for construction and their designed technological characteristics

Mills	Output capacity (thousand tons of ore annually)	Production of concentrates (tons annually)			Metal content in concentrate (%)			Percentage of metal being recovered %		
		Lead	Zinc	Copper	Lead	Zinc	Copper	Lead	Zinc	Copper
Kherset Joucef	120	5,830	23,550	-	70	55	-	85	85	-
Kef-oum-Teboul (Kef-um-Tebul)	120	2,770	5,730	7200	65	50	25	75	75	75
Cavallo	240	5,900	6,780	13000	60	50	20	70	70	70
Budaka	100	1,870	5,600	3050	65	55	25	80	80	70
El-Abed	2000 x)	10,000	50,000	-	70	58	-	85	93	-
Wad-Oudina	60	3,350	3,100	-	70	55	-	85	80	-
Wad-Mesidjet	60	2,410	5,090	-	70	55	-	85	85	-
Gjebel-Ichmoul	80	5,620	-	-	70	-	-	90	-	-
Guerrouma	80	2,220	7,640	-	65	55	-	80	80	-
Gar-Ruban	150	5,460	8,727	-	70	55	-	85	80	-
Gjebel-Gustar	60	1,120	7,640	-	60	45	-	70	7[illegible]	-
Ma Zoula	150	4,500	-	-	65	-	-	75	-	-
Gergur	80	-	7,800	-	-	55	-	-	80	-
Tresel	60	1,820	2,780	-	70	50	-	85	80	-

x) tons/day

§ 2. The Kingdom of Morocco

In 1956 Morocco became an independent state. It is a constitutional monarchy. The king rules the country.

Morocco is situated on the North-Western coast of Africa. It borders on Algeria to the South-East, on Spanish Sahara to the South West. In the North the country is washed by the Mediterranean Sea and in the West it is washed by the Atlantic Ocean.

Territory - 445 thousand sq. km.

Population - 14,140 thousand people.

Population density - 32 persons per sq. km.

Capital - Rabat (379 thousand inhabitants with suburbs).

Principal cities - Casablanca, Marrakech, Fes and Tangier.

Sea Ports - Casablanca, Tangier, Rabat, Safi, Mogador, Agadir.

The North-Western part of Marocco is covered by the high western branches of the Atlas Mountains. The Atlantic coast and the Mediterranean coast are covered with costal plains.

In the South-East of the country there is a desert plateau, the slopes of the plateau reach the Sahara sands.

The climate is Mediterranean with a mild and rainy winter and a long dry, hot summer. Towards the interior the climate becomes more continental.

Morocco has rather a dense network of rivers,

rivers dry up at the end of summer. The biggest rivers of the Atlantic Slope with constant flow are: The Oum er Rebia River (556 km), Wad Sbu ([illegible] km), Wad-Tennsift (270 km), Wad-Sus (I80 km). The River Muluya is emptied into the Mediterranean Sea.

The rivers are mostly used for irrigation. Taken as a whole the country lacks water.

In Morocco there are thermal and hydro-electric stations (Table I).

Table I

Generation of electricity in Morocco

	Years				
	I958	I963	I964	I965	I966
Installed capacity (thous. Kw)					
Total	372	374	388	392	388
Installed capacity of hydro-power stations	290	292	292	302	30I
Generation (million Kw-hr)					
Total	948	I,232	I,232	I,362	I,43I
Generation of electricity by hydro-power stations	843	I,I27	I,I27	I,215	I,055

Hydro-electric stations are mostly situated on the rivers of the Atlantic Slope. More than 6,5[illegible] workers are employed at the electric power stations of Morocco.

The country's demand for fuel is covered by the country's production of oil, gas and coal.

In Morocco there are oil fields and gas fields. They are exploited by the Franco-moroccan company "Societe Cherifienne de Petroles". An oil refinery was built in the country.

Coal is mined in the North-eastern part of the country. More than half of the mined coal is delivered to France, Algeria, Italy, Belgium and to other countries.

The network of railway lines in Morocco exceeds 2,500 km. 760 km of the railways are electrified. The most important railway line from Marrakech to Tunisia runs throught the country via Casablanca and Fes. Another important railway line connects Fes with Tangier, The lines Casablanca - Oued-Zem-Safi-Louis-Jantille and Oujda-Bou-Afra connect mining complexes with the trunk-line. The line Oujda-Bou Afra is the beginning of the Transsahara trunk-line. The network of highways and earth roads amounts to 50 thousand km, 15.9 thousand km being paved roads. The fleet of motor vechicles totals 168.6 thousand passenger cars and 68.0 thousand trucks.

Sea transport is of great importance. 75% of sea trade go via Casablanca. Among others Rabat and Tangier are of significance. There are international airports in Casablanca and Rabat. The range of non-ferrous metals in the country is rather wide: in Morocco there are deposits of copper, lead, zinc, tin, nickel, cobalt, antimony, molybdenum, tungsten.

Aluminium Industry. The country does not produce aluminium. Bauxite is not produced in Morocco. There are deposits of bauxite in the Atlas Mountains. The bauxite reserves are estimated at 20 million tons, bauxite containing 40-55% of alumina.

The reserves are not utilized as they are located far away from railways and roads.

Metal-working industry is poorly developed. Aluminium semi-manufactured goods are imported from other countris: I96I - I.7 thousand tons, in I962 - I.7 thousand tons, in I963 - I.8 thousand tons, in I964 - I.9 thousand tons, in I965 - I.6 thousand tons.

In I966 a new plant fabricating aluminium civil structures from the aluminium of the company "Moroccan Aluminium" was put in operation.

Besides, in Morocco there is a small plant, producing aluminium wrapping foil.

Copper industry is poorly developed. Total copper reserves in the country are estimated at 40 thousand tons, 20 thousand tones are considered proved and probable.

The ores contain 2-3% of copper.

Table 2

Mine production and export of concentrates, thous. tons

	Year				
	I960	I965	I966	I967	I968
I	2	3	4	5	6
Mine production (copper content)	I.6	I.9	2.5	2.2	2.6.

I	2	3	4	5	6
Copper-in-concentrates exports	I.2	I.4	I.9	2.1	I.2

Copper is mined at nine small deposits, located mainly in the West of the country. About 90% of copper mining come from Bou-Skaur, Djebel-Klak and Aheg... mines. The annual output of the mines does not exceed several thousand tons of ore. The remaining 10% comes from lead-zinc mines of Bou-Beker and Toussit, and pyrit-pyrrhotite mines of Kettara, the ores containing 0.6-0.8% of copper. Bou-Skaur deposit is situated to the South-west of Casablanca. Its reserves are estimated at 1 million tons of oxidized and sulphide ores, containing 1-3% of copper.

A new deposit in the Mid-Atlas near the Oued-el-Abiad River is being prepared for exploitation now. Initial Survey showed that the reserves amount to 2 million tons of ore, containing 2% of copper, the reserves are believed to be greater.

In I967 the signs of copper sandstone deposits were discovered in this area, on the slopes of the mountains. Large-scale prospecting work for copper has been carried out for the last few years in the Anti-Atlas, in South Morocco. The copper ores are concentrated at the concentrators Djebel-Klak and Bou-Skaur, the daily output capacity of which is I20 tons. The processed ores contain

2-3% of copper. For ore concentration the flotation process is used.

The concentrator Bou-Skaur produces copper concentrate containing 32% of copper, 92% being recovered.

The output of the plant is about [illegible] thousand tons of copper concentrates a year.

The Azegur deposit which was known before as a molybdenum deposit gives annually about 1 thousand tones of copper concentrates containing 29% of copper. This amount is exported to Poland, FRG, Spain and Sweden. Table 3 gives the main characteristics of copper concentrators of Morocco.

Table 3

Technological characteristics of copper concentrators operation

Mill	Daily output capacity (tons)	Copper content in ore (%)	Copper content in concentrates (%)	Extraction (%)	Electricity consumption per I ton of ore (KWh)	Staff	Labour productivity (ton/year per worker
Djebel-Klak	...	2.65	32.3I	70.39	-	25	-
Bou-Skaur	I20	3.0	32.88	92.0	2I	18 I/	1,737

I/ workers

Lead-zinc industry dominates in non-ferrous metallurgy of Morocco. The total reserves of lead in the country are estimated at 1,000 thousand tons (1,[illegible] thousand tons are considered proved and probable), zinc reserves are estimated at 800 thousand tons (580 thousand t tons are considered proved and probable).

The ores contain 4.0 - 6.0% of lead, and about 5.0% of zinc.

The most important deposits containing about 50% of the total reserves of lead and almost 80% of the total reserves of zinc are Bou-Beker and Toussit deposits, situated in the North-East of Morocco near the border with Algeria.

The ore contains 2-7% of lead, 5-[illegible]% of zinc, from 300 to 1,200 g/t of silver. The central region of the country between Khenifra and Midelt also abound in lead ore (Mibladen, Aouli and others).

A new lead-zinc deposit was recently prospected in the valley of Muluya. Its reserves amount to [illegible] thousand tons of lead, the ore containing 3.5% of lead. Zinc reserves are not estimated. The thickness of the impregnated rock is from 5 to 20 meters. This deposit is planned to be worked out first by open-pit mining and then by underground mining. The expected annual output capacity of the complex is 0.5 -1.0 million tons of ore.

The volume of mining, production and exports of lead and zinc ore given in table 4.

Table 4

Mining, production and exports of lead and zinc from Morocco (in thousand tons)

	Years					
	I955	I960	I965	I966	I967	1968
Mine production (lead content)	89	I10	76	78	78	90
Mine production (zinc content)	43	50	49	46	40	42
Production of primary lead	27	29	17	19	21	23
Lead ore and concentrates exported (Pb content)	96 I/	56	100	66	62	65
Zinc ore and concentrates exported (Zn content)	90 I/	59	52	44	45	43
Primary lead exported	26	27	I4	I6	20	26

I/ Concentrates.

Zinc and lead mining has been started since I940 by the companies "Societe des Mines des Zellidja" and "Astourienne des Mines Société Anonyme" at Bou Beker and Toussit mines. The annual designed output capacity of each complex is 0.5-I.0 million tons of lead-zinc ores. Lead-zinc ores are also mined at Aouli, Mibladen, Djebel-Aouat mines. The annual output capacity of the Djebel-Aouat mine is 0.3-0.5 million tones of ore. Lead-zinc ore dressing in the country is carried out at Bou-Beker concentrator, the daily output capacity of which is 4.500 tons, at Aouli concentrator with daily output capacity of ?,??? tones, at Toussit concentrator with daily output capacity of I,500 tons, at Mibladen with daily output capacity of I,200 tons and at Djebel-Aouat with daily output capacity of 315 tons. At newly found Maluya deposit a new concentrator with daily output capacity of 2,000 - 3,000 tons of ore was commissioned.

In Bou-Madin region a new concentration complex is under construction.

Mainly oxideezed and sulphide ores, containing from 2% to 10% of lead and from 3% to 16% of zinc are processed at concentrators. Lead-zinc ore dressing at Moroccan concentrator is done by the flotation process.

At Toussit and Bou-Beker concentrators oxideezed and sulphide ores are processed separately with recovery of sulphide concentrates and oxidized concentrates.

Three types of concentrates are recovered: sulphide lead concentrates, sulphide zinc concentrates and oxideezed zinc concentrates.

At the Aouli concentrator, processing lead ore, containing 90% of sulphides and 10% of oxides, preliminary ore dressing in heavy suspentions is used.

Table 5 gives the characteristics of Morocco's concentrators.

In Morocco there is only one lead plant at Wad-el-Khaimer, belonging to the company "Société des Mines des Zellidja".

Table 5

Some characteristics of lead-zinc ore dressing in Morocco

Concentrators	Daily output in tons	Metal content in ore (%)		Metal content in concentrates		Recovery %		Electricity consumption in Kwh per ton of ore	Staff	Labour productivity in tons per one worker a year
		Lead	Zinc	Lead	Zinc	Lead	Zinc			
I- Bou-Beker										
Concentrator I	1,000	2.00	16.0	70	62	90	97	27.0	35	7,429
Concentrator 2	4,500									
I) sulphide section		1.7	5.0	70	59	..	..	...	...	...
2) oxidized section		2.5	9.0	72/51 [1]	56	80	75	23.0	128	9,140
II Toussit	1,500	4.33	2.86	69,16	57/39 [2]	88.9	-	...	...	...
III Aouli	2,400	6.0	-	74.8	-	95.6	-	...	42.0	14,900
IV Mibladen	1,200	6.53	-	75/82 [3]	-	94.3	-	...	...	...
V Djebel-Aouat	315	10.16	-	63.47	-	86.4	-	23.0	...	...

1/ Numerator - lead content in sulphide concentrate, denominator-lead content in oxidized concentrate.

2/ Numerator-zinc content in sulphide concentrate, denominator-zinc content in oxidized concentrate.

3/ Lead content in flotation concentrate/lead content in gravitation concentrate.

The annual output capacity of the plant according to 1.1.68 data is 28 thousand tons of refined lead and 22 kg of silver. At the plant they use ore-hearth smelting with subsequent refining of the metal. Up to the present time the Wad-el-Khaimer mill processed concentrates coming from the Bou-Beker and Toussit mines and concentrates coming from Algeria mines located near by.

The concentration mill and lead plant at Wad-el-Khaimer, belonging to Societe des Mines de ... suffered greatly as supplies of raw material from Algeria decreased in connection with the nationalisation of the mines in Algeria. In this connection, at the beginning of 1968 the government of Morocco and Algeria signed an agreement under which Algeria undertook to supply the Moroccan concentrator at Bou-Beker with 30... thousand tons of lead-zinc ore coming from El-Abed annually.

Lead concentrates will be processed at the Wad-el- Khaimerplant. Zinc concentrates will be reexported to Algeria.

In the country there are two plant processing lead, they are situated in Casablanca. A plant of the firm "Maison Marocaine de Metaux et Entreprises", affiliated to the French firm "Trefimetaux", produces lead pipes. The annual output capacity of the plant is I,000 tons.

In 1964 the plant produced 280 tons. A plant of the firm "Pimenta Fabrication Metallurgique et Metallique" produces lead pipes, sheets and lead solder.

<u>Tin industry.</u> Tin deposits are discovered in the interior of the province of Rabat. Tin occurs in poor veins and deposits, the sands containing 0.4 kg/m^3 of cassiterite. No information about the amount of tin reserves in the country is available.

Table 6 gives data on tin production in the country and on tin imports to the country.

Table 6

Production and imports of tin

	Year					
	1965	1960	1965	1966	1967	1968
Tin in concentrates production	13	10	15	12	12	12
Primary tin production	8	10	15	12	12	12
Primary tin imported	200	250	140	160	240	208

Small amounts of tin (9-15 tons a year) are extracted at El-Karit mine, 80 km to the east of Casablanca.

The concentrate contains 60% of tin.

Tin smelting is done at a small local mill.

The country's consumption of primary tin averages 250 tons a year. The company Societe des Mines D'Etain" extracts and produces tin-in concentrate.

Primary tin is imported from Indonesia and Malasia.

The Tunisian Republic

In March 1956 Tunisia became an independent state.

In July 1957 monarchy was overthrown and the Tunisian Republic was set up. Tunisia is situated in North Africa and borders on the West on Algeria and on the East on Libya. In the North the country is washed by the Mediterranean Sea.

Territory - 164,200 sq.km.

Population - 4,600,000

Population density - 28 persons per sq.km.

Capital - Tunis

Principal cities - sea ports! Tunis, Sfax Bizerta, Sousse

The country has a plain relief in the main. Mountains cover less than 1/3 of the territory of the country.

The climate is subtropical, dry.

The number of rivers with constant flow is rather small. Except small rivers discharging themselves into the Mediterranean sea, all other rivers are inconstant streams, they reach the sea only when rains are exceptionally heavy.

The largest river is Medjerds (460 km).

Thermal plants supply the country with electric power. The share of power generated by hydro-electric stations in it is rather small (Table I.).

Table I

Generation of electricity

	Years				
	1958	1963	1964	1965	1966
Installed capacity (thous.kw)					
Total ...	135.2	151.1	146.2	212.8	210.8
Installed capacity of hydro-power stations	26.8	27.9	27.9	27.9	27.9
Generation (M Kwh)					
Total ...	276	367	446	494	574
Generation of electricity by hydro-power stations	32	30	38	42	27

Oil fields and natural gas fields are situated in the west of the country near the border with Algeria.

Proved reserves of oil amount to 40.5 million tons; proved and probable reserves of natural gas amount to 14.2 billion m^3.

In 1966 Tunisia extracted 1.5 million tons of oil and 8.4 million m^3 of natural gas; in 1967 Tunisia extracted 2.5 million tons of oil and 9.3 million m^3 of natural gas.

The total network of railways in the country is about 2,100 km.The country possesses about 10 thousand kilometres of highways.

Tunisia is connected by the South-African trunk-line with Algeria and Morocco.International air port El-Aouina is situated near Tunis.

Aluminium industry is based on the production of semi-finished products from imported aluminium.

In 1964 a plant fabricating aluminium civil structures was put into operation .Import of aluminium semi-finished products reached in 1960 - 0.1 thousand tons, in 1965 - 0.5 thousand tons, in 1966 - 0.4 thousand tons .

Copper industry. A number of small copper deposits were discovered in Tunisia, but none of them is workable. Local requirements are covered by copper import from France and Italy. Copper import amounts to 700 ~~thousand~~ tons annually.

Lead-Zinc industry won a place of higher importance. Lead reserves in the country are estimated at 160 thousand tons, zinc reserves are estimated at 60 thousand tons. The reserves are considered proved and probable. The Northen and North-western parts of the country abound in lead and zinc. Pure lead deposits dominate in the country.

Lead-zinc deposits are of secondary importance. Average lead content in ores is 6%, the content varies from 1.0% to 10%. Zinc content is 4%. The deposits are not great: lead reserves average from 10 to 15 thousand tons (in rare cases they amount to 30 - 40 thousand tons); zinc reserves do not exceed 10 thousand tons.

For the extraction of ore at newly explored zinc deposits near Ferji Hassin a new France-Tunisienne company "Pennaroya-Tunisia" was set up. The construction of a concentration complex is scheduled by the company.

The country annually extracts 14-16 thousand tons of lead and 3-5 thousand tons of zinc (Table 2)

Table 2

Lead and zinc mining, production and export

	Years					
	1955	1960	1965	1966	1967	1968
Mine production /Lead content)	27	20	16	15	22	25
Production of primary lead	27	20	16	15	14	18
Exports of primary lead	25	19	14	12	12	...
Mine production (zinc content)	5	4	5	4	3	...
Zinc ore and concentrates exports (metal content)	13	4	3	3	7	...

Out of 50 known deposits there are only about 20 deposits in operation in the country.

New mines at Djebel-Azered near Foussan in the interior of the country were put into operation in 1967. Now a new zinc deposit in Ferji-Hassic is being prepared.

Sulphide and sulphide-oxidized lead-zinc ores are concentrated. The ores are subjected to a flotation process.

The produced lead concentrates contain 65-70% of lead, zinc concentrates contain 50% of zinc.

At the Bou-Djaber concentrator lead-zinc ores and barium ores are processed separately.Lead-zinc ore is subjected to a flotation process.The produced lead concentrates contain 73% of lead, 95% being recovered; the produced zinc concentrates contain 48% of zinc, 72% being recovered.

In Tunisia in Megrin there is a lead-works.The annual output capacity of the plant is 20 thousand tons of refined lead; the works also produced silver, copper matte, antimony lead, rolled lead.

The plant processes sulphide lead concentrates from the mines by the conventional technology.

The lead-Souk-el-Hemis mill with ore-hearth smelting, producting 4 thousand tons of lead annually was shut down in 1966. At present the mill in Bizerta does not produce lead also.There are no zinc mills in the country.Lead is almost completely exported to France.Zinc concentrates are also delivered to France.

The United Arab Republic

The United Arab Republic is situated in the South-Eastern Part of Africa and partiallyin in Asia (the peninsula of Sinai). In the north the United Arab Republic is washed by the Mediterranean Sea, in the east by the Red Sea and by the Suez Canal. In the South the country borders on Sudan, in the West - on Libia, in the north - east on Israel.

Territory - 1001 thousand square kilometres
Population - 30.9 million people
Population density - 31 persons per sq.km
Capital - Cairo
Principal cities; Alexandria, Port-Said, Suez.
Sea ports: Port-Said, Suez, Alexandria

The great extent of the Libyan desert (situated in the West) and the Arabian desert (situated in the east) is interrupted by the Nile valley and the Delta.

The climate is hot, the range of temperature is great.

The only river in the Republic is Nile. 1500 km of the river are within the country's boundaries.

Subsurface water is the only one mean of water supply in the oases of the Libyan desert. The water is gathered in porous sandstone at the depth of 100 - 250 m and goes up to the surface through artesian wells.

The country pays great attention to the development of power energetics.

The Republic allocates considerable summs for the construction of the irrigational system and for the construction of the Aswan Dam. These measures raised the generation of electricity in the country.

Table I

Electricity generation

	Years				
	1958	1963	1964	1965	1966
Installed capacity (thounds Kw)					
Total	785	1,305	1,335	1,469	1,681
Installed capacity of hydro-elcctric stations	5	345	351	351	345
Electricity generation million kw-hr					
Total	1,905	4,460	5,106	5,473	5,895
Electricity generation by hydro-electric stations	8	1,280	1,670	1,774	1,837

The prospects of increasing electricity generation in the country are rather favourable. In 1970, after putting in operation the last tenth turbogenerator, the Aswan hydro-power station will generate about 10 milliards kwh of electrical energy annually. Besides, the termo-power stations of the country generate annually about 7-8 milliard Kwh.

The electric-power resources of the country make it possible to build projects consuming large quantities of electric power, for instance: aluminium plants, zinc electrolytic plants etc.

Coal deposits are known on the penninsula of Sinai but the deposits are not exploited.Oil fields are located along the coast of the Gulf of Suez, on the peninsula of Sinai, on the islands of the Red Sea.Transport in the United Arab Republic is nationalized.The country possesses 7 thousand km of railways.The most important railways in economic respect are the following: Cairo - Aswan, Cairo - Alexandria, Port Said - Suez.In 1966 they started constructing a railway between Helwan and Baharia, the length of the line is 350 km. The network of highways is about 20 thousand km. The most important are the following: Alexandria - Cairo, Cairo - Aswan.The most important sea and air routs pass through the country. The Suez canal is of paramount importance. The range of non-ferrous metals found in the country is rather wide - copper, lead, zinc,titanium, tin , tungsten, molybdenum, beryllium, zirconium and gold.

Aluminium industry. A new nepheline-syenitic deposit Jebel-Abu-Hruk was discovered in the Arabian desert, in the east of country.This deposit is situated on the coast of the Red Sea, 120 km from Merca-Alam and 240 km from Idfu, situated on the bank of the Nile river.The Abu-Hruk deposit is connected with Idfu and Merca-Alam by an asphalt road, running from the Nile River to the Red Sea, Tentative estimates of the reserves amount to 25-30 million tons of nepheline and syenitic ores, Al_2O_3 averaging 22%.

The mining at the deposit can be carried out by open-pit operations, almost without opening-up.

Along with these reserves, the United Arab Republic has large reserves of limestone, which are necessary for the production of alumina from nepheline-syenitic ores.Limestone deposits are known to occur in the Nile Valley to the south and north from Minia, near Suez.The deposits estimated at 1 milliard tons each, are located in the developed areas of the country.Mining can be carried out by open-pit operations.

But it is necessary to carry out additional surveying to define the reserves and Al_2O_3 content before starting exploiting the deposit. It is also reasonable to make technological and economic investigations to ascertain the possibility of obtaining alumina for the production of aluminium from this raw material.At the same time the considerable resources of the electric power in the country and the growing consumption of aluminium raise the question of the construction of an aluminium plant in the country.Modern industry,processing aluminium, was established in 1952. For the period from 1952 - to 1967, the annual production of aluminium semi-finished products increased from 0.3 to 12 thousand tons.By 1980 the annual production of aluminium will reach 30 thousand tons. At present the U.A.R. has output capacity for the production of aluminium of about 23 thousand tons. Output capacity for the production of cable equals to 11.5 thousand tons; output capacity for the production of rolled sheets and strips equals to 5 thousand tons, for the production of castings equals to 3 thousand tons, for tubes - 2 thousand tons, for wrapping foil and tins - the rest.As the country does not have sources of raw materials ready for the production of aluminium, it is possible to build a plant which will work on imported raw materials, for instance on the bauxite coming from the Republic of Guinea.In this connection a possibility of constructing an alluminium plant along with an alumina plant should be discussed.

Copper industry. Total reserves of copper in the country are estimated at 70 thousand tons.There are no data about the amount of proved and probable reserves.Average copper content in ore is 3.6%. Copper reserves are mainly known as complex copper - lead - zinc ores.Cupreous sandstones were discovered in the central regions of the Sinai peninsula, they deserve carefull surveying.In the country there are several plants, processing copper and alloys. the largest plant - state plant N 63 - is located in Helwan (near Cairo).It was built in 1953-1954.The initial designed output capacity of the plant is about 10 thousand tons.The plant produces: sheets, strips, tubes, rods, bronze casting and rolled aluminium.

The plant works on imported raw materials.The raw materials are supplied by the USSR, Canada and other countries.The production of the plant covers only the country's needs.Now the plant is being expanded.By 1970 its output capacity will be increased to 14 thoudand tons.

In Cairo there are two plants.One belons to the firm "Smelting Co" .It produces sheets, strips, rods, tubes and wire from copper, brass and aluminium.The other plant belongs to the firm "Electro Cable Inject Co." It produces wire and cable from copper. The annual output capacity of the plant is 40-50 thousand tons.

Lead-Zinc industry. Oxidized lead-zinc ores are known to occur along the western coast of the Red Sea. Large deposits were not discovered. The Um Gheig deposit, situated 50 km to the south of the port of Kosseir is of the most practical importance. Zinc reserves of the deposit are estimated at 140 thousand tons; zinc content averaging 14%. Lead reserves are estimated at 20 thousand tons; lead content averaging 2%. Copper-lead-zinc sulphide ores are known to occur in the central part of the Eastern Desert. Lead and zinc reserves of some ore bodies reach 10-15 thousand tons; zinc averaging 10-12%, lead averaging 1.5-2.5%, copper - 2%. The Um Samiuky deposit is the greatest. The ores of the deposit contain along with lead and zinc more than 3.5% of copper. Lead and zinc reserves of the sulphidized ores are not estimated. The country's total lead reserves may be estimated at 30 thousand tons, zinc reserves - at 900 thousand tons.

For the development of lead-zinc industry working on local ores, it is necessary to carry out large scale prospecting work for sulphidized lead-zinc ores. In the United Arab Republic there is a lead plant, belonging to the company "Egyptian Smelting". It produces annually 2.2 thousand tons of refined lead; purity being 99.97%. The plant processes secondary lead raw materials and local ores. The plant produces also by-products, containing silver, gold and platinum.

Besides, the plant produces rather a considerable amound of rolled lead and copper (sheets, tubes, plates for storage batteries, etc.).

Tin industry. In the eastern region of the country quarts veins with cassiterite, tungstenite and various sulphides are embedded in granites and crystalline slate.

The tin- tungsten Igla - Abu - Dabbob deposit and Nuweibi deposit are situated 20-30 km from the coast of the Red Sea, and 200 km to the east of Idfu.

Table 2 gives the data on the surveyed tin deposits of the Unites Arab Republic.

Tin reserves of the country

deposits	Surveyed area (thousands square km)	The depth of tin-bearing sand (m)	Sand reserves, (thou.m^3)	Tin content kg/m^3	Tin reserves (t)
Abu-Dabbob	148	1.7	254	2.8	712
Nuweibi	185	2.7	500	0.9	478
Igla	112	1.2	136	4.7	644
Total	445	2.0	890	2.0	1834

At the above-mentioned deposits it is possible to use simple portable dressing installations for the production of tin concentrate.

In the area there are known other both alluvial and primary tin deposits.

They are: El-Meulcha (20 km to the south of the highway Idfu-Merca-Alam) and Vasi Nugruc (60-70 km of Merca-Alam).But they are not serveyed yet.

The Republic of Ghana

The Republic of Ghana includes the former British colony Gold Coast and Togo, the former trusteeship territory of Great Britain. The independence of the country was proclaimed on March 6, 1957. On July 1, 1960, Ghaha has become a Republic.

Territory 238.5 thous. sq.km

Population - 8.1 million people

Population density - 34 persons per sq.km

Capital - Accra

Principal cities - Kumasi, Cape - Coast, Tamale

Sea ports - Takoradi, Tema, Accra.

Ghana is situated in West Africa on the northern coast of the Gulf of Guinea and borders on the west upon Republic or Ivory Coast, on the north - upon Upper Volta, on the east - upon Togo, on the south it is washed by waters of the Gulf of Guinea.

Climate is hot, tropical and humid on the south and the south-east.

Ghana is rich in rivers which mainly fall into the Gulf of Guinea. The biggest river of them is the Volta River. Ways of communication belong to the state. Railways are concentrated on the south of the country. The length of railways is about 1,000 km, of motor roads - 7.6 thous. km. The main railway line connects the bauxite deposit to port Accra. Till 1966 Ghana was supplied by electric power from small electrical stations (Table 1).

Table 1

Number of electric stations and generation of electric power

	Years				
	1958	1963	1964	1965	1966
Number of electric stations (Total)	...	21	21	22	22
including hydro-electric stations	...	-	-	1	1
Installed capacity Total, thous.kw	88.9	143.4	146.9	409.7	681.6
including hydro-electrical stations	-	-	-	256.0	512.0
Generation of electric power, million kw-hr (Total)	312	470	489	528	807
including hydro-electrical stations	-	-	-	107	408

In September 1965 the first two turbines of the hydro-electric station with the capacity of 256 thous.Kw on the Volta River (near Akosombo), which is being built by an American company, have been put into operation. After the completion of the construction (6 turbines) the capacity of the hydroelectric station will reach 768 thous. kw.

In November 1966 the electric equipment works has been commissioned in Accra.

The construction of the hydro-electric station has been commenced in Bvi on the Black Volta River on the north-west of the country.

The non-ferrous metallurgy is represented by the produc-tion of gold, diamonds and bauxites.

Aluminium industry. The total reserves of bauxites are not precisely determined, but they are estimated at 250 to 290 million tons and according to some information they ex-ceed 400 million tons.

45 million tons are considered as proved and probable.

The deposits are scattered in 240 km long zone of 80 km width located 130 to 160 km to the north of the coast. The bauxites are of laterite type, gibbsite with insignificant admixture of bemite.

The main mining of bauxite carried out by open-pit me-thod is concentrated on the south-west of the country in the Avaso district, see table 2.

Table 2

Production of bauxite, of primary aluminium, foreign trade, thous. tons

	Years					
	1955	1960	1965	1966	1967	1968
Production of bauxite	118	228	308	353	353	307
Production of primary aluminium	-	-	-	-	49	109
Exports of bauxites	118	228	287	311	...	...
Imports of aluminium semi-finished products	1.1	1.9	6.0	7.2	...	...

Almost the entire raw materials mined in the country are being exported.

Endeavouring to establish its own aluminium industry the country embarked on building the aluminium works (completed in 1967), new harbour in Tema and on deepening the harbour. At present British company "British Aluminium" develops bauxite deposits in Ghana. Bauxites mined are delivered to the alumina works of the same company in Scotland.

At the beginning of 1969 it is supposed to put into operation the complex of enterprises on the basis of the Isiniso deposit of the Avaso group including crushing, transportation and drying of bauxites. The output of the mine is 400 thous. tons of bauxites (by dry weight). The cost of the complex is valued at 1.2 million dollars.

In 1967 the works in Tema, operating on alumina being imported from USA, Australia and Jamaica began to produce primary aluminium.

It is planned to build in future an alumina works with the output capacity of 610 thous. tons per year to be operated on the basis of local deposits of bauxites.

The works belongs to "Volta Aluminium Co" (which is a subsidiary company of USA companies "Kaiser" and "Reynolds", capitals of which make up 90% and 10% of capital of "Volta Aluminium Co" respectively. The productive capacity of the works is 105 thou. tons of primary aluminium, the cost is 120 million dollars. The annual output capacity of the works is planned to be brought to 147 thous.tons by 1974.

Electric power is supplied from the Akosombo hydroelectric station, commissioned in 1965, output being 768 thous. kW at the price of 0.26 cent for 1 kWhr.

The Tema aluminium works is equipped with cell pots for the current of 140 kva with baked anodes. Every cell pot with capacity of about 1 t/day operates at 4.5 v voltage. Dimensions of the cell pot are as follows: length - 8.5 m, width - 3.7 m, depth - 1.2 m, busbars size - 5 x 39 cm. Catodes of 2.84 m length, 42 cm width and 40 cm height are calculated to function for 1000 days.

Installed on every cell pot are 18 anode sets (2 blocks in each) designed to function for 15 days. Alumina is charged into cell pots after every 2 hours; to break the crust of the cell pot there are used pneumatic machines.

Catode blocks for cell pots are imported. Refractory lining and anode blocks are manufactured at the works in the electrode shop, where 2,500 ton hydraulic presses and three batch type furnaces for baking anodes are installed, the duration of baking being 54 hours at temperature 600 to 650°C.

Aluminium produced at the works is partly cast into blocks weighing 500 kg and partly is charged into a mixer for subsequent casting into ingots weighing 5.15 and 25 kg to be exported to England.

Altogether 1,250 indigenous inhabitants and 150 foreigners will be working at the works.

There are two works for treating aluminium in the country the brief characteristic of which is given below:

Company name	Location of works and year of its commissioning	Products	Annual output capacity, thous. tons	
"Ghana Aluminium Products (Ghanal)"	Tema town (near Accra), 1959	Corrugated sheets and sections	6 (0.72 in 1962)	At the works 200 persons are working. There are rolling mills, hydraulic press
"Pioneer Aluminium"	Tema town, 1960	Rolled products, kitchen utensils		In 1963 the works has been expanded with an increase in annual output capacity by 320 tons

Raw materials for processing works are being supplied from the aluminium works located in Tema.

Works' products are consumed inside the country.

§ 6. Republic of Guinea

The Republic of Guinea, an independent state since October 2,1958.On the north it is bounded by Senegal, on east by Ivory Coast on the south by Sierra Leone and Liberia.On west Guinea is washed by the Atlantic Ocean.

Territory - 245.9 thousand km.square.

Population - 3.7 million people.

Population density - 15 persons per 1 km.sq.

Capital - Konakri.

Principal cities: Kankan, Kindia, Siguiri, Labe, Kisidigu, Boké.

The climate of Guinea is tropical, hot with a great amount of precipitation. The mountain region of Futa-Galop is characterised by its more mild climate.

The potential reserves of water power are great.

There are two railway lines in the country.Their overall length is 802 km.The length of highways is 5.5 thousand km.

Konakri and Kankan are connected by a narrow gauge railroad located near bauxite deposits in Kindia region.

Another narrow gauge railway lin connects Fria plants with Konakri port.

Konakri and Kindia are connected by a highway, situated near Kindia bauxite deposits.

The main trade port is Konakri, which is in the stage of reconstruction.

The production of electric power in Guinea, especially grown in I963, is characterised by the following data (in million kwhr.): I958 - 21, I963 - I56, I964 - I68, I965 - I74.

<u>Aluminium industry.</u> The greatest and most valuable deposits of bauxites in Africa are situated in Guinea. The overall reserves of high grade bauxites containing 55-60% of Al_2O_3 are over I.5 milliard tons, 600 million tons of which are proved and probable. Besides there are many bauxite deposits, containing 42-50 per cent of Al_2O_3. The potential reserves of bauxite in the country are estimated at about 26 billion tons.

By bauxite reserves the Republic of Guinea occupies the second place in the world (after Australia).

The deposits are of the laterite type, gibbsite bauxites, often with small boehmite admixtures. They are spreed in several regions of the continental part of the country, and also on the islands of Kassa and Tamara in the Los archipelago. The most considerable bauxite deposits are concentrated in the Boké region. The greated deposit of that region is the Sangaredi which accounts for I50 million tons of bauxites, with the content of more than 58-60% of Al_2O_3, and less than I-2% of SiO_2 (Table I).

Table I

Geographical Distribution of Main Bauxite Deposits in Guinea

NoNo	Region	Location	Bauxite layer, m	Overall bauxite reserves million t.	Average ore content, %	
					Al_2O_3	SiO_2
I.	Boké	90 km North-East of Boké	I5.0	400-700	up to 55.0	about 5.0
2.	Badi-Konkouré	I5 km South-East of Fria	unknown	I50-300	40-45	Less than 2.0
3.	Kindia-Friguiag-bé	120 km North of Konakri and 19 km South-West of Kindia	7.5-9.0	more than 100	40-45	less than 2.5
4.	Dabola	200 km North-East of Kindia		more than I00	47-48	2.0
5.	Tougué-Dabola	Between Tougué and Dabola	4.5-9.0	...	47-48	2-5
6.	The Los Islands	West of Konakri	5.0-I0.0	less than 5.0	51-54	4.5

At the present time deposits are being mined only in two bauxite bearing regions of Guinea: in the region of Fria and on the Los islands.

The bauxite production in Guinea was 1676 thousand tons in 1968. About a half of the produced bauxites into processed into alumina in the country, the rest is exported into Canada, the German Federative Republic and the German Democratic Republic (Table 2).

Table 2

Bauxite Production, Alumina Production, Foreign Trade, thou.t

	Years				
	1955	1960	1965	1966	1967
Bauxite production	493	1378	1870	1375	2722
Alumina production	-	185	520	525	530
Bauxite exports	-	705	244	...	...
Alumina exports	-	171	...	520	...

The mining of bauxites is concentrated in the group of deposits of the Fria area. Mining is done in the open pit and production amounts to 1,700,000 tons per year. In the next few years it is planned to increase production to 2,500,000 tons.

On the base of the Fria bauxite deposits, the Fria alumina plant has been built near the Badi -Konkouré

With an annual production of 500.000 to 600.000 tons of bauxites, these reserves will apparently be depleted in the next 5 years.

At the present time operations are already under way to develop the deposits of the Boké area. The Boké area is the largest in Guinea as regards the reserves. Part of this area (about 1.300 square kilometres), including the Sangaredi deposit, unique by the quality of its bauxites (the reserves are about 150 million tons with Al_2O_3 content of 58 to 60% and SiO_2 content of 1 to 2 %), was handed over in concession to the American company Harvey Aluminium in I962. However, to get operations going at the Sangaredi deposit, which is situated in an uninhabited locality far away from the ways of communication, it is necessary to build, not only the mine itself, but also a residential settlement, a railway to the sea coast (about I35 km in length), a sea port (Kamsar) and a number of other facilities.

The construction of the Kamsar sea port and the railway from Sangaredi to Kamsar will be financed from credits of the International Bank of Development and Reconstruction and by the Government of USA. The construction of the mine and the settlement neat it, the facilities for calcination and loading of bauxite at the port of Kamsar, as well as provision of a railway train for ore transportation, will be provided for by the foreign monopolies participating in the project, which have united into the Halco Company.

Bauxites will be mined by a mixed company - "Bauxite de Guinee", in which 51% of the stock belongs to foreign, mainly American companies.

According to an agreement, the railway and the port of Kamsar, as well as the bauxite mine, are to be put into operation in 1974. During the first five years of the mine's operation it is planned to mine and ship bauxite in a volume of about 5 million tons a years, and in the subsequent 15 years - 8.6 million tons a year.

Construction costs for the whole complex have been determined at 184.5 million dollars, of which: for construction of infrastructure, including the port, the railway from the port to the Sangaredi deposit, as well as a residential settlement at the port - 85.5 million dollars, for construction of the mine and the settlement near it, the facilities for drying and roasting of bauxite, and other auxiliary and service facilities at the port of Kamsar, and for furnishing a railway train for ore transportaion - 99 million dollars.

The agreement provides that the Halco Company is obliged to carry out studies on the possibility of organizing the production of alumina from the Sangaredi bauxites Subsequently, the construction of an aluminium plant may also be considered. At the present time Guinea has not sufficient power capacity, but there are possibilities in the country for a hydroelectric project on the river Concure.

In accordance with the agreement, the Halco Company has begun training about 800 Guineans for work at the mine.

There are possibilities for the organization of national bauxite-mining enterprises in other areas of the country. Thus, a bauxite-mining enterprise can be created in the Boké area (out-side the perimeter alloted for exploitation to the Bauxite de Guinee Company) on the base of the Diandian and Ourougbe deposits whose reserves are estimated at 250 million tons, of which 160 million tons are high grade bauxites (51 to 53% Al_2O_3 and about 2% SiO_2). However, full development of these deposits would require the construction of a branch line 56 km in length from the mine to the Kamsar-Sangaredi railway, the purchase of a train for loads haulage, the erection of a pier and moorings with a complex of loading facilities at the part of Kamsar, and the construction of a residential settlement near the main.

It is possible also to organize the development of the ore fields of the Kindii area, situated near the town of Kindii and the railway Konakri-Kindii (120 km away from Konakri), which according to an estimate, contain reserves of 85 million tons, with average contents of Al_2O_3 40-42% and SiO_2 5.7%.

The development of these deposits and the shipment of bauxites would require not only the construction of a mine with a crushing plant, but also a reconstruction of the existing Konakri-Friguiagbé railway (140 km), and partly, the port of Konakri.

In future, for speeding up the country's industrialization, it might be expedient to consider the question of construction of large alumina plants, and subsequently, perhaps also an aluminium plant.

Guinea has an aluminium semi-fabrication plant, producing ribbed sheets and kitchen utensils out of the imported metal brought to Konakri by sea.

When full capacity is achieved the plant will produce up to I3 thousand tons of ribbed sheets per year.

The plant belongs to the firm "Société Guinéenne de Fabrication" (SOGIFAB), whose stocks are the property of the State and the company Harvey Aluminium Inc (USA).

§ 7 . The Federative Republic of Cameroons

The Federative Republic of Cameroons is situated in West Africa.

The independence was proclaimed on 1 January 1960.

Cameroons bo ders on Nigeria on the west, the Republic of Tchad on the north-east, the Central African Republic and the Congo (Brazzaville) on the east, Gaboon on the South. On the south-west it is surrounded with the Gulf of Guinea.

Territory	- 475.4 thous.sq.km
Population	- 5470 thous.people
Population density	- 12 persons per sq.km
Capital	- Yaunde

The climate of Cameroons is hot and humid on the coast and arid in the north.

The rivers belonging to the basins of the Atlantic Ocean and of the lake of Tchad (Sanaga, Nyong, and Campo) are full-flowing but with many rapids and are navigable only in their lower reaches.

Due to abundant hydro- resources the electric power is generated chiefly by hydro-power plants, table I.

Table 1

Power generation

	Years				
	1958	1963	1964	1965	1966
Installed capacity, total thous kw	160	162	165	170	...
Power generation, mln. kw-hrs Total	675	1127	1068	1100	1008
including hydro-power stations	665	1042	1038	1069	...

On the rapids of Sanaga near Edea a 150 thous kw hydro-power plant was built. There is a small power plant operating on the imported fuel.

The length of railroads is 520 km. There are two lines: Duala - Yaunde and Duala - Knongsamba. A project is developed for construction of a so-called Trans-Cameroons railroad which will continue the line Duala-Yaunde to Ngaundere and further to the Republic of Tchad. This line will be essential in establishing the regular communication between the northern and southern regions of Cameroons.

The main sea port of Duala-Bonabery is accessible to large -tonnage ocean-going ships. The other ports are Victoria and Criby. On the Benue river there is Garua - a large port in the East Cameroons.

The main air fields for external air lines are in Duala, Yaunde, Ngaundere, Tico. The home air lines are Duala -Yaunde-Batury; Duala - Yaunde - Ngaundere - Garua - Fort Lamy (Republic of Tchad).

In the country are known the deposits of bauxite, tin, gold, rutile. The natural gas is discovered, the oil prospecting is underway.

Aluminium industry. Cameroons holds the third place in the world (after Australia and Guinea) in total reserves of bauxite, but the bauxite deposits are not exploited practically.

According to different estimates the total reserves of bauxite amount to 1.0 to 1.5 milliards of tons, of which only 50 millions of tons are proved and probable. The Al_2O_3

content is 40 to 50 per cent.

In 1957 an aluminium smelter in Edea had been put in operation based on the locally generated electric power and imported alumina (from France and Guinea). The production capacity of the plant is 53 thous. tons as on January 1,1968. Both the smelter and the power plant are owned by Alucam (Société Cameroons de l'Aluminium) where 82 per cent of the stock belongs to the French firms Pechiney and Ugine, 10 per cent to a Belgian company and only 8 per cent to the Government of Cameroons.

6 silos of 1000-ton capacity each are built in the port of Duala to store the imported alumina.

The Edea aluminium smelter has four electrolysis buildings (two series) where 220 cells for 100 ka with self-baking anodes and upper bar current supply are installed.

Almost aluminium produced in the country is exported mainly to France and also to the USA, Great Britain, Belgium and Netherlands, table 2.

Table 2

Alumina import: production and exports of primary aluminium, thous. tons

	Years			
	1960	1965	1966	1967
Primary aluminium production	44	50	48	48
Alumina imports	75	85	...	...
Aluminium exports	42	46	...	...

In 1967 the French firm "Péchiney" and "Ugine" put in operation an aluminium semi-fabrication plant in Edea under the management of "Société" Cameroons de Transformation de Aluminium" (SOCOTRAL). The plant construction costed 1.2 million dollars. The annual capacity is 5 thou. tons of sheets and utensils. It is planned to increase the plant capacity up to 8.5 - 10.0 thous.tons.

Copper industry. Small deposits of copper ore are found in the north-east of the country where the exploration is carried out in the Tiffol area. The Cameroons geological service conducts the search for copper in the western regions (Ntole, Mamfe and Cumba) with assistance of France.

Tin industry. The cassiterite deposits are known to be in various regions of the country. The data on ore reserves and quality are not available.

The small mining production which was reduced from 70-80 tons to 40-45 tons in the early 60's takes place in the Mayo-Darle in the western part of the country 55 km south-west of Banio. Formerly the alluvial deposits were exploited there but they are exhausted already. Now cassiterite is produced from more poor secondary deposits. The prospecting that took place in this region recently did not discover any considerable tin deposits.

Besides, the cassiterite, the cassiterite indications are known in the vicinity of Garva (in the northern part of the country). At present the program is being developed for prospecting the deposits of tin and other mineral with assistance of France, great Britain, Germany and the USA.

Since 1949 till 1961 the French company "Société des Etains du Cameroons" was the producer of tin concentrates in Cameroons.

Since 1961 tin mining in the Mayo-Darle mines was resumed by Société de Fibre Mécanique. The tin concentrates are exported to Netherlands, Spain.

Tin containing sands, destroyed pegmatites and old dumps and tails undergo benificiation.

Annually several thousands of tons of tin concentrates containing 66 to 70 per cent of tin are produced in Cameroons.

Sierra Leone

An independent state from April 27, 1961 Sierra Leone is situated on the west coast of Africa. On the north and the north-east it borders upon the Republic of Guinea on the south-east upon Liberia. On the west and on the south-west it is reached by the Atlantic Ocean.

Total area - 71.7 thous.sq.km.

Population - 2,439 thous

Population density - 34 persons per 1 sq.km.

Capital - Freetown

Principal cities - Bo, Makeni, Kenema.

Sea ports - Freetown, Pepel, Bonte, Sulima.

The western and souther parts of Sierra Leone represent the lowland gently sloping towards the Atlantic Ocean. Along the south-eastern part of the coast there is situated a lagoon stretching for the distance of 110 km, open to the west and the east which represents an important waterway of the country.

The country has an equatorial, monsoon climate. Rivers are abounding in water, but because of rapids and waterfalls they are navigable only in lower parts of the current. The length of railways is 593 km, earth roads - 5.4 thous. km. Main sea ports are Freetown and Pepel.

International aeroport - Loongi.

Deposits of oil and natural gas have not been discovered. Oil - products being imported to the country in an amount of 325 - 385 thous. tons per year serve as the basis of the country's fuel balance.

Electric power generation is characterized by the following data:

	Year				
	1958	1963	1964	1965	1966
Generation of electric power, million Kwhr	38.9	72.2	83.7	106.I	109.I

There are non-ferrous metal deposits including big rutile ones. The reserves are estimated at 30 million tons with the titanium dioxide content of I.5 to 1.8 per cent. Annually I00.000 tons of concentrates are being produced at the beneficiation plant. Molybdenum deposits have been also discovered. Gold and platinum bearing sands are being developed. The production of diamonds amounting to I.800 thous. carats has a great importance for the country's economy.

In recent years the mining of bauxites has been started in the country.

Aluminium industry. The total reserves of bauxites in Sierra Leone are estimated to be not less than 30 million tons with the content of Al_2O_3 in the ore from 40 to 60 per cent.

Deposits of bauxites of the highest quality (Al_2O_3 content up to 60%) discovered in 1959 are situated in Mokanji Hills in Moyamba district. In the course of further investigations there was discovered the bauxite belt stretching for 30 km with the width of up to 150 m. The thickness of bauxite bed is variable and reaches 15 m. as maximum. At the end of 1963 the open-pit mining of bauxites at the Makanji Hills mines has started.

The annual production of bauxites in the country was as follows, thous. tons: 1963 - 30, 1964 - 129, 1965 - 207, 1966 - 275, 1967 - 342, 1968 - 340. Almost all bauxites mined are being exported, thou. tons: 1963 - 20, 1964 - 129, 1965 - 176, 1966 - 244.

§ 9. The Republic of Zambia

Zambia was proclaimed a republic on the 24 of October 1964. The republic borders on Congo (Kinshasa) to the north, on Angola to the west, on Botswana to the south, on Rhodesia and Mozambique to the south-east, on Malawi to the east, and on Tansania to the north-east.

Territory - 752 thousand square kilometres
Population - 3,94 million people
Population density - 5 persons per sq. km
Capital - Lusaka

Principal cities: Ndola, Livingstone, Broken Hill.

Zambia is largely a table-land. The mean elevation of it is 1000-1500 m.

The rivers valleys break the table-land into plateaux and rather high mountains.

The numerous rivers mostly belong to the Zambezi basin. The Zambezi river is known for its rapids and falls, and is especially known for the famous Victoria Falls, which is the greatest. The climate is tropical and mountainous.

The communication in the country is of great importance. Before the country broke diplomatic relations with Rhodesia, it had imported and exported goods by the railway running through Rhodesia to the port of Beira in Mosambique.

After that the situation became worse. Now the country exports its goods by the railway running throught Congo to the port of Lobito in Angola, by the railway and the road through Malawi to Beira and by the road to the port of Dar-es-Salaam in Tansania. The railways of the country have worked independently since July 1, 1967 (before the railways were jointly owned by Rhodesia and Zambia). Now they plan to connect the railways with the railways of Tanzania. The program is scheduled for completion in 1973. In March 1966 the government concluded an agreement with the Italian firm "Fiat" for establishing a national transport corporation, which will be responsible for constructing roads in the northern direction. Zambia experiences difficulties in supplying the country with electricity (Table 1).

Table 1

Electricity generation in Zambia

	Years				
	1958	1963	1964	1965	1966
Installed capacity Total (thounds kw)	280	263	261	261	262
Installed capacity of hydro-power stations	40	49	49	50	50
Electricity generation Total (M.Kwhr)	967	748	713	666	602
Electricy generation by hydro-power stations	239	311	305	276	...

The Kariba hydro-power station on the southern bank of the Zambezi River and a number of thermo-power stations supply the country with electricity.

The hydro-power station in the Katanga province in [illegible] ([illegible]) also supplies the country with some electricity. The hydro-power station is believed to stop supplying Zambia with electricity in 1971 because of the increase in the consumption of electricity in Congo. There is every reason to believe that by 1972 the country's need for electricity will exceed the amount which will be generated by the power stations. To meet the country's need for electricity, a new hydro-power station on the river of Kafue 50 km to the south of Lusaka, is under construction now. The expansion of the hydro-power station on the Kafue river is under consideration. Fuel resources of the country are modest and do not satisfy the growing requirements of the industry. Coal mining in the country can be illustrated by the following figures; in 1966 114 thousand tons of coal were extracted and in 1967-423 thousand tons.

The country's need for oil is completely met by oil import. In September 1968 a new pipeline between Dar-es-Salaam, a port on the coast of the Indian Ocean, and the Ndola copper electrolyte plant in Zambia was put into service. Mining and production of copper, lead, zinc and cobalt dominate in the non-ferrous industry of Zambia. The country does not produce aluminium. A new plant producing 1 thousand tons of aluminium wire from imported aluminium is contemplated for construction in 1969.

Zambia has accounted for the great bulk of world output and production of blister and refined copper. Zambia is known to have the greatest reserves of copper, estimated at 54.0 million tons; 27.4 million tons are considered proved and probable. The ore is characteriesed by a high copper content; which varies from 2.41% to 4.83% averaging 3.4%.

Copper industry contributes 41% of the Gross National Product of the country and 95% of export earnings. Table 2 gives general data about the copper industry of Zambia.

Table 2

Mining, production and export of copper

	Years					
	1955	1960	1965	1966	1967	1968
Mine production (copper content)	359	576	696	623	663	600
Production of primary blister copper	353	576	696	596	633	670
Production of refined copper	180	403	522	494	535	538
Consumption of refined copper	1.6	1.1	0.1	-	-	-
Exports of blister copper	175	153	160	90	80	90
Exports of refined copper	171	405	510	502	527	535

Copper mining is mostly carried out by underground working. However at new complexes they plan to use on a wide scale open pit operations. The characteristics of the most important mines of Zambia (belonging to two main monopolies of the country) are the following:

Table 3

Mines	Ore reserves million t	Average copper content in ore(%)	Copper output in 1967 (thousand tons)	Designed output capacity million tons of copper annually)	Way of working
1	2	3	4	5	5
		Roan Selection Trust Ltd			
Mufulira	151.5	3.37	120.3	3.0	Underground working
Luanshya	77.5	2.86	72.2	do	do
Chibuluma	6.3	4.83	17.9	0.5-1.0	do
Chambeshi	35.05	3.05	14.0	do	open-pit operations
Baluba	101.6	2.41	-	do	underground working, the mine is being prepared for exploitation
Kalenga	0.6	16.0	-	0.09	open-pit operations, the mine was to be commissioned in 1968
		Zambian Anglo American Ltd			
Nchanga Nchanga	235,3	4.01	169.7	more than 3.0 1.0-3.0	underground working open-pit operations
Rhokana	113,6	2.77	83.2	more than 3.0	underground working

1	2	3	4	5	6
Bancroft	87.8	3.51	29.7	1.0-3.0	underground working
Chingola	10.3	3.9	-	1.0-3.0	open-pit operations
Mindola				0.15-0.3	open-pit operations

The Rhokana, Chibuluma, Baluba, Chambeshi deposits contain also cobalt: 0.14%, 0.17%, 0.16% and 0.17% respectively. In Zambia sulphide, oxide and oxide-sulphide copper ores, of the type of cuprous sandstone are subjected to dressing. Copper content in the ore varies from 2.5% to 5.2%. Copper ore is treated at mills with high output capacity. The technological charecteristics of the mills are very high.

Table 4

The main working characteristics of copper concentrators in Zambia

Mills	Daily output (tons)	Copper content in ore,%	Copper content in concentrate (%)	Percentage of copper being recovered	Electricity consumption (kWh/t)	Staff (per cent)
1	2	3	4	5	6	7
			Roan Selection Trust Ltd.			
Mufulira	25.000	2.5	46.0	90.0	19.64	334
Luanshya	20.000	2.6	50-52	91-92	17.8	230
Chibuluma	2.200	5.23	36.4	93.0	17.1	144
Chambeshi	2.700	...	46 & 30	...	...	...

1	2	3	4	5	6	7
Zambian Anglo American Ltd.						
Nchanga	25.000	5.45-5.52	30	88.4		
Bancroft	7.000	3.5-3.79	30	84.[illegible]		
Rhokana	20.000	5.000				

At the end of 1967 a new concentrator at Nchanga West with the output capacity of 175 thousand tons of ore monthly was put in to operation.

Zambia does not export its concentrate. The concentrate is processed at metallurgical works. In Zambia there are 7 metallurgical works. The production data of the works are given in table 5.

Table 5

Metallurgical works of Zambia

Company	Location	Flowsheet	Annual output capacity (thousand tons)
Roan selection Trust Ltd.			
Mufulira	Mufulira	Processes concentrate coming from the Mufulira and Chibuluma works, smelting of crude charge in the reverberatory furnace, matte converting, anode casting, electrolysis, slab casting	18[illegible]
Roan Selection Trust Ltd. (Luanshya Division)	Luanshya	Processes concentrates from the Luanshya complex (former Roan Antilope): bunker charging, smelting of crude charge	[illegible]

		in reverberatory furnaces till 1969. converting, anode casting, in 196[illegible] concentrate roasting in fluidized bed was introduced.	
Chambeshi Mines	Chambeshi	The Chambeshi hydrometallurgical plant works according to two flowsheets: 1. Poor sulphide concentrate roasting in fluidized bed, mixing with finely pulverized oxidized ore, agitation leaching, electrowinning of copper. II. Percolation leaching, electrowinning of copper	23
	Zambian Anglo American Ltd.		
Rhokana Corporation	Nkana	Bunker charging, smelting in reverberatory furnaces, converting, anode conversion. The plant processes concentrate coming from Nchanga and Bancroft complexes	250
Nchanga Consolidated Copper Mines Ltd.	Chingola	Sulphide concentrate roasting in fluidized bed, leaching of the calcine of oxidized and sulphide concentrate, electrowinning of copper. Cake flotation after leaching with the production of sulphide concentrate.	1[illegible]
Zambia Rhokana Copper Refineries Ltd.	Nkana	Electrolysis of the Nkana plant production. Production of wire bars from own cathode copper and from the copper supplied by Chingola plant.	34[illegible] (electrolysis)
Ndola Copper Refineries	Ndola	Electrolysis of anodes from the Luanshya mill; wire bars production.	127 (casting)

1) The output capacity of the plant is reported to be increased up to 230 thousand tons by 1971.

In Zambia a new company was set up for the construction of a copper processing plant with the annual output capacity of ~~3 thousand tons of wire and cable. The plant is to be put in~~ operation in 1970. The plant will supply mostly the local market of the country.

Two copper semi-fabrication plants are scheduled for construction. One, producing copper tubes, sheets, strips and wire will be situated in Kitua Nkana. The plant will be 5.6 million dollars worth and will be administered by the firm "African copper Industries", belonging to Zambian private capital.

The other plant, producing copper and aluminium wire is contemplated for construction in 1969. The plant will be 4.1 million dollars worth. The Government of Zambia has a 51% interest and foreign firms ("Phelps Dodge" U.S., "Anglo-American Corporation Ltd" and others) have a 49% interes. Two large monopoly groups control copper mining and production in Zambia. They are: "Zambian Anglo American" Ltd. and "Roan Selection Trust Ltd. The first group includes the following copper companies: "Bancroft Mines Ltd.", "Nchanga Consolidated copper mines Ltd", "Zambia Rhokana Copper Refineries Ltd".

The second monopoly group includes: Mufulira Copper Mines (Luanshya Division), Chibuluma Mines, Chambeshi Mines, Baluba Mines, Mwineluba Mines (Kalenga) and others.

Roan Selection Trust Ltd. is part of financial monopoly "Selection Trust". American companies possess a 80% interest of "Roan Selection Trust Ltd".

New development of the copper industry in Zambia. "Zambia Anglo American Ltd". allocate considerable sums of money for Nchanga mining enterprises to increase mining of copper ore in the region up to 725 thousand tons monthly (in 1966 mining of copper ore was about 500 thousand tons monthly). In 1968 the fifth quarry in the region of Nchanga - River - Load was to be put into service; its monthly output was to be 33 thousand tons. The reserves of the deposit are estimated at 6 million tons of ore. The ore coming from the Mimbula-Fitula and River Load quarries will be processed at the new concentrator in Nchanga.

The Bwana Mkubwa quarry (the annual output of copper in ore is 27 thousand tons) is being prepared for exploitation by the Torco process.

The quarry is to be put into service in 1970, the investments are estimated at 10 million dollars, including the investments for the Bwana concentrator. The obtained concentrate will be delivered to the Rhokana mill. At the Kansanshi Mine more than 10 thousand tons of ore were extracted by open-pit operations. The extracted ore is treated by the TORCO process at an experimental processing plant. If the results of the tests are good it will be possible to reestablish the Kansanshi mine with the help of foreign capital.

The investments of the company for the five-year period which ends in 1972, are planned at 186 million dollars. Japanese firms were reported to give a loan to the company "Zambian Anglo American Ltd". "Mitsubishi Metal Mining Co, Ltd." gave 28 million dollars, "Mitsui Coal Mining Co.", Ltd." gave 28 million dollars, "Mitsui Coal Mining Co. ", Ltd. gave 42 million dollars.

The loan will be paid off by the deliveries of Zambian copper to the Japanese firms, at the rate of 80-100 thousand tons of copper annually.

"Roan Selection Trust Ltd". is reported to be engaged in the following construction work : the company plans to increase the annual output capacity of the Mufulira complex from 165 to 190 thousand tons. The investments in the construction work are estimated at 12.4 million dollars. The complex is to be commissioned in 1971. The monthly output of ore will be increased up to 720 thousand tons.

The company is preparing for exploitation the Kalenga quarry, the expected output of the quarry is 100 thousand tons of ore annually; copper content being about 16%. The possibility of exploiting the Baluba deposit near Luanshya, the reserves of which are estimated at 112 million tons of ore containing cobalt, copper content averaging 2.4%, is under consideration now.

If the exploitation of the Baluba deposit proves reasonable, the mining will be carried out by underground working. The concentrator is scheduled for putting in operation into six years. Its output will be 22 thousand tons of copper and 950 tons of cobalt annually.

In December 1968 the output capacity of the Mufulira mill was reported to be increased by 50 thousand tons, to 230 thousand tons. The exploitation of fresh capacities is scheduled for July 1971. A new electric furnace (30 MVA) and a converter will be installed.

At the Zambian mills a number of technical improvements were introduced. At the Nkana mill a new oxygen plant with the efficiency of 600 tons of technical oxygen annually was put in operation. It will feed oxygen to all reverberating furnaces and two converters.

Certain quantities of the oxygen will be used for ore processing by the TORCO process.

This method was worked out for the processing of oxidized, silicate and oxidized sulphide ores, which widely occur in Zambia and which are dressed with difficulties. This process is carried out in the fluidiged bed and comes down to copper segregation at the temperature of 700° with the addition of sodium chloride and the reducing agent.

The TORCO process was introduced at the Nchanga complex on an experimental scale.

As the results of the tests proved good, "Anglo American Corporation Ltd." offers to realize the process on an industrial scale.

It was reported that the reserves of copper bearing ores and waste dumps which can be treated only by the TORCO process are rather great; copper content being 2.5-4%. As copper industry dominates in the economy of the country, the government takes measures to strengthen the mining industry and to exercise strict control over it.

The plan adopted in Zambia provides for the increase of copper production to 750-850 thousand tons annually by 1969-1970 and to 910-1,200 thousand tons by 1979-1980.

Now they are training specialists for the copper industry to replace Non-African employees by qualified Africans. A special committee on "Zambianization of job" was set up. The representatives of the government, of the companies producing copper, of trade-unions participate in the work of the committee.

By 1971 considerable part of the authorites of the mines will be represented by Zambian citizens.

Copper royalty arrangements in Zambia are the folloing: payment for the extraction of natural resources depends on the price for copper; export taxation at the rate of 40% from the part of the price exceeding 840 dollars per ton; income taxation at the rate of 45% from taxable profit (except for the first 280 thousand dollars from which the income taxation is levied at the rate of 37.5%).

In 1967/1968 "Roan Selection trust Ltd." allocated to the state budget 124.6 million dollars; Zambian Anglo American allocated 243.6 million dollars, which equaled 69.1% of the gross profit of the company (before providing for taxation). Until recently the two large companies exported 80% of their net profit (after providing for taxation) as dividends. In 1968 the Zambian government banned to export more than 50% of the sum as dividents.

The Zambian government tries to controle the activity of "Rhodesian Selection Trust" and "Zambian Anglo American Ltd." in defining prices and in the sale of their copper. With this in view a special organisation "Metals Marketing Co. of Zambia" was set up. The Government has a 51% interest and 5 seats in the Board of directors, "Rhodesian Selection Trust" and "Zambian Anglo American" have a 24.5% interest and 2 seats in the Board of directors each.

The government of Zambia along with the government of Congo, Peru and Chile participate in the work of the governmental council of the countries - exporters of copper (CLPEC) the aim of which is to creat favourable trading conditions for the countries on the copper market and to establish favourable prices.

Lead-Zinc industry. All known lead and zinc reserves are concentrated in one large Broken Hill deposit, which is situated in the interior of the country. Proved and probable reserves of lead are estimated at 550 thousand tons; zinc proved and probable reserves amount to 1,160 thousand tons. Metal content in the ore is the following; lead content is 11-15%, averaging 12.5%; zinc content is 25-29% and 26.4% respectively.

In the country there are known to exist other small deposits of lead and zinc, but they are not surveyed.

The figures, illustrating mining, production, consumption and export of lead and zinc are given in table 5.

Table 5

Mining, production, consumption and export of lead and zinc in Zambia (thousand tons)

	Years					
	1955	1960	1965	1966	1967	1968
1	2	3	4	5	6	7
Lead mine production (metal content)	16	15	34	21	20	20

1	2	3	4	5	6	7
Zinc mine production (metal content)	31	40	47	32	54	69
Production of primary refined lead	16	15	21	20	20	23
Production of primary zinc	28	30	47	42	45	54
Consumption of primary lead	...	1	4	4	5	6
Exports of refined lead	15	13	16	26	17	15
Exports of primary zinc	26	30	45	39	40	50

Mining is carried out by underground working. The output of the mine is 300-500 thousand tons of ore annually.

All the ores extracted in the country are dressed and processed at iron and steel works of the country.

Lead and zinc are processed at three works, situated in Broken-Hill and belonging to the company "Zambia Broken-Hill".

One of the plants was put in operation in 1962. The output capacity of the plant is 25 thousand tons of zinc, purity being 98.5%, and 18.3 thousand tons of lead, purity being 99.99% (1968 data). Besides, the plant produces Dore alloy. The plant works according to the Imperial Smelting Process. The zinc electrolytic plant at Broken Hill produces 30.5 thousand tons of zinc, purity being 99.95%; elecctolytic cadmium, sulphuric acid, zinc powder and leaded zinc.

Besides, in the country there is one more old plant with orehearth smelting for rich copper concentrate.

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

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

§ 10. CONGO (Kinshasa)

The Democratic Republic of Cong- has been an independent state since June 1960. In the north, Congo borders on the Central African Republic and the Soudan; in the east, on Uganda, Ruanda, Burundi and Tanzania; in the south, on Zambia and Angola; in the west, on the Republic of Congo (with the capital Brazzaville).

Territory	- 2345,000 sq.kilom.;
Population	- 16353,000 people ;
Population density	- 7 people per sq.km;
Capital city	- Kinshasa;
Major towns	- Lubumbashi, Kissangani, Luluaburg;
Sea ports	- Matadi and Boma.

Congo is situated in the equatorial part of Africa and occupies almost the whole of the basin of the river Congo and a part of the basin of the Upper Nile. It has a narrow (35 km) exit to the Atlantic Ocean.

The climate of Congo is hot, equatorial-type. Most of the rivers form one mighty network of the river Congo. In their northern and middle portions the rivers are always abundant in water; in the south there is some rainfall during the winter season.

The total length of railway lines in Congo (some of them with a narrow gauge track) is 4600 km. From the main mining area of Catanga a railway runs to Port-Franco on the river Cassai; from there cargoes are transported by river to Kinshasa and then by a branch line to the port of Matadi.

A considerable quantity of mineral raw materials are shipped by the Trans-African Railway connecting the port of Benguela on the Atlantic Ocean with the port of Beira on the Indian Ocean.

The total length of macadam and earth roads is 15300 km.

Water haulage is done along the river Congo and its tributaries, by which passes 70% of the country's imports and 60% of exports. The main river ports are: Kinshasa, Kokiyaville, Kissangani, Cubalo, Congolo, Albertville and others.

There are air fields in Kinshasa, Kissangani, Kokiyaville, Port-Franco and other points.

Th lack of any considerable fuel reserves and the availability of water-power resources have contributed to the creation in Congo of a number of water power plants, whose total capacity at present amounts to over half a million kW. Among the largest of these are the 4 water power plants situated in Catanga: Francki, with an annual capacity of 77100 kW, completed in 1930; Bia, with an annual capacity of 46800 kW, built in 1950; Delcommune, with an annual capacity of 120000 kW, built in 1953; and Le Marinel, with an annual capacity of 276000 kW, the construction of which was completed in 1956.

Feasibility study is under way on a fifth hydroelectric project on the river Lualuba. All this power system is intended mainly to serve industrial enterprises of the Copper Belt and also, partially, for the railway and municipal transport. Data on the total electroenergy supply by these power plants are given in Table 1.

Table 1

Power Generation

	Years			
	1963	1964	1965	1966
Power supply, million kwhr				
Total	2407	2435	2686	2926
Of this by the hydro power plants in the Province of Catanga	1855	1888	2075	2227

Power from the large hydroelectric plants is transmitted by high voltage power transmission lines with a voltage of 110,000V, which is stepped down to 25000V at substations.

In addition, there are a number of smaller thermal and hydroelectric power stations in other areas of the country, with a total annual output slightly over 600 million kwhr.

The reserves of oil and natural gas in Congo have not been explored and are not used. There are small deposits of coal which is used mainly for the needs of the industry. A small quantity of coal is imported from Rhodesia.

The major importance in the country's economy belongs to the mining industry, the products of which are almost entirely exported. In the mining of a number of minerals

Congo occupies one of the leading places in the world (copper, uranium, manganese), and in the mining of cobalt and technical diamonds; the 7-th place. There are also deposits of such minerals as gold, tungsten, beryllium, germanium and others.

Aluminium industry. The overall reserves of bauxites in the country are estimated at 200 million tons. The main deposits are situated in the western part of the country, between the towns of Matadi and Chela. The bauxites contain 40 to 50% Al_2O_3, 0.5% SiO_2 and 37.0% Fe_2O_3. In addition, laterite bauxites are known to be: in the north of the country, in the watersheds of the rivers Ituri, Bima and Rubi; in the area of the lower reaches of the river Congo, 60 km north of the district Inga; in the west, near the village of Kinzauki, along the road Sumbi-Isanghila.

No mining of bauxites is being done. Construction is planned of an aluminium plant, which will work on local bauxites and power.

There is a small plant in the country (in the city of Kinshasa) producing aluminium sheets from imported aluminium.

The copper industry of Congo (Kinshasa) occupies an important place in the world production of copper. Official data on the reserves of copper in Congo have not been published since 1940. Approximately, the reserves are estimated at 36 million tons, of which 18 million tons are classed as proved and probable. The copper content of the ores varies from 1.0% to 10%, averaging 4%. Besides copper, the ores in industrial concentrations contain zinc (about 2%), cobalt (0.2 to 1.7%) and also silver, cadmium, germanium and other useful components.

About 10 million tons of copper ore is mined and over 320,000 tons of blister copper is produced annually in the country (Table II).

Table II

Data on the production of the Copper Industry of Congo, thou. tons

	1955	1960	1965	1966	1967	1968
Production of blister copper	235	302	289	317	322	325
Production of electrolytic copper	115	176	223	237	240	240
Exports of blister copper	118	157	65	72	81	...
Export of electrolytic copper additionally refined at Oolen (Belgium)	-	-	72	80	80	...
Exports of refined copper (without electrolytic copper additionally refined at Oolen)	113	145	153	158	161	...

Copper is mined from rich deposits of the Upper Catanga area situated in the mountainous south-east part of the country, along the border on Zambia.

The most important mines of the Upper Catanga are divided into three groups: the Western group (with the centre in the town of Colvesi); the Central group (the town of Jadoville); and the South-East group (the town of Lubumbashi). The output of copper ore for the main mines was in 1966 as follows:

Western group:

Mussonoi	- 1,800,000 tons,
Camoto	- 2,800,000 tons,
Ruve	- 1,850,000 tons;

Central group:

Cambove	- 1,100,000 tons,
Seza	- 300,000 tons,
Cacanda	- 700,000 tons;

South-East group:

Kipushi	- 1,100,000 tons.

Ore deposits are worked out mostly in the open-cut, and only at Kipushi and partly at Cambove by the underground method.

A new underground mine has been built at the Camoto deposit. An ever-increasing significance in recent years have been acquiring the mines of the Western group, which are yielding now about 80% of the copper ore produced in the country.

To benefication are subjected sulphide ores of cuprous sandstone type, containing 3 to 5% Cu, and oxidized ores, in which copper content sometimes exceeds 10%.

Some performance data for the ore concentrators in Congo are given in Table III.

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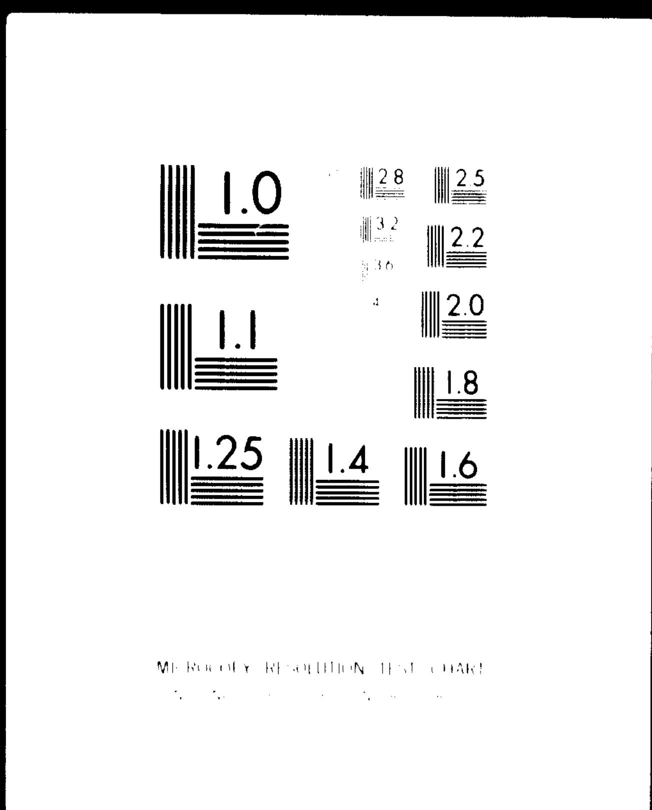

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Table III

Some Data on the Performance of the Ore Concentrators in 1966

Mining and concentrating complexes: Concentrator	Mine	Monthly output, thous. tons of ore	Quantity of ore subjected to concentration, million tons per year	Quantity of concentrates produced, thous. tons per year	Metal content in concentrates, %: Cu	Co	Extraction of copper into concentrate, %
Kipushi	Kipushi	100	1,1	420	25-30	-	86.1
Cambove[1)]	Cambove	85	1.06	185	19-51	1.2-24	...
Cacanda	Cacanda	75	0.7	114	23-25	0.7-1.0	...
Colvesi	Comoto, Mussonoi	330	4.0	670	18-43	1.3-3.7	82.85
Ruve	Ruve	200	1.85	92	21-25	-	80.00

1) In addition, 180000 tons of ore was dressed without floatation.

In 1968 the Camoto dressing plant of 2,640,000 tons of ore per year designed capacity was put in operation.

There are three copper works operating in Congo:

The Lubumbashi copper-smelting plant, of 100,000 tons of blister per year capacity, is processing floatation concentrates from Kipushi. The process includes sintering, shaft furnace smelting and converter blowing. The product - copper of 98.5 to 99% purity - is refined at the Olain plant near Antwerp, Belgium. The blister copper contains also lead, antimony and silver. The shaft furnace slag contains zinc, germanium and cadmium. 79,600 tons of blister copper was produced in 1966.

The Jadoville-Shituru hydrometallurgical plant, with an annual capacity of 150,000 tons of copper and 6,600 tons of cobalt, is processing the copper-cobalt concentrates coming from the Colvesi and Ruve dressing plants of the Western area.

125,000 tons of copper wire bars and 5,200 tons of electrolytic cobalt was produced in 1966. In addition, about 31,000 tons of wire bars was produced from cathodes of the Luilu plant.

The Luilu plant is processing by the hydrometallurgical method the oxidized concentrates from the Colvesi and Ruve dressing plants. The annual capacity of the Luilu plant is 100,000 tons of copper and 3,500 tons of cobalt. The electrolytic copper from Luilu, exported to Belgium, is subjected to an additional refining at the Olain plant; its quantity is about 80,000 tons per year. Wire bars of higher than standard purity are produced from this copper; these are used in the production of very fine wire and sold at elevated prices.

Copper semis production in Congo is insignificant. Since the second World War there exist in the country several fabrication plants of small capacity (about 1,000 tons per year). It is planned to build a copper-semis producing plant at the town of Colvesi worth 2,300,000 dollars.

It is supposed that 55% of the stock will belong to Congolese firms, 25% to Italian firms and 20% to the Government of Congo.

Consumption of copper in Congo presents a small value; almost all copper produced is exported. The main importer of Congolese copper (over 70% of the whole export) is Belgium, at the plants of which products of Congo undergo a final treatment.

The export of copper to Belgium in 1967 was estimated at about 230,000 tons (of which about 70,000 tons of blister copper, 80,000 tons of wire bars and about 80,000 tons of electrolytic copper of the Luilu plant). Considerably smaller quantities of copper are exported to France and Italy (approximately 30,000 tons per year to each).

The copper and cobalt industry of Congo had been, until 1966, in the hands of the company Union Minière du Haut Catanga (Belgian and American capital). At the end of 1966 all the assets and rights of this company in Congo were taken over by the State. The company Societe Generale Congolaise des Minerais (GECOMIN) was established, in which 60% of the stock belongs to the Congolese Government.

The GECOMIN company has concluded an agreement with the company Societe Generale des Minerais in Brussels (closely connected with the Union Miniere company), in accordance with which the company Societe Generale des Minerais will sell GECOMIN's products, furnish equipment and materials and provide trained personnel.

It has been reported of the intentions of some Japanese firms to participate in the exploitation of Congolese copper deposits.

The Congo Mines Development company (COMIDECO) has been formed in Congo, in which 15% of the stock belongs to the Congolese government and 85%, to the Japanese companies headed by the firm Nippon Mining (57% of the stock); besides the latter, the following Japanese firms enter the company: Mitsubishi Metal Mining, Mitsui Mining, Sumitomo Metal Mining, Dowa Mining and Furukawa Mining.

The purpose of the new company is exploration and exploitation of copper deposits in the South Catanga province, in the area south of the territory owned by the GECOMIN company. At the end of 1968 it was reported that a copper deposit had been discovered by the company in this area at Mussoshi, 80 km distant from Lubumbashi, with which it is connected by a motor road and a railway, and 10 km away from the Zambian border, near the Chilibomve works (formerly Bancroft). The reserves are estimated at 30 million tons of ore containing 3.3% Cu. Exploitation of the deposit is to start in 1971.

An ore dressing plant with a daily throughput of 5000 tons is to be erected. The capacity is estimated at 40,000 tons of copper in concentrates per year.

It has been reported also, that the new company is considering the possibility of producing blister copper in Congo, which would be refined in Japan, since transportation of concentrates over such long distances would be uneconomic.

The lead-and-zinc industry of Congo is of smaller significance than the copper industry.

The overall reserves of zinc are estimated at 2 million tons, of which 1 million tons is classed as proved or probable. The small lead reserves available have not been determined.

In Table IV are shown data on the mining, production and export of zinc.

Table IV

Mining, Production and Exports of Zinc, thous. tons

	Years				
	1955	1960	1965	1966	1967
Mine production (zinc content)	68	109	117	117	110
Production of primary zinc	34	53	54	61	62
Exports of ore and concentrates	103	98	86	86	...
Exports of primary zinc	51	35	36	30	...

Zinc is mined together with copper at the Kipushi mine. The Congolese government holds 51% of the shares of the Kipushi mine. In 1968 an agreement was signed between the government of Congo and the Belgian company Societe Generale des Minerais de Belgique, through mediation of the firm Societe Generale Congolaise des Minerais (GECOMIN), on a joint operation of the mine, which was formerly exploited by the Belgian company Union Miniere du Haut Catanga.

Zinc concentrates from the Kipushi mine are supplied to the electrolytic zinc plant at Colvesi belonging to the company Société Métallurgique Catangaise (Metalcat). At the plant there is also a shop producing electrolytic cadmium, of 400 tons per year capacity. The zinc plant at Colvesi is processing dusts containing mainly lead and zinc.

Lead concentrates are supplied to the Jadoville-Panda plant. The lead produced here in a small quantity is used for domestic needs.

Primary zinc produced in the country and a part of zinc concentrates are exported. The main importers of Congolese zinc are the USA and Great Britain, while the main importer of zinc concentrates is Belgium.

Tin industry. The overall possible tin reserves are appreciated at 500,000 t., 200,000 t. of which are proved and probable. Tin deposits are known in two regions: in the South of the country, in the North Catanga province, and in the North in the Kivu province.

In the South region the Manono depost is of primary importance at present. The cassiterite content in the ores varies from some hundred grammes to two kilogrammes per 1 meter cube. The ores contain columbite-tantalite, about 4.5% of the cassiterite content. The explored tin reserves of this field are estimated at 100,000 t.

Besides Manono North Catanga has other known deposits. They are a deposit of tin containing pegmatites in Kitotolo and a number of smaller secondary (alluvial and eluvial) and primary deposits.

The Manono deposit is worked by the well-organized enterprise of the Geomin company. The mining is carried out in an open-cut way by means of excavators with the use of machine drilling and blowing up when necessary. The ore mined is fed into movable crushers, and then by belt conveyors to crushing plants and from there to a washing plant (settling and tables).

The rough concentrate is supplied from the plant to the finishing plant (tables and electromagnetic separators). Here the commercial columbite-tantalite concentrate and the pure tin concentrate are separated. The pure tin concentrate is smelted for metal in the electric furnaces of the metallurgical plant in Manono. The Zeomin Company mines more than 3 million t. and manufactures about 3,000 t. of tin per year. The capacity of the Manono plant is only partially made use of. During the Second World War it produced up to 7-8 thousand t. of tin per year.

In the Kivu province the tin deposits are developed in the Maniema region. The reserves here exceed 130,000 t. of tin. The cassiterite content in the eluvial deposits being worked varies within the range of 0.5-1.5 kg. per meter cube. The primary deposits in the region are less explored.

The tin deposits in the Maniema region are mainly mined by the Simetane Company. Different methods of open-cut mining are used in the company mines, from fully mechanized ones to primitive manual labour. Many types of work connected with hard and dangerous labour, including the stripping of forest sections, are often carried out manually. The mined sands are washed in sluices or movable washing installations supplied with settling machines and concentration tables. Washing plants of the same type, supplied with jaw and hammer crushers, are also used for the concentration of primary ores. The mentioned way produces the rough concentrate which is purified in two finishing plants producing a commercial concentrate with a tin content of up to 75%. The Simetane Company produces about 3,000 t. of tin in concentrates per year.

The Geomin and Simetane companies are the largest in the Congo. The nature of the work of small tin producers is not described in the published sources. There can be no doubt of their technological equipage being more poor.

The data concerning tin industry operation in the country are given in table 5.

The favourable geological basis of the tin industry of Congo makes it possible to consider that the branch can become of considerable importance in the development of the economy of the country.

This can be promoted by wide application of fully mechanised methods of grounds preparation, mining and beneficiation of ores and sands, which could make operations less labour

Table V

Tin Production and Exports, thou. t.

	1955	1960	1965	1966	1967	1968
Production of tin-in-concentrates	15.3[1]	9.3	6.3	7.0	7.1	7.5
Primary tin production	3.1	2.5	1.8	1.8	1.8	1.8
Exports of tin-in-concentrates	12.6[2]	6.0	...	3.0[3]	2.7[3]	...
Primary tin exports	2.6	2.5	...	0.3[3]	0.8[3]	...
Primary tin consumption	...	0.1	0.1	0.1	0.1	0.1

1) The production in Ruanda-Urundi included.

2) The export from Ruanda-Urundi included.

3) The export for the first six months of the corresponding year.

consuming and more productive, reduce metal losts in dressing tails and return all the investments necessary for the development of these methods. All this would make Congo less vulnerable on the international market. In view of these great possibilities, systematic tin exploration in the most promising regions of the country is quite obligatory.

§ II. The Republic of Congo (Brazzaville)

The Republic of the Congo (Brazzaville) is situated in Central Africa.

Territory - 342 thous.sq.km.

Population - 860 thous. people

Pupulation density - 3 persons per sq.km.

Capital - Brazzaville

Principal cities - Brazzaville, Fart - Russe, Impfondo, Mouti.

Sea ports: Pointe - Noire.

Congo Republic is situated on both sides of the Equator and it borders on the west and the north upon Gabon and Cameroon, on the east and the south - upon Congo Democratic Republic (Kinshasa) and Angola.

On the south-west Congo is washed by waters of the Atlantic Ocean.

The territory of Congo is not uniform: the North-East of the country is occupied by the flat plain situated at elevation of about 300 m; on the west and the south there is located the plain with the height of 500 - 1000 m, on the South-West - the coastal lowland turning into the flat sandy coast. The climate is equatorial.

Rivers mainly belong to the basin of the Congo River flowing along the eastern border of Congo Republic. They are navigable, the current is still. The main rivers are Ubangi, Sanga.

Rivers flowing to the south-west to the Atlantic Ocean are full of rapids, have quick current, and are not navigable. The most significant of them is Kwilu.

At present in the country there are operating 6 electric power stations which generate anually up to 45 million kwh (table 1).

Table 1

Generation of electric power

	Years				
	1958	1963	1964	1965	1966
Installed capacity, total , thous Kw	...	22.0	22.0	22.0	22.0
including hydro-electric plants	...	15.0	15.0	15.0	15.0
Generation of electric power: total, million kwhr	30.7	41.6	42.8	42.1	45.5
including hydro-electric plants	...	27.2	26.8	26.7	27.9

External communications (commercial and passenger) are accomplished through port Pointe -Noire, located on the cost of the Atlantic Ocean. The port is connected with Brazzaville by the railway of 512 km length and through well equipped up-to-date airport maya-maya which is 4 km from Brazzaville.

Of non-ferrous metals the deposits of copper, lead and tin are found in the country.

Aluminium industry. In the book by F.Friedensburg title "Die Bergwirtschaft der Erde" (1965) it was reported that the deposits of bauxites have been discovered near Mosenjo about 30 km from the railway running from Pointe-Noire to hinterland.

Their reserves according to preliminary estimation exceed 100 million tons.

Yet, these data have not found confirmation in other later materials.

It is possible that ferrous laterites are existing here which have small value as bauxites.

Copper industry. Reserves of copper in the country are estimated at 40 thous. tons. They altogether are regarded as proved and probable. Copper content in the ore varies from 2 to 4 per cent, averaging 2.2 per cent.

The main part of small copper deposits is located in the basin of the Niari River in the strip with the length of about 140 km.

The development of some deposits began as early as in the beginning of XX century and has been going on till the present time.

In recent years the M'Passa copper - lead - zinc deposit where two isolated ore zones - copper and lead -

zinc are existing has been serving as a main source for the supply of copper in the country.

Copper ores form narrow occurances of band type stretching in the south-west direction with the thickness up to 8-10 m confine to dolomites.

Rich copper ores have been worked out and at present ores with copper content up to 2 per cent are being mined.The copper is produced only at the M'Passa deposit. The production of copper concentrates (in terms of metal) makes 300 tons a year.

The consumption of copper in the country is small-less than 100 tons a year-and it is met by the import of the metal from France and USA.

Lead and Zinc industry. The total reserves of lead make more than 500 thous. tons of which 460 thous.tons are proved and probable; reserves of zinc were not estimated. The main parts of lead - zinc deposits are situated together with copper ones (as mentioned above) in the basin of the Niary River.

Only the M'Passa copper - lead - zinc deposit is being developed. The lead - zinc section of this deposit represents the seam-like body with the length of 250 m, width up to 80 m and thickness up to 1. Om. The ore contains about 20 per cent of lead and 30 per cent of zinc.Till 1961 the Mfuati and Apilo deposits were also developed.The reserves of lead at the former made 460 thous. tons while at the latter - 40 thous. tons.

The beneficiation is being carried out by manual selection of ore. Lead concentrates with the lead content of more than 50 per cent are being exported to Great Britain.

Production and export of lead (by its content in concentrates) amounts to 3 to 4 thous. tons. Beneficiation plant has the output of 120 to 150 thous. tons of ore a day.

Tin industry. The mining and production of tin in concentrates commenced in 1957.

There are no data on reserves of tin in the country. Small deposits being developed in the north-west part of the Maiombe ridge near the border with Gabon are represented by alluvial deposits and small mineralized zones with cassiterite, wolframite and columbite-tantalite.

The content of cassiterite in some alluvial deposits in first years of development amounted to several kilograms per 1 m^3. In mineralized zones the average summary content of cassiterite, walframite and columbite-tantalite makes 6 to 9 kg per 1 m^3 of the rock as mined.

Both alluvial deposits and ores occuring in their place of origin are being beneficiated. The tin content in concentrates makes 75 per cent; annual output amounts to 50 tons of tin in concentrate. Concentrates are being fully exported.

§ I2. The Islamic Republic of Mauritania

An independent Republic from November 28, 1960. It is situated in West Africa and borders upon Morocco, Algeria, Mali and Senegal. On the West Mauritania is washed by the Atlantic Ocean.

Territory - 1,031 thous.sq.km.

Population - 1.1 million people

Population density - 1 person per sq.km.

Capital - Nouakshott

Mauritania occupies plateau of 400 m height in the Western part of Sahara and narrow lowland along the coast of the Atlantic ocean.

The climate is predominantly tropical, hot.

The Senegal River is the only river with a perennial current. The transport communications began to develop only in recent times.

In 1968 there was completed the construction of the first in the country railway from Fort-Gourand to Port Etienne with the length of 675 km from which the railway siding to Akjout will be constructed. The length of earth roads which can be used for the whole year is 2.7 thous km. The territory of the country is crossed by the Nouakshott- Atar - Tindouf highway. The only port on the Atlantic coast is Port Etienne. Air transport has great importance for Mauritania. There are 22 aerodromes in the country.

The fuel resources of the country are limited. Within the country there lies a part of the El-Djouf Oil-Gas bearing basin in which in recent years oil deposits have been discovered. The annual production of electric power amounts to 60.3 million kwhr.

Copper industry in Mauritania is beginning to develop. Copper reserves in the country make up 590 thous. tons, they altogether are considered to be proved and probable. The copper content in ores varies from 1.5 to 2.9 per cent, averaging 2.0 per cent.

The considerable part of reserves is concentrated in large the Akjout Copper - Gold deposit situated 4 km to the North-West of Akjout town.

Reserves of oxidized ores are estimated at 7 to 9 million tons containing 2.5 tc 2.9 per cent of copper and 3 gr/t of gold. Reserves of sulphide ores for open-pit mining make up 18 million tons, containing 1.5 per cent of copper, 1.0 gr/t of gold, and for underground mining - 4 to 5 million tons.

In addition, there are big reserves of copper ores with the copper content of 0.9 per cent.

For exploitation of this deposit "Mining of Mauritania Co" has been set up, shares of which are divided among the following partners: South African firm "Charged Consolidated" (Associated with Anglo-American Co) - 47 per cent; the government of Mauritania - 23 per cent; French private companies - 19 per cent, while the rest 11 per cent belong to French governmental companies.

Capital investments for development of the deposit will amount to 60 million dollars.

It is planned to put into operation in 1970 a mining beneficiating plant. During first seven years oxidized ore deposits will be mined with daily output of ore mining being 3.7 thous. tons.

The output of the beneficiating plant makes 50 thous. tons of concentrates per year.

The mining of sulphide ores will begin after the completion of working out the upper horizon of oxidized ores. The production of ore is planned for 11 years. The exploitation of the ore mine will last for 16 years. During this period 410 thous. tons of concentrates with the copper content of 44.2 per cent will be obtained from oxidized ores and 1,210 thous. tons of concentrates with the copper content of 23.8 per cent will be obtained from sulphide ores.

During the period of the exploitation 446 thous. tons of copper and 31 tons of gold will be obtained from ores of the Akjout deposit.

The construction of crushing and flotation plants, compressor plant, storages, administrative building and service buildings, electric power house as well as the cost of equipment of the mine will cost 20 million dollars. About 6 million dollars will be spent for construction of a township for 400 local workers and their families as well as for 90 foreign specialists.

Provision is made for construction of water

mic.

pipe-line valued at 6 million dollars.

To transport concentrates to Nuakshott port the road valued at 3 million dollars will be constructed.

4 million dollars will be spent for expansion of the sea port. It is supposed to process sulphide - oxidized copper ores of the Gelb-Mogrin deposit.

Sulphide ore contains in average 2.0 per cent of copper, 1 gr/t of gold, 30 to 35 per cent of magnetite; there are also available oxidized ores containing 2.9 per cent of copper, 3 gr/t of gold and 50 per cent of magnetite. It is planned to obtain annually 56 thous. tons of copper concentrates containing 27 per cent of copper, and 10 gr/t of gold from sulphide ores and 15 thous. tons of concentrates containing 66 per cent of copper and 40 gr/t of gold-from oxidized ores.

§ 13. Uganda

The country is situated in East Africa. On the north Uganda borders upon the Sudan, on the south upon Tanzania, on the west upon the Congo (Kinshasa), on the south-west upon Rwanda, on the east upon Kenya. The independence was proclaimed on October, 9, 1962.

Territory	- 236 thous sq.km
Population	- 7.9 million people
Population density	- 34 persons per sq.km
Capital	- Kampala

Uganda is located in the region of Great African lakes. The territory of the country represents the Plateau (1,000-1,200 m).

Vast areas in the south and central parts of the country are swamped.

The climate is equatorial, hot with two rainy seasons. The river network of Uganda is rather dense and belongs to the Nile basin. The biggest river is the Victoria-Nile.

Uganda has a weakly developed railways and motor roads network. The main railway links Uganda with Mombasa port in Kenya. The total length of motor roads - 5,400 km.

On the lakes Victoria, Kyoga and Albert there is local ship navigation; airway communication is being developed; the air port is at Entebbe.

The country does not possess the fuel base of home production.

Coal is not mined.

Though there are indications of existance of oil and gas in several places the oil is not produced.

The country is being supplied with imported oil products, the imports of which vary from 130 to 150 thous.tons a year. Electric power is being mainly generated by hydro-electric power stations (table 1). Uganda is mining copper, tin, wolfram.

Table 1

Power generation

	Years				
	1958	1963	1964	1965	1966
Installed capacity, total thou kw	-	147	151	152	167
including hydro-power plants	106	122	122	122	136
Power generation total, million kw	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
including hydro-power plants	278	496	521	572	634

There is no aluminium industry in the country though bauxite deposits may be discovered in future.

Ferrous laterite covers are widely spread in Uganda. They are developed on tops and slopes of flat hills. The thickness of layers is on the average 3 meters. Among these formations the laterite low-grade bauxites are known in many provinces.

In 1967 it has been announced about the creation of the Meta firm which plans to build in Lugazi the works for producing aluminium wire and cable on the basis of imported aluminium.

Copper industry. The total reserves of copper in the country amount to 180 thou.tons of which 130 thou.tons are proved and probable ones.

Copper content in the ore varies from 1.45 to 2.02 %, averaging 1.9%.

Table 2

Mining, production and exports of copper, thou. tons

	Years				
	1960	1965	1966	1967	1968
Mine production (copper content)	13	16	16	15	16
Production of primary blister copper	15	17	16	15	16
Exports of primary blister copper	15	17	16	15	16

The mining of copper is concentrated at the Kilembe copper and cobalt deposit situated in the Western province.

The proved and probable reserves at the deposits were estimated in 1961 at 8 million tons of ore, containing 1.95 per cent of copper, and probable reserves - at 2.4

million tons containing 1.83 per cent of copper and 0.18 per cent of cobalt.

In recent years prospecting for a new deposit at Bukangama located near Kilembe has been carried out.

Its reserves are estimated at some 5 million tons of ores. The mining at the Kilembe mine is being carried out by an underground method, the output of the mine being 0.9 to 1.0 million tons of ore per year.

The mining was started in 1956. The deposit is being worked by the Kilembe mines Ltd (Uganda) and the Canadian Company Falkonbridge which owns 73 per cent of shares.

Sulphide copper - pyrite ores are dressed at the Kilembe plant which produces primary bulk concentrate subjected after further grinding to selective floatation with a view of extracting copper and pyrite concentrates. The monthly output of the dressing plant is 90 thous tons of ores.

Copper concentrates are delivered to copper works at Jinja, with the annual output of 20 thous tons of blister copper. Blister copper is being exported.

In 1968 "Kilembe mines Limited" signed a five years contract with "Nippon Mining" (Japan) for selling the entire blister copper being produced in the country.

The plant for manufacturing copper wire and cable is supposed to be constructed in Lugazi. Output of the plant will amount to 5.4 million tons a year.

Products of the plant will be consumed in Uganda and partly imported to neighbouring countries: Tanzania, Congo (Kinshasa), Sudan, Zambia and the Mouritius island.

Tin industry. Tin reserves of the country are estimated at 2.0 thou.tons. All reserves are considered to be proved and probable.

In small quantities tin is being mined in the South part of the Western province, in areas of Ankole and Kigezi,where the tin belt from Congo and Rwanda extends to. Simultaneously columbite ore is being mined.

In the area of Ankole "Kilembe mines Limited" has been prospecting for new tin deposits.

Pegmatite tin ores mined in the country are being dressed.

During last years the production of tin in concentrates reached 100-200 tons a year.

Concentrates contain 71% of tin. Concentrates are being exported for melting to Great Britain.

§ 14. The Republic of Kenya

An independent Republic in East Africa from the 12th of December, 1964, Kenya borders on the north upon Sudan and Ethiopia, on the south upon Tanzania, on the west upon Uganda, on the east upon Somali, on the south-east it is washed by waters of the Indian Ocean.

Territory - 583 thous. sq.km.

Population - 9.9 million people

Density - 17 persons per sq.km.

Capital - Nairobi

Main ports - Mombasa, Malindi and Kisumu - on the Lake Victoria.

The biggest part of the country is occupied by the highland with the height up to 500 m on the east and up to 2,000 - 3,000 m on the west.

Along the Indian ocean lies the lowland the width of which is up to 200 km.

The climate on the coast is hot and humid.

The biggest rivers are Tana (navigable) and Galana (Sabaki) fall into the Indian ocean.

On the west the territory of Kenya includes the lake Victoria. The electric power in the country is being generated both by thermal electric plants and by hydro-electric plants (Table I.)

The proportion of electric power being generated by hydro-electric plants is almost 2.5 times more than that being generated by thermal electric plants.

Table I

The generation of electric power in Kenya

	Years				
	1958	1963	1964	1965	1966
Installed capacity, thous. Kw					
Total	82.3	102.2	101.4	100.1	...
including hydro-electric plants	25.9	27.9	27.9	27.9	...
Generation of electric power, million Kwhr					
Total	2I4	263	323	328	346
including hydro-electric plants	I47	I7I	205	198	...

The main railway line Mombasa-Kasese links Mombasa port with Uganda. Several branch lines are going off it. The length of highways is 900 km (including 378 km of bituminized ones) and the length of earth roads impassable in rainy seasons is 26.000 km.

In 1967 the government of Kenya has taken a decision to built an asphalted highway Nairobi - Namanga (instead of earth one), expenditure on its building makes up 2.125 million pounds of Sterling.

The construction of it is planned to be completed in 1970. The Italian company Rizzani is entrusted with construction work.

Kisumu which is situated on the shore of the lake Victoria is an important transport junction. Through the territory of Kenya pass trans-African airlines. The large airport is Embanasi near Nairobi.

The country consumes 800,000 tons of petroleum products a year. Till 1964 imports of petroleum products amounted to 835 to 1,035 thous. tons a year.

Since 1963 the oil refinery with output of 1.8 million tons a year has been operating.

<u>The aluminium industry</u> in Kenya is represented by the plant for treatment of aluminium which was built in 1961 by "Alkan" Company (Canada) in Mombasa, the main port or the country. Aluminium is transported to the plant by sea from Canada. The annual output of the plant makes up 5,000 tons of aluminium sheets and rounds (initial product for utensils).

The cost of the plant is valued at 2.8 million dollars, the further increase in the output up to 12,000 tons a year is in contemplation.

<u>Copper industry.</u> Only one industrial deposit of complex ore, namely Macalder, is situated within a gold-bearing vein, near the lake Victoria coast.

Its total reserves has made up 2 million tons of ore containing 1.26 to 2.2% of copper, 42 gr/t of silver and 2 to 3% of zinc. The Mines and Geological Department carries on study of the indications of the existance of copper in the area to the north-east of Kitale and Meru. "Macalder-Nyanza Mines Ltd" when developing the deposit was extracting from ore only copper, gold and silver while zinc has been wasted. On the basis of the deposit there was operating a beneficiation plant with the output of 10,000 tons of ore a month. Concentrates were processed into cement copper which was delivered for further treatment to Uganda to the plant in Jinja, Uganda (Table 2).

In 1967 the production of ore at the deposit was closed.

Table 2

	Years					
	1955	1960	1965	1966	1967	1968
Mine production (copper content) thous. tons	-	1	2	1	-	-
Imports of refined copper, alloys and scrap	0.3	-	0.1	0.1	...	...
Exports of copper and alloys	-	3.1	3.7	1.6	...	...

In Nairobi there is situated the plant manufacturing copper cable belonging to "East African Cables Ltd" at which the purchased wire rods are being drawn.

§ I5. The Republic of Sudan

An independent republic since January 1 st, 1956

Sudan is situated in North-East Africa, in the Nile basin. In the North it borders on the United Arab Republic, in the West on Libya, Chad and the Central African Republic, in the South on Congo (Kinshasa), Uganda, Kenya, in the East on Ethiopia.In the North-East 560 km of its shores are washed by the waves of the Red Sea.

Total area - 2.5 million km square

Population - 13.9 million people.

Pupulation density - 6 persons per sq.km.

Capital -Khartoum.

Sea - port is Port Sudan.

Principal cities: Omdurman, El-Obeid, Vad-Medani.

A considerable part of the Sudan Territory is a wide hollow occupied by the Nile system.It is surrounded by a plateau 500-1000 m high.The Libyan desert lies to the north-West.

The Sudan climate is transitory from desert tropical to equatorial.

All the great rivers of Sudan, the Gambia, Senegal, Niger, Shari, Nile, Sobat, take their beginnings outside its territory.The Sudan rivers have little water and are often quite dried out during the dry season. The large Chad lake lies in Central Sudan.

The length of the railway lines is more than 5 thousand km, of soil roads 3.5 thousand km.A part of them can be used for autocars.

The length of navigable river ways is about 3.7 thousand km. The main seaport is Port-Sudan.Khartoum has an international airport.

Sudan generates small amount of electric power. Its source is a number of small size power stations (Table 1).

Table 1

Electric Power Generation in Sudan

	Years				
	1958	1963	1964	1965	1966
Installed capacity thousands kw	30.5	59.0	58.9	76.1	-
Electric power generated, millions kw hr	67	163	167	174	262

So far no natural deposits of oil or gas have been found in the country.But it has been supposed that on the Red Sea shore, in the vicinity of the Trinkitat river and close, to the United Arab Republic border some small resources of oil and gas can be found. At present some 450-550 thousand tons of oil products are imported into the country every year.

Iron, copper and lead have been found in the country.

Aluminium industry. The bauxite deposits known in the country are not mined.

Laterite bauxites containing from 45 to 55% of Al_2O_3 have been found on the Napephara and Zitagana plateaus. The overall amount of those bauxites have been calculated to contain 100 million tons.

Copper industry. The overall copper deposits known are considered to contain 300 thousand tons. Their main part is concentrated in one place in Hofrat el Nachas in the South-West part of the Darfur province. It consists of two sulphide deposits. The content of the main deposit down to a depth of 150 m has been calculated to contain 283 thousand tons of copper with an average content of 2.78%. The other deposit has as yet been studied little.

Signs of copper in the Sudan territory have also been discovered in the districts of Port-Sudan, Gudaref and in the South of the Darfur province. But so far no detailed works have been carried out there.

Licences for working out the deposits of Hofrat-et-Nachas have been obtained by the American company African Mining and by the Italian one Pera Trading.

In 1967 - 280 t of copper have been mined.

The needs of the country are also satisfied by metal imports (about 300 t per year) from Great Britain and Denmark.

Lead and zinc industry. In the Darfur province (Kutum region) small lead deposits are known. So far they have been insufficiently studied and not all of them are worked at.

In 1967 721 t of lead concentrates were produced. All the amount was exported into the German Federative Republic.

Tin industry. Small tin deposits are known to exist in the South part of the Darfur province in the Kafia-Kingi district. Recently some signs of tin have been found in the region of the sixth waterfall on the Nile river, near Saba Loga.

§ 16. The Republic of Botswana

An independent state in South Africa from September 30, 1966. On the north it borders upon Angola and Zambia, on the south-upon Republic of South Africa, on the west-upon South West Africa, on the east - upon Rhodesia.

Territory - 600 thous. sq.km.

Population - 593 thous. people

Population density - 1 person per sq.km.

Capital - Gaberones

About two-third of the territory is occupied by the Kalahari Desert.

The northern borderland is irrigated by the middle stream of the Zambezi River, the south-eastern borderland- by the Limpopo River, the south and south-wastern borderland - by the Molopo and Nossob Rivers (the basin of the Orange River). The country experiences the shortage in water and periodical droughts and there is no artificial irrigation.

Railway (0.6 thous. km) runs along the eastern border and has a transit importance due to connection to railway network of the Republic of South Africa.

The length of highways is less than 900 km. The fuel resources are limited. Total reserves of coal are estimated at 550 million tons but it is not mined.

Oil is not produced, only prospecting work is being conducted. The government has granted a concession to "V.P. Blair oil Co." in the southern part of the Kalahari

Desert on the are of 57 thous. sq. km.

The generation of electric power in 1966 was 10.7 million Kwhr including 4.1 million Kwhr of hydro-electric power.

Of non-ferrous metals there are produced in small quantities gold and silver and in the nearest future copper and nickel will be produced.

In recent years depososits copper and nickel have been discovered in Sedibe and Pikve, 96 km to the south-west of Francistown.The mining of 200 thous. tons of ore per annum is planned.

Capital investments of "Roan Selection Trust" which will be developing the deposit will amount to 75-110 million dollars.

Copper industry. Summary reserves of sulphide and oxidezed ores of this region make up 33 million tons of which 29 million tons are considered to be proved and probable.The content of useful components in ores at the Selibe deposit makes up 1.20 to 1.57 per cent of copper and 0.66 to 1.5 per cent of nickel while at the Mitsitamma deposit - 2.15 to 2.87 per cent of copper and there is small admixture of silver and lead.The deposits are under preparation for exploitation. Establishing a pilot beneficiating plant is under consideration.Besides, the deposit of copper ores was discovered in the Tati district where the mine with an output of 10 thou. tons of ore per year and with reserves of ore for 15 years is supposed to be constructed.

The prospecting work for discovering copper, copper-nickel and copper-lead deposits is going on in Tati district.

The economy of exploitation of these copper-nickel deposits is being scrutinized. The preparatory work is financed by the government of Botswana, International Bank and managing council of UNO for developing countries.

It is supposed that capital investments for infrastructure (all the auxiliary structures except mines) including transport means, electric station, water supply will make up from 50 to 60 million dollars.

The mines are planned to be put into operation in early 1970-s.

It is supposed that all construction will be concentrated near the big dam built on the Shashi River 24 km to the south of Francistown.

The construction of a thermal power station to be operated on local coals is in contemplation. The big water resources of the Okavango River delta will be also used.

Industrial structures supplied with water and electric power are located along the railway to Lobatsi, Gaberones and Francistown.

§ 17. The United Republic of Tanzania

The United Republic of Tanzania was set up in 1964 from Tanganyika and Zanzibar. The republic is situated in East Africa. It borders on the North on Kenya and Uganda, on the South on Mozambique, Zambia and Malavy, on the West on Congo (Kinshasa), Rwanda and Burundi.

Territory - 938 thousand sq.km,

Population - 12.2 million people

Population density - 13 persons per sq. km.

Capital and the main port - Dar-es-Salam

The greater part of Tanganyika is an interior plateau with a mean altitude of about 1000-1500 m. Along the coast of the Indian ocean there is a low costal plain.

The Zanzibar island is lowlying of caralline formation.

The climate is equatorial-tropical. In the country generally there are two rainy seasons.

The country river network is poor . The rivers are short, full of rapids and unnavigable. The largest rivers are: Rovuma, Rufiji (navigable for a few miles from its mouth), Pangani discharges into the Indian Ocean), the Kagera (discharges into Victoria lake).

In the country there are several electric power stations with the capacity of 40.7 thousand kw. More than 200 million kwh of electricity were generated in 1963.

The country possesses 2,900 km of railways on the continent.

The network of highways is 6,100 km .Tanzania is connected with other countries by air lines.

The main railway line runs from the Port of Daressalam and near Tabore it forks to the port of Kigoma on the Lake of Tanganyika and to the port of Mwanza on the Lake of Victoria.Other railway lines go inland from the ports of Tanga and Mtwara.

Total reserves of coal in Tanzania amount to 800 million tons (550 million tons are considered proved). In the country there are several deposits of coal: Ruhuhu to east of Lake Nyasa, Tukuyu - on the north-western shore of the Lake Nyasa, and Illima in Rungwa area , near Tanganyika Lake.

Aluminium Industry. Non-ferrous metals are represented by gold and tin; there are also diamonds.

In many regions of the country there are laterites.

They are discovered in Usambara high lands, near Amani, 80 km to the west from the port of Tanga.The analisis of one of three samples showes Al_2O_3 - 57.7%; SiO_2 - 10.5%; Fe_2O_3 - 1.2%; TiO_2 - 1.6% but the two other samples showed high content of SiO_2 and low content of Al_2O_3. It is not estimated yet wether the bauxites are workable or not.

At the present time large-scale prospecting work for bauxite is being carried out.

Lead-Zinc industry has been limited many years to the mining of a vein deposit near Mpanda, 300 km to, the South-west to Tabora.

Several workable ore bodies were [illegible]ed in that region: Mukwamba deposit, Magamba deposit and others.

Prospected and promising reserves of the Mukwamba ore body up to the depth of 200 m were estimated at 2 million tons of ore with the average lead content of 6.5%, copper content - 0.6%, silver content of 120 g/t, gold content of 2 g/t and small amount of zinc.

But further exploration to the depth of the deposit and the prospecting of other ore bodies did not prove the above-mentioned amount of the reserves. The mining of the deposit started in 1950. In 1955 the deposit was expanded; a new concentrator with the daily output capacity of 1,200 tons of ore was built. In 1960 the mine was shut down.

Tin industry . Total reserves of tin in the country are estimated at 3,000 tons, 2,000 tons are considered proved and probable. Tin content in ore varies from 0.1% to 0.5%, cassiterite content in sands is up to 1.0 kg/m^3. Tin content in the extracted ores is 1.0% . The main tin-bearing region of Tanzania Karagive is situated in the north-west of the country.

The company Kyerva Sindikate affiliated to Straits Trading of Singapore is engaged at present in the extraction and production of tin at the Kaborishown deposit in the region of Kymrva.

In 1958 the company has built in the region a concentrator with the daily output capacity, of 1,000 tons of ore.

Later the output capacity was increased. Seekers also increased the ore mining.

Annually the country produces about 400 tons of tin in concentrates. The produced concentrates (containing 72.5% of tin) are exported to Malayzia for the processing at the plants of Straits Trading.

§ I8. The Federal Republic of Nigeria

Nigeria has been proclaimed as an independent state (Federation of Nigeria) on October 1, 1960.

On October I, 1963 it became a Federative Republic. Nigeria borders on the west upon Dahomey, on the north-upon Niger, on the east - upon Chad and Cameroun, on the south it is washed by waters of the Gulf of Guinea.

Territory - 923.8 thous. sq.km.

Population - 6I.5 millions people

Population density - 63 persons per sq.km.

Capital - Lagos

Principal cities - Ibadan, Kaduna, Enugu, Ogbomosho, Kano, Oshogbo.

Sea ports - Lagos, Port - Harcourt.

The biggest part of Nigeria's territory is occupied by hills. On the south along the coast of the Gulf of Guinea stretches a narrow coastal valley.The climate is tropical, hot, in the coastal strip it is humid.The river network in the south part of Nigeria is denser and deeper than that on the north. Many rivers including the Niger River, one of the biggest rivers of Africa, fall into the Gulf of Guinea.

The second big river of Nigeria is the Benue River - the left tributary of the Niger River.

On the north of the country, where there are few surface water currents, the use of underground waters plays a big part.Electric power in Nigeria is being generated by small predominantly thermal power plants (Table 1).

Dams and hydro-electric power plants with the total capacity of 2 million Kw are planned to be built on the Niger River and its tributary the Caduna.

Table I

Generation of electric power in Nigeria

	Years				
	I958	I963	I964	I965	I966
Installed capacity thous. Kw					
Total	I2I	256	272	358	432
Including hydro-power plants	20	2I	2I	2I	2I
Generation of electric power, million kwhr					
Total	344	893	1,024	1,177	1,279
including hydro-power plants	52	II8	I26	I32	I44

The length of railways in Nigeria is 3.5 thous.km, motor roads have length of 75.8 thous km of which 9.8 thous km are asphalted. Main railway lines are Lagos to Nguru through Ibadan, Kaduna, Kano and Port-Harcourt to Kaduna (through Enugu), from these lines go off sidings to big districts.

Navigation is carried out on the Niger River and its tributaries. Airports of international significance are in Ikeja and Kano.

Coal is being mined in a number of districts of the low Niger River basin. Coals have high ash content and are of low grade. Annually over 700 thousand tons of coal are being mined (in 1967- 761 thous. tons).

Prospecting work for oil conducted in 1954 has resulted in important discoveries in the Niger River delta. Production of oil has increased from 850 thous. tons in 1960 up to 21 million tons in 1966.

In 1965 the production of gas has been also set up. In 1966 there was produced 176 million m^3 of gas.

Of non-ferrous metals tin, columbite and gold are being produced in the country.

Nigeria has no its own aluminium industry, therefore the processing of aluminium in the country is based on imported metal.

Imports of aluminium and aluminium semi-finished products year-wise amounted to: (thous. tons) 1955 - 1.8, 1960 - 3.9, 1965 - 2.4, 1966 - 1.3.

Produced by processing works are flat and corrugated sheets and strips, designed for construction purposes.

<u>Lead and zinc industry.</u> Nigeria possesses reserves of lead and zinc but they are poorly studied and are just beginning to undergo development on industrial scale. Estimations of promising reserves according to information presented by some investigators vary in wide ranges from 10 to 600 million tons of ore.

At present only 1 million tons of ore have been prospected, which contain about 10 per cent of lead and 7.3 per cent of zinc and consequently proved and probable reserves of lead make not more than 100 thous. tons and zinc - about 80 thous. tons.

Geological researches aimed at discovering new deposits of lead and zinc and prospecting those already known are going on in various regions of Nigeria.

Till 1960 small quantity of lead (up to 1000 tons a year) and zinc (500 to 600 tons a year) was produced from ores of the Zurak deposit in the northern part of the ore bearing zone of the Adamawa province.

The Nigerian firm "Nigerian Lead and Mining" has prepared for exploitation two deposits: Enuigba and Amari in the Abakaliki province. The mining beneficiating complex will have the productive capacity of 300 tons of ore a day.

The mining of ore at the Abakaliki mine (on the south of ore bearing belt) in the first quater of 1967 made 709 tons while at the Enuigba mine (Eastern Nigeria) there are produced up to 200 tons of lead - zinc concentrates a month.

The "Metalgezellschaft" firm of FRG will buy all concentrates produced in Nigeria during 10 years.

Tin industry is a leading branch of non-ferrous metallurgy of Nigeria. Reserves of tin in the country are estimated at 110 thou. tons, they altogether are considered to be proved and probable reserves. The average content of cassiterite in sands is 0.5 kg/m^3. The main tin producing region of Nigeria lies in the northern part of the country within the Jos plateau. The bulk of the tin is being mined from alluvial deposits. A distinguishing feature of the Nigerian alluvial deposits is their small sizes, therefore the biggest importance have suction dredges, the share of which in 1966 constituted 30.7 per cent of mining, the share of quarries with manual extraction constituted 29.6 per cent of mining, the share of draglines was 24.8 per cent, the share of hydraulic devices was 6.3 per cent and the rest part was constituted by mechanical excavators and drags.

In 1965 the tin works has been put into operation and at present all concentrates are being treated on the spot (Table 2).

The leading place in mining and production of tin in the country is occupied by 11 companies registered in Great Britain and included in the Nigerian union of mining companies ("Nigerian Chamber of Mines").

In 1967 the share of these companies constituted 78 per cent of the mining of cassiterite and 96 per cent of columbite (which is the by product recoverd with cassiterite).

Table 2

Mining and production of tin, thous.tons

	Years					
	1955	1960	1965	1966	1967	1968
Production of tin-in-concentrates	8.3	7.8	9.7	9.7	9.5	9.8
Production of primary tin	-	-	9.5	9.5	9.3	10.1
Imports of primary tin	0.5	0.02	-	-	-	-
Exports of tin in concentrates	8.3	8.0	0.008	0.5	-	-
Exports of primary tin	-	-	10.6	11.7	9.6 I)	-
Consumption of primary tin	0.1	0.1	0.1	0.2	0.2	0.1

I) Export during 11 months in 1967.

The biggest supplier of tin concentrates is "Amalgamated Tin Mines of Nigeria" company (about 50% of the production of tin concentrates in the country) which is associated with the British tin trust "London Tin Corporation".

The less important companies are "Bisichi tin" (10%), "Gold and Base Metal Mines of Nigeria" (7.7%), "Ex-Lands (Nigeria)" (7%) and others.

Of 53 small companies, registered in Nigeria, the biggest ones are "Tin and Associated Minerals" (the branch of American company "Kennekott Copper" - 76% of shares), "Ron Mining and Development " (the branch of "Jantar Nigeria") and "Azigbo Brothers".The specific weight of all these three companies in the total mining of the country constitutes 5.5%.

In Nigeria at the Sungei Besy plant mainly tin bearing sands of alluvial deposits undergo beneficiation.

The primary beneficiation is being carried out at Jigging machines, the secondary one - at screw separators or concentration tables.

Sands of alluvial deposits in a number of cases apart from casseterite contain other heavy minerals such as monazite, zircon , ilmenite.

Recovery of these minerals from initial gravitational concentrates is being carried out at finishing plants with the use of magnetic, electrostatic separations and other special methods of beneficiation.

When beneficiating tin bearing sands with the tin content of 0.025 per cent there are obtained on an average concentrates with the tin content of 70 to 72 per cent with tin recovery of 80 - 90 per cent.

The production of initial tin in Nigeria since 1962 is concentrated at the works at Jos of "Makeri Smelting" company (the branch of "Consolidated Tin Smelters").

The enterprise is completely provided with concentrates and its capacity permits to treat all the Nigerian concentrates. Moreover, about 60 tons of tin in concentrates are being supplied from Niger.

The metal as obtained is mainly exported to Great Britain (more than 8 thou. tons in 1966).

Given below are brief characteristics of the plants at Jos of "Makeri" Smelting" company:

Output - 12.7 thou. tons of metallic tin a year.

Raw material treated - high-grade concentrates of Nigeria and the Republic of Niger containing 70% of tin.

Process flowsheet: smelting in reverberatory furnaces, fired with fuel oil with the addition of coke and limestone, fire-refining.

Finished products: Metallic tin in pigs, alloys and solders. Oil concent in commercial product is 99.98 per cent.

§ 19. The Republic of Niger

The independent Republic in Central Africa from August 3, 1960. It borders on the North upon Algeria and Libya, on the West upon Mali and Upper Volta on the South upon Dahomey and Nigeria, on the East upon the Republic of Chad.

Territory - 1,267 thou. km^2

Population - 3,546 thous people

Population density - about 3 persons per 1 sq.km.

Capital - Niamey

Principal cities - Zinder, Maradi, Bilma, Agades, Tesavi, Nguigmi

The bigger part of the country lies in Sahara. The climate is hot and dry. There are no perennial rivers in Niger. Wadies are widely spread. The country has no railways; the length of highways and earth roads is 3.5 thou.km. The main aerodrome is in Niamey. Data on fuel resources are not available. Surveying and prospecting work for oil was conducted in 1964 by "Petropar" Company in regions of Jado and Talak towns within the area of 130 thous. sq.km.

On the territory of Niger there is only one lead - zinc - tin deposit in the Air area, situated in the central part of the country to the north-east of Agades town within the Air mountain range. The slight indications of the existance of galenite ores were recently discovered in Timia and Aylak.

The traces of copper ores were discovered in Agades area. Surveying and prospecting of copper ores is going on. It is planned to conduct a geological prospecting of minerals in Air and Liptako areas during the period of 3-5 years.

The financing in an amount of 1.2 thous. dollars will be invested by the government of Niger and UNO.

Tin is the only non-ferrous metal being produced in the country at present. Tin reserves of the country have not been estimated. The cassiterite on the Air deposit is sometimes associated with walframite. Here in El Maki and Timia areas alluvial deposits of cassiterite are being developed by primitive methods. The mining and production of tin in concentrates make about 70 tons a year. The tin content in them amounts to 70 per cent. Tin concentrates which formerly were delivered for processing to Great Britain are at present being processed in Nigeria at the plant of "Makery Smelting Co".

The activity of "Société Minièrede Niger" Company is under the State control.

§ 20. The Burundi Republic

The Burundi Republic is situated in Central Africa; it borders on the north upon Rwanda, on the east and the south-east upon Tanzania, on the West upon Congo (Kinshasa).

The independence of Burundi was proclaimed on July 1, 1962; in November 1966 Burundi has become an independent Republic.

Territory - 27 thous. sq. km.

Population - 3.3 million people

Population density - 120 persons per sq.km.

Capital - Bujumbura.

The country is situated in high mountainous region crossed by deep valleys of rivers. The climate is hot with long dry season.

There are no railways in the country. The main part in traffics is played by motor transport and navigation on the lake Tanganyika.

Aerodromes - in Bujumbura and Kitega.

The tin industry. On the territory of Burundi there are known to exist numerous small but rather rich alluvial deposits of tin, which developed mainly at the expense of destruction of tin bearing pegmatites. With cassiterite in alluvial deposits there are usually associated bastnäsite (raw material for obtaining elements of rare earths).

The deposits almost have not been studied from geological point of view, data on reserves are not available.

The deposits of Burundi are apparently the continuation of big tin bearing zone located on the territory of Congo (Kinshasa). Therefore the prospects of discovering new industrial deposits of tin in Burundi are rather promising.

The small production (about 100 tons of tin a year) is being carried out on beneficiated sections of alluvial deposits where the content of cassiterite reaches 1.2 to 1.5 kg/m^3 and to lesser degree-from pegmatite veins. The biggest tin producing company in the country is the Belgium "Minétain Burundi". The concentrates produced are being exported to Belgium and Congo (Kinshasa).

§ 2I The Rwandian Republic

The independent Republic from the 1-st of July 1962. It is situated in Central Africa and borders upon Uganda, Tanzania and Burundi.

Territory - 26 thous.sq. km.

Population - 3.3 million people.

Population density - 126 persons per sq.km.

The country lies in high mountain area (1.5 - 2 thous. meters above sea livel) crossed by deep valleys of rivers belonging to the Nile river system.

The climate is hot, permanently humid on the north with two maximum rainfalls in spring and autumn.

The country has no railways. The main ways of communication are highways and earth roads.

There is navigation service on the lake Kivu.

The generation of electric power in Rwanda:

	Years			
	1958	1963	1964	1966
Installed capacity, thous kw (Total)	8.5	9.0	21.8	22.5
including hydro-electric plants	1.3	7.4	21.1	21.3
Generation of electric power, million kwhr (Total)	16.5	10.8	...	48.1
including hydro-electric plants	3.6	10.3	...	46.8

Of non-ferrous metals the biggest development has received the production of tin, tungsten, beryllium.

<u>Tin industry</u>. The total reserves of tin in the country amounts to 65 thous.tons of which 20 thous.tons are proved and probable.

Tin bearing regions of Rwanda are the continuation of tin bearing zone of Congo (Kinshasa).

Towards the north it stretches to Uganda, towards the east- to Tanzania.

Main deposits developed in areas of Katumba and Kibungu (80 km to the north-west and 50 km to the south-east of Kigali respectively).

There is the open-pit mining of the deposit. The biggest enterprises are "Mowit Kigali", "Rutongo" and "Rvinkavu" having the output of 0.3 to 1.0 million tons of ore and sand a year.

Tin bearing and pegmatite ores and alluvial deposits are being beneficiated.

Pegmatite ores apart from cassiterite contain columbite - tantalite and wolframite and lithium minerals.

Average summary content of cassiterite, columbite-tantalite and wolframite makes 1.2 to 1.5 kg/m^3.

In recent years the production of tin in concentrates amounted to 1.3 thous. tons per year; concentrates contain on an average 72 to 74 per cent of tin.

Tin concentrates are being exported to Belgium and partly to Congo (Kinshasa). The export of concentrates is being carried out through ports of the Indian Ocean Mombasa (1,448 km) and Dar-Es-Salam (1,609 km).

§ 22. Swaziland

Swaziland, independent from September 1968 is surrounded on three sides by the Union of South Africa and on the East hemmed in from the sea by Mosambique.

Territory - 17,400 sq.km

Population - 292,000 people

Population density - 17 persons per sq. km.

Capital - Mbabane.

The main part of the territory is occupied by a plateau lowering by steps from 1500 to 300 m in East-West direction.

Climate is subtropical. The main railway merges the railway running from Johannesburg (Union of South Africa) to Lourenco Marques (Mosambique). Sea exit is through the port of Lourenco Marques on the Indian Ocean.

Non-ferrous metals mined in the country are represented by gold, tin and barite.

Tin industry. There are small alluvial and eluvial deposits of cassiterite together with wolframite which are worked around Mbabane in the western part of the country. The richest of these deposits have been already worked out.

In the recent years pegmatite viens containing cassiterite were found near Forbs-Rief, 20 km north from Mbabane. Proved deposits of ore containing 0.37% of tin are estimated at 50,000 t. In 1963 a small mill was erected here for the production of concentrates.

The annual production of tin-in-concentrates accounts for 12 t. Concentrates are exported to the Union of South Africa for further processing.

§ 23. South - West Africa

South-West Africa was the mandate territory of Republic of South Africa (RSA) after the World War I; in 1949 it has been annexed by RSA.

South-West Africa is situated on the Atlantic coast of South Africa and it borders on the north upon Angola and Zambia, on the east upon Botswana, on the south - upon Republic of South Africa.

Territory - 824 thous. sq. km

Population - 594 thous. people

Population density - 1 person per sq. km

Capital - Windhoek

Principal cities and sea ports - Walvis - Bay and Luderitz. The large part of the territory of South-West Africa represents the table-land. The climate is of the Mediterranean Sea type with a maximum rainfall in summer.

River waterways are weakly developed. For the most part of the year the rivers are dried.

The length of railways is 2.4 thous. km (many of them are of narrow-gauge) and the length of motor roads is 34 thous. km. There is an air link with RSA.

In recent years prospecting work has been conducted for the discovery of oil.

On the south of the country there are met coal - bearing regions but no seams of industrial importance have been discovered.

When the drilling work for water was conducted there was encountered coal in Kanorley area.

The annual generation of electric power in South-West Africa makes up to 200 million Kwhr.

Diamonds, copper-lead-zinc ores and vanadium are the basis of mineral wealth of the country.

Copper industry. The total reserves of copper in the country are estimated in an amount of 700 thous. tons, including 530 thous. tons of proved and probable ones. The copper content in the ore varies from 0.8 to 5.1 per cent averaging 2.1 per cent.

Data on mining, production and export of copper are given in table 1.

Table 1

Mining, production and export of copper.

	Years					
	1955	1960	1965	1966	1967	1968
Mine production (copper content)	21	20	39	38	34	25
Exports of concentrates (Cu content)	21	20	8.7	5.0	2.0	...
Production of primary blister copper	-	-	30	33	32	32
Exports of blister copper	-	-	30	33	32	...

Copper is being mined at several mines, the most important of which is the Tsumeb mine situated on the north of South-West Africa.

The output of the Tsumeb mining beneficiating complex amounts to 2,000 tons of copper - lead - zinc ore per day. Reserves of ore containing 3.6 per cent of copper, 4.4 per cent of lead and 0.5 per cent of zinc at the Kombat deposit are estimated at 2 million tons. Daily output of the Kombat mining beneficiating complex is 750 tons of ore.

According to data published in 1968 "Tsumeb Co" has opened a new copper mine in Windhoek.

45 km from this deposit there were discovered occurences of pyrites from which sulphuric acid is supposed to be produced.

Beneficiation of sulphide copper ores is being carried out at The Klein Aub beneficiation plant with the output of 500 tons of ore per day.

Copper content in the ore is 3.2 per cent. The ore is being beneficiated by flotation with technological process being completely automatic. The plant produces 30 tons of copper per day.

Copper concentrates are also being produced at beneficiation of polymetallic ores at the Tsumeb beneficiation plant.

The Tsumeb beneficiation plant produces combined lead (sulphide and oxidized) concentrate with lead contentof 46 per cent, copper concentrate with copper content of 40 per cent; zinc concentrate of the first grade (sulphide section) with zinc content of 59 per cent, zinc concentrate of the second grade (oxidized section) with zinc conten of 51 per cent and germanium concentrate with germanium content of 0.2 per cent.

The copper works of "Tsumeb Company" has been put into operation in 1962. The works' output makes 35 thous. tons per year. At the works there is used a reverberatory smelting of dry charge and converting. Till 1962 all concentrates, obtained at the Tsumeb mining beneficiating complexwere exported to USA and Belgium. In 1962 Tsumeb copper works has been built which became the basic consumer of the country's concentrates.

The export of concentrates is constantly dwindling and in 1967 it made only 2000 tons. Blister copper is also exported to FRG, Great Britain and Japan. The leading company in the country is "Tsumeb Co." which the Tsumeb mining - metallurgical complex belongs to, comprising the mine, the beneficiation plant, the copper works and the lead works, plants for extraction of cadmium and silver as well as the plant for production of sulphuric acid.

A number of the biggest monopolies, including "Numont" and "American Metal Climax" are the holders of "Tsumeb Co" shares. The share of their participation amounts to 75%; 25% of shares belong to Republic of South Africa.

Lead and Zinc industry. The total reserves (they are also proved and probable) of lead in South-West Africa make up 1,030 thous. tons with an average content of metal in ore being 7.1 per cent, and those of zinc - 850 thous. tons with an average content of metal in ore being 5 per cent.

Data on mining, production and export of lead and zinc are given in Table 2.

Table 2

Mining, production and exports of lead and zinc, thous. tons

	Years					
	1955	1960	1965	1966	1967	1968
Lead mine production (metal content)	74	67	100	90	70	61
Zinc mine production (metal content)	17	14	37	28	23	23
Production of primary lead	-	-	66	75	70	56
Exports of lead in concentrates	78	70	47	27	5	...
Exports of zinc in concentrates	22	15	28	22	20	18
Exports of primary lead	-	-	58	60	63	

Lead-zinc ores are mined at a number of mines of which the Tsumeb and Kombat mines (see Copper industry) are of the most interest.

The Berg-Aukas lead-zinc-vanadium deposit which belongs to "South West Africa Co" (Suako) is also of great importance. At present a shaft is being sunk here by means of which the deeper horizons will be exploited.

At the Rosh Pinah mine the construction of a mining beneficiation combine is nearing completion. The construction is being accomplished by "South African Iron and Steel Industrial Corp." (Iscor). 300 tons of zinc and 25 tons of lead concentrates will be produced daily at the combine. Zinc concentrates will be exported to the smelter in RSA.

Beneficiation of polymetallic ores is being carried out at the Tsumeb complex (see Copper industry). Sulphide and oxidized lead ores at the complex are being separately treated by a flotation method.

At the Berg-Aukas beneficiation plant lead-zinc-vanadium-sulphide - oxidized ores containing 6.19 per cent of lead, 36 per cent of zinc and up to 2 per cent of vanadium are being beneficiated. The Berg-Aukas plant produces about 11 thous. tons of lead - vanadium concentrates per annum. The Tsumeb lead - melting and refinery works is a part of the polymetallic complex

The output capacity of the works is 75 thous. tons of refined lead per annum; cadmium, silver, arsenic are also being produced.

The process flow-sheet which is being used is as follows: agglomeration, shaft melting, pyro-refining with processing silver scum and arsenic skimming.

Germanium product is being also produced.

Concentrates and metal produced in the country are intended for export, mainly to USA, Belgium and FRG.

Tin industry. Total reserves of tin in the country are estimated at 40 thous. tons including 10 thous. tons of proved and probable ones. The content of metal in the ore varies from 0.13 to 0.16 per cent.

Data on production and export of tin concentrates are given in table 3.

Table 3

Production and exports of tin, thous. tons

	Years					
	1955	1960	1965	1966	1967	1968
Production of tin-in-concentrates	0.4	0.3	0.4	0.7	0.7	0.7
Exports of tin-in-concentrates	0.4	0.2	0.5	0.7	...	...

The mining of tin concentrates is being mainly carried out by "South-West Africa Co".

At the Branderburg - West mine which has been put into operation in 1960 the Company supposes to treat 50 thous. tons of ore per month. "South African Iron and Steel Corporation" (RSA) has acquired the right for mining tin at the Omarury mine from "Tin Mining Co".

Tin and tungsten ores with an average summary content of tin and tungsten trioxide of 0.24 per cent are being also mined in the country.

Mixed tin and tungsten concentrates obtained contain 37 per cent of tin, while tin concentrates contain 70 per cent of tin. "Tin Mining Co" has put into operation a beneficiating plant with the output of 1,500 tons of ore per in Omarury district.

After crushing, washing and screening the ore is beneficiated at screw separators and concentration tables.

Concentrates containing 70 per cent of tin after drying are fed to magnetic separation.

SECTION III

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

§ I. The Burmese Union

The Burmese Union is located on the Indo-China peninsula in South-eastern Asia. Burma became an independent republic in January 1948. Burma borders on India and Pakistan in the north-west, on the Chinese People's Republic in the north and north-east, on Laos in the east, on Thailand in the south-east. The western and south-western parts of the country adjoin the Bay of Bengal and the Andaman Sea.

Total area - 678.000 sq.km

Population - 25.8 million people

Population density 38 persons per.sq.km.

Capital - Rangoon

Principal cities - Moulmein, Mandalay, [illegible], Bassein

Burma is a mountanous country (mountains occupy almost half of its territory). In the centre of the country there is a hilly lowland crossed by an extensive river network. All Burma's territory lays in the zone of monsoon tropical climate.

The transport facilities in Burma belong to the state. According to 1966 estimates, the total length of railroads amounts to 4300 km. The main trunk-railway passes northward of Rangoon via Mandalay. The total length of highways amounts to 20.000 km approximately, only II.000 km macadam. River navigation is the main type of transportation. The main waterway is the Irrawaddy River. Basic export products are transported by river. Marine transport serves the external trade. The main port is

Rangoon.

Power engineering properties belong to the state. About 70% of the total electric power production is consumed for everyday service, the rest - on industrial needs (Table I).

Table I

Electric Power Generation in Burma

	Years		
	1958	1963	1964
Installed capacity (thous Kw)	162	252	252
Including hydroelectric power stations	-	84	84
Power generation, million Kwh	384	539	570
Including by hydroelectric power st.	-	230	280

Table 2 lists data on the mineral fuel and natural gas output.

Table 2

Fuel production in Burma

	Years			
	1955	1960	1965	1966
Coal, thousand metric tons	0.007	I.0	10.0	10.0
Oil, thousand metric tons	2II	549	545	600
Natural gas, million m^3	...	2I.0	86.0	109.0

Of non-ferrous metals tin, tungsten, lead, zinc and small amounts of copper, nickel and silver are extracted.

<u>Copper industry.</u> The total copper reserves of the country are estimated as 3 million metric tons approximately, but only 34 thousand metric tons of that ore, according to 1967 data, are proved and probable. Positive copper reserves concentrate in the zinc-lead pyrites deposit Bodvin. Lead concentrates from this ore treated at the Bodvin lead smeltery (Namtu) give 300-400 metric tons of copper matte averaging 38-40% copper.

In the end- 1950's copper-porphyry deposit was found in Monywa district. According to the preliminary evaluation of this deposit its reserves amount to 450 million metric tons, with the copper content up to 1.5%.

In 1967 the exploration of the deposit had not yet been completed, that is why the above-mentioned figures for the reserves need additional exploratory data.

Zinc-lead industry. The forecast reserves of high-grade zinc-lead ores in Burma, undoubtedly, are large, but the positive evaluation of them has not yet been made. The Bodvin zinc-lead deposit is the most explored one. Its total reserves according to the figures published in 1964 - 1965 by the UNO experts amount to 6.268 thousand metric tons of ore, 928 thousand metric tons (14,8%) of lead, 515 thousand metric tons (8.2%) of zinc, 34 thousand metric tons (0.53%) of copper, 1928 metric tons of silver. A third part of all the above-mentioned ore reserves, as it is reported , is not quite proved. The outlook for the ore reserves increase in the Bodvin deposit is favourable mainly because of disseminated and veined ore occurences.

At least about twenty noteworthy manifestations and deposits of lead and zinc ores are known in Burma, but they have been investigated insufficiently. There are large waste slag refuses from ancient workings not far from some deposits (Bodvin and others). It is an important indication for geological survey.

The Bodvin zinc-lead integrated plant which was brought into production in 1910 is working out the Bodvin deposit now. It is the only Burma's zinc-lead plant under operation now, owned by state corporation

People's Bodvin Industry.

The integrated plant includes: the Bodvin underground mine, the ore dressing plant and the lead works in Namtu (sintering, smelting in shaft furnace and refining). The annual mining output and processing of zinc-lead ore at the Bodvin plant amounts at present to I60 thousand metric tons approximately (I965-I966), as compared with 500 thousand metric tons until World War II. The plant produces metallic lead, zinc concentrates (Table 3), fine silver, small amounts of hard (antimonius) lead, nickel speiss and copper matte.

Table 3

Lead and Zinc Mining Output, Production and Exports in Burma (thousand metric tons)

	Years					
	I955	I960	I965	I966	I967	I968
Mine production (lead content)	I4	20	18	I2	I5	I8
Mine production (zinc content)	8	I0	8	6	5	6
Primary lead production	I4	I7	I6	I2	I2	I2
Lead concentrates exports	2	0.7	0.2	...	...	...
Primary lead exports	I6	I4	I2	...	...	...
Zinc concentrates exports	4I	2I	I5	...	...	...

Almost all the production of the Bodvin integrated plant is exported. The modern overall production level of the above-mentioned products is 4 to 5 times less as compared with the level which had been achieved until World War II. A relatively low present production level is a result of uncompleted works on wiping out the damage caused by military operations and a result of the fact that People's Bodvin Corporation has stopped stripping out the mine (At the property, formerly operated by an English joint-stock company, only the highest-grade ore averaging 38% lead and zinc was worked out with ore dilution as a result).

Apart from the Bodvin mine there are only 2-3 deposits in Burma where lead ore is extracted on an extremely small scale. People's Bodvin Industry plans the reconstruction of the Bodvin plant with increase in the overall production (lead, zinc concentrates, silver) level about twice as much as the last year's level. Some part of the work necessary in this connection has already begun.

It is extremely reasonable at the same time with the reconstruction of the plant to intensify prospecting with the purpose of securing of increase in ore reserves in the Bodvin deposit and possible finding of new lead and zinc deposits in the adjoining area. They should investigate in detail the most promising known manifestations and deposits of lead and zinc ore, carry out geological

[illegible] and prospects for those in Gale in the most promi-
sing areas of the country,including the [illegible] part of Shan plateau, organize elaborate exploration and subsequent commercial exploitation of the deposits of the utmost industrial interest.

Tin industry. Known in Burma tin, tin-tungsten (and tungsten) deposits and manifestations of ore extend for a I.200 km belt, which is bounded on the south by Victoria Point and by the southern areas of Shan plateau.In the east and in the south this belt adjoins high-grade tin and tungsten deposits of Thailand. Tin deposits of Burma have been prospected to an extremely low degree.Prospects for tin, with a slight exception, have been running during the last thirty years.That's why in spite of favourable geological positions of tin-bearing areas in Burma the overall tin reserves in the country can be estimated only conditionally as 300 thousand metric tons, including less than I00 thousand metric tons being proved and probable.

Until World War II up to 600 tin, tin-tungsten and tungsten deposits and ore manifestations were found in Burma.In I936-I939 583 mining operations were working out these deposits. 46 mines gave 68,[illegible] of the total Burma's tin production, the others were mined with hand tools without any prospecting and technical supervision on a small scale.

The highest tin output level amounting to 5440 metric tons was achieved in Burma in 1939. The amount of 2.500 metric tons of tin in tin-tungsten concentrate, containing besides I.400 metric tons of tungsten trioxide, was extracted only in the Mochi mine in Karenni state, where the major primary deposit of the same name occurs. In the mine of this mining operation, where adit cut mining was used, up to I50 thousand metric tons of high-grade lode tin-tungsten ore (I.5% tin, 0.75% tungsten trioxide) were extracted annually. The ore was processed in a well-equipped ore dressing plant with a high extraction level for tin (more than 90%) and tungsten (about 90%). The plant had electric power from its own electric power station.

More than ten years ago the operations in the Mochi mine were stopped, though the deposit had not been exhausted and could probably cover the expenses on prospecting and reconstruction works with the purpose of renewal of extraction of tin-tungsten concentrates in the scope sufficient for a profitable operation (even if the new scope of extraction is less than the former one).

The major tin mining plant being in operation nowadays is the Heynda mine in Tavoy district in the southern part of Burma. It is working out placer deposits with proved reserves amounting to 9.000 metric tons of tin in sands averaging 700 g/m^3. The sands are worked out by hydromonitors after preliminary blasting loosening (by single mine wells). Palongs, jiggers, screens, hydrocyclones and concentration tables are used at ore-dressing plants.

In 1939 about 400 metric tons of tin in concentrates were extracted in the Heynda mine. Then the tin output dropped. The ore reserves, mining conditions and water availability would make it possible to attain at least the former output level.

No published data regarding the tin mines being in operation now are available, but they are evidently not high, since the overall tin mining output in the country dropped sharply over the last ten years (Table 4)

Table 4

Tin Production and Exports in Burma, thousand metric tons

	Years					
	1955	1960	1965	1966	1967	1968
Tin production in concentrates	1.0	1.0	0.5	0.4	0.3	0.3
Tin exports in concentrates	1.0	1.5	0.3	...	...	...

Tin concentrates are exported mainly to Malaysia, Singapore and the Netherlands.

Working out tin and tungsten deposits in Burma made possible a highly profitable output and exporting of considerable amounts of concentrates in the past. Restoration of the tin industry and the above-mentioned growth of lead and zinc production would increase Burma's export opportunities and positively affect its economy.

Taking into account considerable potential opportunities of Burma as tin-producing country, they should reconstruct and modernize- tin-mining plants, specifically the Mochi mine, on the scale insured by prospecting resources, organize prospects for tin in the promising areas inland and in sea-coastline with a subsequent exploitation of the most worth-while deposits and firstly of that with the least capital investments.

§ 2. The Republic of India

India is a republic formed in January 1950. In the north it has the boundary with China and Nepal, in the east - with Pakistan and Burma, in the northwest - with Afghanistan and Pakistan.

Total area - 3,270,000 sq.km.

Population - 5II,I00,000 people

Population density - I56 persons per sq.km.

Capital - Delhi

Principal cities: Calcutta, Hyderabad, Bombay, Madras, Delhi

Sea ports: Bombey, Calcutta, Madras, Cochin, Vishakhapatnam, Kandla, Marmagao.

India is situated mainly within the Indian peninsula. In the north it is defined by the Himalayas, and its southern boundaries are defined by the sea: the Bay of Bengal on the south-east. Indian Ocean on the south, and the Arabian sea on the south-west.

The most important rivers: Ganga, Brahmaputra, Narbada, Gadavari, Krishna.

Total length of the railway lines is 56.500 km, of which 55.800 belongs to the state. I.400 km of the railways are electrified. Total length of roads is 675.000 km.

Growth of generation of electric power in India is shown in Table I.

Table I

Electric power generation

	Years				
	1958	1963	1964	1965	1966
Installed capacity, thous.KW					
Total	4324	7617	8371	9745	10200
including hydro-electric power stations	1365	3170	3331	3854	4100
Electric power generation MKW-hrs					
Total	15415	30304	33149	37437	...
including hydro-electric power stations	5861	13973	14807	15405	...

India is endowed with reserves of fuel minerals, but they are not used extensively enough. Thus, the proved reserves of coal are equal to 50,000 M t., those of brown coals - 210 M t. and oil - 222 M t. Total reserves of natural gas are estimated to be 42.500 M cu.m.

Production of coal, oil and gas is shown in Table 2.

Table 2

Fuel production

	Years			
	1960	1965	1966	1967
Coal, M.T	52.6	67.2	67.9	70.2
Lignite, thous.t.	47	2300	2568	2800
Oil, thous. t.	454	3022	4647	5500
Natural gas, M.cu.m.	...	680	292	300

Nonferrous metallurgy includes mainly aluminium, copper and lead-zinc production branches.

<u>Aluminium industry.</u> Total bauxite reserves are estimated to be equal to 276 Mt., of which 76 million ton are considered to be proved and probable. Bauxites contain from 30 to 60% of the aluminium oxide varying from deposit to deposit, reaching in some deposits the figure of 75%. About 75 Mt. of the bauxite reserves, of which the greatest portion is considered to be proved or probable, contain more than 50% of Al_2O_3. Bauxites of a high quality usually contain less than 3-5% of SiO_2 and 5-8% of Fe_2O_3. The deposits of bauxite are known to be of the diasporic type.

The data on the aluminium production, consumption and trade are shown in Table 3.

Table 3

Aluminium production, consumption and trade, thous. t.

	Years					
	1955	1960	1965	1966	1967	1968 1/
Bauxite production	82	387	707	750	789	900
Alumina production	13	26	152 2/	152 2/	152 2/	...
Production of primary aluminium	7	18	64	84	96	120
Production of secondary aluminium	-	6.3	8	8	11	11
Consumption of primary aluminium	11	24	71	93	119	120
Imports of aluminium and semi-products	7	25	14,5	23	48.4	...
Exports of bauxites	9	76	63	80	53,5	...
Imports of alumina	-	12	0.8	16.1	...	...

1/ estimated

2/ the data on the industrial capacities at the year end.

The main portion of the bauxite production is effected by the three plants situated in Bihar and Madhya Pradesh states. Each of them produces 200-300 thous.t. of bauxite per year. Mining is carried out at separate sites where separate ore bodies and their portions are being excavated. It is planned to increase output of the functioning sites and to put into production new ore mines whithin a few years so as to provide the raw ores for the plants which are being built now.

Bauxite production was 82 thous. t. in 1955, but it came up to 790 thous. t in 1968. Almost half of the bauxites produced in the country is used for making alumina, while some portion is exported.

Aluminium is produced at five plants. Each of the plants functioning in India has its own raw ore source and auxiliary works.

Auxiliary works include coal mines, electric power generators, plant for making electrodes and works for porducing aluminium semi-products: sheets, tubes, etc.

Bauxites of the diasportic type are commonly used in India. They are not so easily processed, as bauxites of the hydro-argillitic type, and have to be treated according to the Bayer process - under temperature of 175°C and pressure of 7-8 atm. The recovery of Al_2O_3 in the output is high - about 85-90%.

Aluminium plants in India are equipped with pot cells of a small capacity employing electric current density of 25-50 kA and a continously self- baking anodes with a sidewise and upperwise current feeding line (Huracud, Alupuram, Asansol plants). One of the plants (Renu-cut) is equipped with pot cells for 70 kA with an upper-wise current feeding line are installed at Mettur plant put into operation in 1965.

The increased production of aluminium in India is not matched by the domestic production of alumina, so a certain amount of alumina has to be imported. The most of it is imported from Jamaica.

Only 80% of aluminium for the country domestic consumption are supplied by the domestic production, the rest is imported mainly from Canada.

Table 4

Consumption of primary and secondary aluminium

Consumption for	1956		1966	
	thous.t.	%	thous. t.	%
Stationary and household articles	10.4	45	20.8	18
Building	0.5	2	2.9	2.5
Transport	1.9	8	12.5	11
Electric industry	6.9	30	57.4	50
Packing designs	1.8	8	8.0	7
Others, including exports	1.6	7	13.4	11.5
Total:	23.0	100	115.0	100

The need for aluminium keeps increasing in India for the past few years. Almost half of the aluminium consumed in the country is used in the electric industry where it competes with copper. The more rapidly growing consumption of the metal in this country as compared to its production leads to the increase of its import.

The sheet-type aluminium is consumed in India mostly for making kitchen utensils and household articles. Aluminium foil and sheets are used for packing tea and other food stuffs. A good deal of sheets is used for making roofings.

India has a well developed industry of aluminium processing. There are about 50 aluminium processing plants with total capacity of more than 100 thous.t. per year (1965).

The most part of the aluminium processing industry belongs to 7 companies related to foreign capital. The USA companies control about 80% of industrial capacity of the aluminium processing plants.

A considerable increase of capacity of the aluminium processing industry is being planned. In 1965 the government has licensed building of new aluminium processing plants with annual capacity of more than 155 thous. t.

According to the India industrial statistics only 16-17 largest aluminium processing plants are considered to belong to the plant-mill sector, while the other small plants - to the sector of small private enterprises, each having capacity of less than 1-3 thous.t. per year.

A large number of aluminium processing plants (3/4 of the total industrial capacity) is concentrated in the vicinity of the three largest cities of the country: Calcutta, Bombay and Madras, as well as in some cities like Kundara, Alwais, etc, situated near the sea.

Development of the aluminium industry of India will depend in future upon the solution of the electric power problem.

Copper industry. Total copper reserves of India are estimated to be equal to I Mt., of which 300 thous.t. are proved and probable. Mean copper content of the estimated reserves is about 1%. It varies from 0.8 to 2.57% from one area to another. For the past 2-3 years a number of new ore deposits have been discovered and partly evaluated. The reserves of these new deposits are not taken into account by the official statistics. As can be judged basing upon some reports, the new reserves exceed those already estimated, so the total reserves of copper in India may be approximately estimated as being equal to 2.2-2.5 Mt (the mean content being the same).

Some figures characterising the copper industry of India are given in Table 5.

Table 5

Copper industry of India, thous. t.

	Years					
	1955	1960	1965	1966	1967	1968 I/
Mine production (copper content)	7	9	9	I0	9	I0
Production of primary blister copper	7	9	I0	I0	8	9
Production of refined copper	7	9	9	9	9	9
Imports of blister and refined copper	I6	57	47	20	33	3I
Imports of secondary raw material and copper alloys	0.4	3	I	0.4	0.7	0.7
Consumption of copper	22	62	64	33	45	45
Imports of semi-products of copper and copper alloys	0.2	6	3	4	2	...
Production of semi-products of copper	...	...	I4	I4	20	
Production of semi-products of copper alloys	...	...	I8	I0	I4	...

I/ estimated

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, consentrator and plants for copper smelting and refining. Output of the complex is about IO thous. t. per year.

Measures are being taken for intensifying the ore production and processing, which provide for a planned increase of the complex output up to I6 thous. t. of copper per year.

The following flowsheet is employed at the Maubhandar plant: reverberatory smelting, converting in a vertical converter, anodes making, electrolytic refining, processing and rolling the copper and copper alloys.

Company "Power Gas" is contracted for reconstructing the Maubhandar plant. The reverberatory smelting will be replaced by fluidised bed smelting with a preheated air blast (Outocumpu's method).

The change for a new method of smelting will help to increase the copper concentrates processing up to 80 thous. t. per year, which will increase the plant output up to I6 thous. t. of copper per year. A large amount of leaving sulphur gases will be utilized for production of sulphuric acid.

Constructing of a big copper producing complex has been started in Khentri. Consentrator of this complex in Khetri will process 9600 t. of ore per day. The plant is designed for processing ores containing about 1% of copper. The technique employed is as follows: copper concentrate containing 24% of copper and 16% of moist will be dried up in a rotary furnace until 1% of moist is left, then the concentrate will be fed into the furnace for smelting in a fluidised bed with a pre-heated blast (method of Outhocumpu). The furnace output is 700 t . per day.

Output products of the complex being built:

Electrolytic copper	31 thous. t/year
Sulphuric acid	600 t./day
Superphosphate	214,400 t./year
Gold	250 kg/year
Silver	1.9 t./year
Copper and nickel sulphates	
Selenium and Tellurium	

Total annual output capacity of the copper processing plants in India is about 50 thous. t.: mean annual production is equal to 35 thous. t.

In the country there are about 36 plants producing semi-products of copper and its alloys. The majority of them is concentrated in the vicinity of cities Calcutta, Bombay, Madras (80%), which are known as the most important ports effecting the import and export and as well as industrial and commercial centres.

Here are the major enterprises of the country effecting the copper and its alloys processing: the plant in Bombay City belonging to company "Indian Smelting and Refining" producing sheets and bands, its annual capacity being 16.2 thous. t., the plant in Bombay city belonging to company Rashtria - "Metal Industries Ltd" producing sheets, bands, rolled articles and wires with annual capacity of 9.3 thous. t., the plant in Doruklapa town (near Bombay) belonging to company "Devidayal Rolling and Rifineries Private Ltd" producing sheets, bands and wire bars with annual capacity of 12.0 thous.t. , the plant in Kurla town (near Bombay) belonging to company "Tubes Private Ltd" producing rolled copper, rods and tubes, its annual capacity being 6.2 thous. t.

The annual need of Indian economics in semi-products of copper and its alloys is estimated to increase up to 180 thous. t. by the end of the current five-year plan, which is 4 times more than the amount of semi-products being produced at present. Consumption of copper was 45 thous. t. in 1967.

Lead-zinc industry. Total reserves of lead-zinc deposits, which are found mainly in the Rajasthan state, are estimated to be equal to: 500 thous. t. of lead, of which 110 thous. t. are proved and probable, and 1 m.t. and 270 thous. t. of zinc respectively. Lead content in ores varies from 1.5 to 2% (mean figure over the country is 1.81%) , zinc - from 3 to 4% (mean - 3.56%) respectively.

For the recent years the geological survey for ores has been intensively conducted in India, including survey for lead and zinc.

Data on production, processing and trade as to the lead and zinc are listed in Table 6.

Table 6

Lead and zinc production and trade, thous. t.

	Years					
	1955	1960	1965	1966	1967	1968
Mine production (lead content)	2	5	4	3	4	4
Mine production (zinc content)	3	5	5	5	10	12
Production of primary lead	2	4	3	2	2	2
Consumption of primary lead	14	26	32	40	37	60
Consumption of primary zinc	48	60	70	50	75	82
Imports of zinc concentrates	-	-	-	20	...	...
Imports of primary lead	12	25	38	44	34	...
Imports of primary zinc	32	68	92	49	57	...
Exports of zinc concentrates	5	5	3	-	...	...

Lead-zinc ores containing 1.5% of lead and 3.0% zinc are subjected to benefication. The concentrates thus produced are then processed at the metallurgical plant in

Tanudu town.

There are 2 zinc and I lead producing plants in India. Zinc electrolyte plants were put into operation in 1966-1967. They have relatively small output: 22-24 thous. t. per year. An increase of their capacity is being planned. The lead plant is small: its productivity is 5 thous. t. per year.

It is proposed to build another zinc plant in Vishakhapatnam and in Zavar for processing lead-zinc concentrates using Imperial Smelting Process with the total output of 500 thous. t. of zinc and lead per year.

The amount of the metals produced in the country is not enough for satisfying domestic needs. The lack of metals necessitates their import, mainly from Canada and Australia.

Production of the lead and zinc rolled articles is effected at several plants. Besides the plants utilizing the primary raw materials there is a plant in Hovrah (st. West Bengal) producing zinc, lead, copper and bronze from the secondary raw material. The plant has capacity of: 2 thou thous. t. of zinc, 500 t. of copper, 200 t. of lead and 1600 t. of bronze. It belongs to company "Baurioas Kaila-shnat".

§ 3. Iran

Iran is situated in the south-west of Asia. In the north it borders on the USSR and is washed by the Caspian Sea, in the south it adjoins the Arabian Sea and the Persian Guld, in the east it borders on Pakistan and Afghanistan, in the west - on Turkey and Iraq.

Territory - I.6 mln sq.km.

Population - 26.4 mln. people

Population density - I6 persons per sq.km.

Capital - Tehran

Principal cities - Tabriz, Isfahan, Mashhad

The climate of Iran is continental, dry with a hot summer and a cool windy winter.

The only navigable river of Iran is Karun.

There are 3.8 thousand kms of railways in Iran. In I938 a through railway was commissioned connecting the Caspian Sea and the Persian Gulf (via Tehran). Tehran is also linked by railway with Jolfa, Mashhad and Khoramshahr. In I965-I966 the construction of Sharafkhaneh-Ghotour railway was finished, the total length being 8I kms, which connects Iran with Turkey.

Automobile transport is of great importance. The length of roads is 27 thousand kms, out of them about 3 thousand kms are asphalted. Tehran is a node of roads that connect the capital with the districts of the country and towns on the borders with the neighbouring countries.

The main ports in the Persian Gulf are Abadan, Khoramshahr and Bandar-Shahpoor, at the Caspian Sea-Pahlavi, Bandar-Shah etc.

Air transport is of great importance and serves as a means of communication both inside the country and with other countries.

Electric power generation in Iran is represented by thermo power stations and hydropower stations, as well as by diesel power plants. Data concerning electric power generation are shown in Table I.

Table I

Electric power generation

Indices	Years		
	1958	1961	1965
Installed capacity, thous. kw			
Total	156	543	791
including hydropower stations	...	77	250
Electric power generation, M kwhr			
Total	720	2,928 I/	4,278 2/

I/ estimated,

2/ estimated.

The supply of the mines and dressing plants with power is insufficient and their electric power requirements are satisfied by their own movable or small diesel plants. The latter, owing to the absence of large power systems, are rather widely spread.

Iran has fuel resources - oil, gas, coals.

The scope of fuel production is indicated in Table 2.

Table 2

Fuel production

Kinds of fuel	Years				
	I958	I959	I960	I965	I966
Coal, thous. tons	I84	236	234	275	295
Oil, M. tons	40.6	47.6	52.4	94.I	105.4
Natural gas, billion m^3	0.7	0.9	0.95	1.23	1.38

In I967 it was proposed to produce I50 M tons of oil.

<u>Aluminium industry.</u> In I963 the total reserves of bauxites in the country were estimated by the Iranian geological service to be 7 M tons of commercial ores and I6 M tons of noncommercial ores. In I968 the discovery

of new deposits of diaspore bauxites and high-alumina clays was reported.

Iran does not produce aluminium and from year to year imports it from Canada, Norway and Austria. The import of aluminium and semi-finished products I) was respectively: in 1960 - 1.6 (1.0) thous tons, 1965 - 5.0 (1.4) thous tons, 1966 - 6.1 (2.0) thous tons.

Aluminium is mainly turned into sheets used for the manufacture of dishware and an insignificant quantity is turned into pressed sections and bars.

In 1963/64 the production of aluminium semi-finished products was: aluminium sheets - 364 tons, sections and bars of aluminium - 170 tons.

It is proposed to construct in Iranian town of Arak (the central part of Iran) and aluminium plant of an annual capacity of 50 thous. tons with a rolling mill. The plant will produce sections, wires and cables and other aluminium semi-finished products. The cost of the plant is 46 M dollars.

For the construction of the plant it is intended to attract the funds of Iranian firms (65%), Pakistani firms (10%) and those of the US company "Reynolds Metals". Inside the country 35 thous. tons of aluminium semi-finished products will be consumed, 10 thous. tons will be exported to Pakistan.

Now a plant producting pressed products from aluminium operates in Tehran, it belongs to firm "Sherbar Sanaje Pars va America". The annual capacity of

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I) The figure in brackets shows the import of aluminium semi-finished products.

of the plant is 500 tons.

<u>Copper industry.</u> There are copper deposits in many areas of the country (in the North-West, East and South).

In 1966-1967 in Sar-Cheshmeh a big deposit of copper porphyry ore was discovered, which reserves are estimated to be 300 M tons of ore with a 0.5 - 1 % content of copper. The firm "Iranian Selection Trust" is planning to create on the basis of this deposit a modern mining and metallurgical enterprise. It is proposed to start the construction of the plant in 1969. The capacity of the plant is to be 50 thous. tons of copper per annum. The investments are estimated as 50 M dollars.

Copper ore is mined now in the area of Mazrach and a small quantity in the area of Rashidabad. The products of ore picking are processed into matte in a smelting plant in Zandjan. The matte goes to the Ganniabad smeltery producing only up to 2 thous. sheets, bar and copper alloys per year.

<u>Lead and zinc industry.</u> The total reserves of lead in Iran are determined to be 600 thous. tons and those of zinc - 2200 thous tons out of which only 150 thous tons of each can be placed in the category of proved and probable. The content of lead in the ore ranges from I.5 to 25%, the average being 6%. The content of zinc in the ore is from 2 to 30% , the average being 21%.

Over 80 small lead and 20 lead-and-zinc deposits are known, they are situated in the North-West, East, in

the Center and in the South-east of the country.
30 deposits are exploited at present. Data concerning mining, production and foreign trade in lead and zinc in the country are shown in Table 3.

Table 3

Mining, production, import and export of lead and zinc, thous. tons

	Years				
	1955	1960	1965	1966	1967
Mine production (lead content)[1]	14	17	17	20	20
Mine production (zinc content)[1]	6	8	15	17	-
Production of primary lead	1.4	1.1	0.4	0.4	0.4
Export of lead ore and concentrates	-	13	51	45	...
Export of zinc ore and concentrates	-	16	98	77	...
Imports of primary lead	-	0.02	1	3	...
Imports of primary zinc	-	0.03	0.5	0.8	...

1/ The estimate is not complete.

The production of commercial concentrates (export) has considerably increased, from 1960 to 1967 it increased with regard to lead concentrates by 3.4 times (from 13 to 45 thous. tons) and with regard to zinc concentrates by 4.8 times (from 16 to 77 thous.tons) whereas the melting of metal lead decreased (from 1.1 to 0.4 thous tons) and in 1967 it was stopped altogether.

The biggest mines are: the state enterprise Nakhlak, the mine Anguran of the Simiran Firm, the mine Kushk of the Bafk Mining and the mine Shah-Kooh of the Bama firm.

In 1967 the mining of lead and lead-zinc ores was carried out by 33 enterprises and amounted to 520 thous. tons, the output achieved by the biggest mines was the following: Nakhlak - 67 thous. tons, Anguran - 50 thous. tons, Shah-Kooh - 40, Ze-abad - 38, Se-Changi - 35, Uzbek-Kooh - 31.

The dressing of ore is arranged at a number of mines. Lead ore is mainly hand-sorted or dressed on a gravitational table and in jigging machines. The capacity of dressing plants ranges from 50 to 400 tons of ore per day and the overall estimation with respect to operating plants is 350-400 thous. tons of ore per year.

Flotation plants operate at the Nakhlak mine and in Khaneh-Sorme. A floatation plant is being constructed at the Kushk mine and an operating plant at the Lakhan mine is being reconstructed.

Lead concentrates contain on the average 40-60% of lead, hand-sorted zinc concentrates contain 35-40% of zinc.

For the dressing of oxidized zinc ores the method of calcining in 100 ton capacity stove kilns is employed. The kilns are fired by fuel-oil.

In 1965 the Shahali-Beglu plant was commissioned at which it is planned to produce bulk sulphide concentrate that contains 20% of lead, 30% of zinc, 2% of copper and 424 gr/t of silver. Up to now a small quantity of ore (about I.4 thous. tons) has been processed into metal lead at the Nakhlak enterprise where there is a small smelting furnace.

The internal requirements of the country in lead and zinc in 1967 were as follows: lead - 2.7 thous.tons, zinc I.0 thous.tons, they were satisfied through import.

The major part of the enterprises of lead-and-zinc industry, including big ones (Anguran , Nakhlak, Shah-Kooh, Uzbek-Kooh and others) belong to private persons or companies as well as to foreign firms (Rio-Tinto Zinc). The public sector operates a small number of enterprises. Among them are Nakhlak ,Khanat-Morvan and others.

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After all, lead-and-zinc ores are the main national wealth of the country. The deposits of these ores are spread over many areas of Iran, but their prospecting has not been complete.

The mining of polymetallic ores and production of lead and zinc concentrates can be quickly increased, first of all through the expansion of operating mines and plants as well as through the construction of new mining-and-dressing enterprises.

The present favourable geologic prerequisites for enhancing the reserves of polymetallic ores, which are to be confirmed in future by geological prospecting works, make it possible to outline the development of lead and zinc industry of Iran in the direction of increasing the production of ore and concentrates by 3.5-4 times within the nearest 4-5 years and even more in future, as well as the organization of lead and zinc production.

§ 4. Jordan

The Jordanian Kingdom of Khashimites is situated in the Middle East. It borders on Syria, Israel, Iraq, Saudi Aravia and is washed by Mediterranean Sea.

Territory - 96.6 thous sq.km.

Population - I,935 thousand people

Population density - 20 persons per sq.km.

Capital - Amman.

Jordan is chiefly a country of deserts and semi-deserts. Its larger, eastern part is a plateau formed mainly of the limestone.

The climate of Jordan is subtropical with dry summer, continental.

The river network consists of streams carrying the water chiefly in winter, and of streams running intermittently in the vadies. The biggest rivers are Jordan, falling into the Dead Sea, and its tributary Yarmuk, both of them running round the year.

The railway connects Dera, Amman, Mean, Nakb-es-Satar. Amman, the capital is linked by motor roads with all large towns of the country and with the only sea port of Akaba as well as with Syria and Iraq. Jordan is crossed by the highway Haifa-Bagdad built during the second World war.

The fuel reserves of Jordan are not revealed. The oil prospecting has not produced positive results so far.

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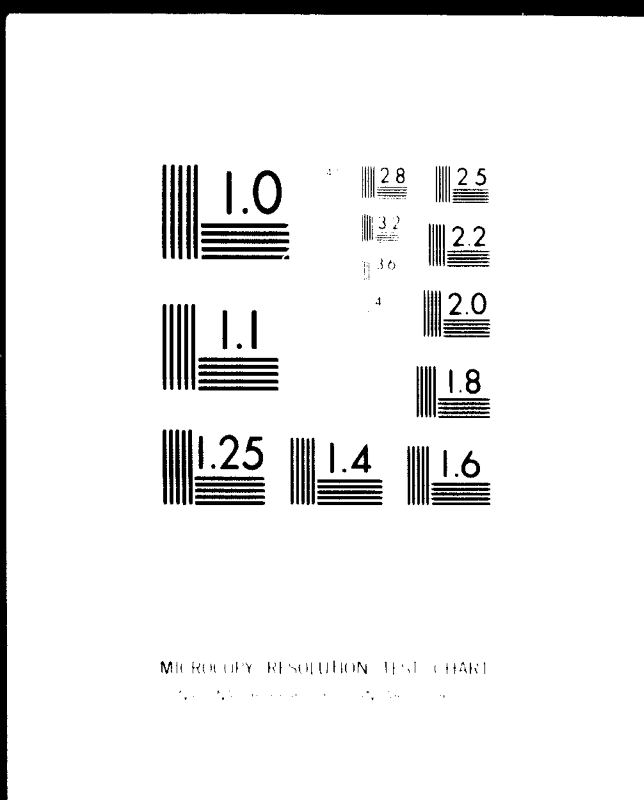

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Copper industry. In Vady-el-Aravo near the Israel frontier copper ore deposits (copper sand-stone) were found. It is supposed that they represent extension of the deposits found in Israel. Preliminary estimates asses the reserves of one of the Jordan deposits as 20 million of tons of ore containing I.2 to I.3 per cent of copper, i.e. 260 thous. tons of copper.

The deposit is poorly explored but seems to be of practical interest. At present the serching and exploration work is being carried out with the UNO assistance.

Insignificant demand for copper of about 0.2 to 0.3 thous. tons is met by the metal imported from FRG and Saudi Aravia.

There are no copper processing plants in the country.

§ 5. The Republic of Cyprus

The Republic of Cyprus is situated on the island of the same name in the eastern part of the Mediterranean Sea.

Tirritory - 9.0 thousand sq. km.

Population - 614 thousand people.

Population density - 66 persons per sq.km.

Capital - Nicosia.

Principal cities - Limasol, Famagusta, Larnace.

Cyprus has a mountainous relief in the main.

The climate of the country is subtropical, mediterranean.

The rivers are small and of inconstant flow.

The largest river is Pedias.

The highways length exceeds I.400 km including about 900 km of asphalt roads.

The most important sea ports - Famagusta, Larnace.

There are no railways in the country.

Fuel resourses of the country are studied now. The Counsil of Ministers of the Republic of Cyprus concluded and agreement with "Forest Cyprus Corporation (affiliated to Forest Oil Corporation) for prospecting for oil, gas on the island itself and off-shore.

Figures of the generation of electricity in the country are given in Table I.

Table I

Generation of Electricity in the Republic of Cyprus

	Years				
	I958	I963	I964	I965	I966
Installed capacity (thouds.kw)	73.0	98.0	102.3	102.3	I59,0
Generation (M kwh)					
Total	202	300	306	355	399
Including generation of electricity by hydro-power stations	I78	272	282	306	349

Mineral resourses of the country are represented by copper, pyrite, asbestus and chromite.

Copper industry. Total copper reserves are estimated at I70 thousand tons, 90 thousand tons are considered proved and probable.

Copper content at various deposits varies from 0.8% to I.4% averaging I.I%.Copper content of 5-6% occurs at some deposits.

The great bulk of copper production, 500-600 thousand tons annually, comes from the Skouriotissa mine.

The underground mines at Mavrovouni (which reserves are mostly worked out) give I50-200 thousand tons, the underground mines at Kalavasos give 100 thousand tons.

Quarries at Levkera and Apliki were put into operation recently, small quantities of cuprous pyrites are extracted in combination with iron pyrites.

The concentrator in Xeros with the daily output capacity of 2,000 tones, processes sulphide-oxidized copper ores of the Skouriotissa mine. The ores contain 2.25% of copper and 48% of sulphur. The ore is subjected to grinding, leaching with sulphuric acid, with precipitation of copper by iron scrap and then subjected to flotation. Sulphide-cuprous concentrate and pyrite concentrate are produced. Ores are concentrated at a number of concentrators. The extracted cement copper contains up to 80% of copper. Sulphide-cuprous concentrate contains 20-23% of copper. Besides , copper ores are concentrated at a number of concentrates at Limni (I.4% of copper), at Minera Agropia and at Kalavasos.

A new concentrators with the annual output capacity of 700 thousand tons of ore is built in the region of Tamasos.

The country does not smelt copper. More than 60-70% of the minerals extracted in Cyprus belong to the American company "Cyprus Mines", the company employs more than 5,500 workers. Besides this American company, the English company "Cyprus Sulphur and Copper" and the Greek company

Hellenic Mining" extract and process copper.

The figures given in table 2 illustrate copper production by the above-mentioned companies.

Table 2

Copper production by the companies
(thousand tons)

Company	Itemps	Years			
		1964	1965	1966	1967
Cyprus Mines Corporation	cuprous pyrites	43.4	II0.9	87.8	78.6
	cement copper	4.5	8.7	I0.2	I0.I
(USA)	cuprous concentrates	28.3	44.8	29.6	24.9
"Hellenic Mining" (Greek)	cuprous pyrites	42.3	63.I	98.4	I0I.9
"Cyprus Sulphur and Copper Company"	cuprous concentrates	I4.0	I8.3	17.8	I9.5
(Great Britain)	cement copper	0.I	0.I	-	-

The produced concentrate is exported by sea to FRG, Spain and France.Copper-bearing pyrites are also exported, the Federal Republic of Germany being especially important customer. Figures illustrating mining and exports of copper-bearing ores are given in table 3.

Table 3

Products and exports of copper-bearing ores (thousand tones) (metal content)

	Years					
	1955	1960	1965	1966	1967	1968
Mine production (copper content)x/	24	35	25	22	22	19
Exports of concentrates	24	...	19	25	18	26
Exports of copper-bearing pyrites	...	253	176	164	208	...
Exports of cement copper	...	2	6	15	5	...

x/ including copper, contained in cement copper.

§ 6. Pakistan

The Republic of Pakistan became an independent state in I947. In I956 Pakistan was proclaimed Republic.

Geographically Pakistan falls into two sections: West Pakistan and East Pakistan, separated by the territory of India.

Territory - 946,700 sq.km.

Population - I05 million people

Population density - III persons per sq.km.

Capital - Islambad

Principal cities - Karachi, Rawalpindi, Lahore, Dacca, Chittagong.

The climate in Pakistan is mostly subtropical, in the East and in the South of the country the climate is tropical. The network of railways is II,300 km, three fourth of the railways run through the territory of West Pakistan.

The railways belong to the State.

In East Pakistan water transport stands out with particular prominence.

Table I

Power generation

	Years				
	1958	1963	1964	1965	1966
I	2	3	4	5	6
Installed capacity (thous.kw)					
Total	277	859	97I	1,074	1,175

I	2	3	4	5	6
Installed capacity of hydro-power stations	67	347	348	348	393
Generation: (M.kwhr)					
Total	I,225	2,900	3,553	[illegible]	3,903
generation of electricity by hydro-power stations	457	I,488	1,710	[illegible]	1,753

The country depends heavily on the imported fuel: coal is supplied by India, oil is imported from Iran. The volume of coal and gas production is not considerable(Table 2).

Table 2

Fuel production in Pakistan

	Years			
	1955	1960	1965	1966
Coal (M tons)	0.537	0.83I	1.23I	[illegible]
Oil (thouds.tons)	276	352	526	508
Natural gas (billion m^3)	0.039	0.633	I.620	...

The known country's non-ferrous metals are represented by bauxite, copper and lead.

<u>Aluminium industry.</u> West Pakistan abounds in bauxite, but the deposits are poorly surveyed.

The estimates of total reserves of bauxite differ from 7-8 million tons to I6-I8 million tons, there are no well explored reserves.

Content of the main components according to the analysis of I57 samples from various deposits, varies in the following limits:

Al_2O_3 - 35.4 - 50.6%; SiO_2 - I2.2 - 32.0%;

Fe_2O_3 - 3.0 - 36.9%; TiO_2 - I.7 - 2.5%.

The greater part of bauxite contains not more than 45% of alumina, but bauxite of higher grades occur in the country.

The country does not produce aluminium now.

Small requirements of the country in aluminium are covered by the US and Canada imports.

Table 3

Imports of aluminium and aluminium raw materials

	Years		
	I955	I960	I967
Imports of Aluminium	0.9	4.7	8.3
Imports of aluminium raw materials	I.0	0.9	...

The non-ferrous metallurgy of the country processes imported aluminium for wire and cable for [illegible] technics.

The problem of the development of aluminium industry on the basis of bauxite prospected in West Pakistan is now under consideration. This development of national economy is expected to reduce the need for aluminium import into the country.

<u>Copper industry.</u> Copper deposits are known to occur in the mountain range Pass-Koh in the Northern part of West Pakistan, near the border with Afganistan. But this region is poorly surveyed.

The Bondagen deposit (near Ghagai) is of paramount importance. Large areas are mineralized in this region.

The deposit is being prospected now.

In 1961 deposits containing 10% of copper and 60% of magnetic were discovered in this region. There were discovered several deposits near Fort Sandeman, but the reserves are not estimated. Surveying and prospecting in this region are connected with difficulties, caused by lack of water and by the fact that there are no railways there.

Copper ores are not extracted.

Copper requirements are covered by copper import from the U.S., Canada, and Great Britain.

There are several small plants processing copper in the country. The total annual output capacity of the plants is 10 thousand tons but actually annual production does not exceed 3-7 thousand tons. The industry works on imported raw materials. The plants are situated near Karachi.

<u>Lead-Zinc industry</u>. Lead-Zinc ores occur in the valley of the Ushu River in Swat and in the region of Chagai.

In Kalat province there are old derelict lead mines.

All known deposits are of the vein type. They are very small, located far away in hardly accessible mountainous regions and are not explored by geologists.

In Peshawar (in Swat) small vein deposits are exploited during summer seasons. Every season more the 100-300 tons of high-grade lead ore are extracted.

Now research work is done in the field of lead-zinc ore concentration. It is found possible to recover 93% of lead into concentrates with 75% of lead content.

§ 7. The Turkish Republic

Turkey (a republic beginning from 1923) is mainly situated in Asia. In Europe it occupies the south-eastern conner of the Balkan peninsula and small islands of the Sea of Marmara and Aegean Sea. In Asia Turkey borders on the USSR, Iran, Iraq and Syria, and in Europe - on Greece and Bulgaria.

Total area - 781,000 sq.km.
Population - 32,700,000 people
Population density - 42 persons for sq.km.
Capital - Ankara
Principal cities - Istanbul, Izmir, Iskenderum.

The most of the peninsula is occupied by the Central Anatolian plateau (heights are about 800 - 1200 m), the plateau being encircled by a mountainous ridges. Between numerous mountain ranges there are mountain valleys.

The country climate is distinguished by a hot dry summer with strong contrasts between day and night time, the winter being very cold.

The Tigris and Euphrates are the major rivers of the country. They run into the Persian Gulf. Only their upper current portions are found to belong to Turkey. A number of rivers run through the Turkey territory into the Black and Caspian seas. The Seyhan and Jeihan rivers run into Mediterranian Sea. The largest lakes of Turkey are located in the depressions of the ground. As a rule the lakes are salty and have no outlets.

As the summer season is dry in Turkey, there is a shortage of fresh water. Many of the rivers are filled with water only in rainy seasons. i.e. in winter and spring seasons, and dry out in the summer.

Total length of the railway lines of the country exceeds 9 thous. km. The busses are widely used as well as transportation by means of cartages and pack animals. Commercial sea fleet is not developed well, it carries out mainly the coast-wise shipping. A good portion of the oversea transportation is done with the aid of foreign ships. Airports of an international importance are situated near Istanbul and Ankara.

Considerable energy of the rivers of Turkey is not used widely enough. Hydroelectric power stations produce less than 30% of the total electric power produced in the country. There are reserves of lignitic coals in Turkey. Coal production has provided for building small-size thermal electric stations producing now a considerable portion of the electric power consumed within the country. Data on the electric power production are given in Table I.

Table I

Electric power Generation

	Years				
	1958	1963	1964	1965	1966
Installed generating capacity, thous. kW,					
Total	1031	1381	1434	1516	1768
of which hydroelectric plants	222	478	498	510	...
Electric power productions, M kW-hrs,					
Total	2303	3983	4435	4941	5535
of which hydroelectric plants	657	2099	1652	2167	2318

The great Keban hydroelectric station on the Euphrates river is under construction. The station is to be put into operation in 1970 , its capacity will be equal to 5,871 M kW.

Turkey has fuel resources as well. Coal and lignitic coals as well as oil are produced in the country. There are coals of a high quality available in Turkey, these coals being mined mainly in the region of Zonguldak.

Oil was first discovered on the left bank of the Tigris river in its upper current near Ramandaga in 1940. Oil produced by this field satisfies I/3 of the country need in oil, see Table 2.

Table 2

Fuel Production

	Production			
	1955	1960	1965	1966
Coal, M.t.	3.5	3.7	4.4	4.9
Lignite M.t.	I.2	I.9	3.I	3.6
Oil, M.t.	0.2	0.4	I.5	2.0

<u>Aluminium Industry</u>. Total reserves of bauxites of a high quality with at least 56% of Al_2O_3 in content are equal to 65 M t., out of which 30 M t. are considered to belong to the proved and probable reserves. Besides this, there are about I00 M t. of bemitic and diasporic bauxites with alumina content of 50 - 56% , and more than I00 M t. of ore containing 45 - 50% of Al_2O_3.

The country imports a certain small amount of aluminium and aluminium semi-products (see Table 3).

Table 3

Bauxite production, imports of primary aluminium and semi-products, thous. t.

	Years					
	1955	1960	1965	1966	1967	1968
Production of bauxities	-	-	10.3	32.3	35.0	35.0
Imports of primary aluminium	-	0.3	5.6	8.2	9.0	...
Imports of aluminium semi-products	1.2	1.4	1.7	2.9	-	...
of which foil	-	-	0.9	1.9	-	...

Bauxite production at a low rate initiated near Akseki in 1964, but the region Seydisehir is about to start to play the leading role in bauxite production of the country,as there are considerable reserves and more favourable geological and mining conditions.Construction of a plant for mining 500thous. t. per year in open pits is being completed here, (the figure showing the planned bauxite production).

At present aluminium is not produced in Turkey, but it is planned to build an aluminium plant with a rolling shop with annual output of 25 thous.t.

Aluminium semi-products are produced by several small plants in cities Istanbul and Ankara. Two aluminium processing plants are being constructed with an investment of the USA capitals (annual output of one of them will be 10 thous. t.).

Copper industry. By the beginning of 1967 total reserves of copper in Turkey were estimated to be equal to 1.25 M t., of which 530 thous. t. were considered as proved and probable. Percentage of copper in these reserves varies from 1.5 to 12%, means value being 2.1%.

Main deposits discovered and deposits already put into production are concentrated within three regions: in Ergani the central part of the Eastern Turkey, where reserves of ore with 5.5% of copper in content are equal to 2.5 M t., excluding a large amount of poorer ores, Murgul, the north-eastern part of Turkey, where about 40 M t., of ore containing 1.2 - 1.8% of copper and small amounts of cobalt, gold and silver are available, Kure, the littoral of the Black Sea, where the reserves of ore containing 1.3 - 6% of copper are found, totalling about 11 M t., Recently some new large deposits have been discovered.

Mining , production, imports and exports of copper are shown in Table 4.

Copper ores are mined in open pits. Up to the just recent time the industrial capacity of the Ergani mines was equal to 300-350 thous. t. of ore per year, and only

Table 4

Mining ,Production, Imports and Exports

of Copper, thous.t

	Years					
	1955	1960	1965	1966	1967	1968
Mine production (copper content)	24	27	34	32	32	32
Exports of concentrates	3.7	0.8	8.0	I.0	I.0	...
Production of primary blister copper	24	24	26	27	25	24
Exports of raw copper	I2	I8	20.2	I9.9	I5.3	I4
Production of refined copper	I0	6	7	6	8	8
Imports of copper and copper alloys	-	0.2	0.2	0.2	0.3	...
Copper consumption	2	4	7	6	8	8

rich ores (6-7% of copper) were being mined. Beginning from I968 poorer ores started to be used, and the ore production will be increased to 600 thou.t. of ore per year, with still greater increase in the future. The mines of Murgul produce 500-600 thou. t. of ore per year. It is planned to increase the Murgul output to the value of 8.5 thou. t. per day by I97I. Output of mines in the Kure region does not exceed I50 thou. t. per year. As a rule the sulphide ores of a high grade containing such minerals as pyrite and chalcopyrite are subjected to the concentration

About 90% of the total amount of copper concentrates are produced using copper ores containing 9-I0% of copper.

At present a number of concentrators processing the copper ores are being re-constructed so as to increase their output.

The concentrator Ergani belonging to company "Estibank" will increase its output from 750 to 3000 t. per day. The same company plans to construct a new plant for enriching copper ores of a low grade.

Sulphide ores of the Murgul deposit contain at average 2% of copper, silver, gold and 0.08% of cobalt. It is planned to increase the output of the Murgul mines and concentrator to the figure of 8.5 thous.t, of ore per day.

A concentrator will be constructed in the region of Kure for processing ores containing 2-7% of copper. The ores are mined from a small deposit situated in the region. The plant will produce 25% copper concentrate.

Almost all of the produced ore is processed at two plant producing blister copper: the Ergani-Maden plant (output is I8 thous. t.) and Murgul plant (output is I2 thous. t. per year).

More than half of the blister copper produced is exported to Spain, FRG and Great Britain. The rest is refined at the domestic copper electrolyte plant in city Istanbul.

The electrolyte copper is fully consumed within the country.In Ankara and Istanbul there are plants processing copper and its alloys.Copper is used in making wires and cables for electric industry, in making sheets for kitchen utensils production and other articles produced at small private enterprises.

Turkish company Etibank controls the mining of deposits and production of copper. During 1967 the Etibank company has conducted the building of a new copper smelting plant in Hopa (the Black Sea coast) with annual output of 40 thous. t. of blister copper.The building is carried out with a participation of an American company.The plant will be equipped with a sulphur acid installation, with annual output of 200 thous.t.

To supply this plant with a sufficient amount of crude materials it is planned to increase the output of the Murgul concentrator.As soon as the above plant is put into operation the production of blister copper in Turkey will rise up to 55 - 60 thous. t. in 1970 - 1971. The rise in the refined copper production is also being considered.

<u>Lead-zinc industry.</u> For a long time some production of lead and zinc is effected within the territory of Turkey.This production is not very extensive, as it is based on a number of small-size deposits many

of which are already depleted. For the past ten years the reserves of lead have decreased from 70 to 40 thous. t., while those of zinc remained approximately at the same level of 40 thous. t. All these reserves are proved and probable.

The ores contain 8-12% of lead and 5-15% of zinc.

The deposits being in number of more than 30 are distributed all over the country. The most important of them are concentrated in regions Keban, Madeni and Zamanti.

Reserves of individual deposits do not exceed 200-300 thous. t. of ore. Sometimes copper, silver, gold, cadmium and other elements are extracted as valuable by-products. Data as to the production and trade of lead and zinc in Turkey are shown in Table 5.

Table 5

Lead and zinc production and trade in Turkey, thous. t.

	Years					
	1955	1960	1965	1966	1967	1968
Mine production (lead content)	3	1	2	4	5	4
Mine production (zinc content)	3	2	2	6	3	6
Production of primary lead	2	2	1	1	1	2
Exports of lead concentrates	-	3	2	1	...	...
Exports of zinc concentrates	1	2	8	17	...	...

Table 5 continued:

Imports of primary lead	0.6	2	-	3	...	...
Imports of primary zinc	-	4	6	3	...	...

The lead-zinc ores are mined in underground mines at IO separate sites, some of them functioning only from time to time. Output of the largest mines does not exceed 30-40 thous. t. per year.

The lead - zinc ores containing 8-I2% of lead and 5-I5% of zinc are subjected to concentration. Some of the ores contain gold (up to IO g/t), silver (up to 400 g/t) and copper (2-3%).

Presence of oxidized lead- zinc ores has been reported, these ores are processed with some difficulties. The method of concentration for these ores is now being developed.

The lead concentrate produced contains 68% of lead, the extraction of lead being 90% and that of silver reaching the figure of 80%.

The zinc concentrate contains 56% of zinc, the extraction being equal to 74%.

Primary lead is smelted in small amounts at the plant in town Deneka. The country exports lead and zinc concentrates and imports the primary metals.

§ 8 The Philippines

The Philippines is a former colony of the U.S. In 1946 the Philippines became independent, the Republic of the Philippines is situated in South-East Asia.

Territory - 300 thousand sq.km.

Population - 34.7 million people

Population density - 116 persons per sq.km.

Capital - Quezon City

Principal cities - Manila, Cebu, Davao, Basilay, Illoilo, Zamboanga.

The republic is situated on the archipelago of the same name (in the Pacific ocean) consisting of more than 7,000 islands. The largest islands are: Luzon and Mindanao.

The Philippines is a mountainous country. More than 3/4 of its territory are covered with mountains dissected by deep gorges and plateaus. The climate is mostly tropical, in the South of the country the climate is equatorial. The rivers of the country are mainly short, abounding in water with quick flow, the range of variations in the discharge of the rivers is great. The rivers are perfect potential sources of water power.

The country possesses 1,167 km of railways, mainly located on Lozon, Gebu and Panay. The network of highways amounts to 55.8 thousand kilometres.

Sea transport is of paramount importance in the country.

The main port is Manila. 90% of the whole imports of the country goes through Manila.

In Manila there is also a large international airport.

Power is generated mainly by thermo-power stations. The share of hydro- powers stations in the installed capacity is not great, but the share of hydro-power stations in the generation of electricity is somewhat higher - about 30% (Table I).

Table I

Electricity generation in the Republic of the Philippines

	Years				
	1958	1963	1964	1965	1966
Installed capacity (thouds Kw) Total	495	958	970	I,085	I,222
Installed capacity of hydro-power stations	I87	29I	29I	29I	29I
Electricity generation (M Kwh) Total	I,955	4,2I8	4,6II	4,959	5,567
Generation of electricity by hydro -power stations	748	I,444	I,548	I,509	I,479

The country mines only 0.I-0.2 million tons of coal annually. The greater part of the extracted coal comes from the mines belonging to the government and situated on Cebu.

Oil production does not meet the needs of the country. The needs of the country in oil are covered by oil import, amounting to 3 million tons a year.

The country extracts (1967 data) the following non-ferrous metals,

copper in ore	- 85.8 thousand tons,
gold	- 15.3 tons,
silver	- 42.6 tons
mercury	- 90 tons
molybdenum(in concentrate)	- 45 tons
cadmium (1966)	- 5 tons.

Aluminium industry is limitted by prospecting for bauxite and by the processing of imported aluminium. On the Philippines large areas are rich in laterites but they are mostly ferro-nickel laterites. Only on the island of Nonoc there are three deposits of aluminous laterites, the reserves are estimated at 28 million tons, with alumina content not exceeding 45%. For the last few years in the above areas more than 7 million tons of bauxite, containing 48.2% of alumina and 3.5% of silicon earth, were determined. The aluminium is imported to the country mainly from the U.S.A., as well as aluminium semi-finished products.

Table 2

Imports of aluminium and aluminium semi-products

	Years	
	1960	1965
Aluminium	5.7	4.3
Aluminium semi-products		I.0
including foil	0.5	0.3

On the Philippines in Manila there are two plants processing aluminium.One of them belongs to "Reynolds Philippines". It was built in 1954 - 1959.The plant is 6 million dollars worth.The annual output capacity is 12.5 thousand tons of sheets, disks, foil and shapes.The plant works on the imported aluminium.The bulk of the production is consumed in Luzon.The other plant producting aluminium shapes belongs to "Huven Philippines". The annual output capacity of the plant is 1.5 thousand tons of aluminium shapes.

Copper industry.From 1937 attempts were made to develope copper industry.Copper total reserves on the Philippines amount to 3 million tons. I million tons are considered proved and probable.Average copper content in the ores is 0.8% , but ores of higher grades also occur.At some deposits, gold, silver, molybdenum, lead, zinc and other metals occur as extracted impubities. Copper-porphirous ores are the most important though copper content in them is the lowest. Average content is 0.6 - 1.2%. Usually reserves of such deposits amount to 2- 3 or 10-20 million tons of ore. On the Philippines there are great copper deposits, for instance, Toledo deposit reserves on the Cebu island amount to I50 million tons of ore, or Sipalay deposit reserves on the Negros island amount to 75 million tons.

A new deposit was recently discovered on the Marinduque island. More than 80 million tons of ore were explored. Prospecting work has been stopped, in spite of the fact that the deposit is not explored completely. Next in importance are vein deposits. Such deposits are smaller, their reserves are from several hundred thousands to million tons of are. The greatest deposit of this type is Lepanto deposit on the Luzon island. Its reserves amount to 8 million tons of ore. But the ores, as a rule, are of higher grades, copper content is 2-5%.

Mining is carried out by open-cut operations and by underground working.

The former method is used at copper-porphirous deposits and the latter - at vein deposits.

There are from I2 to I5 mines in operation now, generally each consisting of a number of working plots. Copper production has greatly increased in the country for the last few years: in 1955 it amounted to I7 thousand tons, in I968 it was five times as much as in 1955 and amounted to 90 thousand tones (Table 3).

All the extracted copper is exported as concentrate mainly to the US and Japan. In the country there are no smelteries and refineries.

Table 3

Production, exports and imports of copper
(in thousand tons)

	Years					
	1955	1960	1965	1966	1967	1968
Mine production (copper content)	17	44	62	74	86	90
Exports of copper concentrate (copper content)	17	44	62	74	86	90
Imports of copper and alloys	...	4	4	4	4	4
Consumption of copper	...	4	4	4	4	4

Small needs of the Philippins in copper, which is processed in the country, are covered by the import of copper from Japan. The prospecting work for copper is carried out by the monopolies of the U.S., Canada, Japan and by the government of the Republic of the Philippines. In 1955 the Canadian company "Consolidated Mining" started exploiting a copper-porphirous deposit at Toledo, on the island of Cebu. Mining is carried out by open-cut operations and production exceeds 3 million tons of ore annually.

The Philippine company "Lepanto Consolidated Mining" exploit next in importance Lepanto deposit on the island of Luzon.

The concentrate is delivered to the Tacoma smeltery (Washington State, US). The Canadian company "Marinduque Mining" exploit the Sipalay and Bagasay deposits. The concentrate is exported to Japan.

Ores coming from the greatest depost at Toledo are processed at the concentrator at Atlas (on the island of Cebu), the daily output capacity of the mill is I2 thousand tons of ore. The copper content in the processed ore is 0.75%, the ore containing considerable amount of gold, silver and magnetite.

At the plant copper is subjected to the flotation process. Sands and slime are treated separately. The plant produces cupreous and magnetite concentrate. The plant produces montly 8,500 tons of cupreous concentrate containing 29% of copper.

The ores coming from the Leparno deposit are processed at the concentrator, with the daily output of I000 tons of ore. The processed ore contains 3.4I% of copper, from 0.5 zo 4 g/t of gold, I0.8 g/t of silver. The greater part of gold is found in combination with pyrite. The separation of copper is done by the flotation process. The concentrator produces cupreous concentrate, with a high content of gold-bearing pyrite. The produced cupreous concentrate contains 28.19% of copper, 92.7% being recovered.

At Bagasay concentrator ores coming from Amacs-Nippon, and containing 0.82% of copper, 0.3-0.5 g/t of gold, and I6 g/t silver are processed.

At this concentrator ores are subjected to the flotation process with the recovery of cuprous and pyrite concentrate. The concentrator at Sipalay (the Negros island) processes ore, containing 0.8-1.17% of copper. The daily output of the concentrator is 6.5 thousand tons of ore. A copper concentrator with the daily output capacity of 5 thousand tons of ore is under construction near Manila. By 1970 copper production will reach 120 thousand tons of ore on the Philippines. New copper deposits were discovered in 1966 - 1968, mining at the above deposits will be carried out as well as — output of existing concentrators being increased. Philippines and foreign companies are engaged in the construction of the concentrators. The company Marcopper (the government of the Philippines has a 60-percent interest, and the government of Canada has a 40-percent interest) makes ready for open work operations the copper Aybo-Santo Cruz deposit on the Marinduque island. The reserves of the deposit are estimated at 100 million tons of ore, containing 0.74% of copper. The designed daily output capacity of the concentrator is 15 thousand tons (30 thousand tons annually according to copper content).

Extraction is planned to be started in 1970 Investments are estimated at 39 million dollars. The Japanese company "Nippon Mining" will buy cuprous concentrates from the Marinduque concentrator for 10 years beginning with 1970. Within this period the company will receive about 24 thousand tons of concentrates. Copper reserves of the company "Atlas Consolidated Mining" are estimated at 160 million tons of ore, the average content of copper being 0.74%.

By the middle of 1969 the company "Phillips Mining" (the U.S.) will increase the daily output capacity of the concentrator from 5 to 6 thousand tons of ore.

"Bagujo gold Mining" company makes ready for exploitation the Nino deposit.The reserves of the deposit are estimated at 18-20 million tons of ore, the daily output capacity of the concentrator is 6 thousand tons of ore.On the Philippines smaller deposits are being made ready for exploitation. "Black Mountain" company makes ready for exploitation by block equipment the Kennon deposit on the island of Luzon.The reserves of the deposit are estimated at 12 million tons of ore, containing 0.7% of copper, and small quantaties of gold and silver. The daily output capacity of the concentrator is 1.500 tons of ore.

The Japanese company "Nippon Mining" gave the company "Black Mountain" a loan for about 1 million dollars, beginning with 1968 the "Black Mountain" complex will deliver to Japan 250 tons of cupreous concentrates every month.. The company "Consolidated Mines", with the financial help of Japanese companies construct the Isao-Pili mine.

In accordance with the long-term agreement the company delivers to Japan I2 thousand tons of cupreous concentrate, containing 25% copper, annually, beginning with the spring of 1968.

The Pilippines company "Dison Copper Silver Mines" and the Japanese company "Nippon Mining" will built near Manila a copper concentrator with the daily output capacity of 5 thousand tons of ore.

'Marinduque Mining" and "Industrial Corporation" plan to increase the daily output capacity of the concentrator at Sipalay from 6.5 thousand tons to 8 thousand tons of ore by June 1968. In the country there are three plants processing copper. Their total annual output capacity is IO thousand tons, but they produce only 7 thousand tons. The Marinduque Iron Mines Agents plant at Iligan-Bay (the island of Mindanao) produces copper strips from powder. The powder is obtained from ore by the method of hydrometallurgy. The strip has higher mechanical properties, and a lower oxygen content than the strip produced by the classical method - smelting - moulding - hot rolling. Weld tubes are fabricated from the strips. The plant exports its production. In Makati, near Manila, there is a small plant producing wire and cable from imported copper, the annual output capacity of the plant is 4 thousand tons. The plant belonging to Metal Extrusion" in Binondo near Manila produces pressed rods and shapes from copper and its alloys.

Lead-zinc industry is poorly developed in the Philippines.The explored reserves of lead are modest - only IO thousand tons, the reserves of zinc are 70 thousand tons, they are considered proved and probable.Lead and zinc are found in combination with copper and gold.Pure lead-zinc deposits have been discovered only for the last few years. A considerable ore field on the island of Mindanao, the reserves of which are estimated at IO million tons of ore and the Torrijos deposit in the province of Marinduque which is now being prospected are of the greatest importance.In future, it will be possible to increase lead and zinc output in the country by exploiting these deposits.Figures,illustrating production and import of lead and zinc in the Philippines are given in table 4.

Table 4

Production and foreign trade of lead and zinc
(thousand tons)

	Years			
	1955	1960	1965	1966
Mine production (lead content)	2	0.I	0.I	0.05
Mine production (zinc content)	-	5.0	2.0	I.0
Imports of primary lead and semi-products	...	I.4	4.0	...
Imports of primary zinc and semi-products	0.I	I4.0	23.0	...
Exprts of cupreous concentrate	-	-	4.0	...

Small quantaties of lead and zinc are obtained from copper and gold deposits.

Complex polymetallic gold-bearing ores, containing 0.4-1.75% of lead, 0.4-0.5% of zinc and 30-60 g/t of silver are concentrated. When dressing these ores, lead (about 100 tons annually), zinc (3-5 thousand tons annually) and silver (20-30 tons annually) are recovered as by-products. In Mamburao a lead smelting and refining plant used to work since 1937.

At present the plant does not produce lead. The country's needs in lead and zinc are covered by import. The "S.S. and Son" company plant at Kovalichi (Quezon city) processing the imported metals produces lead for storage batteries, solders, babbits and printing alloys. The annual output capacity is 60 tons, in 1964 the plant produced 25 tons.

§ 9. The Republic of Indonesia

Indonesia is situated in south-east Asia. It comprises about three thousand islands of the Malay Archipelago.

The total land area: 1,492 sq.km

The population: 110 M people, including 71 M people on Java.

The population density: 74 persons per sq.km on the Java island and 2 persons per sq.km in West Irian.

The capital of the country is Djakarta.

The islands of Indonesia are divided into four large groups: Greater Sundas (Kalimantan, Sumatra, Java, Sulawesi) Lesser Sundas (Bali, Lombok, Sumbawa, Flores and others), the Moluccas and West Irian.

Indonesia is located in the area of equatorial climate. Monsoon equatorial winds, which prevail here blow above the seas and drop rain during the whole year.

The railway network of Indonesia is concentrated mainly on Java (4.7 thous.km) and on the Sumatra island (about 2 thous. km). There are 80 thous. km of highway.

Sea transport is of great importance in the life of this island country. The main seaport are Tanjung-Periuk and Surabaja on Java, Palembang, Balawan on Sumatra, Balikanah on Kalimantan.

Rivers are used for shipments within the country.

Air transport also has a great importance.

Power is generated both by thermo stations and hydroelectric plants (see Table I).

Table I

Power generation in Indonesia

	Years				
	1958	1963	1964	1965	1966
Installed capacity, total, thous.kW	351	658	...	...	...
including hydro-electric plants	132	182	258	258	282
Power generation, million kWhr	1,005	1,294	1,406	1,513	1,520

Indonesia suffers great shortage in power. In recent years the modernization of old power plants and the building of new power stations are underway in this country.

Indonesia has considerable fuel reserves (Table 2).

Table 2

Fuel production in Indonesia

	Years			
	1955	1960	1965	1966
Coal, thous.tons	814	658	281	320
Oil, million tons	11,730	20,596	23,819	22,455
West Irian including	0.474	0.248	0.058	0.060
Natural gas, b.cu.m	1.908	2,431	2,446	1.601

Oil production is of great importance. About 50% per cent of oil is processed in the country and the rest with great part of final products is exported to other countries (in the main to Japan and Australia).

Indonesia has reserves of various non-ferrous metals such as tin, tungsten, nickel, copper, lead, zinc, mercury, bauxites, diamonds and others.

Aluminium industry of Indonesia is engaged in the mining of bauxites and the treatment of imported aluminium.

It was estimated that in 1967 the total reserves of commercial grade bauxites in Indonesia amounted to 25 million tons among which 15 M tons are considered proved and probable. Above that there are about 11 M tons of bauxites, containing 45-50 per cent of Al_2O_3. However according to the opinion of a number of research experts these reserves of low grade bauxites are very underestimated.

Main bauxite deposits are found on small islands in the southern area of the strait of Malacca, small deposites are known on Sulawesi island. In 1960 new, insufficiently studied bauxite deposits were discovered in the western region of Kalimantan, 20-25 km south-west of Songkawang (according to the preliminary estimates the reserves of four deposits amount to 2.3 M tons).

The major part of reserves (17.5 M tons, estimated in I964) is located on the Bintan island, 95 km south-east of Singapore. Mines, situated in this area, produce the major quantity of bauxites with the aid of Japanese investments.

Smaller deposits of higher grade bauxite are found on the islands of Bangka, Batam, Singkep, Kundur and others. As a result of the prospecting works, carried out in the beginning of the 60ties, new reserves of high grade bauxites, amounting to 1.3 M tons were discovered on the small islands, located near Bintan and Bangka. According to the opinion of research experts, only a small part of the areas with probable bauxite deposits has been studied in this and other regions of Indonesia and hence there are great possibilities of increasing the known reserves. In recent years prospecting is being carried out almost entirely by American and Japanese companies. The data about the results of this work are not published.

Bauxites, mined in the country are not treated and exported to other countries, mainly to Japan (Table 3).

Table 3

Bauxite production and exports, imports of aluminium, thous.tons

	Years					
	1955	1960	1965	1966	1967	1968
Bauxite production	264	396	688	701	912	900
Bauxite exports	263	348	694	683	...	...
Aluminium imports	2.4	2.8	...	...	...	...

In Indonesia there is a plant at Bandung (the Java island) which produces plates and dishes from aluminium sheets, imported from West Europe and Japan.

Rolled aluminium is mainly consumed by the plants producing plates and dishes, cups for rubber sap, tubes and cigarettes.

There is a project of building a new aluminium plant at Medan, northern Sumatra. Its rolling mill will have a rated capacity of 12 thous.tons per annum. However due to economical difficulties the construction of the plant has not yet begun.

Copper industry. Until recent time only small unworkable vein deposits were known in the country. A small quantity of copper was mined together with gold.

In the 60ties two copper deposits were found in the country. The first Sancoroly deposit, located in the southern part of the Sulawesi island was explored with the aid of Jugoslavija. Mining was expected to start at the end of 1966, but the beginning of operation has been delayed.

The second deposit at Erstberg (West Irian) has a shape of a stock 280 m long and 190 m wide. It is traced to a depth of 180 m. The ore body contains an average of 3% copper and 38% iron (magnetite); gold and silver are also present in some quantity. It is estimated that ore reserves for open-pit mining amount to 30 M tons.

According to the data, published in 1968 US company "Freeport Sulphur" reported about preliminary results of prospecting work, carried out by its subsidiary "Freeport Indonesia" company on the area of Erstberg deposit in West Irian. Investments for a mine construction will amount to 75 million dollars.

The costs of a project on deposit working are expected to be about 2 million dollars.

Copper consumption in the country does not exceed 100 tons a year. Imported copper is used by . railway repair shops.

Lead and zinc industry. There are very small and mainly unworkable lead and zinc deposits in the form of sulphide veins in volcanic rocks. Rich leads and zinc ores are mined sporadically.

A small quantity of lead is produced as by-products while mining gold and silver deposits on Sumatra (an area of Lebong) and Java.

Tin industry. Indonesia being one of the main world tin producers in the past, at present has lost its position in tin industry. The share of the country in world mining and production of tin-in-concentrates decreased from 20% in 1955 to 8% in 1967. Mining, production and exports data are listed in Table 4.

The data about exports of tin-in-concentrates and metallic tin are compiled on the basis of its imports to the countries, which import this metal.

Table 4

Tin production and exports, thous.tons

	Years					
	1955	1960	1965	1966	1967	1968
Tin-in-concentrate production	33.9	23.0	15.1	12.7	13.8	16.8
Tin-in-concentrate exports	32.3	25.0	13.4	10.0	12.5	16.2

	1955	1960	1965	1966	1967	1968
Primary tin production	1.8	2.0	1.8	1.5	1.5	4.6
Primary tin exports	1.5	1.8	1.1	1.1	1.6	4.8
Primary tin consumption	0.5	0.5	0.7	0.4	0.1	0.2

The total tin reserves in Indonesia amount to 800 thous. tons, including 550 thous.tons considered to be proved and probable. The main sources of tin are alluvial deposits, originated from primary rocks and cassiterite intruded in granites.

The reserves mentioned above were estimated on the assumption that sands contain an average of 0.5 kg/cu.m. Even small reduction of this limit would result in a sharp growth of reserves.

The major known tin deposits are found in the region of three islands, located to the north of Sumatra on the Malacca Peninsula: Bangka, Billiton and Singkep. A major part of the reserves is on the Bangka and Billiton islands. Small alluvial deposits are also known on Sumatra, B.Karimun, Kundur and on the islands of the Riouw and Linga Archipelago.

Mostly rich deposits are located on the northern and north-east area of the Bangka island. An average cassiterite content is about 0.5-1.2 kg/cu.m. In other areas deposits are not so rich as those mentioned above.

The deposits differ in length, the layer depth usually does not exceed 1 m. A characteristic feature of this area is the accurance of sea bed alluvial deposits with alluvial layers of old valleys, located below sea level. They are traced to a distance of more than 20 km from the beach at the depth of 40 m. There is a great number of primary tin deposits, containing 0.1-4% Sn but in the majority they have not been explored, reserves are not measured and excluded from the overall estimates.

At present primary tin deposits in the main have not been worked. In 1965 West German companies began restoring the old Klappa Kampit mine on the Billiton Island, where mining was carried out in the zone of cassiterite sulphide ore deposits, containing 2-4% Sn. The mine was expected to yield 2000 t of tin a year, but up till now this production rate has not been reached. Other primary deposits, witho the exception of tributor's work with hand sorting of large cassiterite crystals, are not being developed.

The overall tin reserves in alluvial deposits can be considerably increased. Prospects for new primary deposits seem to be very promising.

Alluvial type deposits are worked by various methods. There are 33 dredges in the country including 10 units of sea type, one of which is the world largest sea dredge with a digging depth of 40 m. A considerable quantity of tin ore is mined by gravel pumping and hydraulics. There are also a great number of small plants with old mining practice.

Primary sand dressing is carried out directly at the dredges or at dressing units. Rough concentrates are finally treated at final stage dressing plants.

Dressing facilities include screens, vanners and jigs. After primary treatment a concentrate containing 40-60% Sn is sent to final-stage dressing plants, where rough material is finally treated by jigs, concentration tables, magnetic and electrostatic separators.

On the Billiton Island there are three final dressing plants: Tanjungiandan plant, producing 2 thous.tons of concentrate a year, Manggar plant with a rated capacity of 2.4 tons per annum and Lengane plant. At these plants rough concentrates are finally treated to yield commercial grade products. Tailings, containing up to 15% Sn in some cases, are dumped into the sea.

On the Singkep Island concentrates are finally treated at Dabo dressing plant.

On the Bangka Island there are five final-stage dressing plants, including two large plants operating at Muntok and Sungailiat, the latter with a rated capacity of 2.5 thous. tons of concentrate a month.

At all dressing plants concentrates are dried and packed into bags.

Metal content of concentrates after final dressing is usually about 70-75%. Extraction is 70 per cent. Metal losses during dressing operations are in the range of 28-30 per cent.

In 1964-1966 tin mining industry was modernized with the aid of Dutch, English and West-German companies. During 1965-1966 "Lubeck Machinen" (F.R.G.) shipped 10 small dredges for Indonesia. The total output capacity of all ten dredges is about 2 thous.tons of tin-in-concentrate a year.

At the end of 1965 in "Scotland"British Stephans and Sons C°", and "Simons Lobniz C°" completed the construction of a large dredge Bangka I, estimated at 7.8 million dollars. In April of 1966 this dredge began operating with the initial capacity of one thous.tons of tin per annum; a full year capacity is to be two times higher.

Now the government of Indonesia pays great attention to prospecting for tin deposits. In July of 1968 the Indonesian government signed a 40 year contract with "Dutch Billiton C°" on off-shore prospecting.

"Billiton C°" reports that capital investments in planned prospecting are estimated at 2.8 million dollars. "Rio Tinto" Zinc C°", "Bethlehem Steel " and "Simons Lobniz C°" are also negotiating with the Indonesian government about receiving rights on prospecting for tin on the islands of the Riouw Archipelago and particularly on the islands of Karimun and Kundur.

In 1968 mining companies received the right to have at their disposal 86 per cent of the total revenues, in foreign currency gained from products shipments. On the opinion of the government these measures will provide for growing tin-in-concentrate production.

The Indonesian government hoped to rise tin-in-concentrate production up to 35 thous.tons per annum by 1970 with capital investments of 70 million dollars. However, this level of production can not be reached by that time.

Being an important world producer of tin concentrates, Indonesia had no enough capacities for tin smelting until 1967. A small quantity of tin was produced at the old Muntok plant (the Bangka Island). In February of 1967 a new tin smelter with a rated capacity of 25 thous.tons a year began operating at Peltim on the Bangka Island. The plant was built by "Klockner Industrianlagen" (F.R.G.), the costs of the plant construction are in the order of 6.5 million dollars.

Some data about tin smelters in Indonesia are listed below.

<u>The plant of "Tin Mines C°", at Muntok</u>. The plant had been operating before the World War II.

Capacity: 2,000 tons of tin a year.

Raw materials: rich concentrates, containing 72-75% Sn.

Flow sheet: concentrate smelting in a modernized shaft furnace "Vlaanderen type" (reduction agent-charcoal without fluxes).

Final product: tin of BANGKA grade.

Composition (%): tin - 99.935, antimony - 0.008, arsenic - 0.004, copper - 0.009, lead - 0.036, bismuth - 0.001, iron - 0.007.

<u>The plant "Peltim Smelters" at Muntok</u>:

The year of introducing into action: 1967.

Capacity - 22.7 thous.tons a year.

Raw materials: rich concentrates, containing 72-75% Sn.

Flow sheet: concentrates and rich slags smelting in rotary-type furnaces with reduction by charcoal and fluxes (limestone) and fire refining of crude tin.

Final products: Metallic tin - 99.95% Sn.

It is planned to produce 25 thous.tons of tin a year by 1970.

In 1967 the tin output of both plants at Muntok, owned by "Bangka Tin Mines C°" and Peltim amounted to 1.7 thous. tons.

The Peltim Smelters plant has not yet reached its rated capacity in view of delays in the operation of rotary furnaces.

Indonesia occupies one of the richest region of the South-East Asia tin belt. Reconstruction and further development of tin mining industry in Indonesia would strengthen economic position of the country. The following measures should be taken to achieve this goal:

1) Planned prospecting of tin deposits in potential areas inland and off-shore.
2) Installation of modern equipment at operating and new plants and in the first place dredges and spare parts for them, particularly bucket dredges with a large digging depth and hydraulic dredges for working deep sea-bed placers.
3) Developing the richest primary deposits.

§ 10. Federation of Malaysia

Federation of Malaysia which came into existence in 1963 comprises the former Federation of Malaya, Sarawak and Sabah (North Kalimantan).

Territory - 333,000 sq.km

Population - more than 10 M people

Population density - 63 persons per sq.km (Western Malaysia) and 7 persons per sq.km (in Sabah and Sarawak)

The capital - Kuala Lumpur.

The Bederation is a mountainous country surrounded by plains deeply etched by multiple river valleys.

Climate of Malaysia is equatorial and moist with falls during the whole year.

Rivers form a dense network and are deep and highwatered during all the seasons. The longest streams: Sungei Pahang (320 km) and Sungei Perak (270 km).

Country railway totals about 2,000 km. The main line runs the length of the country from Singapore to Thailand passing through the cities: Singapore, Gemas, Kuala-Lumpur, Bat Hat Yai on Utophao (Thailand). A branch line connects Gemas and Kuala Lipis running further to the North till merging the main line in Bat Hat Yai. Metalled roads also play an important role together with a well developed sea transport system.

Fuel resources are small. Coal has not been discovered. Oil is mined in Sarawak at the stable level of 50,000-60,000 t a year. Data concerning electroenergy generation are given in the table I.

Table I

Electroenergy generation in Malaysia

	Years				
	1958	1963	1964	1965	1966
Installed capacity in thousand kW	301	413	525	536	...
Electroenergy generation, M kW-hr	...	1,700	1,948	2,242	2,522

Malaysia is rich in natural resources.

There occur mineral deposits of tin, wolfram, bauxite, iron ore, gold, columbite, uranium bearing ores.

Aluminium industry. The bauxite ore deposits in Malaysia (including Sarawak) are estimated at 45 M t, of which 15 M.t. are considered to be proved and probable. According to more cautious assumptions the explored bauxite deposits account for 10 M.t. All deposits are of lateritic type. Similar to other Asian countries the estimated resources of Malaysia can be significantly increased by the exploration of new fields and by determination of the richest grounds in the fields already known.

Mining output of bauxite in 1967 was at the level of 900,000 t. All mined ore is exported (mainly to Japan). In its turn, Malaysia imports small amounts of aluminium and aluminium semi-finished products.(table 2)

Table 2

Production and exports of bauxite, imports of aluminium and aluminium semi-products (thousands t.)

Items	Years				
	1955	1960	1965	1966	1967
Bauxite mining	226	748 [1)]	994 [1)]	955	900
Bauxite exports	264	719 [1)]	849 [1)]	1,023	...
Aluminium imports	-	-	0.6	1.6	...
Aluminium semi-products imports	2.7	3.7	3.3	3.0	...

1) Data on Sarawak which before 1965 were put into separate statistical tables are here included.

Bauxite mining was carried out on different scale starting from 1936 in Johor and Malakka states and in Sarawak.

By the end of 1967 only 2 mines in Johor were in operation.

The biggest of them Telok Ramunia mine produces annualy some 600,000-700,000 t of open-cast bauxite. The mined ore is washed. The final product contains 52-56% Al_2O_3; 3-5% SiO_2; 6-10% Fe_2O_3 and 0.7-1% TiO_2.

The production can be increased by applying more efficient methods of mining and washing which permit even poor ores to be economically mined.

Malaysia imports aluminium mainly from Canada. The imported aluminium in consumed by the "Alkan Malayan Aluminium C°"

(85% capital of the Canadian company "Alkan Aluminium" and the rest of the Malaysian Government) for the production of aluminium sheets and rounds at its Petaling Jaya plant Near Kuala Lumpur. This $ 1.3M plant with annual capacity of 3,500-4,000 t was built in 1963. The production of the plant is used for fabricating roofings, kitchen utensils and metallic caps for harvesting wild rubber.

The erection in Petaling Jaya of a plant for the production of aluminium cables is planned by "Malayan Cables Ltd", affiliated company of "British Insulated Callender's Cables Ltd".

Copper industry of Malaysia is underdeveloped and no estimated copper resources are known. Small amounts of copper are recovered as a by-product of tin from primary ore mainly at the mine Sungei Lembing in the state of Pahang.

In the earlier 60s rich deposit of copper porphyry ore was discovered in Sabah on the Eastern slope of Mount-Kinabalu. This ore body is estimated at 35 M t. of ore with average content of 0.7% copper. The Japanese partially state-owned company "Overseas Mineral Resources Development" begins to explore this deposit during the spring 1969. Capital investments for the exploration period of 3 years will make up $ 2 Mln. The ore field is situated 120 km North from Jesselton. In case the exploration gives positive results mining will be started in 1973. Capital investments for the erection of a dressing plant will account for $ 51 M...

Annual capacity of the mill is to be 45,000 t. tin-in-concentrates. There are other similar deposits currently being explored in the same region: in particular Junong Nungkok and Bidu Hidls.

The discoveries of the last years make it possible to assume that North Borneo can become a comparatively large copper mining region. Copper demand of Malaysia is satisfied at present by the import of semi-finished products, averaging about 2,000 t a year.

Tin industry. Tin resources of Malaysia are among the largest in the world and account for 1.2 M t. by metal content, of which 600,000 t are proved and probable.

Similar to other Asian countries the tin-ore deposits of Malaysia are mainly of secondary character-that is eluvial and alluvial, containing cassiterite in amounts of 0.2-0.3 kg/m^3. Primary deposits account only for 15% of the country's ore. The tin content in primary deposits is about 1-3%. During the last years a large number of new ore-bodies, including some off-shore deposits, have been discovered. The off-shore mining is to be carried out with the participation of "Rio Tinto Zinc" (Great Britain) and "Bettleham Steel" (U.S.A.). Capital investments in the exploration works are supposed to be about $ 651,000.

In October 1967 the Malaysian government signed an agreement with a number of foreign companies, including "N.V. Hollandse Metallurgische Industrie Billiton" (Netherlands) on the off-shore mining in the western part of the country (deposits in Negri-Semibalan, Malacca and Johore Regions).

Capital investments planned by the company for geological exploration works account for $ 270,000.

$ 339,000 are given by the U.N.Development Fund for the off-shore exploration in Malaysia. The Malaysian government plans to pay for these works another $ 394,000.

Malaysia is the largest tin concentrates and primary tin producing country. The Malaysian share in the world production of tin-in-concentrates and metallic tin accounted in 1967 for 42.3% and 43.8% respectively. (table 3).

Table 3

Malaysia: tin production, consumption and trade
(thous.tons)

	Years				
	1955	1960	1965	1966	1967
Tin-in-concentrates production	62.2	52.8	64.7	70.0	73.3
Primary tin production	71.8	77.3	73.6	72.2	77.5
Primary tin exports	72.0	77.6	74.6	72.8	75.0
Imports of ore and concentrates (tin content)	11.2	21.8	7.3	0.6	2.2
Primary tin consumption	~ 0.1	~ 0.1	0.04	0.06	0.09

At the end of 1967 there were 1,072 mining units and areas in Malaysia. At 66 deposits ore was won by dredges. Dredging sector of Malaysian industry is almost entirely in the hands of foreign companies.

Malaysian production of tin-in-concentrates by methods of mining is shown in the table 4.

Table 4

Methods of tin mining in Malaysia

Methods of mining	1960		1967	
	number of mining units	tin-in concentrates production	number of mining units	tin-in-concentrates production
		thou. t		thou. t
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
Total	591	52.8	1,072	73.3

Due to the exhaustion of a number of dredging grounds and insufficient exploration and preparation of new ones, the output of tin by the dredging method , which is the most productive of all, has been reduced during the period of 7 years from 28,500 t to 24,200 t. Number of dredges in operation reduced for the same period by 3 units (table 4). The total production of tin by the country nevertheless increased during the period from 52,800 t to 73,300 t. mainly due to the increase of a number of gravel pumps, which do not demand any great capital investments and are economically feasible for grounds too small for dredging operations.

The share of the gravel pumps sector in the production of tin increased accordingly from 34.3 to 55.5% while the dredging share reduced from 53.9% to 33% during the period of 1960-1967.

In 1967 the average annual output per one dredge and per one gravel pump unit make up 367 t and 42.5 t respectively.

High tin price level especially in 1964-1965 permitted the economical feasibility of even poor and small ore deposits Average tin content in alluvial and eluvial ore mined during the last years was at the level of 0.2-0.3 kg/m^3 against 0.3--0.9 kg/m^3 during 40ties. Reduction of the market price having taken place during 1967-1968 resulted in the shut down of many enterprises previously quite profitable.

Primary deposits which demand greater capital investments (in comparison with alluvial) have been insufficiently worked and explored. Their share in the country tin production is only 3-4% by metal content. The largest is Sungei Lembing mine in Pahang, the underground mining production of which equals to 200,000-250,000 t a year of ore containing about 1.5% of tin. Besides that some open-cast mining is carried out at Kaki Bukit field in Perlis region.

Benefication of ores broken down by weathering and sorted by flowing water (which do not need preliminary crushing and grinding) is done in the mills, and washing installations of different types and capacity. The feed material is screened. For the purpose of classification and slime separation hydro-cyclones are used. Clay is washed out if necessary at the beginning of the benefication process by means of pumps and paddle washers. Benefication itself is carried out by means of jig washers and often by sluicing on the Malayan sluices (palongas), much labour consuming devices which do not seem to give optimum results of metal recovery. Along with big dressing mills using well developped schemes of operation there are many small plants with no experience technical control.

The concentration of metal in rough concentrates produced by washing devices is further increased with the help of special installations often serving each a group of mines. These installations consist of concentration tables, magnetic separators and lanchutes. The concentrate after additional benefication is very rich (up to 75 %) and contains only small amounts of contaminating impurities.

Tin smelters belong to the foreign, particularly English companies.

Tin metal production has reached 77,500 thous.t. The total annual capacity of all tin smelters is more than 120,000 t. No data are available concerning the individual smelters production. Tin smelting plants are briefly described below:

<u>Dato Kramat plant</u> of the Eastern Smelting C° at Penang has the annual capacity of 60,000-70,000 t of metallic tin.

The raw material are tin concentrates from Malaysian mines with the content of 75-76% Sn; concentrates imported from Laos with 60% Sn, from Burma - 72% Sn (also containing bismuth and lead) and from Tansania - 72% Sn.

The flowsheet is as follows: Roasting of rich-in-sulphur tin concentrates in multihearth furnaces under low temperatures; smelting of the roasted and crude pure concentrates in reverberatory furnaces; fire-refining of the crude tin; smelting in small reverberatory furnaces of the rich primary slag, mixed with iron scrap, for the purpose of hartling recovery which circulates then to the concentrate smelting furnaces. The final product: I. Straits refined tin with following content %: tin - 99.898; antimony - 0.003; arsenic- 0.027; lead -0.037; bismuth - 0.004; copper - 0.023; iron - 0.003; sulfur - 0.001; nickel - 0.002; silver - traces. II;Lead and lead alloys.

The Smelting Works of the "Straits Trading C°" at Butterworth (Penang)

Annual capacity: 40,000 t. of metallic tin.

Raw material: 72-73% tin concentrates imported from Indonesia according to an agreement which came in force in march 1968.

Flowsheet: Smelting of concentrates and rich circulating slags in reverberatory furnaces; fire refining of crude tin.

Final product: Straits refined tin with the following content %: tin - 99.901; antimony - 0.004; arsenic - 0.03; lead - 0.029; bismuth - 0.007; copper - 0.02; iron - 0.009; nickel + cobalt - traces.

Oriental Tin Smelters' Works at Klang (Near Port Swettenham)

Brought into operation in 1964.

Annual capacity: 12,000 t. of tin.

Raw materials: concentrates from Malaysian mines situated in the region of Perak (tin - 76.88-66.01%; lead - 0.08-0.004%; arsenic - 0.207-0.006%) and from Kuala Lumpur (tin - 77.41-59.01%; lead - 0.152-0.002%; arsenic - 0.400-0.002%).

Flowsheet: Chlorinating and oxidising roasting of concentrates; smelting of the roasted product in reverberatory furnaces with the addition of hartling, coke, primary slag (13% of the charge weight) and limestone small fraction; fire refining of the crude tin (liquation and melting out); mould casting. Smelting of the rich primary slag (17.5% Sn) in reverberatory furnaces with the addition of coke, lime (7% of the charge weight) with the recovery of crude tin, hartling, and waste slag.

Final Product: O.T.S. refined tin with the following content (%): tin > 99.9; arsenic < 0.026; lead < 0.029; copper < 0.02; iron < 0.006; antimony < 0.002; bismuth - < 0.007.

Methods for the recovery of wolfram, zirconium, tantalum and niobium from tin smelting slags are being presently investigated at this plant.

The capital for the construction of the Klang plant was gained from the Japanese company "Isihara Sangio Kaisha" ($ 3.75 M.) and government organisation Malaysian National Investment. The total cost of the construction was $ 5 M.

<u>The Smelting C° Ltd Plant for the Production of secondary non-ferrous metals</u> built on Penang in 1965.

Besides refined tin the plant produces lead and lead alloys (solders and printing type).

The plant production goes for home consumption.

The annual capacity is 2,000 t.

Tin home consumption is very small: it accounted in 1966 for 60 t and in 1967 - 90 t.

Malaysia is the leading exporter of metallic tin. Tin export in 1967 accounted for 75,000 t (by 3,300 t more than in 1966) and was distributed as follows:

USA - 32,900 t; Japan - 19,400 t; Italy - 4,100; India - 2,900 t.

The preservation by Malaysia of its present leading position in the production of tin together with high profitability of its mines, will depend above all on the choice of the right scale and direction of the exploration works as well as the availability of necessary equipment for the development of rich and large primary and off-shore deposits.

Judging by the experience of Malaysia and neighbouring countries, a relatively short period of time is needed for the return of the capital invested in necessary geological exploration works in the promising regions of the Malaysian tin belt and of the investments made for the construction of mines.

§ II. The Kingdom of Thailand

The Kingdom of Thailand occupies an area in the centre of Indo-China peninsula and Northern part of the Malacca peninsula. On north-west Thailand borders on Burma, on north-east and east on Laos and Cambodia, on the south on Malaysia. On west it is washed by the Andaman Sea, on east by the South-Chaina Sea:

Total area - 514 thous.sq.km.

Population - 32,7 million people.

Population density - 6I persons per sq.km.

The capital of the country is Bangkok.

Principal cities: Chiang Mai, Korat, Muang Lumpang.

Plains occupy more than half of Thailand's area, the remaining part is occupied by medium height mountains. Thailand lies in the part of the world, affected by tropical monsoon climate. In the major part of the country there are three seasons: warm dry (in winter), hot dry (between winter and summer monsoons) and hot wet (in summer). A rainy season is continued during 6-8 months.

A river network in Thailand is very dense. A water level in rivers greatly varies during a year. The most long and abounding in water is the Mekong river (on the border with Laos) and its right tributary Mun. There are some lakes, the largest of which is Kam lake (in the basin of the Mekong river). The main transport means are railways, which connect Bangkok with nothern, southern and eastern regions of the country and also with Malaysia, Singapore and Cambodia. The railway's length is 3,500 km. Waterways (rivers and canals) have a great importance as transport means inside the country, particularly in the region of the Menam plain.

Bangkok is located on the way of many international air lines.

Power in the country is generated by thermo stations and hydro-electric plants which have a greater importance in power generation comparing with installed capacity (Table I).

Table I

Power Generation in Thailand

	Years				
	1958	1963	1964	1965	1966
Installed capacity, thous kW,					
Total	167.I	36I.7	548.3	559.2	...
including hydro-electric plants	-	-	I40.0	I40.3	...
Power generation, million KW-hr,					
Total	...	906	I092	I406	I8I6
including hydro-electric plants	...	-	288	[illegible]	...

Coal deposits are known in various areas of the country, but now only one workable brown coal deposit has been prospected at Mae Mo. It is located at a distance of

500 km from Bangkok near the railway connecting Bangkok with Chiang Mai. Coal mined here by open pit practice is mainly consumed by power stations in Bangkok. The annual coal production is about IC0–I50 thous ton.

<u>Aluminium industry.</u> In Thailand there are laterite formations having the depth of 2 m with bauxite concretions, containing up to 80% Al_2O_3. However both bauxite mining and aluminium production have not been organized.

For home needs aluminium as well as aluminium semi-products are imported from other countries (mainly from U.S.A. and Japan), Table 2.

Table 2

Aluminium and aluminium semi-products imports, thous. tons

	Years			
	I955	I960	I965	I966
Aluminium	0.3	0.3	I.8	3.9
Aluminium semi-products	I.3	2.8	3.3	2.9
including foil	0.2	0.5	I.0	I.0

At two old plants in Bangkok imported aluminium is processed into sheets and rounds for producing plates and dishes.

In I961-I965 Canada's "Alcan Co" built two new plants in Bangkok, which produce aluminium semi-products. One of these plants has facilities to produce 2.5 thous. tons of sheets and I.5 thous.t. of wire and cables. The second plant is designed to make shapes used in construction.

Copper industry. In 1966 large copper-porphyry deposits were found in the province of Losi, in north-east region of Thailand. Now these deposits are being studied; according to the initial estimates ore reserves amount to 80 million tons, but data about ore grade are not available.

Some quantity of copper (about 400 tons a year) for home needs is imported, in the main from Australia, USA and Great Britain. U.S. "Phelps Dodge Copper Co" in cooperation with Thailand's companies are planning to build a plant (near Bangkok) which will produce wire and cables from copper and aluminium.

Lead and zinc industry. It is estimated that total lead and zinc ore deposits amount to 250 thous. tons of lead, including 50 thous. tons considered to be proved and probable, zinc reserves respectively amount to 190 and 40 thous tons. Ores contain 21-44% Pb and [illegible]-2% Zn.

In recent years a new zinc deposit was found at Me Sod (Northern Thailand). The estimated reserves here amount to 3 million tons of ore, containing at an average 35% Zn and some lead. This deposit can be mined by open pit practice. In Northern Thailand small vein lead and zinc ore deposits are known in the Pren region.

At present in the country lead and zinc are produced in a small quantity (Table 3).

Table 5

Lead and zinc production and trade, thou. tons

	Years			
	1955	1960	1965	1966
Mine production (lead content)	5	2	6	7
Mine production (zinc content)	3	I	2	2
Primary lead imports	-	I	I	I
Primary zinc imports	-	2	9	I2
Lead ore exports	...	5	II	I2

Lead ore is mainly exported to Japan and Belgium. Thailand consumes some quantity of imported lead and zinc.

Tin industry. Thailand is one of the major tin producers.

As a result of prospecting carried out in 1960 tin ore reserves in Thailand considerably increased. In 1967 the reserves were estimated to have totalled to 1.5 million tons, but a majority of deposits have not been properly studied.

Proved and probable reserves are estimated at 400-600 thous. tons: cassiterite content of placer deposits usually varies from 0.2 to 0.5 kg/cu.m. amounting to an average of 0.3-0.4 kg/cu.m. Main tin deposit areas are located on the Malacca neck comprising a portion of the western tin bearing belt of Malaysia.To the north, as in neighbouring Burma, tin mineralization is replaced by tin-tungsten ore- bodies and sometimes by pure tungsten mineralization.A major portion of tin deposits is found in the area of the Tongkah Gulf and on the west shore of the Gulf of Siam.Small tin-tungsten deposits are also known in a basin of the Mekong, near the border with Laos (Pilock and Mhe Sarjang areas).

As in Malaysia, primary tin and tin-tungsten deposits greatly vary in nature and size.They are also insufficently studied, the share of ores in tin reserves and mining production is rather small (less than 10 per cent) though deposits occur in many areas.

The Van-Bra and Khao-Khiam mines are operating on a more regular basis, but each of them produces only IO-I5 thous. tons of ore per annum.

Main known reserves are in the form of placers of all types, but as in Malaysia a major role is played by alluvial deposits.Very large sea-bed placers, valley and beach sand deposits have been discovered in recent years.Tin content in sea-bed placers is higher and amounts to 0.7÷I.0 kg/cu.m.

The largest tin deposits are located in the southern peninsula district of the country.

Placer deposits account for 90 per cent of tin concentrates.The provinces of Phuket,Panga and Ranong furnish 75% of tin , produced in the country.

Until recent time 50% of tin was produced by foreign companies. Now the share of the national capital in tin mining has grown up to 80 per cent.

This can be explained to a large extent by the fact of putting into production of several new hydraulic gravel pumps. Number of these facilities belonging to local companies increased during the last 10 years from 85 in 1957 to 391 in 1967.

Working capital invested in tin industry of Thailand is estimated at 96 million dollars (only 45 % of the shares are in the hands of the foreign countries).

Tin-in-concentrate production in the country is constantly increasing (Table 4).

Table 4

Tin production, consumption and exports, thous. tons

	Years					
	1955	1960	1965	1966	1967	1968
Tin-in-concentrate production	11.2	12.3	19.4	23.0	22.0	24.0
Primary tin production	-	-	5.6	17.3	27.0	24.8
Primary tin consumption	0.1	0.1	0.1	0.1	0.1	0.1
Tin-in-concentrate exports	11.2	12.8	10.9	0.5	0.0[illegible]	...
Primary tin exports	-	-	5.0 [1]	17.6	26.9	[illegible].4

1/ Exports to the United States.

A considerable growth of tin-in-concentrate production in the country was due to comparatively high prices of tin, which rarely declined below 3,300 dollars per ton during 1964-1967.

Due to this price it was possible to put into operation a great number of hydraulic gravel pumps, which provide for economic tin ore mining despite relatively high production costs.

At the end of 1967 in Thailand there were 712 mines in operation including 22 dredges (18.3 % of the total tin mining). The share of tributors in the total production amounts to 2.9%.

The Thailand government hopes to increase tin-in-concentrate production up to 35 thous. tons by 1971 with proposed capital investments amounting to ฿ [illegible] million.

A great attention is payed to prospecting for sea-bed and beach sand deposits.

Marine placers between Phuket island and the mainland are being worked by two bucket dredges. One of these dredges is owned by "Tongkah Harbour Tin" the other is operated by "Aokam Tin Ltd". The latter is building another dredge Aokam Tin N 3 for working marine placer deposits. The costs of oonstruction is on the order of ฿ 2.8 million.

In October of 1967 a new hydraulic dredge was put into operation by "Southern Kinta Co.". This dredge is working beach shallow placers in the Takuapah area (Western Thailand).

The initial costs of construction (including equipment on the shore) are about 1.4 million dollars, which is somewhat less than half of the costs, needed for construction of a modern bucket dredge having a large capacity.

The country began tin smelting only in 1965 (5.6 thous.tons) at a new smelter on Phuket island, owned by "Thailand Smelting and Refining" (a subsidiary of US Union Carbide and Thai Eastern Mining and Development of Thailand).

At this plant with a rated capacity of 33 thous. tons per annum tin concentrates and slags are smelted in modernized reverberatory furnaces.

Tin, produced by the plant is exported to other countries. The costs of plant construction amount to 7 million dollars. There is a number of small plants, producing tin for internal market.

Tin exports pattern has changed in recent years.

Until 1965 all tin concentrates were exported to other countries, mainly to Malaysia and Holland.

Beginning from 1966 the country exports tin metal only (26.9 thous. tons in 1967). Tin is exported mainly to the United States (16.8 thous. tons in 1967) and Holland (3.1 thous. tons).

With available reserves, tin production of Thailand can be considerably increased, primary deposits are considered as important sources of raw materials. There are chances of discovering new large placers and this is shown by a new deposit, found in 1966 in the well studied mountains Khao Luang in Southern Thailand:

In 1967 the labour force employed in tin industry consisted of 37.7 thousand workers. Tin-in-concentrate output per one worker amounted to 0.65 ton a year.

§ 12. The Kingdom of Laos

Laos, independent from 1954, is a landlocked kingdom in the centre of the Indochinese penisula bounded North by China, North-east by North Vietnam and East by South Vietnam, South by Cambodia and West by Thailand and Burma.

Territory - 237,000 sq.km

Population - 2.8 M people

Population density - 12 persons per sq.km

Capital - Vientiane

Laos is mountainous country. The main stream is Mekong. Climate is tropical, monsoon.

There are no railways in the country. Out of 4000 km of roads only half can be used for traffic during rains.

The most important of the various mineral resources found in Laos are tin, copper, gold, antimony, coal, bauxite.

<u>Tin industry</u>. The resources of tin in the country total 60,000 t. All deposits are proved and probable. Tin content in ores is 0.4-0.5%, rarely 1-2%.

At present some 300-400 t of tin are mined in the country annualy. The main mining operations are carried in the province of Cammon by the French company "Société d'Etudes et d'Exploitations Minières de l'Indochine". The deposit is situated in the Nam Patene basin in the Phon Tiou region about 80 kilometres North from Thakhek. The body is worked by open-cast mining with the annual capacity 30,000 t of ore.

The beneficiation of sulfide-cassiterite ores with metal content of 0.4-0.5% is carried on the concentration tables. The capacity of the mill is 35-40 t of 60% tin concentrate per month.

Additional concentrating capacities were put into production by the company in 1966 with the capital investment of $ 816,000.

The company plans to begin working dumps (which have been accumulated from 1920) for the production of 150 t of 50% tin concentrate.

There have been reports of the resumption of tin mining in the district of Boneng and of the re-working by a new company "S.A.Mixte des Mines de Nong Sun", of deposits formerly operated by the "Cia.des Etains d'Extreme-Orient". The production is small-some 100 t tin concentrate per year.

The Japanese firm "Mitsubishi" is considering the erection of a smelter in Laos.

All concentrates produced in the country are exported (mainly to Malaysia).

<u>Lead-zinc industry</u>. There are many practically unexplored lead-zinc vien deposits in which gold also often occurs. These deposits are concentrated in three regions. Capaban, Chepon and Vientiane. The resources are neither estimated nor accounted.

Recently new, supposingly large, deposits of lead in which zinc and silver are also present were found near Chepon.

The Laos government is striving for the economical dovolopment of the country. The railroad construction is carried out and certain steps are made for the development of river and air transport.

§ I3. The Republic of Singapore

The Republic of Singapore is located on the island of the same name and some small islands adjoining the Southern extremity of the Malay Peninsula in South-eastern Asia.

Singapore became an independent country in August I965. Before it was a part of the Federation of Malaysia.

Total area - 58I sq.km.

Population - 1.9 million peoples

Population density - 3 293 persons per sq.km.

Capital - Singapore

Singapore is connected with Malaya by a railway and a highway running along the dam. Singapore is a naval base and a seaport, through which about 60 international routes pass. Table I lists the data on electric power generation in the country.

Table I

Electric power generation

	Years				
	I958	I963	I964	I965	I966
Installed capacity, thousand kw	I52	224	224	344	464
Power generation, million kwhr	565	823	9I4	I047	I236

In 1966 the second five-year plan (1966-1970), which pays serious considerations to industrial development, was started. The total assigned sum amounted to 1250-1300 million Malay dollars. In 1966 63 industrial projects were under construction, including a metallurgical plant, a new port and a new shipyard.

At present about 2000 metric tons of aluminium sheets a year are imported to Singapore from abroad, mainly from Japan.

Two American companies plan the construction of two aluminium-sheet works in Singapore. The plants will be based on aluminium obtained from the USA.

Tin smeltery, owned by Straits Trading Co., is located in Pulau Brany. According to estimates the plant has a capacity of 15000 metric tons of metal a year.

Concentrates are imported from Malaysia and other countries of south-eastern Asia (Burma, Indonesia and others).

Reverberatory smelting of blister metal and fire refining of blister tin are used.

SECTION IV

ALUMINIUM, COPPER, LEAD, ZINC AND TIN IN THE DEVELOPING COUNTRIES OF LATIN AMERICA

§ 1. United Mexican States

The United Mexican States (a Federal Republic) is the most northern country among other Latin American countries. It has a land frontier with the U.S. on the north and with Guatemala and Honduras on the south-east. Its coasts are washed by the waters of the Atlantic Ocean (Mexican Gulf and the Caribbean Sea) and the Pacific Ocean.

Territory	- 1972 thous sq.km
Population	- 45.7 million people
Population density	- 23 persons per sq.km
Capital - Mexico City	

Principal cities: Monterrey, Guadalajara, Puebla, Morida, Torreon, San Louis Potosi.

Sea Ports: Tompeco, Vera Cruz, Mazatlan Acapulco, Salina Cruz.

Mountains and a plateau occupy the greater part of the Mexican territory. Their average heights are 1000-2500 metres above the sea level. The distant 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. The rivers are abunding in water and rich in hydropower. There are few lakes.

The railway lines are running from the central plateau with its highly developed economy, to the North to the U.S.; the latitudinal railway lines provide connection with the ports of the Pacific Ocean and the Mexican Gulf. The total length of the railway lines is above 23 thousand km.

The main roads go from Mexico to Vera Cruz, Acapulco, Nuevo Laredo. Their total length is 45 thousand km. An extra amount of 7,5 thousand km of highway roads is being additionally built since 1966.

The total installed capacity of private and state electric power plants in 1966 was 5684 thousand kilowatts, hydroelectric plants accounted approximately for 50% of this. New power plants with the total capacity of 954 thousand kw. are being built now.

Table 1

Electric power generation

	Years				
	1958	1963	1964	1965	1966
The installed capacity, in thousands k.w. The total amount	2560	4193	5189	5245	5684
including hydro-electric power	1184	1597	2285	2292	...
The output of electric power, in millions k.w.h. The total amount	9058	13567	17146	17253	19024
including hydro-electric power	4450	6024	7075	8609	...

Mineral fuel resources and the output are shown in table 2.

Table 2

Fuel production

	Years			
	1955	1960	1965	1966
Coal, in thousand tons	1342	1074	943	1261
Oil, in thousand tons	12786	14171	16874	17317
Natural gas, in million/m3	3392	9665	13965	14985

Many non-ferrous metals such as copper, lead, zinc, silver, tin, mercury, antimony, are mined in the country.

Aluminium industry of Mexico founded in 1963 is working on the imported alumina.

Mexico has no aluminium resources of its own. There is only one known bauxite deposit. It is located between the towns of Tampico and San Louis Potosi and is at the reserve disposal of the Mexican Government. No data about this deposit are available.

The production and consumption of aluminium and its export trade is shown in table 3.

Table 3

Production and consumption of primary aluminium, foreign trade, in thousand tons

	Years					
	1955	1960	1965	1966	1967	1968
Bauxite imports	-	6.0	15.0	9.9	...	...
Alumina imports	2.1	6.4	49.5	47.5	...	...
Production of primary aluminium	-	-	22	21	21	22

Continued

	Years					
	1955	1960	1965	1966	1967	1968
Consumption of primary aluminium	8.0	11	20	22	20	20
Aluminium imports	8.0	11.2	0.5	0.1	-	-
Imports of aluminium semi-products	3.1	0.6	4.4	1.2	...	...

A recently built aluminium plant is operating in the State of Vera Cruz. The productional output is about 20 thousand tons, the construction of it costed 20 million dollars. The alumina and electrodes for it are imported from the aluminium works in Point-Comfort, Texas, U.S.A., at the distance of 1040 km. Power is supplied from the hydro-power plant in Amaskal.

72 pot cells are installed at the plant on 100 ka current. The capacity of the Vera Cruz plant is to be increased up to 30 thousand tons by the end of 1968, and by another 10 thousand tons by 1970. Thus the production of aluminium will reach 40 thousand tons annually.

Since 1967 large scale operations are undertaken to produce aluminium from the local alunite ores, the deposits of which in the country are in abundance. After the fulfilment of these plans the country would turn into one of the large producers of aluminium from alunite. The capacity of the alunite processing plant after the completion of construction will amount to 600 thousand tons per year.

More than 10 plants controlled mainly by the aluminium companies of the U.S.A. and Canada, are producing the semi-finished aluminium products. These plants are processing aluminium produced by the Vera Cruz plants as well as one exported from the U.S.A.

Altogether 10 horizontal hydraulic presses are installed at the aluminium plants for production of profile sections and tubes.

Copper industry. The total calculated copper reserves in the country are 1 million tons. Out of this amount 680 thousand tons can be considered proved and probable. The concentration of copper in the ore ranges from 0.5% to 4.7%; the average extent being 1%.

Mining , production and export trade of copper are shown in Table 4.

Table 4

Production, exports and consumption of coppor in thousand tons

	Years					
	1955	1960	1965	1966	1967	1968
Mine production (copper content)	55	60	69	74	63	63
Production of blister copper	56	52	52	51	50	55
Production of refined copper	35	28	46	48	47	51
Consumption of refined copper	14	20	36	30	34	34
Exports of copper concentrates	37	21	7	6	...	...
Exports of blister and refined copper	46	35	9	8	...	...

More than 50% of copper is mined from the copper-porphyry deposit of Grin-Cananea belonging to the Minera de Cananea company. The concentrator of Cananea, with the total output of 22 tons per day, processes the copper-porphyry ores with 1% of copper and 0.005% of molybdenum content. The copper concentrate has 25% of copper.

Copper concentrates are also obtained as a byproduct during the process of ore dressing at the concentrators Parral and San Francisco (see table 5).

Table 5

Some figures showing the work of the concentrators

Mill	Production of ore in tons per day	Copper content in ore, %	Copper content in the copper concentrate, %	Extraction in the above concentrate, %
Cananea	22000	0.78	26	...
San Francisco	2000	0.8	25	...
Parral	1450	...	30	52

The ore and concentrates are brought to the copper smelting plants of Cananea, Santa Rocalia, San-Luis Potosi. Here is a short description of some copper refining and smelting plants of Mexico.

The Cananea plant was put into operation in 1937, its output is 40 thousand tons of crude copper per year. The plant processes the copper concentrates of the concentrator of Cananea . It produces copper by concentrate smelting in the reverberatory furnace. These is also an installation producing cement copper by underground leaching; its output is 5 thousand tons of cement copper.

The output capacity of the smelter in San Luis Potosi is 50 tons of crude copper.

The capacity of Santa Rocalia smelter is 7 thousand tons of crude copper.

The capacity of the single copper electrolitic plant of Mexico in Atzacapotzalco became 54 thousand tons after extension. It refines crude copper from the Cananea and partially San Luis Potosi plants. The finished products are: wire bars cathodes(plates), billets and copper vitriol.

The country consumes 50-55 thousand tons of refined copper annually. It is treated at 10 copper processing plants with total capacity of 40-50 thousand tons per year.

Until the 60th the American monopolies controlled the non-ferrous metallurgy of Mexico to a great extent. The copper industry (mining, production, processing) was in the hands of two U.S. companies Anaconda and American Smelting and Refining (ASARCO). The latter together with the Penoles (American Metal Climax subsidiary) controlled the lead-zinc, the precious metal industry , and so on.

A governmental decree issued in 1961 required that not less than 51% of shares of the operating in Mexico foreign firms should be taken over by the Mexican capital. But a group of mexican manufacturers was able to aquire 51% of the

ASARCO shares only in 1965. The company was then renamed ASARCO Mexicana.

This decree has not yet been applied at the copper industry enterprises of Cananea and Cobre; they still belong to the US monopoly "Anaconda".

A number of measures taken at the end of 1966 and during 1967 helped to reduce the taxis on the mining industries with the prevailing mexican capital. They were granted some tax priviledges at the period of explotation of new or regenerated enterprises.

Lead and zinc industry. Mexico ranks third in supply of these metals after the U.S.A. and Canada. The total reserves of lead here are 6.0 million tons, 3.2 out of them can be referred to as proved and probable; the zinc reserves are likewise - 12 million tons and 3.6 mln.tons. The average content of lead in the ore is in the range of 1.5-5.6%; of zinc 4-13%; but in different and sometimes rather wide areas the content is much higher amounting to some dozens per cents.

The total number of deposits is more than 200 and they are scaterred all over the country. The developed deposits can be found in 22 out of the 29 states.

Some figures illustrating the output and consumption of lead are given in Table 6.

The mining is conducted mostly in underground mines. The majority of mines are small only some of them are large and fairly mechanized. Among the latter there are pits: Parral, Santa Barbara, Naica, Minera-Fricko (all of them in the State Chiuaua); Fresnillo (State Sacatecas) with the output of 0.5-1 million tons of ore per year; Charcas in the State of San Luis Potosi and Taxo in the State Sacatecas producing about 200 thousand tons of ore annually.

The prospects of the further growth of ore mining in Mexico are rather bright. In spite of the fact that many deposits are being mined constantly since the XVI century, and that mining has reached the depth of about 500-900 meters down from the surface, there is no exhausting of deposits.

Table 6

Mining, production, consumption and exports of zinc and lead in thousands tons

	Years					
	1955	1960	1965	1966	1967	1968
Mine production (lead content)	211	190	170	168	167	164
Mine production (zinc content)	269	244	233	238	237	239
Production of primary lead	198	173	164	172	170	171
Production of primary zinc	56	53	63	72	74	72
Consumption of primary lead	18	32	55	60	63	63
Consumption of primary zinc	13	23	32	35	37	36
Exports of lead ore and concentrates	4	4	6	2	...	...
Exports of zinc ore (zinc content)	371[1)]	203	164	163	160	162
Exports of pig lead	4	12	10	15	12	
Exports of primary lead (including antimony in lead)	180	133	97	99	86	115
Exports of primary zinc	49	30	26	39	50	36

1) The full weight of the ore

Vice versa at a number of places new and rich ore bodies are found at a greater depth. There are also possibilities of discovering new deposits and a good proof of it are the recently found large accumulations of lead and zinc ores in Sierra Mocgina (State Chiuaua) and in Mexico State.

Mexico occupies the fourth place in the world after Australia, Canada and the U.S.A. in lead ore mining, and the sixth place after Canada; the U.S.A., Australia, Peru and Japan in zinc ore mining.

The dressing of the zinc and lead ores takes place at 7 concentrators , the largest of which are: El Potosi - 2900 tons per day, San Francisco - 2000 tons per day, Parral - 1450 tons per day, Esmeralda - 1000 tons per day, Santa Barbara , Tresmilio, San Antonio. The ores are dressed according to the technological flowsheet including crushing, screening and direct selective floatation of zinc and lead minerals.

The metallurgical processing of almost all mined lead ~~are~~ is carried out in Mexico. The greater part of the crude lead smelted in the country is refined locally and only a small amount (some 10-15 thousand tons per year) is exported to the refininf plants of the U.S.A. and Belgium.

But only about 30% of zinc concentrates are processed at the metallurgical plants of Mexico. More than 70% are exported (mainly to the USA and Japan). There are 8 plants in Mexico altogether: five lead and three zinc plants.

The lead smelting works Torreon (State of Koauila) is in operation since 1894. The output capacity of it for 1968 - is the processing of 318 thousand tons of charge. The output products of this works are: crude lead, copper matte , arsenic, sulphuric acid. The lead concentrates contain 55% of lead; 2.2% of copper; 0.31% silver and 0.05% of cadmium.

The lead smelting works of Chiuaua is operating since 1906. Its capacity for 1968 was processing of 450 thou. tons of charge.

The lead smelter Muskis (State of Coanila). The production capacity is 20 thousand tons of crude lead per year. The product of the smelter is crude lead.

Lead refining plant Monterray, of the Metallurgical Mexicana Peniles company is situated in the Nuevo-Leone state. It is refining the crude lead of the Torreon plant as well as of some other small mexican plants. The production capacity for 1968 was 118 thousand tons of refined lead. The ready products are: refined and antimony lead (1900 tons); bismuth (90 tons); silver (635 tons); gold (5.5 tons); lead oxide (270 tons); babbit, solder.

Lead refining plant is Monterray of the Asarco plant (State of Nuevo-Leone) is operating since 1926. It is refining crude lead of the Chiuaua plant. The production capacity in 1968 is 163 thousand tons of refined lead.

The ready products are: refined lead, gold, silver, copper matte , antimony and bismuth alloys.

Zinc distilling plant in Saltillo was put in operation in 1964. It is processing 60 thousand tons of sulphide zinc concentrates per year. The annual production capacity of the plant is 50 thousand tons of pig zinc, 99.9% pure; 240 tons of cadmium and in addition sulphuric acid. The plant is distilling zinc in horizontal retorts and is refining it in rectifying colomns.

The zinc plant of Nuevo-Rocita (State of Coahila). The production capacity of it is 63.5 thousand tons of distilled zinc annualy. It processes sulphide concentrates. The main product is the distilled zinc Prime Western (98.5% of zinc). Zinc is distilled in horizontal retorts.

The plant is equipped with 8 furnaces, the total amount of retorts in which is 8064.

The zinc refining plant Tlalnepan' (State of Edo). The annual production capacity of the plant is 16 thousand tons of special highgrade zinc" (99.99%of zinc) and some zinc alloys of the "Samak" type. It is processing zinc of the Prime wastern grade (98.5% of zinc) and some non-ferrous metals for alloys. The main scheme is fractional distillation in the vertical colomn.

About 35% of the produced lead and 48% of zinc is consumed in the country and is used for the production of rollings, , litharge, zinc oxide, zinc dust, etc.

There is a small plant for zinc rolling in the town of Tlalnepantla. It is built in 1954 and producers zinc plates, anodes, and sheets.

The main importer of the Mexican zinc and lead is the U.S. Some amounts of primary lead are exported to the FRG and Japan.

The leading company in the zinc-lead industry (as well as in the copper industry) is the Asarco Mexican with 51% of Mexican investments and 49% of shares belonging to one of the largest U.S. firms American Smelting and Refining company (Asarco). Asarco Mexicana owns also two crude zinc smelting plants in Chiuaua and San Luis-Potosi (the latter is not operating now) a lead refining plant is Monterrey and zinc distilling plant in Monterrey and zinc distilling plant in in Nyevo-Rocita. The Company has announced its intention to invest some 870 thousand dollars in the extention and modernization of their plants.

The second largest company in Mexico is Minera and Metallurgical Mexicana Penioles, with a 100% Mexican capital. It owns lead refining and melting plants. The company intends to construct a shaft furnace for smelting of lead-zinc concentrates by the Imperial Smelting Process. The estimated cost of the construction is 240 thousand dollars.

Tin industry. The total estimated reserves of tin in Mexico are 28 thousand tons, out of which 20 thousand tons are considered proved and probable. The metal content in different deposits has a wide range from a hundredth part of one percent in complex ores to 5-8% in the most enriched zones.

The tin deposits are numerous (more than 1000) they are found in 20 States, but the majority of them are either too small or have a low content of metal. Many of the tin deposits are not yet thoroughly studied. Recently some new deposits are discovered, among them a very large zone (State of Najarit) with an estimated reserve of 20 thousand tons of metal.

The following table gives some figures illustrating the mining and output of tin in the country (Table 7).

The main regions of tin mining are the States of San-Luis-Potosi and Durango. About 400-600 tons of tins are mined annually. The leading mining company is "Minera de Estano". The primary tin is produced at the small plants inside the country. The largest of the plants controlled by "Estano Electro" is in the town of Tlalnepantla. The brief characteristics of the plants are:

Table 7

Production of tin in thousand tons

	Years					
	1955	1960	1965	1966	1967	1968
Production of tin-in-concentrates	0.6	0.4	0.5	0.8	0.6	0.7
Production of primary tin	0.2	0.7	1.0	1.0	1.0	1.0
Consumption of primary tin	0.7	1.2	1.2	1.2	1.6	1.6
Imports of tin	0.5	0.6	0.7[1]	0.5[1]	0.2[1]	0.4
Imports of tin-in-concentrates	-	-	0.1	0.2	0.1	-

[1] According to the figures about U.S. export

<u>Output:</u> 1.3 thousand tons of metallic tin per year

<u>The processed raw materials</u>: mexican complex concentrates having some 45-65% (sometimes 15%) of tin, with additions of lead, zinc and silver

Technological Scheme

Roasting - melting in the reverberatory furnace - electrolysis.

The ready products are: pig tin and tin solder.

Tin consumption (%): tin - 99.833; Antimony - 0.033; lead - 0.038; bismuth - 0.003; copper - 0.007; iron - 0.003.

The consumption of primary tin in the country amounts in average to 1.2 thousand tons per year. In 1967 it was increased up to 1.6 thousand tons. A small amount of this metal is imported, mainly from the U.S.A.

§ 2. Republic of Bolivia

The Republic of Bolivia borders on Brazil,Paraguay, Argentina, Chile, Peru.

Territory I.I M sq. km.

Population - 3748 thous. people

Population density - 3 persons per sq.km.

Capital - Sucre (legal), La Paz (actual)

Principal cities: Cochabamba ,Oruro, Santa Cruz.

The western part of Bolivia is occupied by the And mountain ranges, which frame the Altiplano plateau , theeastern part is a flat country. The climate varies from cold and desert in And mountains to damp and tropical on the plains.

The transport communications in the country are hampered.The extension of railway lines is only 3.7 thousand km., the share of state lines is 2.4 thousand km.The network of highways is still less.Pack animals are rather widely used in the mountains.

The Bolivia's electric power is mainly generated in hydro-electric stations.In the total installed capacity the share of thermal power plants does not exceed 40%, their share in the generation of electricity is still less (Table I).

Table I

Electric Power Generation

	Years				
	1958	1963	1964	1965	1966
The installed capacity total , thous. kw	143	159	160	163	213
the share of hydro-stations	92	93	93	92	...
The generation of electric power, M. Kwhr					
[illegible]	444	531	534	541	584
the share of hydro-stations	332	409	421	426	...

Fuel resources are limited by the mining of oil and natural gas (table 2)

Table 2

Fuel production

	Years			
	1955	1960	1965	[illegible]
Oil, thous. tons	351	466	438	[illegible]
Natural gas M. m^3	-	-	103	[illegible]

The eastern plain of Bolivia lies in the region of the Amazon in the Bolivian zone of the so called "Brazilian shield", it occupies 60% of the country's territory, but is inhabited only by I5% of the population. Lack of roads, dense forests and a thick alluvial layer (stratum) make geological prospectin and industrial development of the mineral resources of this region very difficult.

The best explored part of the country is the Bilivian Ands which can be placed among the richest ore districts of the world.Poor vegetation and very often quite barren rocks make prospecting easy, but lack of roads is a serious difficulty even under such conditions.

There are largest deposits of tin ores in Bolivia as well as considerable reserves of antimony and wolfram. Copper, lead and zinc are also mined in the country.

<u>Aluminium industry</u>. In 1955 the discovery of a bauxite deposit was reported from Sud Yungus Province and near Suri ,La Paz province.But no information concerning the size of the deposit, the quality of bauxites, their industrial importance was published neither in that report nor later.

<u>Copper industry</u>. According to the figures of the corporation Comibol (Corporation Minera de Bolivia) published in I967 the total reserves of copper in Bolivia amount to 267 thous. tons, the prospected I9 thous.t. included.

The copper deposits are situated in the western part of the country within the lofty Altiplano plateau. The largest of them is in Corocoro region, where copper sandstones are prevailing. The seams are 0.5-6 m thick, copper concentration being 0.6-3%. The deposit is not worked yet.

Recently exploration and prospecting for copper deposits have been intensified with the participation of Japanese firms. The Carangas deposit 200 km south of Corocoro has been discovered, having an approximate supply of 13 M tons of ore with a 5% copper content. The geological data suggest the possibility of the new large deposits discovery.

The Hacarilla pit is the main producer of copper. The veins containing chalcosine are mined here. The prospected amount of this deposit is 3.9 thous. t., the total - about 30 thous. t. of copper, the ore containing 2.17-2.5% of metal. Besides, a part of copper is recovered as by product from the lead zink ores of the Matilda deposit situated at the Titicaca lake and from some tin deposits.

The annual output of copper concentrates is averagely 6 thous. tons. After dressing the concentrates are exported to the U.S.A. and Japan. There is no smelter in the country.

The Japanese consortium, among the members of which are the firms "Nippon Mining", "Micubici Iumitomo", "Dova and Furukava", made an agreement with the mining

Bank of Bolivia, representing small and middle pits . about exporting to Japan 4-5 thous. t. of copper in concentrates for the period of 3 years.

The contract provides that the cost of concentrates processing should be not more than 34.9 dollars per ton. The copper content in concentrates is averagely 25%.

Lead-zinc industry is one of the developing branches of the non-ferrous metallurgy of the country.

The situation connected with raw material resources of these metals is quite an unique one. The total reserves of lead and zinc in the entrails are not large and amounted in 1967 according to the limited figures to 234 thous. t. of lead, of which 125 thou tons, ~~thou~~, can be considered proved and probable, and 67% and 755 thousand tons of zinc correspondingly. Large pure lead-zinc rich deposits are comparatively few, the majority of them having sharp prevailance of zinc.

At the same time complex tin and tin-silver deposits are widely distributed in the country and have been mined for many centures. The ores of the above deposits contain lead and zinc in large amounts, but they are not taken into account when total reserves are estimated. Besides, these deposits have been worked for long periods either as silver or as tin deposits, the rest of the associated components were not extracted. Therefore great amounts of different waste material: dumps of poor (for the antient periods of processing) eres, dressing tailings, slags and so on are stored near the old mines, the content of lead in them amounting to dozens of per cent. The processing of these "wastes" will apperantly enable the work of a metallurgical plant for a long period of time, but special studies are required to establish their total volume and the amount of metal concentration in them.

All the pure lead-zinc deposits can be referred to as the lode type, veins running through different rock formations. The content of zinc in them ranges from 8.3 to 19.2%, the average being 17.2%. The average content of zinc is only 2.8%, copper is present almost everywhere (0.3-0.8%), as well as silver (30-200 g t.)

A great number of small or poorer lead-zinc deposits, which remain almost unstudied are known in the country. Thus the raw material resources allow to develop lead and zinc mining but complex geographical and economic conditions are the main obstacle to this development.

Figures about the output and exports of lead and zinc from Bolivia are given in Table 3.

Table 3

Production of lead and zinc, thous. tons

	Years					
	1955	1960	1965	1966	1967	1968
Mine production (lead content)	19	21	20	20	20	20
Mine production (zinc content)	21	4	13	12	16	15

At present lead-zinc deposits are worked in the Potosi district, at the Maria-Louiza and Sectio - Chasaya mines. Mining at all of them is conducted in galleries under very difficult alpine conditions. The output of different mines is from 100 to 250 thous. tons of ore anunually, but the reserves of these deposits are nearly depleted, and they may be closed for a time in the near future, just in the same way, as it happened to the [illegible]caya mine situated here.

The main quantity of zinc produced in the country is obtained from the Matilda deposit at the Titicaca lake, the deposit has aquired great importance lately. Its reserves are estimated at 3.6 M. tons of ore,

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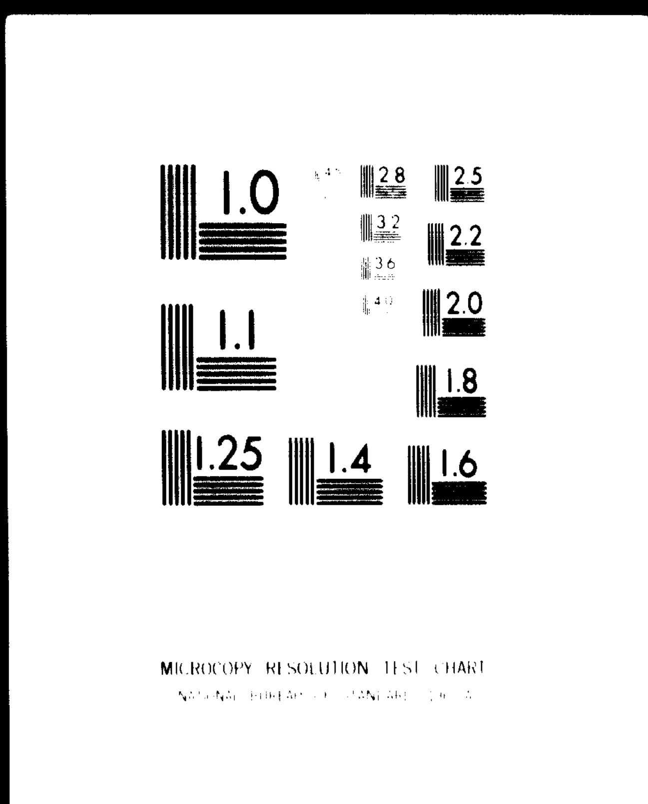

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containing 2.0-2.5% of lead, 17-18% of zinc, 0.4% of copper and 50-60 g /t of silver. The planned annual output of this pit is 250 thous. t. of ore.

All lead and zinc concentrates produced in Bolivia are exported.The main mining company is "Empresa Minera Matilda", controlled by the state firm "Corporacion Minera de Bolivia" (Comibol).

At present two U.S.A. companies "United States Steel" and "Filipps Brothers" are completing the preparation for exploiting one more pit in Bolivia.

<u>Tin industry.</u> According to the Comibol figures the total reserves of tin in the country for 1967 were 1150 thous. t., out of which 689 thous t. in ore deposits, 228 thous. t. in old fusions and tailings, and 223 thous. t. in field deposits.The proved and probable reserves were respectively total - 386.5 thous. t., out of which - 247 in ore mine deposits: 112 thous. t. in dumps, 27.5 thous.t. in field deposits.

The Bolivian tin belt stretches almost for 800 km, having a 100 km width from the Peru border in the Titicaca lake district up to the northern part of Jujuy province in Argentina.The size of different deposits in the northern part of the belt is not large, tin reserves in the largest of them (Monserat) do not exceed 8-9 thous. t., but the ores are immensely rich (up to IO-I2% of tin).

Chiefly important is the sourthern part of the belt, stretching south of La Paz up to Potosi. A number of tin deposits is concentrated here. The chief deposits with the supply of 50-I20 thous. t. of tin each (Llalagua, Huanani, Colcviri, San Jose) are situated at a distance not more than I00 km from Oruro, only one deposit Cerro Rico de Potos, located in the Potosi district is somewhat away from the main group. Tin content in the chief deposits ranges averagely from 0.5% to 2%.

The placers are of minor importance. For some years especially after world war II, the geological prospecting for tin was conducted on a very small scale. Only recently, after a long interval, the explorin and prospecting for tin deposits in the country was renewed. Thus, in I967 a large deposit with reserves of 2.4 M t. of ore, containing I.3% of tin was found in the vicinity of Celluani mine, 35 km north of La Paz.

Figures illustrating the work of the Bolivia tin industry for different years are given in Table 4.

Table 4

Production and exports of tin in Bolivia, thous. t.

	Years					
	1955	1960	1965	1966	1967	1968
Production of tin-in-concentrates	28.4	I9.7	23.4	25.9	27.7	29.6
Production of primary tin	0.I	I.I	3.5	I.I	I.I	0.06
Consumption of primary tin	-	0.04	0.05	0.06	0.06	0.08
Exports of concentrates (metal content)	28.0	I8.6	20.7	25.I	26.0	29.3
Exports of primary tin	0.I	I.I	3.5	I.I	I.I	0.06

Almost all local deposits of Bolivia, with the exeption of pegmatitic bodies, are worked by means of underground mining.

The ore bodies are mostly thin (less than I m), steep veins. The system used in their working is the shrinkage breast system sometimes combined with stowing. At the largest Llalagua mine, thick (up to 5 m.) ore zones formed by the concentration of thin veins, another more productive system of block caving is used.

The greater part of tin-in-concentrates (more than 70%) is produced at th plants of the state cor...

tion "Comibol".

The chief mines of this corporation are: Catavi (Cerro Rico de Potosi deposit), Chorolque and San Jose. The annual production of them is from 200 thous tons. to 2.5 M tons of ore. Besides, there is a great number of smaller mines, including many hundreds of little shop pits owned by private capital.

The results of the work of twelve mostly known dressing mills of the "Comibol" corporation are shown in Table 5.

Extraction of tin from tin streams was of little importance lately. Only in 1967 a new drag sheduled for 1300 tons of tin annually was put into explotion on the largest Avisaia stream at the Anteguera river, having a 2.5 Mm^3 reserves of sands, containing 0.13-6.6 kg/m^3 of cassiterite.

The typical feature of the tin producing industry of Bolivia (and some other countries) is the growing reduction of tin content in the mined and processed ores.

Working of the rich zones in mines conducted for a long time without any considerable expense on exploring and prospecting for new tin deposits contributed to this fact.

The average content of tin in the processed ore of

Table 5

Resulting output of the "Comibol" corporation dressing mills for I964 1/

Name of the Mill	Ore dressing, thous. t. per year	Average concentration of tin in ore %	Average content of tin in concentrates %	Extraction of tin, %	Total tin in concentrates, t/year
Total, "Comibol" included	2,7I8.0	0.8I	34.08	50.9	II,2I3
Caracoles	56.25	I.55	57.5	72.7	634
Chorolque (Sala-Sala)	8I.84	I.95	5I.I2	72.I	I,I5I
Huanani	209.3	0.77	36.4I	6I.4	990
Viloco	38.63	I.24	40.89	55.5	266
Catavi (Llallagua)	I,204.4	0.54	49.75	46.0	2,992
Morococola	30.0	I.2I	I9.97	34.3	I25
Colcviri	46I.I	0.84	39.66	50.I	I,94I
Japo	3I.I	I.I	36.62	50.0	I7I
Santa Fe	54.6	I.II	I8.I	36.9	224
Machacamarca (San Jose)	II6.7	I.4I	2I.55	43.0	708
Potosi	2I0.9	I.I8	20.65	54.3	I,352
Tasna	54.8	I.84	40.28	44.0	444

1/ According to the figures given in the D.S.Fox paper - "Bolivian tin industry" presented at the technical conference on tin in I967, London.

different concentrators shown in the table amounted to 0.81% in I964 compared to I.87% in I950 and more than 3% in I938. Low extraction of tin at the Bolivia concentrators, draws everybody's attention. This fact is explained by the complex mineralogical composition of the ore, large quantites of sulphide minerals and often by very fine impregnation of tin. The classical scheme of tin ore dressing by gravitation and flotation for the removal of sulphide does not provide a satisfactory extraction of tin in such cases.

The majority of Bolivian concentrates are exported to Great Britain - 19.7 thou.tons, U.S.A. - 5.7 thou.tons FRG- I.5 thou.tons (I967 figures evaluated for tin).

Metallic tin is smelted at two small metallurgical plants in Oruro. The production of it in I967 amounted only to I.I thou.tons. The plants process also low grade concentrates, the method used is sublimation in rotary furnace.

"Comibol" corporation intends to construct a central concentrator for benification of low grade ~~the~~ tin concentrates, produced at the dressing mills, working on hardly processed ores. The concentrator will provide the smelters with stable and high grade concentrates.

In March I967 Bolivian government signed an agreement with a FRG company "Klockner Industrielle Anlagen" providing the construction of a tin smelter in the Vinto region, 8 km east of Oruro, with the initial capacity of 7.5 thou.tons of metal annually.

The construction cost is 9.2 M.dollars, out of which 5.6 M will come from the FRG credit and more than 4 M from a state subsidy. The exploitation start is sheduled for the end of I969. The final capacity will be 20 thous. tons of tin annually. Managing and production activity will be carried out by the state company "Empressa Nacional de Fundicione" (ENAF) under the "Comibol" control.

The technological scheme of the plant is, roasting of concentrates, smelting in the reverberatory furnace for crude tin and high grade slag, sublimation of tin from slag for the production of tin oxide (50% of tin) with the further remelting in the reverberatory furnaces, fire refining of crude tin, casting of anodes, electrolysis in cresolsulfone electrolyte and processing of slime in the rotary furnace.

The final products are: refined tin - 99.95% Sn alloys on tin base.

Beginning with 1961 the state corporation "Comibol" undertakes reconstruction and modernization of its mining industry enterprisis. In this connection a three-sided agreement was signed between U.S.A. (International development agency), FRG (Saltzgitter Mashinen firm) and Interamerican Development Bank, about a 38 M. dollars loan to Bolivia.

The first two stages of the reconstruction program were accomplished by 1963. The capital investment reached 22 M. dollars - mainly for providing the equipment, as well as technical and scientific assistance.

After the agreement concluded, a national economy development plan for the 1962-1971 period was adapted providing an increase of tin concentrate production up to 30 thous.tons annually.

The measures taken soon resulted in some increase. Tin concentrate output was raised up to 29.6 thous. tons in 1968 compared to 27.3 thous.tons in 1967, and 25.9 thous.tons in 1966.

The production expenses on the nationalized mines decreased and some of them began to raise profits after selling their products.

Tin output of Bolivia is sheduled to be increased in the near future up to 40-42 thous.tons annually. This amount will be achieved as a result of the construction of new enterprises, development of strippable part of the Llallangua deposit by open-pit working, as well as output increase of the mines in operation. The increase of the working of old dumps is likewise sheduled. These are the dumps formed during the long period of several centures (XVII-XIX), when some of the deposits were mined only for silver, no tin being extracted.

One of the most serious problems of the Bolivian tin industry is the improvement of processing of hardly dressed ores of complex mineral composition. The chief aim is to reduce the enormous waste of metal during dressing, amounting sometimes to half and even more of the total metal content quantity in ore.

One of the probable ways of solving this problem would be obtaining at the dressing and benefication mills of low grade concentrates for special pyrometallurgical processing, may be of the fuming processing type, in addition to high grade concentrates used in ordinary tin smelting. This would enable the extraction of tin from the poorly dressed ore products, as well as from the metallurgical refined products, and production of rich-in-tin sublimates which will be routed to the electric furnaces for smelting. Evidently preliminary experimental tests and thorough economic calculations concerning the specific conditions of every enterprise will be necessary before elaborating any suggestions in this field.

§ 3. Federative Republic of Venezuela

The Federative Republic of Venezuela is located in the north part of South America on the Caribbean coast. On the south and south-east it borders on Brazil and Colombia.

Territory - 912 thous. sq. km.

Population - 9352 thous.people

Population density - 10 persons per sq.km.

Capital - Caracas.

Large cities - Maracaibo, Barquicimento,Valencia.

The main port - Maracaibo.

As to the terrain relief three regions can be distinguished in Venezuela: on the west and north - the spurs of Cordillera, in the centre - the Orinoco lowland, on the south-east the Guiana upland.

The climate is chiefly hot, tropical with seasonal distribution of rainfalls.

Due to seasonal rainfalls the dischange of the rivers of Ven.zuela is variable with vigorous floods in the rain season and abrupt decrease in water flow in the dry season.

The transport communication is carried out through the railroads formed of separate lines with different track gauges not linked into a common network. The railroads are concentrated mainly in the western mountainous regions and in the northern coastal regions. The total length of the railroads makes 1400 km, motor and auto-cart roads -

over 10 thous. km. The highway connecting Caracas with Bogota (Colombia) is a part of the Panamerican highway.

The main water way is the river of Orinoco navigable up to the Colombia border. Air lines are serviced by aircraft of the American and Venezuela companies.

The coal, oil and gas production figures are shown in table I. The oil industry makes the basis of the Venezuela economy.

The country holds the 2-nd place in the world (next to the USA) in oil production and the I-st place in oil export (I32 million ~~of~~ tons). About 70 per cent of crude oil produced in the country is exported and only 30 per cent is processed in Venezuela.

Table I

Fuel production

	Years		
	I960	I965	I966
Coal, thous.tons	35	3I	34
Oil, million tons	I47.4	I82.4	I76.4
Natural gas, mlrd cum	4.6	6.5	6.8

Table 2

Electric power generation

	Years			
	1962	1964	1965	1966
Electric power generation, million kw-h	5922	7597	8245	8735
Including hydro-power plants	651	1223	1369	1405

The country soil contains copper, nickel, gold, silver, diamonds, tin, uranium, thorium, However their production is insignificant.

Aluminium industry. The total reserves of bauxite in Venezuela are estimated 105 millions of tons, 10 milions of which are considered proved and probable with an average Al_2O_3 content being 40 per cent.In addition to the registered reserves there are vast deposits of poorer aluminious laterits almost unexplored, among them rich fields worth of mining may be probably found.

Almost all known bauxite deposits belong to the laterit type and are concentrated far from the coast in the mountaneous part of the state of Boliver which are difficult to access. Their location and absence of roads hamper exploitation of these deposits.

In 1967 production of the primary aluminium have been first started in this country by the smelter on the river of Carony (Table 3).

Table 3

Aluminium production, and aluminium and aluminium raw material imports, thous.t.

	Years					
	1955	1960	1965	1966	1967	1968
Primary aluminium production	-	-	-	-	2	10.
Aluminium imports	...	0.7	3.0	1.8	...	...
Imports of aluminium semi-products	...	7.9	4.8	6.4	...	...

The plant is 570 km east of Caracas, obtains the electric power from a hydro- power plant on the river of Carony and in future will obtain it from the great 525 thous. kw Cury hydro- power plant. The plant first stage has a series of 70 electro-winning cells with pre-baked anodes for 58 KA, the production capacity is II thous. t. of aluminium per year. Alumina and electrodes are supplied by the Reynolds company (USA). Upon the agreement made with Surinam Venezuela will get bauxite from that country. Now the second stage of the plant is under construction which will be completed by the end of 1969 to increase the plant capacity up to 23 thous tons/year, the final capacity of the plant will be 50 thous.t. of aluminium per year costing 83 millions of dollars. An anode making plant is under construction which is due to be put in operation also by the end of 1969. The machinery for continuous casting, hot and cold rolling and finishing of aluminium sheets is installed in the plant.

The aluminium semi-fabricaction industry is represented by comparatively small enterprises.

In the early 60's the construction of several plants for processing non-ferrous metals was started, many of them are owned by the American capital.

In the town of Guacara (160 km west of Caracas) a plant for production of packing aluminium foil is built and the project for construction of a pressed aluminium sections plant is prepared with participation of the Aluminium Kaiser company (USA).

In the town of Maracaibo in the north-west of the country Reynolds Extrusions had put in operation a plant produc~~t~~ing pressed aluminium products worth of 60 millions of dollars with 10 thous.t. annual capacity.

The aluminium products from these plant are all intended for the local market.

. Copper industry. Copper is not produced there. The total copper reserves of Venezuela are estimated at about 20 thous. tons, there are no explored resources. The only workable deposit is Aroa in the state of Yaracui where a small amount of copper concentrate is obtained as a by-product of pyrite production, Since 1957 the mine is been laid off though the copper content was rather high (3.5 per cent).

There are also a few unexplored appearances of copper ores. Early in 1958 an important deposit was reported to be discovered in the state of Aragua, now it is under study.

The Mining Ministry has allocated 3.8 millions of dollars for studies of possibilities of its exploitation.

The demand for copper in the country is satisfied by import of cast billets and alloys in amount of 5 to 7 thous. tons per year. The copper is imported from the USA, Chile, Canada, Mexico.

There is a small copper processing plant Alcave owned by the Felps Dodge company (USA). The plant is located in Maracai (near Valencia). The annual capacity in production of copper wire and cables is 3.8 thous tons. In 1964 the plant produced 3090 tons of products made of the imported wire rod.

Lead and zinc industry. The industrial scale deposits of lead and zinc are not found there. In 1967 lead and zinc appearances were reported to be found on the Guiana border but there was no further details on their exploration.

Tin industry. Tin deposits were discovered in Venezuela in 1967. According to the 1968 reports they are disposed in 5 ore bearing zones: Monte Carmelio and Meruda in the Trujillo region near Barquicimento in Lara, not far from Chacon and Altagracia de Orituco in Guarico.

§ 4. Guiana

Guiana is located in the north-east of the South American continent. The country became independent in May 1966.

Territory - 215 thous.sq.km.

Population - 680 thous.people

Population density - 3 persons per sq.km.

Capital and main port - Georgetown

The country borders on Venezuela from the west, on Brazil from the south and south-west, on Surinam from the east. From the north it is surrounded with the Atlantic Ocean.

The climate of Guiana is hot, humid, and equable.

The rivers are full-flowing but with numerous rapids and reservoirs. The length of railroads totals 134 km, motor roads - 600 km, navigable rivers - 650 km, canals - 25 km.

The data on power generation in the country are not available with us. However basing on some figures for 1958-1964, we can state that installed capacities of power plants had grown from 39.4 thous. kw in 1958 to 98.1 thou kw in 1964 and accordingly the production of electric power has increased from 70 million kw-hr to 212 million kw-hrs.

As for the sources of non-ferrous metals ores in Guiana deposits of bauxites, diamonds, tantalum, niobium, rare earth metals are known to be available.

Bauxite production has acquired the greatest importance.

<u>The aluminium industry</u> of Guiana is confined to bauxite and **alumina** production.

The registered resources of industrial bauxites in the country total I50 million tons, 50 million tons of which are explored to the degree of proved and probable. The Al_2O_3 content in these resources varies from 50 to 60 per cent, in some areas it is as high as 67 per cent, the silica content is 3 to I2 per cent, **iron oxides - 2,5-5 per cent. Besides that big reserves are known** of lower grade, unfavourably located on insufficiently explored bauxite and other aluminum containing materials the amount of which according to different estimates makes up from 250 m t. to I billion t.

In Guiana bauxites are processed at the aluminium plant in Mackenzie with the annual capacity of 350 thou. tons. The plant is capable of processing only 20 per cent of all bauxite produced in the country. The major part of bauxite is exported mainly to Canada and in less amount to the USA.

Export of bauxite from Guiana is hindered by the necessity to trans-ship the ore loads from the river ships to the sea-going vessels. The aluminium is also exported. The exports are shown in table I.

Table I

Bauxite and alumina production, foreign trade, thou. tons

	Years					
	1955	1960	1965	1966	1967	1968
Bauxite production I/	2474	2517	[illegible]68	[illegible]	[illegible]I	3658
Exports of dry bauxite	1948	1817	1284	[illegible]	...	...
Exports of calcined bauxite	256	312	502	500	...	...
Alumina production	-	-	284	302	349	...
Aluminium exports	-	-	280	30[illegible]	...	....

I/ In terms of dry bauxite.

The leading bauxite producing company is Demerara Bauxite which works the Mackenzie deposit.

Copper industry. As a result of prospecting carried out in the recent years with assistance of the UNO Special fund several grounds containing copper and zinc ore bodies have been discovered. Any further details on these deposits have not been published.

§ 5. Haiti

The Republic of Haiti is situated in West Indies, it occupies the western part of the island of Haiti and two neigh-bouring islands.

Territory - 27.8 thous. sq. km.

Population - 4.6 million people

Population density - 165 persons per sq. .

Capital - Port-an-Prince

Haiti borders on the Dominican Republic in the east, and is surrounded with Atlantic Ocean in the north and with Caribbean Sea in the south; in the west Windward Passage separates Haiti from Cuba.

The climate of Haiti is chiefly torrid und humid on the windward hillside and dry in closed valleys.

The length of the railroad network is 25[illegible] .The length of motor roads is about 3 thous. km (about 4[illegible] km are macadamized). Air lines link Haiti with neighbour countries.

The capacity of power plants is stable since 1963 totalling 30 thous. kw. Power generation varied from year to year in the following way: 47 M kw/hr in 1958, 74 M kw/hrs in 1963, 71 M kw/hr in 1964; 78 M kw/hr in 1965; 73 M kw/hr in 1966.

The Atlantic Refining Company (USA) has obtained the right to prospect and produce oil in the country.

Aluminium industry. Since 1957 Haiti became one of the principal bauxite producing countries. Production of raw materials for the aluminium industry is controlled by the US Reynolds Metals company. The registered resources of bauxite total 23 M.t all of them being considered as proved and probable (Al_2O_3 content is 45 to 55 per cent).

Almost all the produced bauxite is exported, ref. table I.

Table I

Bauxite production and exports, thou. tons

	Years					
	1955	1960	1965	1966	1967	1968
Bauxite production	-	346	435	419	376	380
Bauxite exports	-	401 I/	388	333	...	...

I/ Including shipments from stocks accumulated when stripping the deposit.

<u>Copper industry</u>. The copper reserves in Haiti make up 90 thou. tons, all of them are explored to the degree of proved and probable and are located in the area of Terre Nuove.

There is the deposit of chalkopyrite incorporated ores containing 1.7 to 2.2 per cent of copper. Some mine is exploited there using the underground technique to produce annually 3 to 5 thou. tons of copper in the ore according to the recent years. Gold is recovered as by-product.

In the nearest future the annual copper output is expected to be increased up to 7.5 - 9 thou, tons. The deposit is not yet completely explored and there is a great possibility of further increase in reserves.

Copper mining was commenced only in 1960.

In 1961 the Mome mining and beneficiation complex with the capacity of 1.5 thous.tons /day of ore was put into operation. The concentrate containing approx. 35 per cent of copper is exported to Japan and Spain.

An affiliated company of Canadian Hollynel is prospecting for copper during the recent years. In 1968 this company discovered a new deposit. Home consumption of copper is insignificant and makes up less than 100 tons a year. The metallic copper is imported from the U.S.A.

§ 7. Surinam

Surinam (former Netherlands Guiana) is a Dutch colony in the north-east of South Africa.

Territory - 163.3 thous.sq.km.

Population - 363 thous.people

Population density - 2 persons per sq.km.

Administrative centre - Paramaribo.

The climate of Surinam is hot, humid, and equable.

The river of Surinam about 600 km long is full-flowing (fed from the rainfalls), navigable up to the rapids.

The length of railroads is 219 km, motor roads - 846 km.

Agriculture and bauxite mining make up the basis of the country economy. Apart from bauxite, gold is mined also: 153 kg in 1960, 195 kg in 1965, 161 kg in 1966.

The tungsten, manganese, and beryllium deposits are also known. There are reports on the diamonds found in a number of the regions of Surinam. The prospecting of oil and iron ore produced no tangible results.

The electric power availability is featured by the following data in Table I.

Table I

Electric power generation

	Years				
	1958	1963	1964	1965	1966
Installed capacity, thous. kw Total	...	39.I	39.4	[illegible]	...
Electric power generation, million kw-hr					
Total	66	II9	I28	244	681
including hudro-power stations	-	-	-	85	464

Aluminium industry. The total registered reserves of of bauxite in the country make up 300 million tons, 200 million of that being considered as proved and probable. An average Al_2O_3 content is 50 to 59 per cent, SiO_2 - 2 to 5 per cent, Fe_2O_3 - 7 to II per cent.

The mining is carried out by the open-cast method, production is concentrated in three main regions: Paramaribo, Moengo and Paranam. The annual outputs of quarries in these regions range from I to 3 million tons of bauxite. Surinam possesses great possibilities of expanding bauxite production.

Data on production of bauxite, alumina and primary aluminium are listed in Table 2.

Table 2

Production of bauxite, alumina and primary aluminium, foreign trade, thous.t.

	Years					
	1955	1960	1965	1966	1967	1968
Bauxite production	3123	3455	4360	5565	5466	5765
Alumina production	-	-	130	430	684	...
Primary aluminium production	-	-	4	27	31	44
Primary aluminium exports	-	-	-	25.7	31.1	...
Bauxite exports	3060	3634	4369	4584	3866	...
Alumina exports	-	-	...	349	684	...

Surinam holds the **2nd** place in bauxite production next to Jamaica.

Alumina and aluminium production was started in Surinam in 1965 when the aluminium plant of annual capacity of 60 thous. tons of aluminium was put into operation in Paranama. Alumina production has been established at the plant. Late in 1966 the 4-th stage of an alumina plant was put into operation, its capacity had reached 800 thous.tons by 1.1. 1967. At the present time the Suralco company is building the 5-th alumina shop of 200 thous.tons production capacity; thus the annual capacity of the Paranama plant will reach 1 million tons of alumina.

§ 7. Jamaica

Jamaica is an independent country in Caribbean Sea.

Territory - II.0 thous.sq.km.

Population - 1876 thous.people

Population density - I7I persons per sq.km.

Capital and main port - Kingston

The climate is humid, tropical.

The most significant Black River is navigable (by small vessels) for 40 km.

The length of railroads is over 330 km, motor roads and country roads - over II thous. km.

Electric power in the country is generated by the thermal power plants and only partially by the hydraulic power plants. During 1958 to 1966 power production, in Jamaica has Increased almost 2.3 times (Table I)

Table I

Electric power generation

	Years				
	1958	1963	1964	1965	1966
Installed capacity, total thous kw	II0	I86	...	240	[illegible]
including hydro-power stations	I3	2I	I9	...	...
Power generation, million kw-hr					
Total	383	652	712	799	[illegible]
including hydro-power stations	85	138	I54	I33	III

Aluminium industry. Since large and rich bauxite deposits were found in 1952 (beginning of the exploitation) Jamaica plays an important role among the aluminium producting countries.

Total reserves of industrial bauxite with an average Al_2O_3 content of 50 per cent amount to 600 millions of tons 200 thous. tons of which being considered as proved and probable. Besides there is about the same volume of lower grade raw material the feasibility of which is now being thoroughly investigated.

Bauxite is mined by an affiliated company of the Canadian Alcan Aluminium (four big enterprises) using the open-cast tecnique in the largest deposits. The production capacities are expected to be enlarged in the nearest future with the further increase in the output.

In 1955 this country contributed 21.6 per cent and in 1967 26.1 per cent of the world bauxite production.

An average annual rate of production growth made up 7 per cent for the last seven years (1961 to 1967). Only 18 per cent of all bauxite produced in the country is converted into alumina, ~~the~~ **Alumina** produced is exported to Canada and Norway **(table 2).**

Table 2

Bauxite and aluminium production, foreign trade, thous. tons

	Years					
	I955	I960	I965	I966	I967	I968
Bauxite production[I]	3040	5872	8722	9226	9396	9481
Bauxite exports[I]	2207	42I4	6856	7I32	7256	...
Alumina production	I87	676	732	805	838	...
Alumina exports	I87	676	732	803	838	...

I, In terms of dry bauxite.

Growth of bauxite production is stimulated by the fact that the cost of raw material transportation from Jamaica to the USA and Canada is almost 4 times lower than from Surinam. In the coming years considerable expansion of the bauxite mining in Jamaica is expected. The especially extensive program will be carried out by the Kaiser Bauxite company. This program comprises the development of bauxite deposits in the St.Ann. area, the construction of a harbour for ocean-going ships and a jetty in Discovery Bay, and the construction of a railroad.

In 1967 the **alumina** production in Jamaica by two plants Yearton and Kirquin was 838 thous. tons. The Alcan Jamaica company has started expansion of the existing enterprises to increase the total **alumina** capacities up to I million of tons already in the coming years and up to 3 millions of tons by 1971.

In I969 an **alumina** plant is expected to be put into operation in Jamaica with the followin interests of American companies: Reynolds Metals - 40 per cent, Anakonda - 3I.4 per cent, Kaiser Aluminium and Chemical Corp. - 28.6 per cent.The initial capacity of the plant will be 220 thous. tons with the future increase up to 794 thous. tons. The capital investments are estimated at I75 million dollars.

There are two aluminium semis producing plants operating on the metal imported from the USA and Canada. One of them in Kingston produces I.5 to 2.0 thous. tons of corrugated aluminium sheets per year, the sheets are used in construction (roofings,walls, partitions), the second one is a small plant producing aluminium construction elements.It was built in I955 by the Kaunir Jamaica company (USA) which is an affiliated company of a large non-ferrous metals producing firm: Amax Aluminium.

Copper industry. Several unexplored deposits of poor copper ore are known.In the recent years the work is in progress in Gallas Valley where a promising appearance of cobalt-nickel-copper minerals was recently found.The copper ore deposites are continued to be searched in the eastern part of the island.

§ 8. The Dominican Republic

The Dominican Republic is situated in West Indies and occupies the eastern part of the island of Haiti.

Territory	- 48 thou.sq.km
Population	- 3.9 million people
Population density	- 80 persons per sq.km
Capital	- Santo Domingo

In the west it borders on the Republic of Haiti, in the north it is surrounded with the Atlantic Ocean, in the south - with the Caribbean Sea; in the east the Mona passage separates it from Puerto Rico, the US possession.

The climate of the country is tropical with uniform monthly temperatures high on the lowland and more moderate in the mountains.

The length of railroad network is I.4 thou. km, that of motor roads - over 5 thou.km.

Electric power generation by years (millions of kw-hrs) runs as follows: 284 in 1958; 452 in 1963; 517 in 1964; 485 in 1965; 617 in 1966. In the country there are the deposits of iron ore, bauxite, nickel, salt, gypsum and other minerals. The Canadian company Falconbridge Nickel Mines is going to exploit nickel deposits in the eastern part of the country.

Aluminium industry. The total bauxite reserves are estimated at 85 million tons, 60 millions of which are considered as proved and probable. An average Al_2O_3 content in the explored sources varies from 45 to 50 per cent. The most valuable deposits are in the Azeitillar area in the province of Barajona. An average composition of bauxites here is the following: Al_2O_3 46 to 48 per cent; SiO_2 under 3 per cent; Fe_2O_3 about 20 per cent. They are mined by the open-cast method, the annual production comes presently to I million tons.

Poorer deposits are known to be in the region of Bucan Polo and other places of the province of Barajona. The Al_2O_3 content in bauxites here rarely exceeds 45 per cent. These deposits are not exploited so far. The data on production and exports of bauxite are given below (Table I).

Table I

Bauxite production and exports, thou.tons

	Years					
	I955	I960	I965	I966	I967	I968
Bauxite production	-	584	942	807	983	980
Bauxite exports	-	787	II39	806 I/	...	...

I/ Bauxite exports to the USA

The larger bauxite deposits are exploited by the Canadian Alcan Aluminium company. The mining was started in I959.

<u>Copper industry</u>. Since I967 the Mata Granda deposits in the province of Santiago have been ~~are~~ exploited. The copper

content of mined ore is about 2 per cent. There is no information on the reserves. In future it is expected to mine about 30 thous. tons of ore per year.

About I thous. tons of copper and copper alloys imported from the USA , Canada and France are consumed in the country.

§ 9. Republic of Argentina

The Federal Republic of Argentina occupies the south-eastern part of the South American continent, and the eastern part of Tierra del Fuego island, separated from the mainland by the Straits of Magellan.

Argentina borders on Chile on the east, Bolivia on the north, Paraguay on the north-east, Brazil and Uruguay on the east. On the south-east the Argentina coast is washed by the waters of the Atlantic Ocean.

Territory - 2778 thous. sq.km.

Population - 23.0 million people.

Population density - 8 persons per sq.km.

Capital - Buenos Aires

Principal Cities - Rosario, Cardoba, La Plata, Tucuman.

Almost the entire country lies to the south of the tropics. The climate in different regions is greatly varied. The southern part of the La Plata lowland, the so called Pampa, is a steppe with dry, moderate, subtropical climate. It gradually passes into the Patagonian southern rocky plateau with a rather rigorous climate.

The extension of railway lines is more than 46 thousand km, that of roads and highways - more than 8I thousand km. The largest railway junction - Buenos Aires is connected with Chile and Bolivia by a network of railway lines. The export shipment is carried out by the sea transport.

The most important ports, besides Buenos Aires, are: Rosario Santa-Fe and Bahia Blanca. The air service transport is under development . The chief rivers Parana, La-Plata, Paraguay are navigable for steamers.

The electric power in Argentina is generated by the thermal power plants and by the hydropower plants. The share of the latter is very small amounting to 9-10% of the total output of electric power in the country (Table I)

Table I

Electric power generation

	Years				
	I958	I963	I964	I965	I966
Installed capacity in thousand kw					
Total output	2947	4686	5050	5363	...
Including hydro-electric power stations	278	363	373	...	...
Generation of electricity in millions kwhr.					
Total output	94I8	I2449	I3752	I4964	I5400
Including hydro-electric power stations	...	II86	I236	[illegible]	...

Rich resourses of oil and natural gas are known in the country mainly in Patagonia. The output of oil has lately greatly increased, as well as the output of natural gas (Table 2).

Table 2

Fuel production

	Years			
	1955	1960	1965	1966
Coal in thousand tons	75	175	1965	1966
Oil in million tons	4.365	9138	14.062	14.975
Natural gas in billions/m^3	0.719	1.383	4.264	4.531

Some non-ferrous metals such as copper, lead, zinc and tin are obtained in the country.

The aluminium industry of Argentina is limited to the processing of aluminium imported from other contries (Table 3)

Table 3

Consumption of primary aluminium, imports of bauxites and aluminium, thousands tons

	Years					
	1955	1960	1965	1966	1967	1968
Imports of bauxite 1/	2.7	30.0	29.4	43.6	...	...
Imports of aluminium	14.8	12.1	36.4	36.9	...	...
Consumption of primary aluminium	...	12	25	25	25	25

1/ Bauxite imports for the needs of the abrasive, refractory and ceramic industry.

The construction of an aluminium plant with the help of the U.S. capital, is sheduled in the country. This plant with the 10 thousand tons per year capacity will be put into operation in 1970.

There are 4 aluminium mills in the country now owned and controlled by foreign aluminium companies and some 10 small primitive milling shops controlled by the national capital.

By 1966 the total annual output of these 14 aluminium processing plants was increased up to 85 thousand tons, but they are using not more than 50% of their capacity.

Copper industry. The estimated supply of copper in Argentina is only 30 thousand tons, the average copper output in ore being 2.5%, the figures of the prospected deposits are not published. Besides copper the ores contain lead, zinc , silver, gold and sometimes antimony and arsenic.The deposits are not mined, a small amount of copper ore is recovered as by-product while mining other mineral resources.

Since 1963 the Argentina government is intensively exploring and prospecting the eastern slopes of Ands. And as a result a number of large copper-porphyry deposits is found in Mendosa and San-Juan provinces, which are being prospected now.According to the preliminary estimates the reserves of these deposits are not less than 100 million tons of ore.The copper content in ores of the better explored deposit Paramillo sur is in the range of 0.7-1.7%. Besides some large lode deposits with copper concentration of 1.2-1.8% are found in this very region recently.

For 7 years the prospecting has been carried out with the assistance and participation of the American "Felps Dodg" company. The U.N.O. has also alloted some funds for this prospecting.

Thus in the near future some considerable copper reserves may be prospected in Argentina, and it would enable the development of modern copper mining industry in the country.

The copper industry of Argentina can be characterised by the figure of Table 4 (in thousand tons).

Table 4

	Years					
	1955	1960	1965	1966	1967	1968
Mine production (coper content)	0.5	0.5	0.5	0.5	0.5	0.5
Exports of concentrates	-	1.4	0.2	0.3	...	...
Imports of refined copper	14	21.7	23.2	14.2	20	20
Consumption of refined copper	6	26	33	25	20	20

The copper output in the country is very small. Out of the polymetallic ore mined at the Castanjo Bicho in the San Guan Province (containing some 0.45% of copper) , copper concentrates are obtained, containing 20% of copper.

The country has no plant of its own for copper concentrates treating.The small amounts of concentrates produced in the country are exported to Chile.

The country covers its own copper consumption by importing refined copper and alloys from Chile,the U.S.A., FRG, Peru,Zambia.

The intended construction of a copper smelter in Tucuman with an annual output of 6 thousand tons of copper, was reported but this information was not confirmed recently.

The total annual capacity of all the plants processing copper and copper alloys is 80-100 thousand tons, but the actual output is 20-33 thousand tons per year.Foreign capital controlls about 70% of the total country's copper industry.

The largest firm producing copper and brass roll is the "Guliermo Deker Co.".Four small copper plants operating in Buenos Aires are owned by the "Felmet", "Siat" and "Industria Rab" firms. An aluminium processing plant of the "Camea" firm produces up to 5.5 thousand tons of copper rolling annually.

<u>Lead-zinc industry.</u> All the estimated reserves can be referred to as proved and probable and account for I.I. million tons of lead and I.5 million tons of zinc. Only high grade ores are prospected, containing 6.7-II% of lead (the average IO.2%) and 7.0-I6.0% of zinc (the average I4.6%). Besides there is a great amount of low grade ore, the supply of which is not established.

The major part of the reserves (about 80%) and output (more than 90%) of lead and zinc is found within the bounds of a large ore deposit Agvilar, and worked at the mine bearing the same name. It is located in the Jujuy Province, in the mountain region in the north-eastern part of Argentina. The deposit is being mined. The output of the mine for the last three years increased from 300 to 500-550 thousand tons of ore per year. Silver is mined as by-product together with lead and zinc.

The output and smelting of lead and zinc is steadily increasing for the last years (Table 5).

Zinc and lead (as well as copper as by-product) are mined at the small but rich deposits of Castanio Viejho (San Juan. Province) and Toncalito (Rio Negro privnce), at present the Argentina government as well as private companies began wide exploring prospecting for the new lead, zinc and copper deposits. They are

Table 5

Production, Consumption and Exports of Lead and Zinc, thousand tons

	Years					
	1955	1960	1965	1966	1967	1968
Mine production (lead content)	23	27	29	29	31	28
Mine production (zinc content)	21	34	29	27	29	26
Production of primary lead	18	26	39	36	36	38
Production of primary zinc	14	17	23	22	23	21
Consumption of primary lead	25	26	38	36	36	36
Consumption of primary zinc	20	16	27	23	22	23
Exports of lead ore	-	-	0.2	0.2	...	...
Exports of zinc ore	-	27	3	-	...	...
Exports of primary zinc	-	...	0.1	-	...	...
Imports of primary zinc	0.2	0.5	3	2	...	...

also trying to give the estimation of the already prospected deposits.

A short characteristic of three lead and zinc plants is given below.

A lead refinery and smelter in Puerto-Vilelas (Barranqueras, Chako province) is controlled by the National Lead Co.The output capacity is 30 thousand tons of refined lead annually. The output products are: refined lead, 99.97% pure, antimony lead, silver, copper matte.The lead sulphide concentrates containing up to 74% of lead are processed.The basic flowsheet is: melting in the furnace and fire refining of crude lead.

The lead plant of San Justo (Buenos Aires province) is owned by the Sudamericana de Industria and Comercio company.The output capacity is I2 thousand tons of refined lead per year.It produces also lead, antimony, tin, copper, silver zinc and aluminium alloys. It is processing mainly the secondary raw material of lead and other non-ferrous metals and some amount of rich lead are as well.The basic flowsheet is shaft melting and fire refining.There is one more small lead plant in Argentina, in Mataderos, Buenos Aires province, owned by the A.Piterman company with the annual capacity of I.6 thousand tons of refined lead.

The zinc-distilled plant in Comodoro-Rivadavia of the Metallurgical Austral company is operating since 195I. The output of it is I4 thousand tons of distilled zinc per year.The plant processes sulphide-zinc concentrates.The product of the plant is distilled zinc (98.5-

99.5% of zinc). The basic flowsheet of the plant is sintering in the belt agglomeration plant with the further electrothermal distilling of zinc in the shaft electric furnace according to the Josef-town plant model.

The zinc-electrolytic plant in Borgi, near Rosario, owned by the Sulphacid company is working on zinc concentrates from the Agvilar mine. The output capacity of the plant is I2 thousand tons of electrolytic zinc annually.

The zinc-electrolytic plant in Sarate is owned by the Meteor company. The output capacity of it is 7 thousand tons of electrolytic zinc per year.

The zinc-electrolytic plant in Rio-Torsero, Cordoba, owned by the Dirxion General de Fabrikacion Militare has a very small output capacity - only I.4 thousand tons per year. Besides electrolytic zinc the plant produces copper, copper alloys, semi-finished products, wire and cable.

The country's demand in lead and zinc is fully satisfied by the domestic production of these metals. Primary zinc is exported in small amounts (about 2-3 thousand tons per year).

The majority of the non-ferrous metallurgy enterprises in Argentina are controlled by the U.S. capital. Thus, 99.9% of shares of the largest Argentina firm Minera Agwilar are in the hands of one of the leading American companies St. Joseph Lead. The Minera Agvilar company owns the lead and zinc mines in the Jujuy province and controles with the help of its subsidiaries Sulphacid and Metalurgica Ostral Argentina the zinc plants in Borgi and Comodoro-Rivadavia.

The American "National Lead" has a subsidiary company National Lead in Argentina, which owns the lead plant in Puerto-Vilelas (Chako).

The Sudamericana de Industria y Camercio (INSUD) Company founded on the basis of the joint Chilian, Peruan and Brasilian capital owns the lead plants in San-Justo.

Some small Argentina companies are operating in the country: Meteor (zinc-electrolytic plant Sarate), A Piterman (lead plant Mataderos), Elaboracion General del Plomo (lead plant of Mercedes which is not operating at present).

Since 1967 the Minerva Agvilar company is carrying out a programm of increasing zinc and lead output as well as the production of concentrates. The overall cost providing for the 70% increase of the production capacity amounts to 4 million dollars.

<u>Tin industry.</u> The total tin resourses in Argentina are estimated approximately at 10 thousand tons. The well known deposits are concentrated in Jujuy

province at the south end of the tin belt of Bolivia. The output of tin in the country is shown in Table 6.

Table 6

Production and exports of tin, thousand tons

	Years					
	1955	1960	1965	1966	1967	1968
Production of tin-in-concentrates	0.09	0.2	I.2	I.3	2.I	I.9
Production of primary tin	0.I	0.I	0.I	0.I	0.I	0.I
Exports of tin-in-concentrates	-	0.2	-	-	0.8	0.8
Imports of primary tin I/	2.3	I.7	I.3	I.3	0.9	...

I/ tin (metal and alloys)

The main tin output is provided by small field deposits and tin ore lodes in the Abra-Pampa region (Jujuy province).

Some time before the greater part of tin was produced by the silver-tin-ore deposit of Pircvitas (tin content in the ore was 8-10% , silver I-2%). At present this deposit is practically worked out.

Lately the working at the Sierra-Galan mine, an extension of Pircvitas deposit, has been renewed. The mining company is Sisiedad Minera Pirquitas. The tin content in concentrates varies from 45% to 15% for different years.

The tin smelter Triquitas in Buenos Aires is processing the local concentrates.

Here is a short characteristic of this plant.

The output capacity: 15 thousand tons of metallic tin per year.

The raw material: tin-silver concentrates from the Jujuy mines, containing 15-50% of tin, beginning with 1965-mostly concentrates containing about 18% of tin.

The flowsheet: **smelting** of tin concentrates and production of crude tin; the slags are delivered to Great Britain for processing.

Some amount of tin in concentrates is also exported, mainly to Great Britain (0.8 thousand tons in 1967).

The average consumption of primary tin in the country is 1.6-1.8 thousand tons annually.

Metallic tin is imported mainly from Malasia and Singapore.

§ IO. Brazil

Brazil is a federative republic occupying central and eastern parts of the continent of the South America. The eastern margin of the Brazilian territory is defined by the Atlantic Ocean, the lenth of the shore-line being about 8 thous.km. On the land the territory of Brazil borders on that of IO states (French Guiana, Gayana, Sourinam, Venezuela, Colombia, Peru, Bolivia, Paraguay, Argentina and Uruguay).

Territory - 8,5I2,000 sq. km.

Population-85,700,000 people

Population density - IO persons per sq.km.

Capital - Brasilia (beginning from I960, the former capital was Rio de Janeiro).

Principal cities - Rio de Janeiro, Sao Paulo, Recife, Bello-Horizonte, Porto-Alegre.

Brazil includes in its territory the most portion of the Amazon basin with its extremely thick tropical forest. To the south from the Amazon there is the Brazilian high lands comprising 3/5 of the total area of the country. The northern part of the highlands is crossed by the Parana and Sao Fransisco river (tributary of the Amazon). The rivers are interrupted by falls and rapids and have a great hydro-energy potential, but are not navigable at many places. The climate of Brazil varies from tropical to subtropical from north to south.

Total length of the railway lines of Brazil exceeds 37 thous.km. (of which 2.4 thous.km are electrified). The railways are developed mainly in the south-east of the country along the Atlantic shoreline and in regions of Rio de Janeiro and Sao Paulo. Roads are of a great importance (their length totaling to 375 thous. km.).

Inland waterways are developed only on the Amazon and its tributaries. Sea ports are as follows: Rio de Janeiro, Santos, Vitoria, Recife.

Air transportation is widely used. Major airports are situated in Rio de Janeiro, Sao Paulo and Brazilia.

The electric power consumed in the country is produced mostly by hydroelectric stations (Table I).

Table I

Electric power generation

	Years				
	1958	1963	1964	1965	1966
Installed generating capacity, thous. kW					
Total	3993	6355	6840	7411	7566
including hydroelectric	3224	4480	4894	5391	5524
Electric power stations M kW-hrs.					
Total	19766	27869	29094	30128	32654
including hydroelectric power stations	17485	20728	22097	25515	27905

Fuel resources of the country include oil, natural gas and coal (Table 2).

Bauxites, copper, lead and tin are produced in the country.

Table 2

Fuel production

	Years			
	I955	I960	I965	I966
Coal, thous .t.	2268	I277	I76I	I734
Oil, thous.t.	265	3870	4488	5548
Natural ga, M.cu.m	62	535	684	789

Aluminium industry. Total reserves of bauxites in Brasil are estimated to be 300 M t., but only 40 M t. of them containing from 54 to 62% of aluminium oxide are considered as proved and probable.

The majority of bauxite deposits is of the lateritic type. The largest deposits are found within the Pocos de Caldas plateau in state Minas Gerais. The reserves in this regions are estimated as being equ l to I50 M t. of bauxites containing 62% of aluminium oxide, I-5% of SiO_2, 4 - I0% of Fe_2O_3.

The bauxites are still mined not very intensive - ly. They are excavated at open sites in Pocos de Caldas. The reserves ensure a sharp increase in production, but there is a shortage of suitable means of transportation. In 1967 bauxite production reached the figure of 261 thous. t. (see Table 3).

The most portion of the bauxites produced in the country are processed at two aluminium plants producing Al_2O_3: Sorocaba, state Sao Paulo (put into production in 1955), and Saramenia, state Minas Gerais (put into operation in 1945).

A brief specification of the two plants is given here below.

Table 3

Production of bauxites, aluminium oxide, primary aluminium and semi-products, trade balance, thous. t.

	Years					
	1955	1960	1965	1966	1967	1968
Bauxite production	45	121	193	250	261	250
Alumina production	-	39	60	68	74	...
Production of primary aluminium	2	18	30	32	36	32
Consumption of primary aluminium	-	25	52	63	78	78
Production of aluminium semi-products	-	-	-	41.4	48.0	...
Bauxite exports	3.3	2.1	2.2	2.3	2.2	...
Imports of aluminium	6.4	14.8	21.8	39.5	28.0	...
Imports of aluminium semi-products	0.3	0.3	0.4	1.4	-	...

The Scrocaba plant includes: an alumina shop with output of 43 thous.t. per year, the bauxite being supplied from the Pocos de Caldas deposit. The bauxite is processed using the Bayer's scheme of alumina recovery, and electrolitic shop with output of 36 thous. t. of aluminium per year, equipped with I62 Italian - made round pot cells designed for the use of electric currents of 30 kA density and continuous self-baking anodes of the Soderberg-Monticatini type with an upperwise current feeding line. Besides the primary aluminium the plant produces rolled metal, tubes, foil, wire, cable, casting alloys. It is planned to increase the productivity of the plant up to 50 thous. t. per year by I975.

The Saramenia plant consists of four shops:

Alumina shop with output of 36 thous. t. of calcined Al_2O_3 per year. The aluminium oxide is obtained using the Bayer's scheme, it is planned to increase the capacity up to 50 thous. t.

Electrolitic shop (consisting of two separate buildings) with capacity of 23 thous. t. of aluminium per year (the figure is given for I/I - I968). The output was increased in I967 as a result of installing 64 additional pot cells. and changing over the electric power rectifier substation for silicon rectifiers designed for 425 V.

Anode paste shop with output of I4.5 thous.t.

of anodes per years.

Cable - making shop for making cables with steel central core (put into operation in May 1966).

The Saramenia plant is supplied with electric power from hydroelectric stations built on rivers Meinart and Piranga.

It is planned to modify all the shops of the Saramenia plant.

Total industrial capacity of the aluminium processing plants in Brazil is 65 thous. t. per year. Actual production of rolled metal is equal to 35 thous.t. per year, of which: plain rolled metal - 20 thous. t.: and shaped rolled metal - 15 thous. t.

About 2/3 of the total amount of rolled aluminium produced in Brazil belong to four companies (of which three are foreign and one is Brazilian: "Kia Brasileira de Alumino C.A."). South America's largest aluminium processing plant is situated in town Utinga (near Sao Paulo) and belongs to company "Aluminio do Brazil C.A." (property of "Aluminium Ltd.", Canada). The annual output of the plant is 26 thous.t. The plant is manned with 4000 employees. The second largest aluminium processing plant with annual output of 20 thous. t. belongs to company "Kia Brasileira de Alumino C.A.". It is planned to double the output of this plant.

In this country there are several small enterprises engaged in aluminium processing and belonging to companies independent from the aluminium monopolies of the USA.

The rolled aluminium is fully consumed within the country.

For the past few years consumption of aluminium has increased in Brazil from 25 thous. t. in 1960 to 78 thous. t. in 1967.

According to the statistics of the National Bank of Economics Development for 1967 , the main branches of consumption of aluminium semi-products in Brazil are as follows: making kitchen utensils (11.6 thous. t.), producing wire and cable for electric industry (9.2 thous. t.), construction (6.35 thous. t.), packing (4.69 thous. t.), electric industry (5.6 thous. t.), transport (8.23 thous. t.), and others (2.3 thous. t.).

Almost 50% of aluminium consumed in the country are imported from Canada, the USA and Norway.

At present an aluminium producing plant is being built in state Minas Gerais, Brazil.The plant will produce aluminium oxide as well.Aluminium will be produced at a rate of 23 thous. t. per year, and Al_2O_3 - 45 thous. t. respectively.Raw ores will be supplied to this plant from bauxite deposites of the Pocos de Caldas plateau, and the electric power will be generated by the Rio-Pardo hydroelectric stations.Invesments into the plant construction are made by Bainton Company (Brazil) and company "Alcoa" (the USA).

Copper industry. Total reserves of copper in Brazil are defined as being equal to I M t., of which 260 thous. t. are considered as proved and probable. The copper content in ores varies from 0.7% to 3.8% at average I.2%.

The copper (impregnated) ores are found mainly in the regions of Mina de Camacva in state Rio Grande de Sul, where a number of small mines is available producing the ores quite irregularly.The ores here contain I - 3% of copper.Deposit Caraiba is situated in state Bahia.Its reserves are estimated as being equal to 600 thous. t. of copper, the ores containing about 0.9 - I.2% of copper.

In I967 a deposit of I50 M t. of copper ores (estimated figure) was discovered in state Pernambuco near its boundary with state Bahia.In this very state another large deposit has been found near Petrolino.

In I968 Brazilian geologists have discovered a copper deposit in Suden (state Minas Gerais) with reserves being estimated as 80 M t. of ore containing 0.9 - I.0% of copper.

However, all the deposits already known do not match the copper market in Brazil.

Production of copper (in the form of ore) is equal to 3 thous. t. per year only (see Table 4).

Tabl. 4

Production, Consumption and Imports of Copper, thous. t.

	Years					
	1955	1960	1965	1966	1967	1968
Mine production (copper content)	-	2	3	3	3	3.5
Production of primary blister copper	-	2	3	3	3	3.5
Production of refined copper	-	2	3	3	2.5	3.5
Imports of refined copper	15	29	22.6	42.4	...	...
Consumption of refined copper	15	30	35	46	39	39

Concentrates produced at the consentrators Itapeva and Camacva containing 28-30% of copper are used at the Itapeva plant producing blister copper.The blister copper is transported to the refining plant Utinga situated at a distance of 10 km from city Sao Paulo.The plant produces 4.2 thous. t. of electrolytic copper per year.According to the program of development, the output of the plant is to be increased up to 15 thous. t. of electrolytic copper per year. The ore production of the mines Camacva and Itapeva will be increased respectively.

About 90% of the copper consumed in the country is imported from Chile, Peru and Mexico in the form of refined metal.

Annual capacity of enterprises engaged in copper processing is 70 thous. t., but actual output is about 40 - 50 thous. t. per year.

The plant situated in city Sao Paulo and belonging to company "Industria Sud America de Metal" is known to be the main plant producing rolled and drawn semi-products of copper and its alloys. Annual capacity of this plant is I2 thous. t. and will be increased up to 30 thous. t. in the future. Half a stock of this plant is controlled by company "Riveir Corra and Brass" (the USA). The plant belonging to company "Laminaco Nacienal de Meto" in the Utinga town produces up to I0 thous. t. of semi-products of copper and its alloys, per year.

In Rio de Janeiro City there are plants belonging to company "C.A. Marvin" (related to the USA company "Anaconda") with total industrial capacity of I0 thous. t. of rolled copper per year including brass, and a small copper sheets producing plant, which belongs to company "C.A. Industrias Vitoratim".

In Sao Paulo city there are three small plants for copper processing. They are the property of three companies: "Laminaco de Metas Langone", "Metallurgica Brasileira Ultra" and "Industria Iorchir de Brazil".

In this city there are plants producing copper wire and cable with productivity of about 30 thous. t. per year. The largest plant belonging to Italian Company "Purell" produces 23 thous. t., plants belonging to companies "Electro Sao Marco", "Inbrass" and Isofil" produce I thous.t., 2 thous. t. and 2.I thous.t. per year respectively. The rest is produced by other small enterprises.

Lead-zinc industry. Brazil possesses large reserves of lead-zinc ores. By the beginning of 1967 total reserves of lead and zinc were equal to 3.0 and 4.0 M t. respectively, of which I.I. and I.6 M t. respectively were considered as proved and probable. These figures account for only rich ores excluding a number of poor ore deposite .Metal content in the ores varies within a wide range: lead content varies from I.0 to 7.0% from one area to another reaching at places the figure of 20-50% (oxidized ores), zinc cont nt varies from 2.9 to 35% at places being equal to 45%. For the majority of the deposits (more than I00 deposits) mean metal content is close to the upper limite shown above.

Data on mining, production, consummption and imports or lead and zinc are given in Table 5.

Table 5

Production, consumption and imports of lead and zinc, thous. t.

	Years					
	1955	1960	1965	1966	1967	1968
Mine production (lead content)	4	10	16	22	23	19
Production of primary lead	4	10	16	16	17	16
Production of primary zinc	-	-	-	7 1/	7 1/	...
Consumption of primary lead	14	25	24	24	25	25
Consumption of primary zinc	14	31	41	41	39	40
Imports of primary lead	13	9	2	6	...	...
Imports of primary zinc and alloys	14	31	31	37	...	...

1/ estimated

Ore is mined mainly at open pits, the zones of the richest oxidized and calaminic ores being excavated as a rule. The mines are of a low productivity, the capacity of the largest of them (Boicura, State Bahia) not exceeding 200 thous. t. of ore per year.

Zinc recovering from rich calamine-type ores has started on the base of the Vasante deposit (state Minas Gerais) in 1962. Estimated reserves of this deposit are equal to 6 M t., ~~the~~ zinc content being 30 - 45%. Total reserves of calamine ores in this deposits are estimated to be from II to I5 M t. according to different reports, the mean zinc content being I7.4%. For the past few years such ores were obtained from deposits Itagua (state Rio de Janeiro) and Itacarambe situated in the region of Yanuaria (state Minas Gerais). The reserves of the latter are equal to 600 thous. t. of ore containing I7% of zinc (mean content). Vanadium is recovered as a valuable by-product, its content in ores is 4 - 5%. In 1962 a new zinc deposit (Paracatu) has been discovered in state Minas Gerais, this deposit is now being prospected in detail. The reserves of ore are estimated to be equal to 35 t. at the mean zinc content of II.6%.

Available reserves provide for a sharp increase of production of lead and zinc. These reserves can be increased considerably by studying in detail those deposits which have not been studied well, and by discovering new deposits while doing the geological survey works. These works are being carried out by the country government chiefly in states Parana and Bahia.

Lead and zinc are produced at small plants with output of about 8-I4 thous. t. per year. There are 5 plants in Brazil (3 lead plants and 2 zinc plants).

In Apiai, state Sao Paulo, at the Institute de Paxias Technologicas, there functioned a pilot lead smelting and refining plant. Now it does not produce metal in commercial quantities.

Below a brief specification of the five operating plants is given.

Zinc Electrolytic plant in Itagua belongs to company "Sia Mercantil e Industrial Inga". It processes zinc siliceous ores. At the beginning of the plant operation percentage of zinc in ores was great (up to 35% of zinc). The plant was put into production in 1965. Its industrial capacity is 8 thous.t. of electrolytic zinc per year. The output is planned to be increased up to 17 thous. t. per year. At present extraction of zinc is equal to 92% (mean value).

Zinc electrolytic plant in Tres Maria, state Minas Gerais, belongs to company "Sia Minera de Meto". The plant utilizes mainly the oxidized zinc ores supplied from the mine situated in the vicinity of Vasante. Industrial capacity of the plant is 10 thous. t. of electrolytic zinc per year. It is planned to be increased up to 20 thous. t. of zinc per year by 1970.

Lead plant in Penelas, state Sao Paulo, is a property of company Sia Brasileira de Chumbo "Cobrac". The plant utilizes lead ores supplied from mines situated near Plumbum and belonging to the company. Output capacity of the plant is 8 thous. t. of refined lead per year.

Lead plant in Santa - Omara, state Bahia, also belongs to company Brasiliers de Chumbo "Cobrac". It uses lead ores supplied from mines of the company situated in Bocuira, state Bahia. Plant output is equal to I4 thous. t. of refined lead per year.

Lead plant in Minicipio Adrianolis, state Parana, belongs to company "Industria Brasileira Mineracao". It processes lead concentrates. Output capacity of the plant is 8 thous. t. of refined lead per year. Silver is recovered as will.

More than 65% of the lead consumed in Brazil is produced by the domestic industry. The rest of the metal is imported. Production of the primary lead is fully satisfied by the domestic production of ore.

For the recent years consumption of primary lead has varied from 35 to 4I thous. t. per year.

Semi-products of lead, zinc and their alloys in the form of bars, rods and wires are produced at the three plants in Brazil.

The tin smelting plant "Volta Redonda" (see below) produces (besides tin) lead powder, babbit, solders and lithographic alloys.

The plant in city Sao Paulo belonging to company "Fundicao de Meto Bera" produces bars and blanks of secondary lead and its alloys.

The rolling-pressing plant in the Nova Iguacu town (Rio de Janeiro) belonging to company "Sociedad Anonima Marvin produces semi-products of different non-ferrous metals and their alloys, including a small amount of rolled zinc.

Tin industry of Brazil has recently become one of the most promising branches of the non-ferrous metallurgy. Data on the present state of the tin industry are given in Table 6.

Table 6

Production and consumption of tin, thous. t.

	Years					
	1955	1960	1965	1966	1967	1968
Production of tin-in-concentrates	0.I	I.6	I.2	I.2	I.6	I.6
Production of primary tin	I.2	I.3	I.4	2.3	2.I	2.I
Consumption of primary tin	I.3	I.6	2.0	2.I	2.I	2.I
Imports of tin-in-concentrates	I.4	I.5	I.2	...	0.I	...
Imports of primary tin	0.07	0.02	0.00I	...	...	...

The data on reserves of tin in the country are not available, but they can be estimated approximately as being equal to some 20 thous. t., of which I0 thous. t. can be considered as proved and probable.

Up to the just recent time relatively small amounts of tin were mined almost uniquely in state Minas Gerais.where small placer deposits and pegmatitic veins are found containing cassiterite and columbite-tantalite, beryl and lithium minerals as well.

Beginning from 1962 production is effected in a new tin-bearing region situated in state Rondonia in the vicinity of Porto Velho within the area occupied by the upper current of the Madeira river.Here within a vast territory, which is not explored completely so far, a large number of relatively small placer deposits of cassiterite are developed.The cassiterite content varies from several hundred grams to 60-70 kg/cu.m. At first the mining was not mechanized at all,but introduction of machines practised for the last few years helps to increase the productivity rapidly enough.

Tin containing sands mined in pits of the Rondonia deposit with cassiterite content of 20-60 kg/cu.m. are subjected to the dressing in Brazil.Concentrates contain up to 75% of tin.

Ores of the Ipameri deposit contain 3% of tin.

Primary tin is smelted mainly at the Volta Redonda plant (state Rio de Janeiro) belonging to company "Estanifera do Brasil". Output of the plant is 6-7 thous. t. of metallic tin per year.The company has also a number of mines as its property.

Below a brief specification of the Volta Redonda plant is given.

The plant is put into operation in 1958.

Actual output 2.I thous.t. of tin per year.

Crude materials being processed (data for 1965): 50% are comprised of concentrates containing 40 -60% Sn prepared at the plant and concentrates supplied from the Rondonia deposit containing up to 65-75% of tin as well as traces of iron, niobium and tantalum. The other 50% of the crude material are comprised of concentrates supplied from Thailand. Concentrates contain 65% of tin and almost free from other metals.

Besides the concentrates secondary raw matorials are processed at the plant: slags containing 4% of tin, drosses containing 25% of tin, by-products of the tinning process of iron-smelting plants.

80% of the total amount of tin produced are smelted from ore crudes, the other 20% are obtained from the secondary raw materials. The method employed is as follows: improvement of low grade concentrates containing admixtures - electric melting of the concentrates - liquation of the primary tin- pouring the tin into plates - electrolyzing the plates.

Extraction of tin is 97.33%.

Products obtained:

Tin of the fol.composition: (%) tin - 99.982, antimony - 0.005, lead - 0.007, copper - 0.003, iron - 0.00I, silver - traces.

Lead, antimony, bismuth, silver, babbits.

Powders of tin, lead ,solders, tin dioxide.

Tantalum- niobium concentrate.

Plant in San-Juan-del-Rei:

Industrial capacity is I thous. t. years (of metallic tin).

Crude materials used: concentrates supplied from the San-Juan-del-Rei deposit containing admixtures of tantalum and niobium.

Consumption of primary tin in the country is equal to 2-2.I thous. t. per years.Brazil ceased to import the metallic tin some years ago.

Further increase of the tin production in the country can not be achieved, as the crude material industry is not well developed.The deposit recently discovered and put into operation in state Rondonia, which supplies concentrates containing up to 70% of tin and having a simple chemical composition is situated in a remote hardly accessible region.There is lack of employees, fuel and electric power.The tin concentrates have to be transported to the Volta-Redonda plant by air.

§ II. Republic of Peru

The Republic of Peru is located on the Pacific Ocean's coast in the western part of South America. It borders on Ecuador, Colombia, Brazil, Bolivia and Chile.

Territory - 1,285 thou. sq.km.

Population - 12,4 million people

Population density - 10 persons per sq.km.

Capital - Lima

Principal cities and sea ports: Callao, Lima, Talara, Pisco, Salaverry, Pimentel.

A long belt of hilly plains extends along the sea-coast in the western part of the country, a mountain chain of the Andes with thick ranges, occupying the central part of the country, is located to the east. The eastern areas of Peru are a plain of Amazon Lowland.

Peru is located in the zone of equatorial and tropical climate. River drainage belongs to the Amazon river system. The largest rivers are the Maranon, Ualjaga, Mantaro. The rivers are navigable in the eastern plains only. Motor transport is the main type of transport facilities. The total length of roads is 40 thousand km.

The total length of the railways is not very large (4,000 km) because of the difficulties in their construction in mountainous relief. Pack transport is important, but the river-ways are of no great importance both for the external and internal communications.

External shipments are significan. A network of air routes is growing rapidly. It increased four times as much in 1959-1966.

Electrical energy is supplied by hydroelectric power stations mainly.

This index (Table I) has been doubled since 1958 to 1965.

Table I

Electric power Generation

	Years				
	1958	1963	1964	1965	1966
Installed capacity, thou kw	653	999	1123	1148	...
including hydroelectric stations	401	551	663	680	...
Power generation,					
total million kwh.	1190	3419	3689	3839	4080
including by hydroelectric stations	1453	2159	2448	2625	...

The fuel resourses of the country are relatively small (Table 2). The main oil fields are

Negritos and La Montania. Coal is mined in some areas of the mountainous part of the country.

Table 2

Fuel production

	Years			
	1955	1960	1965	1966
Coal, thousand metric tons	136	162	126	...
Oil, million metric tons	2,303	2,572	3,081	3,075

There are sizable reserves of copper, lead, zinc, gold, silver, arsenic, antimony, bismuth and other commercial minerals in Peru.

Aluminium industry. Aluminium is not produced in Peru, but the aluminium mills treat an imported metal (Table 3).

Table 3

Imports of Aluminium and Aluminium Semi-Products, thousand metric tons

	Years		
	1955	1960	1965
Aluminium imports	0.1	0.5	1.8
Imports of aluminium semi-products	0.9	1.4	2.3

Aluminium is imported from Canada partly. There is a small plant for manufacturing aluminium shaped presswork. Aluminium sheets are planned for manufacturing in the plant.

Copper industry is a key branch of the non-ferrous metallurgy in the country. In 1967 the total copper reserves in Peru amounted to I3 million metric tons, I0.9 million metric tons of that are proved and probable. These reserves contain an average of 0.9I% copper ranging from 0.6% to 3.5% in individual deposits . Exploration works which took place in I967 - 68 revealed an increase in the ore reserves to 16 million metric tons (a number of new ore bodies were discovered and the boundaries of the known ones were widened).

Large copper porphyry deposits, discovered firstly in the southern part of the country as an extension of the belt of the Chilean copper deposits and found later in the central and northern parts of Peru, are of great importance. They are: the Tocepala mined deposit with reserves of 3.6 million metric tons of copper, the Cuahones developed deposit with reserves of 530 million metric tons of ore running I% copper which is located not far from the first one, the Cerro Verde developed deposit 25 km south-east of Arequipa with reserves of I40 mill metric tons of oxidized sulphide and complex ores running an average of I% copper, the Michicuilley deposit in the northern part of the country, the Berenguela deposit 55 km east of Caya Maria, the Antamina deposit (I50 million metric tons of ore averaging more than 1% copper), the Chalcobamba deposit south-west of Cusco (50 million metric tons of ore) and others. Molybdenum occurs in some of these deposits in commercial quantities.

The second group of copper deposits is not so large (some million metric tons of ore), but it is more rich in copper (3 - 3.5% copper). They are: the Cobriza mined deposit in Huancavelica department, the Chapi mined deposit in Arequipa deparment, the Condestable developed or proved deposits in Lima district, the Catanga and Huarca deposits to the south of Cusco, the Madrigal copper-lead-zinc-silver deposit in Arequipa district, the Cenamari copper- tin deposit in Puno department and a number of others.

Sizable amounts of copper ore are extracted from copper-lead-zinc deposits in the Cerro de Pasco, Morococha, Casapalca, San Cristobal, Yauricocha mines and other smaller mines. There are cadmium, antimony, selenium, tellurium and indium in some of these deposits.

The copper reserves have increased in the Morococha and Cerro Verde deposits, a number of new small deposits have been discovered in various areas.

In the Morococha deposit, located I50 km to the east of Lima, a new large ore body with reserves evaluated at I54-327 million metric tons of ore running 0.76% copper is being explored. The known reserves of mined part of the deposit amount to 5 million metric tons of ore (about I00 thousand metric tons of copper) now. The ore contains an average of I.58-2.58% copper, I.42% lead, 5.06% zinc, I40 g/t silver.

The Halcobamba deposit (Cusco department) is being explored now. According to the preliminary evaluaction, its reserves are 32 million metric tons of ore, running I.5% (480 thousand metric tons of copper).

New copper-porphyry deposits have been discovered in Ancash and Lima departments. They are being investigated now.

Table 4 present the data figures on copper mining output and copper production in Peru.

Table 4

Production and Exports of Copper, thousand metric tons

	Years					
	I955	I960	I965	I966	I967	I968
Mine production (copper content	43	I82	I77	I84	I86	2I3
Exports in concentrates I/	I0	20	23	23	23	25
Production of primary blister copper	33	I65	I58	I56	I66	I88
Exports of blister copper	4	I22	II8	II5	I23	I53
Production of refined copper	28	29	4I	36	36	42
Exports of refined copper	27	24	38	33	29	32

I/ it is copper content of concentrates.

The main mines working out the domestic copper deposits are the Tocepala quarry with annual output of IO million metric tons of ore approximately and the new underground Cobriza **mine with** annual output of 300 - 500 thousand metric tons of ore. Apart from that, a number of smaller mines is under operation nowadays.

Ore dressing of sulphide copper and copper-molybdenum ores running 0.5-5% copper is carried out in the entrichment plants as follows:

Tocepala running at a capacity of 36,500 metric tons of ore per day,

Cerro de Pasco running at a capacity of I,000 metric tons of ore per day,

Morococha running at a capacity of I,000 metric tons of ore per day,

Huaron running at a capacity of 600 metric tons of ore per day,

Pacvayococha running at a capacity of 225 metric tons per day,

Azulcocha running at a capacity of 100 metric tons of ore per day,

Cobriza (a new plant) running at a capacity of I,000 metric tons of ore per day. The plants produce copper concentrates containing from I2 to 33% copper with the extraction ratio from 80-85% to 90% and more.

In the largest Toquepala copper plant copper-molybdenum ores averaging 0.5-3.0% copper and 0.15% molybdenite are processed. There is an installation for molybdenum extraction at the plant. About 15% of copper in concentrates are exported to Great Britain and Japan. The rest is smelted in Peru. About 80% of blister copper is exported. The main countris - importers are the USA, Belgium and Federal Republic of Germany, the rest of blister copper is refined in the La Oroya plant with a capacity of 4I thousand metric tons. Copper is produced at two plants in Peru. The copper branch of the copper-lead-zinc plant La Oroya owned by Cerro de Pasco Co. takes the following flowsheet: roasting, reverberatory smelting of candle-end, converter process, electrolytic refining. The plant is running at an annual capacity of 50 thousand metric tons of blister electrolytic copper and 4I thousand metric tons of copper from the anodes of the same plant.

The Ilo plant owned by Southern Peru Co. applies the following flowsheet: reverberatory smelting, converter process. An annual dapacity is I60 thousand metric tons of blister copper.

Copper consumption in the country is not large. There is a plant for the production of copper wire and cable in Lima.

It is expected, that copper consumption will increase considerably in the near future in view of bringing into operation a copper wire and wire bars plant in La Oroya. The plant will be operated by Cerro de Pasco Co. and will be running at 45 thousand metric tons a year.

Copper plants in Peru are owned mainly by two American firms: Southern Peru Copper Co. (51.5% - American Smelting and Refining, 22.5% - Cerro, 16% - Phelps Dodge and 10% - Newmont), which extracted 113 thousand metric tons of copper in 1967, and Cerro de Pasco - 37 thousand metric tons of copper in 1967. Both companies gave 150 thousand metric tons or 80% of the total copper output in ore in the country.

Projects of a further development of copper industry in Peru are under consideration. It is supposed to redouble the copper output in ore by 1972 (it will come to 400 thousand metric tons). Capital investments for these purposes will amount to $ 473 million.

They intend to invest a capital of $ 165 million more in order to raise the copper output of ore to 635 thousand metric tons.

For the purpose of realization of the plan (planned copper output increase) new facilities were brought into operation and the old ones were expanded in some plants in 1967-1968.

The new Cobriza underground mine with reserves evaluated at 7.4 million metric tons of ore averaging

2.0% copper and 14 gramm per ton silver was brought into operation in 1968 by Cerro de Pasco Co.In the initial period of exploitation the mining output amounts to 6.3 thousand metric tons of copper and 5.7 metric tons of silver a year.

A daily capacity of a concentrator is 1,000 tons. The concentrate contains 25% copper and 93 silber ~~gram~~ per ton, ~~silver~~. The conncentrates will be smelted at the La Oroya plant.At this stage the capital investiments amount to $ 20 million approximately. It is possible to raise the daily capacity to 4000 thousand metric tons. The same company is investigating the workability of a large deposit near Morococha.The reserves are evaluated at 360 million metric tons of ore running 0.76% copper and small amounts of silver and molybdaenum.The deposit may be worked out by open-cut method.

Southern Peru Co. began to develop for open-cut mining the Cuahones deposit, located near the Tocepala integrated plant, the expected copper output is 140 thousand metric tons a year.It was planned to construct an ore-dressing plant with daily capacity of 30 thousand metric tons and to double the capacity of the Ilo plant.The capital investments, including those on the construction of a settlement and a railway branch-line, are planned at $ 280 million.The construction works are planned for a 5 years period.

Andes del Peru Co., Anaconda's subsidiary, plans to work out the Cerro Verde deposit. It is planned to build a copper leaching plant with a capacity of 10 thousand metric tons for the treatment of oxidized ores, which will be mined firstly. Then a floatation concentrators with a capacity of 20-30 thousand metric tons is intended to be built.

Lead-zinc industry. The total lead reserves amount to 3.3 million metric tons, including 2.8 M. metric tons of being proved and probable, 7.5 and 5.8 million metric tons, respectively, for zinc. The lead content is in the range from 2.5 to 10.0%. zinc content- from 4.5 to 16.0% ,though areas with more high-grade ores are not rare. All the ores contain copper, lead, zinc, silver, gold, cadmium, antimony, bismuth, arsenic, tungsten, tin and other elements.

The largest Cerro de Pasco lead-zinc deposit has reserves, according to 1965 figures, of 565 thousand metric tons of lead and 1356 thousand metric tons of zinc averaging 5.0% lead, 12.0% zinc, 70 g-t silver and 0.15% copper.

There are some other large deposits which are as follows: The Casapalca deposit in the department of the same name with ore reserves of 400 thousand metric tons of lead approximately, 800 thousand metric tons of zinc approximately, 160 thousand metric tons of copper ore averaging 4% lead, 8% zinc, 1.8 % copper, 370 gpt silver, the Santander deposit in Santa department with explored reserves of 4 million metric tons and geological reserves of 3 million metric tons and ore content averaging 2.5% lead, 12% zinc, 0.5% copper, 46-83 gpt silver, the San-Cristobal deposit averaging 1.7% lead, 8.0% zinc, 3.0% copper, 365 gpt silver, the Raura deposit averaging 3% lead, 10% zinc, 700 gpt silver and 0.3 gpt gold, the Morococha and Amacocha depo - sits and numerous small deposits.

Rather a high level of lead and zinc output in ore and production of both metals is characteristic of Peru (Table 5).

Table 5

Production, Consumption and Exports of Lead and Zinc, thousand metric tons

	Years					
	1955	1960	1965	1966	1967	1968
Mine production (lead content)	119	132	154	149	158	163
Mine production (zinc content)	166	178	254	258	318	300
Primary lead production	61	72	87	89	76	87
Primary zinc production	17	33	63	64	63	72
Primary lead consumption	-	3	6	6	4	5
Primary zinc consumption	-	2	5	5	4	3
Lead exports in concentrates	49	58	66	64	74	63

Table 5 (continued)

	1955	1960	1965	1966	1967	1968
Zinc exports in concentrates	I28	I33	212	226	241	258
Primary lead exports	57	60	66	87	77	72
Primary zinc exports	I9	24	56	56	61	51

The most part of the deposits is worked out by the underground mining method.Open-pit mining is used only in the Ma Kun mines, Cerro de Pasco department, and in the Santander mines (partly) - from large mines.

The annual capacity of the Serro de Pasco, Mac Kun and Casapalca mines amounts to 1 million metric tons of ore, the capacity of the other mines is not so large. Numerous small mines with the output amounting to some hundred metric tons of ore a year are characteristic of Peru.Sizable amounts of lead and zinc are mined together with other metals, copper and gold mainly.

The most large ore-dressing plant is the Serro-de-Pasco plant running at a capacity of I.700 t per day, the rest of the plants are running at a lower capacity, the Huaron ore-dressing plant - 700 t per day,Carahuacra - 600 t. per day, Santander - 450 t. per day, two plants in Amacora district - 225 and 8I0 t . per day, respectively, Milpo - 450 t. per day, Colcviyrc - 270 t. per day, Raura - I20 t. per day, two ore-dressing plants in Serro-de-Pasco distract - 50 t per day.

Copper-lead-zinc ores are processed at the Casapalca plants runing at a capacity of 1,100 t. per day; Maar-Tunel - 670 t. per day; Tamburaco - 360 t. per day; two ore-dressing plants in Sacracancha district with capacities of 270 and 400 t. per day, respectively; Huarochiri - 180 t. per day; Rio Pallanga and Alpamarca - 315 t. per day each one; Pacococha - 112 t. per day. The Yauricocha plant, which was brought into operation in **1966**, is running at a capacity of 1,000 t. per day since 1968.

Sulphide lead-zinc ores ranging from 1 to 7% lead and from 4.4% to 12% zinc are processed at Peru's ore-dressing plants.

The processed complex copper-lead-zinc ores contain an average of 1.5% copper, 2% lead, 9.5% zinc and 170 gpt silver.

Above 50% (55% in 1967) lead in concentrates is processed in the domestic metallurgical plants, the rest of the concentrates is exported, to the Federal Republic of Germany mainly.

Zinc concentrates, which reprocessed at domestic metallurgical plants, amount to less than 25% (23% in 1967) of the overall production of zinc concentrates. Annually Peru exports above 200 thousand metric tons (247 thousand metric tons in 1967) of zinc in concentrates to the USA, France, West Germany and Japan mainly. As to the complexity of the utilization of raw materials, the plant owned by Cerro de Pasco Co. is keeping one of the leading places in the world. Apart from the basic, rare and precious metals, the plant produces copper sulphate, zinc sulphate, calcium arsenate, arsenic trioxide, sulphuric acid and various alloys.

It is reported that a zinc plant which is scheduled for completion in 1970 is under construction in Ancon Colyao. Its designed capacity is 30 thousand metric tons of zinc.

A brief characteristic of operating plants is listed below.

The La Oroya, Uaymanta, lead smeltery and refinery. It is owned by Cerro de Pasco Co. Its capacity is 90 thousand metric tons of refined lead a year. It was brought into operation in 1906. The plant is processing sulphide lead concentrates averaging 55% lead, 9.2% copper, 6-7% zinc, 21-27% sulphur. The products: refined lead, copper matte, silver, gold, antimony, antimonial lead, bismuth (highest grade) and bismuth alloys, selenium, tellurium. Lead purity -99,996% (99,996% lead in the product).

The La Oroya, Uaymanta zinc plant. It is owned by Cerro de Pasco Co. It was brought into operation in 1952. Its annual capacity is 168 thousand metric tons of electrolytic zinc. It is processing concentrates from the mines operated by the same company. The concentrates contain an average of 44% zinc, 4% lead, 15% iron, 34% sulphur. The products: electrolytic zinc of 99.99%

purity, zinc sulphate, cadmium - 630 t, indium - 5.6 t, sulphuric acid.

The major Cerro de Pasco Corporation, operating complex deposits, concentrating plants, the La Oroya copper, lead and zinc works, is a subsidiary of Cerro Corporation (an American company).

Lately the expansion of Japanese capital into Peru' lead and zinc industry may be observed. The Japanese Mitsui Mining Co. invests $ 5 million in the construction of a concentrating plant of the Huansala lead and zinc mine, located in the Central Andes, 300 km north-east of Lima. The plant will be running at a capacity of 500 t ore a day with an annual output of 27 thousand metric tons of zinc concentrates, 12 thousand metric tons of lead concentrates and 9 thousand metric tons of copper concentrates.

In summer of 1966 the Peruvian Santa Lusia Co. which owned the Huansala deposit has sold it to the above-mentioned Japanese firm for $ 900 thousand.

<u>Tin industry.</u> Tin concentrates in Peru are produced at placer gold operations in Puno department, near the Bolivian border. Apart from that, tin is extracted as by-product in metallurgical processing of lead concentrates from the complex Cerro de Pasco deposit (Table 7).

Table 7

Tin Production in Peru, thousand metric tons

	Years					
	1955	1960	1965	1966	1967	1968
Production, tin-in-cgncentrates	-	0.02	0.02	0.02	0.02	0.02
Exports, tin-in-concentrates	0.002	-	0.03	0.02	0.01	0.01
Primafy tin imports	0.7	0.02	0.06	0.09	0.05	0.09

§ 12. Republic of Chile

The Republic of Chile is located in South America; it borders on Peru, Bolivia and Argentina.

Territory	- 756,900 sq.km
Population	- 8.7 million people
Population density	- 12 persons per sq.km
Capital	- Santiago

There are three different relieves in Chile: the Central and Western Cordillera in the east, the Coastal Cordillera in the west and the Longitudinal Valley between them. There are desert mountainous plateaus in the north.

Chile's climate is tropical in the north, subtropical in the Central Chile and temperature humid in the Southern Chile.

Rivers belong to the basin of the Pacific ocean mainly, all of them are very short. Only the Loa river riches the Ocean in the north. Numerous rivers of the Central Chile are of great importance for irrigation and hydroelectric power generation. The rivers of the Southern Chile are longer and fall into the Pacific Ocean too.

Chile's transport facilities are rather developed. The trunk railway traverses the whole territory of the country from the north to the south. The railway routes connect Chile with Argentine and Bolivia. The Pan-American highway runs from the Peru's border via Chile (Santiago) as far as the Argentina border. There is a sizable fleet of motor vehicles in the country.

The rivers of the Southern Chile and the largest lakes are used for navigation within short distances.

Power is supplied by thermo power stations and hydro-electric power plants. The hydroelectric power stations generate a major proportion of power (Tabl. 1).

Table 1

Power generation

	Years				
	1958	1963	1964	1965	1966
Installed capacity, total, thousand kw.	1014	1336	1495	1454	1493
including hydroelectric power stations	522	683	711	710	710
Power generation, total, million kw-hr	4146	5623	5932	6131	6662
including - hydroelectric power stations	2661	3404	3723	3954	4168

Chile has domestic fuel resources. Coal, oil and natural gas are produc~~tion~~ed here (Table 2).

Table 2

Fuel production

	Years			
	1955	1960	1965	1966
Coal, million metric tons	1.889	1.297	1.544	1.461
Lignite, million metric tons	0.229	0.068	0.085	0.067
Oil, million metric tons	0.336	0.943	1.656	1.620
Natural gas, billion m^3	0.466	0.888	1.729	1.584

As regards non-ferrous metals, copper, gold, silver, molybdenum and mercury are produced.

The aluminum industry in Chile is limited by processing of imported aluminum.

Small bauxite deposits were found in Montenegro district 40 km north of Santiago in the beginning of 1960's. Their industrial importance has not been ascertained exactly, but they are not likely to have a considerable importance because of their small dimensions.

Chile is a minor consumer of aluminum which is imported from abroad, mainly from Canada.

Imports of Aluminium and Aluminium Semi-Fabricated Products, thousand metric tons

	1955	1960	1965
Aluminium	1.1	1.8	3.1
Aluminium semi-fabricated products	0.5	0.2	0.2

Aluminium treatment for semi-fabricated products is being carried out at some small plants, located in Santiago and its environs. The main consumers of aluminium rolled products are located in Santiago district, in the main seaport Valparaiso and in some other towns of the Central Chile.

A total of 900 metric tons of aluminium wire rope for electric transmission lines was produced in 1965 for the first time in Chile.

Copper industry. Chile occupies one of the first places in the world by its copper reserves and mining production. The share of Chile constitutes 23% of total reserves, 26% of proved and probable reserves and 16% of total mine production.

Of total copper reserves evaluated as 59 million metric tons 42 million tons are proved and probable. The copper content ranges from 0.73 to 3.5 per cent averaging 1.5 per cent copper. Probable reserves are estimated at 92 million tons. A total of 661 thousand metric tons of copper in ore was produced in Chile in 1967 (Table 3).

Table 2

Copper Mining, Production, Exports, Consumption, thousand metric tons

	1955	1960	1965	1966	1967	1968	evaluation
Mine production (copper content)	434	532	586	636	661	660	
Exports of copper concentrates	27	37	28	31	30	34	
Production of primary blister copper	406	505	558	605	630	630	
Exports of blister copper	175	273	275	235	241	243	
Production of refined copper	241	226	289	357	353	350	
Including electrolytic copper	128	147	191	259	262	...	
Exports of fire refined copper	103	75	67	95			
Exports of electrolytic copper	107	141	149	222	361	364	
Consumption of refined copper	34	13	73	40	17	20	

Three American companies play the main rôle in the mining and production of copper in Chile. They account for over 80% of all copper mined in the country. These companies are:

The Chile Exploration which owns the mining and metallurgical complex Chuquicamata and the large Exotica deposit which is being prepared for exploitation;

The Andes Copper Mining Company which owns the mining and ore dressing complex El Salvador and a copper-smelting plant at Potrerillos;

The Braden Copper Company, since 1966- Sociedad Mineral El-Teniente, to which belong the mining and metallurgical complex El-Teniente and the copper-smelting plant at Caletones.

Two of the above-mentioned companies - Chile Exploration and Andes Copper Mining - are subsidiaries of the largest monopoly of the USA - Anaconda, and the third - Braden Copper - is a subsidiary of another USA monopoly - Kennecott.

The significance of the facilities of these companies in the overall production of copper in the country can be seen from the data shown in Table 4.

Table 4

Ore Mining and Copper Production at the Plants Operated by the United States Companies in Chile

	Ore Mining, million metric t	Copper production, thousand metric t					
		electrolytic		fire refined		blister	
	1967	1967	1968	1967	1968	1967	1968
Anaconda Co.:							
Chile Exploration	30.3	183.5	163.4	-	-	93.8	115.7
Andes Copper	8.1	41.6	69.3	-	-	36.6	17.2
Kennecott Co.: El Teniente (previous Braden)	11.7		-	70.2	59.5	112.4[1)]	101.2

1) Including 30.3 thou tons of blister copper, refined by electrolysis at the state owned plant at Las Ventanas.

The rest of the copper in Chile (124,000 tons in 1967) is produced by medium-sized foreign and state-owned Chilean companies as well as by a great number of small private national enterprises.

Among the medium-sized companies are two comparatively large enterprises: the mining and metallurgical complex. Mantos Blancos (mine and plant), belonging to the foreign company Empresa Minera de Mantos Blancos, and the copper-smelting plant at Chagres (having also a dressing plant at El-Melone), belonging to the foreign company Minera Disputada de Las Condes, formerly Minière M'zeta, an affiliated company of the French firm Société Minière at Metallurgique de Penarroya.

Preparations are under way for the start of operations at the Rio Blanco mining and concentrating complex belonging to the Minera Andina Company (with 75% of the stock in the hands of the Serro Corporation of USA).

The state-owned enterprises of Chile's copper industry are united by the state mining company ENAMI (Empresa Nacional de Mineria).

The state company ENAMI is not engaged in the mining of ores; it purchases ores and concentrates from small private enterprises and smelts them into metal at its two smelters - Paipote (existing since 1952) and Las Ventanas (since 1964). Besides this, ENAMI has five concentrating and hydrometallurgical plants with a total capacity of about 6,000 tons of copper in concentrates and in cement copper per year. After the start-up of an electrolytic refining shop at the Las Ventanas plant, in 1966 all primary copper produced by the state-owned smelters of ENAMI is refined on the spot.

Such is the organization of Chile's copper industry.

Copper ore in an amount of up to 80% of its total production in the country is mined at three major mines -

the Chuquicamata open-pit mine and the underground mines El-Salvador and El-Teniente.

The Chuquicamata open-pit mine is one of the largest in the world. Its output is approximately 110,000 to 115,000 tons of ore per day, including 40,000 to 45,000 tons of oxidized ore and 70,000 to 75,000 tons of sulphide ore. The reserves of ore are estimated at 1 thousand million tons. The average copper content of the ore is 1.5%. The ore contains also molybdenum.

Large mining enterprises are also the underground mines El Salvador, with a daily output of 26,000 tons of ore containing 1.5% Cu, and El Teniente, with a daily output of 36,000 tons of ore containing up to 2.0% Cu.

Oxidized ores are mined by the open pit method also at the Mantos Blancos deposit, with a daily output of 4,500 tons of ore.

The ores mined are oxidized (especially on upper levels), sulphide-type and mixed, which predetermines the methods of their processing . Because of a complex composition of ores, some plants use combined processing flow diagrams including floatation, hydro- and pyrometallurgical processes.

The copper content of the ores mined is fairly high: at large mines it averages 1.5 to 2.5% Cu, at small and medium-sized ones it is considerably higher - up to 5-8% Cu, which is possibly due to a selective character of mining operations performed in a small volume.

Concentration is applied mainly to sulphide ores. The characteristics of the largest copper ore dressing plants of Chile are briefly summarized in Table 5.

Table 5

Copper Ore Dressing Indexes for Large Chilean Plants

	Capacity, t per day	Ore contents per cent		Concentrate contents, per cent		Recovery, per cent	
		Cu	Mo	Cu	Mo	Cu	Mo
Chuquicamata	55,000	1.5	0.015	50.0	48.0	90.0	40.0
El Salvador	26,000	1.5	0.015	50.0	54.0	88.0	56.0
El Teniente	36,000	2.0	0.012	33.0	54.0	...	70.0
Rio Blanco	11,500	1.58	-	30.0	-	...	-

In cases where ore dressing plants are processing copper-and-molybdenum ores, the copper concentrates are sent to a molybdenum floatation plants. On the average , about 4,000 tons of molybdenum in molybdenum concentrates per year is produced.

Of the plants shown in the Table, of particular interest is the El Salvador ore dressing plant. All processes at this plant are mechanized and automated, which makes it possible for a plant with a daily capacity of 26,000 tons of ore to be run by a staff of only 140 men.

Besides the large ore dressing plants shown, there are many minor ones in Chile, working at medium-sized and small copper mines. Capacity of these plants is in the range of 100, 200 and sometimes 300 tons of ore per day.

At the state-owned Paipote copper smelter there is an ore dressing plant with a capacity of 500 tons of ore per day, which is processing ores purchased from small enterprises mining copper ore in a primitive way.

The copper industry of Chile has 7 metallurgical plants, of which five use a pyrometallurgical flow sheet; one, hydrometallurgical technigue; and one (Chuquicamata) has two shops, one of which is processing sulphide concentrates by the pyrometallurgical method and the other, is treating ores by the hydrometallurgical method. The characteristics of the copper plants operating in Chile are briefly summarized in Table 6.

Table 6

Copper Smelters and Copper Refineries in Chile

Company	Location	Technological scheme	Yearly capacity, thousand metric t (evaluation)
Chile Exploration	Chuquicamata	1.Reverberatory smelting of dried concentrates,converter blowing; fire refining of part of the products;electrolytic refining of some part of anode copper,wire bars casting	200 257 of electrolytic copper1)

continued

Company	Location	Technological scheme	Yearly capacity, thousand metric t (evaluation)
		2. Hydrometallurgical treatment of oxide ores, electrowinning of copper, cathodes smelting for wire bars	130
El Teniente	Caletones	Drying and roasting of concentrates, smelting of sinter; converter blowing, fire refining of part of the production	180 blister copper total, including 90 fire refined copper
Andes Copper	Potrerillos	Reverberatory smelting of dried concentrates, converter blowing, fire and electrolytic refining, cathodes smelting for wire bars	90 total including 60 electrolytic copper
Empresa National de Mineria	Las Ventanas	Reverberatory smelting of crude concentrates, converter blowing, electrolytic refining, smelting for wire bars	48 84 refined[1]
Empresa Minera de Mantos Blancos	Mantos Blancos	Hydrometallurgical scheme of percolation leaching with precipitation of copper chloride, pelletizing, smelting of pellets in drum-type furnace for blister copper, fire refining	25 fire refined copper 25 cemment copper
Empresa National de Mineria	Paipote	Reverberatory smelting of crude concentrates, converter blowing	24 blister copper refined at Las Ventanas

Company	Location	Technological scheme	Yearly capacity, thousand metric t (evaluation)
Minera Disputada de Las Condes	Chagres	Reverberatory smelting of crude concentrates, converter blowing	20 blister copper

[1] including copper from anodes of the same plant

Of undoubted interest is the Mantos Blancos plant, which is processing oxidized ores with high chlorine content (0.4 to 1.5 %). The plant uses a unique (the only one in the copper industry of the world) combined hydro-pyrometallurgical technique using the method of precipitation of copper in the form of chloride ($CuCl_2$). The flow diagram includes percolation leaching , $CuCl_2$ precipitation, pelletizing, smelting and refining.

Total capacity of copper processing industry is 170 thousand metric tons rolled products a year.

Manufacturas de Cobre Co. is the main producer of rolled products from copper and its alloys; 85 per cent of stock of this company belongs to Chile, and 15 per cent - to foreign countries (the USA and Italy).

The firm operates two plants: the first plant is located in Antofagasta and produces electrotechnical copper rolled products, copper wire and cable.

The second plant is located in Madeco (not far from Santiago); it produces wire, cable, rods, sheets, tubing and strip of copper and brass.

Cobre Serrillos Co. located in Las Corillos (not far from Santiago) produces copper rods, wire and cable.

Electrolytic copper is used for anufacturing copper wire bars and small amounts of wire and cable. Fire refined copper is processed into thick sheets mainly. From consideration of Table 3 (data figures on copper consumption) it can be seen that the copper mills in Chile are not run at the ultimate capacity.

The programme of large capital investments in the copper industry, with the purpose of doubling the copper production and stren gthening the governmental control over the copper industry, was approved of in Chile.

The planned capital investments in the chilean copper industry (including the capital investments into facilities for the refined copper production) are listed in Table 7.

Table 7

Capital Investments in Chile's Copper Industry

Companies and properties	Supposed yearly increase in copper minning and production, thousand metric t	Designed capital investments, million dollars
Chuquicamata // El Salvador // Exotica // (Anaconda) //	100	220
	90	

continued

Companies and properties	Supposed yearly increase in copper mining and production, thousand metric t	Designed capital investments, million dollars
El Teniente (Kennecott)	100	230
Minera-Andina (Serro)	65	89
Sagasca	28	35
Average and small mines	100	82
Total	483	656

As Chile's State Corporation reported, a sum of $ 225 million has been spent on account of these investments (Minera Andina) in 1968 only.

The structure of planned capital investments in the Chile's copper industry is as follows; mines development - 24 per cent: ore dressing - 18.9 per cent; metallurgy - 19.4 per cent; water supply - 48 per cent; power supply - 9.5 per cent; roads - 6 per cent; settlements - 11.5 per cent; other working expenses - 5.9 per cent.

On account of these capital investments a number of works has been carried out.

The capacity of the Chuquicamata refinery was increased from 220 thousand metric tons to 387 thousand metric tons in 1968. The capacity of the Potrerillos ~~of the~~ electrolytic plant has been increased from 40 thousand metric tons to 65 thousand metric tons. The capacity of the El Salvador mine, the ores from which are treated at this plant, has been increased respectively; the capital investments for expansion of the mine amounted to 8 million dollars.

In June 1967 overburden removal started in the Exotica mine, with reserves amounting to 153 million metric tons of oxidized ores containing 1.35 per cent copper. By the mid-1970 26 thousand metric tons of oxidized ore per day are supposed to be mined (stripping - 80 thousand metric tons). The ore will be transported for hydrometallurgical treatment at the Chuquicamata plant; after leaching the copper will be precipitated as cement copper and treated by hydrometallurgical cycle in the Chuquicamata plant. A new sulphating facility with a capacity of 600-800 metric tons per day will be built at the plant. The copper production will amount to 112 thousand metric tons a year. The capital investments are 38 million dollars.

Expansion of the major underground mine El Teniente is planned. By the mid-1970 the copper production in the Caletones plant (working on the base of this mine) will be increased to 280 thousand metric tons as compared to 180 thousand metric tons before. Financing will be on account of the Export-Import Bank ($ 110 million), the Chile Government ($ 20 million), Braden Co. ($ 80) million .

Minera Andina Co. which operates the Rio-Blanco mine (its reserves being evaluated as 120 million metric tons of ore averaging 1.58 per cent copper), plans a $ 157 million

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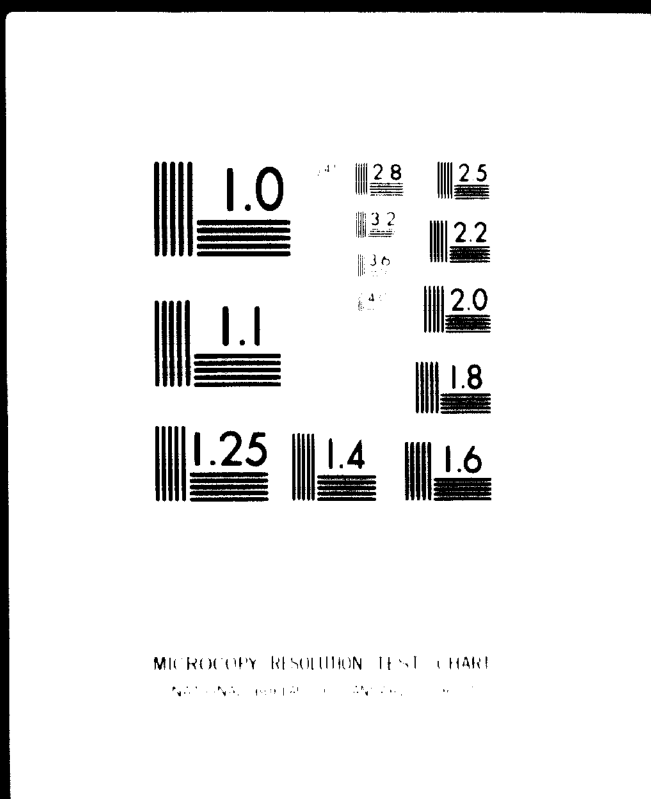

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Minera Andina Co. which operates the Rio-Blanco mine (its reserves being evaluated as 120 million metric tons of ore averaging 1.58 per cent copper), plans a $ 157 million investment for the construction of a mining Complex with a capacity of 65 thousand metric tons of copper metal a year.

Japanese firms (Sumitomo, Mitsubishi, Nippon) lend $40 million (of that sum) on terms of importing 150 thousand metric tons of concentrates annualy during ten years on the account of lended sum.

The rest of the concentrates will be treated at the Las Ventanas plant. The plant is scheduled for completion in 1971.

Cuprera Sagasca Co. has been carrying out preparative exploratory work in the Sagasca deposit for the purpose of exploitation. A hydrometallurgical plant with a designed capacity of 4 thousand metric tons per day is under construction.

The reserves are evaluated at 16 million metric tons of oxidized ores running 2 per cent copper. The yearly capacity is 25 thousand metric tons of Cu as cement copper. Capital investments are $ 32.5 million.

In Chile's State Corporation report targets of copper production in 1972 for major plants are listed as follows (thousand metric tons): Chuquicamata - 390; Exotica (Anaconda) - 1125; El Salvador (Anaconda) - 110; El Teniente (Kennecott - Chilean Government) - 302 ; Rio Blanco (Cerro-Chilean Government) - 77.5; total - 992 thousand metric tons.

Apart from that, copper production of average-scale and sm small mines is expected to be 250-300 thousand metric tons.

Major companies of the USA (Anaconda, Kennecott) keep predominant positions in the Chile copper industry. In recent years the Chilean Government started taking a number of measures on providing control of copper industry development. According to the law signed in October 1966, the Chilean Government received control shabe holding from Braden Co., a Chilean subsidiary of the American Kennecott Copper Co. A new Sociedad Mineral - El-Tiente Co. with 51 per cent interest acquired by the Chilean Government and 49 per cent interest - by Kennecott Copper Co. was formed then.

However, a number of American companies are keeping the leading role in some firms, as Minera Exotica Co., which is owned 75% by Anaconda Co.'s interests and 25% by Chilean Government's interests; Chile-Exploration Co., which is owned by Anaconda Co.'s (USA) interests; Mineria Andina which is owned 25% by Chilean Government's interests and 75% by Serro (USA); Cuprera Sagasca, which is owned 25% by Chilean Government's interests and 73% by Continental Copper and Steel Industries' (USA) interests.

About 80 per cent of copper is produced by plants owned by major USA companies (Anaconda Co., and Kennecott Co.),the rest 20 per cent - by small and average-scale Chilean plants.

The lead-zinc industry is not quite developed. Lead and zinc are recovered on a small scale (0.5-2.0 thousand metric tons of metal a year) in Aisen district.

Chile has large copper reserves, but [illegible] and zinc. The total lead reserves are evaluated at 40 thousand tons with 20 thousand metris tons being proved and probadle 20 and 10 thousand tons, respectively, for zinc.

§ 13. HONDURAS

The Republic of Honduras lies in Central America. It borders on Guatemala on the north, El Salvador on the south and Nicaragua on the south-east . Its territory is washed by the waters of the Caribbean Sea on the north-east and a small patch of it faces the Fonseca Gulf of the Pacific Ocean.

Territory	- 112.1 thous. sq.km
Population	- 2364 thous. people
Population density	- 21 persons per sq.km
Capital	- Tegucigalpa

The principal cities: San-Pedro-Sula; La-Seiba.

A narrow strip of lowland is stretching along the Caribbean Sea coast. This lowland has some convenient harbours on the west and widens up to 80 km on the east. The rest of the Honduras territory is a plateau with the prevailing height of 500 to 1500 m.

The climate in the North and North-East is torrid and damp; in the South and especially inland it is torrid but dry.

The railway lines are running only along the Caribbean Sea coast. Their total length is 1500 km. The total extension of earth roads is about 2000 km. The main roads are connecting Tegucigalpa with the Fonseca Gulf and Caribbean lowland. The air service plays a very important part in the internal and external transport communications.

The sea shipment is carried out by foreign ships.

The share of hydropower plants (as far as their output and production of electric power are concerned) is constantly growing.

Table 1

Electric power generation

	Years				
	1958	1963	1964	1965	1966
The installed capacity in thousand k.w.	30	36	70	73	77
including hydroelectric stations	4	4	33	33	33
The output of electric power in million k.w.h.s, total	80	115	128	175	204
including hydroelectric stations	13	...	...	105	129

The fuel resources in Honduras are not abundant. Thus the reserves of brown coal are estimated as 4 mln.tons, of coal - 1 mln. tons. Traces of oil are found in Santa Barbara province.

Some resources of metals (such as lead, copper, zinc, iron) are reported in the country, but only silver and gold are mainly mined and exported to the U.S.A.

Aluminium industry. Resources and traces of bauxite of lateritic type are found in Honduras. But their industrial value remains unestablished. In 1964 the summary resources of Honduras and El Salvador were estimated as 10 million tons of bauxite, but apparently the share of El Salvador is much greater than that of Honduras.

Copper industry. At the beginning of sixties traces of copper ore were discovered in south-western part of Honduras. The deposits have the porphyry type of ore with a small metal content.

Lead-zinc industry. All the established resources of lead and zinc can be referred to as proved and probable; they amount to 80 thousand tons of lead and 80 thousand tons of zinc. The average content of metal in ore is 7.6% and 7.7% respectively. About 9/10 of these ores can be found in the deposits of Rosario, San Pedro Sula department in the west. The ore is mined at the El Mochilo mine with the aim of recovering silver and gold; lead and zinc are recovered as by-products. In 1967 new lodes, containing up to 14% of lead 18% of zinc and 500 g./ton of silver were opened while boring below the mine working level. The reserves are supposed to increase greatly.

Small amounts of lead and zinc are mined in the Akia-Fria region, south-west of Tegucigalpa and recovered together with gold and silver.

In 1967 some Canadian companies got a licence for the prospecting of the area of 5000 km^2 in the Maya Mountain Range district, where some traces of copper and zinc mineralisation had been established before.

Lead-zinc-silver ores of El Mochito field are mined and processed. The content of lead in them is 6.3%; zinc - 8.4%; silver - 893 g /t; and gold - 0.68 g /t.

The ore is processed at the concentrator with an output capacity of 300 tons of ore per day.

More than 50 tons of silver; about 5 thousand tons of lead; 6 thousand tons of zinc; and a small amount of gold are produced every year.

§ 14. GUATEMALA

The Republic of Guatemala is on the north-west of Central America. It borders on Mexico on the north and west, Salvador and Honduras on the south-east, British Honduras on the north-east and is surrounded with the Pacific Ocean on the south-west.

Territory	- 108.9 thous.sq.km
Population	- 4.7 million people
Population density	- 43 persons per sq.km
Capital	- Guatemala

Large cities; Quecamtenango, Sacana, Coban, Puerto-Barrios.

A lowland strip 40 to 60 km wide extends along the Pacific coast. The highland occuping most of the country rises above the lowland.

The climate is hot and dry on the Pacific coast and temperate on the plateau.

The length of Guatemala railroads totals 1150 km, 1048 km of which are owned by the American companies. Early in 1969 the Guatemala government had nationalized this railroad by a special decrée. The main lines link the capital with the ports of San José and Champerico on the Pacific coast and Puerto-Barrios on the Caribbean coast. There are about 7 thous. km of earth roads. A section of the Panamerican highway crosses Guatemala.

Electric power is generated chiefly by hydro-power stations (Table I).

There are practically no fuel reserves in Guatemala. Intensive prospecting of oil produced no tangible results. The country possesses gold, silver, lead, zinc, iron, chromium, antimony but they are exploited to a very limited extent.

Thus, iron ore production does not exceed 4 to 5 thous. tons per year.

Table 1

Electric power generation

	Years				
	1958	1963	1964	1965	1966
Installed capacity, total thous. kw	55	89	100	114	135
Electric power generation, millions kw-hr Total	219	364	434	480	520
including hydro-power stations	158	332	...	...	...

Copper industry. Copper mining is not carried out in spite of the Mata deposit located 75 km south-east of the Guatemala City at a height of 1700 m above the sea level. An average copper content in ore is 2.5 per cent, the ore also contains 0.31 g /t of silver.

The reserves are not estimated. It is known that the mineral bearing zone is 180 m long, 45 m wide and the bed thickness is 120 m. Small appearances of copper and copper

-gold ores are also known, but they still remain completely unexplored .

At present the country consumes only about 200 tons of copper and copper alloy semi-finished products which are imported from the USA.

Lead and zinc industry. There are small lead and zinc deposits in which copper, silver and gold are usually also present. The reliable data on reserves are not available, but basing on various inderect considerations they could be provisionally estimated as 160 thou.tons of lead and 120 thou.tons of zinc, of which 80 thou.tons of lead and 60 thou.tons of zinc are referred to as proved and probable. Lead and zinc produced in some regions of the country are all exported. However even this production is gradually decreasing. Thus, in 1958 8 thou.tons of lead and 5 thou.tons of zinc in ore were produced , but by 1967 the production went down to 500 and 600 tons of metal respectively. Somewhat 100 to 200 tons of lead per year are smelted by the home--industry.

§ 15. COLOMBIA

Republic of Colombia is located in the South-West of South America, bounded on the North by the Caribbean Sea, on the East by Venezuela and Brazil, on the south by Peru and Ecuador.

Territory	- 1138.9 thous. sq.km
Population	- 19.2 millions people
Population density	- 17 persons per sq.km
Capital	- Bogota

According to the nature of its relief Colombia is clearly divided into the mountainous West and the plain East. On the West Cordilleras stretch over the country, on the East the plain slopes down towards the vallies of Orinoco and Amazon. The climate is equatorial.

The river network of Colombia is very dense. The rivers are fed chiefly from the rainfalls. The main rivers, Magdalena with the large left tributary Cauca, Sinu; Atrato run into the Caribbean Sea. The short but rapid and full-flowing rivers of San-Juan, etc. belong to the Pacific.

The transportation main line of the country is the river of Magdalene connecting the most import.nt regions of the country to the Carribbean Sea. To by-pass the river section with many rapids near the town of Onda, a railroad was built. However in the dry season navigation is ceased there. The rivers of Cauca, Atrato, San-Juan and some others are also navigable. The total length of river ways makes 5900 km.

The chief ports are Barranquilla and Cartagena on the

Caribbean Sea and Buenaventura on the Pacific Ocean.

17 railroad lines total 3467 km, but they are not linked together to form a single network and they differ in the track gauge.

The length of macadam roads is 1200 km. The Panamerican highway runs from Acanti on the Panama border to Ipiales on the Ecuador border with branches to Bogota and Caracas.

The oil is the most important source of heat and power generation . Its resources is 80 millions of tons, production-about 5 thou. t per year. Half of the oil produced is consumed within the country, the rest of it is exported.

The coal is also available there, annually about 1 million t. is mined.

Hydroelectric power plays a significant part. Capacity of power plants and electric power generation has been doubled for the period of 1958 to 1966 (table I).

Table 1

Electric power generation

	Years				
	1958	1963	1964	1965	1966
Installed capacity, total thou.kw	874	1371	1469	1546	...
including hydro-power	505	773	793	843	
Power generation, total mln kw.hrs	3034	5268	5916	5824	6350
including hydro-power stations	2049	3218	3721	...	...

Platinum, gold, radium, palladium, iridium are mined in this country and exported to the USA.

Colombia possesses the sources of coppor ores (departments Santander, Boyaca), zinc, tin, lead, mercuty,sulphur, iron, manganese, phosphorite and other minerals. But their production is insignificant.

Aluminium industry is Colombia at the present time is represented only by aluminium processing.

Bauxite reserves are not estimated. The bauxite deposits have been discovered in Colombia in the late 50's in the departments of Narino and Boyaca, and latter near Quiya in the department of Antioquia. In the most cases Al_2O_3 content of bauxites does not exceed 40 to 42 per cent, though in some parts of the Quiya area it rises up to 60 per cent. In 1967 a new bauxite deposit was found in Sierra de la Maserena in the east part of the country. It is expected that it will be an industrial scale deposits.

Aluminium is not produced in Colombia and is imported chiefly from the USA and Canada (table 2).

The main consumer of rolled, aluminium products is the building industry (corrugated and plain sheets, sections and tubes). Accordingly all the aluminium semi-fabricating plants in the country are located in the main cities of the most populated part of the country. Most of these enterprises are fully or partially owned by the aluminium companies of the USA and Canada.

Table 4

--- Imports of aluminium and aluminium raw materials

	Years			
	1955	1960	1965	1966
Bauxite imports[1)]	-	4.7	9.2	9.0
Aluminium imports	...	3.0	3.9	8.6
Imports of aluminium semi-products	2.3	1.6	0.6	1.2

1) For use in abrasive, refractory and ceramic industry

Copper industry. The copper reserves in Colombia are not estimated . There are known copper deposits in Corrdilera Occidental at a height of 2000 to 3000 m above the sea level.

The deposits are poorly investigated, the copper is not mined due to lack of transportation means. Recently new deposits were discovered in the departments of Antioquia and Caldas, now they are being explored.

Small requirements of the country in copper are satisfied with the import of 600 to 1000 tons of metal per year.

A small amount of copper semi-products is produced by local plants of "Perfiles de Alumino y Cobre" and "Felps Dodge" (USA).

Lead and zinc industry is hardly developed. There are no registered reserves of lead and zinc in the country.

Production of each metal does not exceed 1 thous tons a year, they are by-products of exploiting the vein gold deposits. The major part of zinc and lead is recovered from the ores of the Frontino deposit in the department of Antioquia where the underground mining is practised. The mine output is about 200 thou. tons of ore per year.

In the last years the intensive prospecting effected with participation of West German and French experts resulted in discovering numerous appearences of lead and zinc in the department of Antioquia and Caldas. Now the exploring of the most interesting of them is underway.

There is only a very small zinc plant in Bogota operating on a hydro-metallurgical plus electrowinning flowsheet. The plant production capacity is 1.7 thou.tons of electrolytic zinc per year.

§ 16. ECUADOR

The Republic of Ecuador is located in South America. Ecuador borders on Colombia in the north, on Peru in the south and east, adjoins the Pacific Ocean in the west.

Territory	- 270,700 sq.km
Population	- 5.04 million people
Population density	- 18 persons per sq.km
Capital	- Quito

Principal cities; Guayaquil, Cuence, Ambato, Riobamba.

Two Cordillera ranges (Western and Eastern), divided by a plateau and hollows, traverse the Ecuador's territory. Lowlands prevail to the west of the Andes. The largest one is a lowland extending to the Guayaquil gulf.

The climate of Ecuador is equatorial. Almost the whole territory of Ecuador is covered by a thick branchy river network. The rivers of the Andes and Oriente are fullflowing all the year round.

The main railway route is Quito - Guayaquil. The total length of highways is more than 6200 miles (10000 km). The main seaport and river port is Guayaquil. The international and domestic air routes are operated by a North-American company. The data on electric power generation in the country are listed in Table 1.

Fuel reserves in the country are insignificant. Coal has been discovered in a number of areas. But the coal mines have been closed after a temporary operation because of the unfavourable transport conditions.

Table 1

Electric Power Generation

	Years				
	1958	1963	1964	1965	1966
Installed capacity, total, thousand kw	101	166	186	182	255
including hydroelectric power stations	34	67	70	67	...
Power generation total, million kwh	324	495	551	572	700
including hydroelectric power stations	154	239	248	249	...

The oil output is not large. Oil deposits occur in the Pacific Ocean near shore at the area westwards of Guayaquil in the Santa Elena Peninsula. The Ancon oil field provides 95 per cent of the total oil output. The annual output is 350-400 thousand metric tons.

The main non-ferrous metals which are mined in the country are gold and silver, small amounts of copper, lead and zinc.

Copper industry. The Ecuador copper resources are not estimated, but copper occurs on a commercial scale (3-4%) as yellow copper ore, copper glange and copper mica in the gold-silver vein deposits Macachi and Inslivi in the eastern mountainside of the Andes. The most part of copper minerals is not extracted, but small batches of copper concentrates containing a total of 100 metric tons of copper a year are produced.

American Phelps Dodge Co. plans the construction of a small copper works for copper wire and cable production in Guito. The production will be based mainly on imported copper.

Lead-zinc industry. Conditionally the country's lead reserves are evaluated at 20,000 metric tons, only about 10,000 metric tons of that total being proved and probable.

The only noticeable but not yet worked out deposit Pilsun occurs in the Eastern Cordillera. There are thin veins averaging 9% lead, 12% zinc and some gold and silver here.

In the Coastal Cordillera, Zaruma district small amounts of lead (about 100 metric tons a year) are extracted together with gold and silver.

Table 2

Lead and Zinc Mine Production and Exports, thousand metric tons

	Years				
	1955	1960	1965	1966	1967
Mine production (lead content)	0.1	0.1	0.1	0.1	...
Mine production (zinc content)	-	...	0.2	0.1	...
Lead concentrates exports	0.2	1.0	0.7	...	...

CONCLUSION

In recent years the developing countries of Africa, Asia and Latin America have scored definite successes in the development of their economy.

In many of these countries a number of branches of the up-to-date industries has been set up, big enterprises of heavy industry have been put into operation, an energy-producing base have been expanded. Non-ferrous industry in these countries also was developing at rapid pace.

The setting up and upgrowth of non-ferrous industry, which is one of the basic branches of the up-to-date industry, is regarded at present as one of the most important conditions for the attainment of a high economic potential, and independence of a state. Rates of the upgrowth of the industry in a country on the whole depend upon the level of production and consumption of non-ferrous metals.

2. Basic factors which influence the upgrowth of industries of aluminium, copper, lead, zinc and tin in a country are as follows:

a) row material prerequisites which mean the availability of prospected natural resources, the rich content of metals in ore, geological and mining-engineering conditions;

b) technical prerequisites - the availability of required quantity of electric power, fuel, water, equipment, materials and transport communications;

c) outlook on a home market of the given country coordinated with tasks of development of other branches of industry;

d) possibility of selling the above-mentioned metals for export and its economical feasibility.

e) availability of skilled personnel;

f) choice of process flow sheets.

Development of the production of aluminium, copper, lead, zinc and tin is a complicated complex problem of technical and social-economic character and to solve it all factors of development have to be considered in their interdepedence.

Naturally, at the same time this problem has its peculiarities for each particular country and must be tackled taking into account these peculiarities.

3. In developing countries at present there are concentrated over 90 per cent of proven and probable reserves of tin, about 65 per cent of copper, over 50 per cent of bauxites and about 25 per cent of lead and zinc. During the period from 1958 to 1967 the proven reserves of minerals in developing countries have sharply increased including for aluminium - by 4.5 times, for copper - almost by 2 times, for lead - by 3.2 times, for zinc - by 3.5 times, and for tin - by 2.1 times.

The mining of ores of above-mentioned metals in particular bauxites (by 2.6 times) and copper ores (by 1.7 time) have also increased.

During the period under review in many countries there were conducted considerable geological prospecting work for non-ferrous metals and for the first time the existance of big reserves of metals in rather rich deposits has been discovered.

Yet the existance in some countries of a very big gap between the "total" amount and the amount of "proved" reserves is indicative of an urgent necessity to continue geological and prospeoting work in particular in those places, where only prospecting work was carried without exact estimation of deposits reserves.

4. Many developing countries have set about the construction of metallurgical plants to treat rich raw material resources on the spot.

Thus, during the period from 1955 to 1967 there has been set up for the first time the production of aluminium in Latin America, namely in Brazil, Mexico, Surinam, Venezuela; in Africa - in Gana, Cameroun; the production of alumina - in Guinea; and in Asia - in India. In a number of countries copper works, lead works and zinc works have been put into operation. There have been built tin works (in Nigeria, Thailand, Brazil). The production of the following metals have sharply increased in the developing countries in recent years; aluminium - more than by 30 times (from 9 thou/tons in 1955 up to 283 thou/tons in 1967); refined copper - by 2 times (from 616 thou/tons in 1955 up to 1,233 thou/tons in 1967); zinc - by 1.8 times (from 149 thou/tons in 1955 up to 269 thou/tons in 1967) and tin - by 1.5 times (from 78.3 thou/tons up to 121.4 thou/tons).

In some cases the metallurgical plants are constructed in developing countries designed to operate even on emported raw materials (ores and concentrates).

This above all refers to the countries where the industrialization is being realized on a large scale and plants of ferrous metal industry, machinery building, chemistry, electric power engineering, which are consumers of non-ferrous metals have been already built.

India, where two zinc electrolytic plants operated on imported concentrates have been built, may serve in this respect as an example.

The construction of non-ferrous metal plants and increase in production of metals is indicative of the desire of these countries to accomplish the industrialization and to gain economical independence.

5. The technical level of non-ferrous metal enterprises (mines, beneficiating plants, smelters) built in recent 10-15 years in the young developing countries, as well as of enterprises in such developing countries where non-ferrous metal industry occupies a leading position in world-wide production is not in many cases inferior to the level of making non-ferrous metals in the most developed countries with respect to techniques and technology.

Yet in most developing countries, where old plants and smelters with obsolete equipment are existing the technical and economic level is low and these enterprises need reconstruction.

6. The home consumption of non-ferrous metals in the deve

loping countries in 1955-1964 has considerably increased: aluminium - by 7.3 times; copper - almost by 2 times, lead - by 2.6 times; zinc - by 2.9 times.

It should be noted that there is the general desire of the developing countries to built plants for treating non-ferrous metals with the yield of rolled-drawn products.

Above all this refers to aluminium; plants for treating aluminium, operated often on imported raw materials, have been built almost in all countries.

The production of bands, sheets, corrugated sheets and other rolled products being used in making kitchen utensils, foil and tare for packing food-stuffs being exported, the yield of galvanized products in the countries where ferrous metal industry have been created, products of copper for machinery building-all this have brought about an urgent necessity to build in the developing countries non-ferrous metal treating plants.

The treating plants are available in the following developing countries of those which are under review in this survey: in Africa - in 15 countries there are plants for treating aluminium and in 5 countries - for treating copper; in Asia - in 11 countries there are plants for treating aluminium and in 3 countries - for treating copper; in Latin America-in 12 countries there are plants for treating aluminium and in 8 countries - for treating copper.

7. The important factor for developing non-ferrous metal industry is reliable and economically advantageous selling of

finished products being determined by the existance of home commodity market and existing possibilities for export.

Home market for consuming non-ferrous metals in the developing countries in just beginning to emerge and it undoubtedly is very promising.

By the present time the consumption of five non-ferrous metals has already considerably grown, but even in case of proceeding from the lowest rates of the per capita consumption in the developed countries, with 1.5 milliard population in the developing countries at present their consumption of non-ferrous metals could make more than 2 million tons of aluminium and I.5 million tons of copper, lead and zinc, each per annum. Ever growing requirements of the developing countries in cable products (due to development of transmission lines), increase in the production of ferrous metals and rolled products (which is connected with the growth of demand for galvanizing and lead plating), establishment of machine-building plants (using alloys on the base of non-ferrous metal),construction of oil refineries and chemical plants will further the growth of consumption of non-ferrous metals and expansion of home markets of these countries.

The availability of large geological reserves of non-ferrous metals, predetermines great perspectives for the activities on the international market with a considerable role, played by export-import operations within the framework of the developing countries.

8. The very important problem which determines the development of non-ferrous metal industry in the developing countries is the training of national skilled workers and engineers and other technical personnel.

For non-ferrous metal industry which is diversified and very complex by variety of technological processes, the problem of trainingof the personnel has a decisive significance and it can be solved provided measures are taken in these countries for training this high-skilled national personnel.

9. As a result of considering this brief review one may draw a conclusion that in the developing countries favourable conditions are existing for considerable development of aluminium, copper, lead and tin industries thanks to the availability of big reserves of non-ferrous metal in bowels of the earth, possibility for using potential resources of hydropower, the availability of labour force (after appropriate training).

Concrete evaluation of the expediency of developing definite trends of non-ferrous metal industry in the developing countries is in complicated dependency upon the whole complex of many factors and for each country it should be determined by thorough study of the local conditions and by detailed technical and economic calculations of possible alternatives of this solution.

REFERENCES

I. Statistical Yearbook, United Nations, 1963, 1967
2. Monthly Bulletin of Statistics, United Nations, 1968, 1969.
3. Lead and Zinc Statistics. Monthly Bulletin of the International Lead and Zinc Study Group, 1956, 1968.
4. Statistical Summary of the Mineral Industry, 1952-1957, 1959-1964, 1961-1966.
5. Minerals Yearbook, Bureau of Mines, Washington, 1965, 1966, 1967.
6. Yearbook of the American Bureau of Metal Statistics, New York, 1955, 1967
7. Walter R.Skinner's Mining Year Book, London 1966, 1967
8. Blei und Zinc von G.Berg, F.Eriedensburg, H.Sommerlate, 1950, Stuttgart
9. Beerman's All Mining Year Book, 1967, Johannesburg
10. Non-ferrous Metal Works of the World, First, Edition, 1967, London
11. The Mineral Resources of Africa, Nicolas de Kun, Amsterdam, Lkndon, New York, 1965.
12. Mining Journal, Annual Review, London, 1962, 1963, 1964, 1965, 1966, 1967, 1968.
12. Metallstatistik. Metallgesellschaft, Frankfurt am Main, 1958-1967.
13. World Non-Ferrous Metal Statistics. 1968, 1969.
14. Tin International, the monthly magazines, 1960-1968
15. Statistical Bulletin, International Tin Council, 1960-1968
16. Statistical Yearbook, International Tin Council, 19[illegible]-1967
17. Statistical Bulletin for Latin American, 1968, V, N 1.
18. World Mining Catalog, Survey and Directory number, 1968
19. Bauxite, alumina and aluminium, Overseas geological surveys, 1962, London.
20. Industrial Minerals, 1968, 1969
21. Emil Kraume, Kupfer, die Metallischen Rohstoffe, Band [illegible], 1964.

23. World Mining, I967, June; I968, July
24. Ameriaan Metal Market, I967, I968
25. Mining Journal, I96I, N 6545, N 6548, N 657I; I962
N 6596, N 6598, N 6602, 6604, 6606, N 6620, I963,
N 6609, N 668I, 6683; I967, n 6903.
26. Mining Magazine. I963, I09, N 3, II9, N 3; I968, April,
p.284
27. Mining Geology. I967, I7, N 2-3.
28. Mining Engineering, I966, N 5, p. II; I967, N 4.
29. Mining Congress Journal, August, I962, v., 48, N 8,
p.III
30. Engineering and Mining Journal, I964, I65, N I2; I966,
I67, n 4; I967, I68, N 2, I0, II.
3I. Mineral Trade Notes, I965, 60, N 2, 6 6I; N I,3-6, 8-I0
I966, 62, N 5,6, N 3, N 2-4
I968, 65, N 6
32. China Trade Journal. I965, N 72.
33. Economic Geology, I967, 62, N 4, 6
34. Canadian Mining Journal I966, 87, N 8
35. Annales des Mines, I967, N 5, pp.29I-3I9; I968, N 10,
p.70
36. Europe France outre mer, I964, 4I, N 4II.
37. Gassedanne Y. Mettallogenie du plomb et du zinc dans
l'etat de Bahia. An.Acad brasil ciens, I966, 38, N 3-4
38. Nature, I966, 74, N I.
39. Unformation Circular, Bureau Mines of U.S.Dept. Interior.
I963, N 8I96, I47,pp. III.
40. Mines et Metallurgie, I965, N I0(3600); I967 N 36I8,
36I9; I968
4I. Nigeria Trade Journal, I963, II. N 2.
42. South African Mining and Engng Journal, I965, 76, N 3777;
I968, march,79, N 39I8, p. 542.
43. Geological Survey Bulletin, I928, United States Government Printing Office, Washington, I967.
44. Bulletin Geological Survey India, I965, A., N 23.

45. Zeitschrift für Erzbergbau und Metallhüttenwes, 1965
I8, N 6; 1965, I8, N 9; 1966, I9, N 3; 1967, 20,
N 3; 1968, 2I, N 8.
46. Bergakademie, 1967, I9, N I2.
47. African World, 1964, Apr. N 4-5, 1965, Nov. N I4.I5.
48. Compressed Air Magazine, 1964, 69, N 2.
49. Annual Association Americain Geographers, 1965, 55, N 3
50. Geo-Surveys, 1966, I7 th, April
5I. Chronique des mines et rech. miniere, 1964, 32, N 330
52. Rudy i metale nieżelazne, 1966, II, N 7.
53. Rudy, 1967, I5, N 5.
54. Geological Survey Profess. Paper 1963. N 475.B
55. Mining Devision in Asia and the Far East, N 27, 1967
56. Far East Economic Review, 1963, 43, N 5, 40, N I3-
57. Journal of Industry and Trade, 1963, I2, N II.
58. Indian Minerals, 1962, I6, N 3, 4.
59. Indian of Industry, 1964, 8, N 9-I0. 1965, N 7, 9
60. Journal Geological Society of India.
6I. The Eastern Metals Review, 1968, v. XXI, N 4.
62. Symposium Mining Geoly and Base Metals Ankara, 1964
63. Technical conference on Tin, London, 1967
64. Transactions, Institute Mining and Metallurgy, 1966,
march, p. 95-III.
65. Canadian Mining and metallurgical Bulletin, 1968, 6I,
N 677, I075-I082
66. The South African Mining and Engineering Journal, 1968,
march 8, v.79, N 39I8, p. 542
67. Mining and Minerals Engineering, 1966, 2, N 3.
68. Engineering and Mining Journal, november 1967.
69. Transaction Society of Mining Engineer. December, 1967
70. Aluminium, 1968, N 6, pp. 390, 397
7I. Aluminium, 1967, 43, N 3
72. Light Metal Age, 1963, 2I, n 7-8, 29
73. Aluminium, 1968, 44, N 8, s. 5I5, 5I8.
74. Chemical Week, 1967, v. I0I, n I2, Sept. I6, p.72-84
75. Aluminium, 1964, N 5, s. 333-335.
76. Revue de l'Aluminium, 1964, 4I, N 320, 525-527;

77. Rev. Escola mincs. 1965, 24, N I, 43-45
78. Mining Journal, 1967, June, 9, v. 268, N 6877, p.469
79. Journal du four Electrique, 1967, 9,p. 25I; 1968, N IO
80. Engineering and Mining Journal, 1968, Febr., p. IOO-IO3
8I. Revue de l'Aluminium, 1968, N 362, p. 29I
82. Light Metal Age, 1967, 25, N II-I2. p.I9.
83. Alumunium. 1968, 44, N 4, s. 26I-266.
84. Revue de l'Aluminium, 1968, N 360, p. 56-57
85. Mining Journal, 1968, March, 29,v. 270, N 69I9, p. 234
86. Aluminium. 1963, 43, N 3, s. 209-2I4
87. Revue de l'Aluminium, 1967, N 353, p. 397-399.
88. Technique et industrie, 1966, v. 44, N 6I9
89. Rev. River Plate, 1964, v. I35, N 3525.
90. Light Metal Age, 1967, 25, N I-2, p.27.
9I. Mining Journal, 1966, 267, N 6833, 78.
92. Aluminium, 1968, N I, S. 20-22.
93. Journal du four Electrique, 1968, 5, p. I20
94. Aluminium, 1968, 44, N 2, S. I42
95. Aluminium, 1967, N 5
96. Revue de l'Aluminium, 1965, 42, N 385, p. I093-I095
97. Revue de l'Aluminium, 1968, N 363, p. 4I2; 365, p. 642.
98. Austral. Mining Journal. 1968, 60, N I9, p.II8-II9
99. Mining Journal, 1968, v.270, N 69I3, v.27I, N 6934, 6942
I00. Journal of Metals, I960, N 5, p.385-388
I0I.Revue de l'Aluminium, 1957, v.34, N 24
I02. Journal du four Electrique, 1968, N IO
I03. Metall, 1968, v.22, N I, S. 85-88
I04. Aluminium, 1968, N 7, S. 45I-457
I05. Revue de l'Aluminium, 1967, N 359, p.278
I06. Mining Journal, 1965, Jan,8, v.264, N 675I, p. 26
I07. Metal Billetin, 1968, N 5299, p. 24
I08. Journal of Metals, 1960, N 5
I09. Chemical Engineering, 1968, N 2I, p. 42-44.
II0. The Eastern Metals Review, v. XXI, N 40, 1968, p. 993
III. Aluminium, 1968, N IO, S. 658.
II2. The Eastern Metals Review, 1968, Aug. 3I
II3. Metal Bulletin, 1968, N 5325, p. I7-I9; N 5349, p.[illegible]

II4. Journal of Metals, I963, I5, N 2, I52-I56
II5. Journal of Commerce, N 7, I965, p. IO
II6. American Metal Market, I968, May, 29, N IO4
II7. Metal Bulletin, I967, I,27, N 5I68, p.I5
II8. Journal of Metals, I968, X, IO, p.43
II9. Metal Bulletin, I967, I, 27, N 5I68, p,I5
I20. Engineering and Mining Journal, I967, N I68, p. 93
I2I. Metall gesellschaft, I968, N II
I22, Erzmetall, I964, XVII, p.II7-I24
I23. Revista Industrial, Mexico, I965, N 57, 57-90
I24. Mining Magazine,I969, N 3, March, p. I44
I25. World Mining, I966, I2, p. 48
I26. Metallurgia, I967, 76, N 458, 238
I27. Erzmetall, I968, Bd. XXI, June, heft 6, S.292.
I28. Pyrometallurgical processes in non-ferrous metallurgy, vol 39, I967
I29. The mines magazine, I968, Jule, S. 27.
I30. Chemical Age India, I968, I9,3, I6I
I3I. B.Barlin. The Imperial Smelting furnace for the simultaneous recovery of lead and zinc in developing countries I969, London
I32. Aluminium, I967, N 2
I33. Revue de l'Aluminium, I968, N 363

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