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DIRETORIA DE OPERAÇÕES

MINERAL RESOURCES OF BRAZIL

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C O N T E N T S

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OUTLINE OF THE GEOLOGICAL AND TECTONIC FEATURES OF THE BRAZILIAN PLATFORM

FOLDED BASEMENT

All the territory of Brazil is situated within a large stable Precambrian cratonic region, lying east of the Andean fold belt and named the Brazilian Platform. The folded basement of this platform is extensively exposed in the Guyana, Central Brazil and Atlantic Shields, as well as in several other minor areas. Elsewhere, this basement is hidden under platform cover, that vary in age from the Proterozoic to Cenozoic.

The evolution of this folded basement was completed by end of the Baikalian Epoch, when the Brasiliane (Baikalian) folded systems ceased to evolue and where consolidated along the borders of still older platforms tying some of them together.

The pre-Baikalian folded complexes that also constitute the folded basement of the Brazilian Platform, were developed and consolidated in earlier major geotectonic cycles, such as the Guriense (more than 2.600 MY), the Trans-Amazonic (2.600-1.800 MY), the Espinhaço (1.800-1.300 MY) and the Minas-Uruaçuan (1.300 - 900 MY).

The regions of Guriense folding have been mapped in the Guyana Shield in Venezuela and Guyana. Several other regions of probably equally ancient folding are known, but are still compiled as regions of pre-Brasiliane folding because of lack of data.

The evolution and consolidation of most of the folded basement of the Brazilian Platform probably took place in the Trans-Amazonic epoch.

In the regions of the Brasiliane systems in the Atlantic Shield, in large regions of the Central Brazil Shield and Guyana Shield, and in the extensive ancient regions between the western Brasiliane systems, the ancient basement, regardless of possible rejuvenation, is now considered to be Trans-Amazonic in age. On the tectonic map, however, most of these areas are still classed with the regions of undivided pre-Brasiliane folding, ancient cores, and undivided rejuvenated basement, because of lack of supporting data. Some of them have already been represented as regions of Trans-Amazonic folding, as for instance Roraima, Gurupi, Serra dos Carajás, Amapá and Jacobina regions.

Regions of Espinhaço folding in the Atlantic Shield are found along the Serra do Espinhaço in south-central Brazil. Some of the rock complexes in this area, which were formerly correlated with younger Minas complexes, are being considered by some authors as also beloging to the Espinhaço folding.

The Araxá and Minas fold systems, wich extend along the western, southern and eastern borders of the old São Francisco cratonic region, constitue the regions of Minas-Uruaçuan folding as represented on the tectonic map. The Araxá complex forms, in part, the basement of the younger Brasilia fold system, wereas the Minas rock complex, now considered by several authors to be older and continuous with the Espinhaço rock complex, constitute most of the Espinhaço Chain and Quadrilátero region.

The basement of the old pre-Baikalian platforms probably was finally consolidated in the Minas-Uruaçuan cycle.

Brasiliane fold systems surround the ancient pre-Baikalian platforms and constitutes intra-Gondwanic belts as defined by Muratov (1969).

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Bounding the southern and eastern borders of the Amazon pre-Baikalian Platform, is the Paraguay-Araguaia fold system, which displays the rock sequences of several stages, including those of an extensive fore deep.

Bordering the western side of the São Francisco pre-Baikalian Platform, and separeted from the Paraguay-Araguaia fold system by the large ancient central Goias massif, is the Brasilia fold system. It display rock sequences representing several structural stages.

To the northeast of the São Francisco Platform, and occupying much of northeastern Brazil is the region of the Caririan system. This system is represented by metassedimentary rock sequences, ancient cores and rejuvenated basement. The region has been divided into blocks by a complex pattern of extensive transcurrent faults.

Separating the São Francisco Platform and the region of the Caririan complex is the wedge shaped Sergipean fold system. This system is boundéd by large faults and is composed of several metassedimentary rock sequences, ancient cores and undivided pre-Brasiliane rejuvenated basement.

Extending along the present coast line, from the state of Bahia in northeast of Brazil, to Uruguay, is the Atlantic fold system. This fold belt inflects to the west contouring the southern border of the old São Francisco Platform. It is made up of rejuvenated basement and undivided metassedimentary sequences.

PLATFORM COVER

The cover of the Brazilian Platform may be divided as follows:

A) Proterozoic platform covers found in regions of very ancient cratonization;

B) Riphean and Eo-Paleozoic platform covers which are sometimes gently folded;

C) Tabular paleozoic and post-paleozoic cover, which is divided into

1) Silurian to Triassic rock sequences and
2) Post-Triassic rock sequences.

The first group comprises the extensive covers of the Amazon Platform. The proterozoic age of these covers indicates a long period of stability for the Amazon Platform. The folded basement underlaying these covers, probably was developed and consolidated in tectonic epochs of the early Proterozoic or earlier.

The Riphean and Eo-Paleozoic platform covers may be gently folded and seem to have been deposited under extremely variable tectonic conditions, such as: in stable regions of the pre-Baikalian platforms; along the borders of platforms where Baikaliam geosynclines were developing; overlying recently consolidated basement, etc.

In Silurian time when the Brazilian Platform had attained on orthoplatform condition, the deposition of tabular paleozoic cover started in the great synclises, as well as over large areas throughout the Platform.

Due to the strong Mesozoic reativation in the Brazilian Platform, deep tectonic depressions were developed by faulting in the present coastal region, which became depositional sites for thick Meso-Cenozoic sedimentary sequences. Thin post-Paleozoic , flat lying sedimentary series were deposited over unnafected areas, and they, together with the former, embody the last group of the sedimentary covers.

MAGMATIC ROCKS

Two main groups of magmatic rocks may be distinguished in the Brazilian Platform: Those related to folded regions and those of the platform type. Notable among the magmatic rocks of folded regions are the granitoids of the Braziliane Epoch, which showed a tendancy for sialiac magmatism; the mafic-ulltramafic rocks of the Minas-Uruaçuan Epoch, during which femic magmatism prevailed; and the siliceous vulcanic rocks associated with intermontane basins of the Braziliane Epoch.

Typical of the platform-type magmatic rocks are the extensive tholeiitic flows of the Paraná basin, alkaline intrusives and extrusives, minor granitic intrusives along the Atlantic coast, and the cratonic granites of Rondonia. Ultramafic rocks intruded into ancient platform basement and the siliceous vulcanics which crop out extensively in the area of the ancient Amazon Platform are probably also platform-type magmatic rocks.

A L U M I N I U M

Aluminium, like steel, is closely associated with the development stage of a country.

As Brazilian economy expands and reaches actually high levels, domestic consumption of aluminium grows accordingly and creates an ever growing dependence on the foreign market, since domestic production is still defective .

Aluminium comes second only to copper, with which Brazil spends more than with any other single metal, for acquisition abroad .

In the three years period 1969/1971, the cost of aluminium imports was US$73,789,000, equivalent to 27.8% more than the amount spent in the preceding period, 1966/1968, when such cost amounted to US$57,733,000 .

Three companies produce metallic aluminium in this country: Cia. Mineira de Alumínio (ALCOA) has its plant located in Poços de Caldas, State of Minas Gerais, started its operations in September 1970, and produced since then 7,900 tons. Its production capacity is of 30,000 yearly tons, and it is expected that this will be doubled up to 1976, according to project already submitted to the Board of Industrial Development of de Ministry of Trade .

Cia. Brasileira de Alumínio (Industrial Group Votorantim), with its plant located in Sorocaba, SP, is expected to reach, within the current year, a capacity of 40,000 annual tons , and plans to reach 100,000 tons per year within the next 15 years.

Alumínio Minas Gerais (ALCAN) has its plant in Ouro Preto, Minas Gerais, with an available capacity for the production of 28,000 tons per year and expansion plans aiming at 48,000 tons by the end of the current year, in joint production with units installed in Salvador and Aratu, Bahia.

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At present, the three companies are still unable to supply the domestic market, thus making it necessary to make use of the foreign market.

If demand prospects of Ministry of Trade experts are right and their forecasts of a consumption around 380,000 tons of aluminium by 1980 are confirmed, we shall have to increase fourfold our present production capacity, so as to no longer depend upon imports to meet growing domestic requirements.

In Brazil, the most expensive production factor as regards the cost of aluminium is electric power (50%), followed by bauxite, amounting to about 10.76%.

Bauxite now used in this country for the production of metallic aluminium has its source in the Poços de Caldas and Ouro Preto - Belo Horizonte deposits, reserves of which are estimated at 65 million tons of high-grade ore and are sufficient to meet the consumption of our aluminium producing industry for at least 50 years.

The extensive deposits of Oriximiná and Paragominas, in Pará, substantially altered the prospects of bauxite in this country.

In Oriximiná alone, reserves reach the region of 800 million tons, while the reserves of Paragominas are estimated at about 1 billion tons of high-grade aluminium ore. These reserves have arousen the interest of important domestic and foreign groups, such as CPRM, CVRD, ALCAN, ALCOA, KAISER, PECHINEY and ALLUSSUISSE, which have applied for research areas.

CVRD and ALCAN, which had been engaged in a project of bauxite exploration in the region of Trombetas, have recently executed an agreement aiming at a new joint survey, with a probable duration of another six mounths, to determine for how long and to what extent there will be a revival of the project, which had been interrupted last year by ALCAN.

Cia. Mineira de Alumínio, of the ALCOA group, will probably follow this survey and may wish to take part in the undertaking, once all its characteristics are defined.

Cia. Brasileira de Alumínio, together with CVRD, has also plans for the establishment of an aluminium plant in Pará, of international size, which may reverse Brazil's position as aluminium importer .

Meanwhile, so long as understructure conditions do not allow the installation of an industrial compound in Pará for the obtention of metallic aluminium, the bauxite of that region will have to be exported, since the ore from Minas Gerais is sufficient to meet present domestic requirements, as well as the expansion plans already devised .

ALUMINIUM STATISTICS

I - IMPORTATION

YEAR	TONS	US$	US$/t
1961	18,583	10,158,285	546,64
1962	19,790	10,602,139	535,73
1963	26,272	13,558,940	516,10
1964	18,803	9,873,094	525,08
1965	22,237	11,823,674	531,71
1966	40,904	22,361,223	546,68
1967	29,101	16,719,664	574,54
1968	32,842	18,652,343	567,94
1969	54,200	32,180,907	593,74
1970	32,500	22,352,108	686,49
1971	29,238	19,255,814	658,59

Source : CACEX (Trade and Export Bureau)
CIEF (Bureau of Economic and Fiscal Information)

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II - PRODUCTION (t)

YEAR	ALCAN	CBA	ALCOMINAS	T O T A L
1961	9,600	8,270	-	17,870
1962	13,000	7,979	-	20,979
1963	13,500	6,558	-	20,058
1964	14,600	11,439	-	26,039
1965	15,400	14,163	-	29,563
1966	17,200	15,734	-	32,934
1967	19,300	18,775	-	38,075
1968	22,123	19,301	-	41,424
1969	22,824	20,100	-	42,924
1970	25,129	23,118	7,900	80,647
1971	...	...	...	80,647

SOURCE: Brazilian Aluminium Association (ABAL) and DNPM (National Department of Mineral Production).

B A U X I T E

I - EXPORTATION

YEAR	TONS	US$	US$/t
1961	1,700	53,060	31,22
1962	2,000	68,225	34,11
1963	2,300	76,961	33,46
1964	3,550	124,436	35,05
1965	2,200	79,403	36,09
1966	2,270	80,462	35,45
1967	2,230	75,523	33,87
1968	3,244	93,265	28,75
1969	2,720	77,572	28,52
1970	3,414	129,440	37,91
1971	3,605	126,682	35,14

SOURCE : CACEX

II - PRODUCTION

YEARS	TONS
1960	129,671
1961	118,616
1962	137,066
1963	196,898
1964	187,965
1965	168,798
1966	267,806
1967	260,858
1968	284,696
1969	350,912
1970	509,803
1971	584,999

SOURCE : DNPM (National Department of Mineral Production)

A S B E S T O S

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1 - INTRODUCTION

Asbestos is a commercial expression applied to several fibrous minerals unlike each other from mineralogical and chemical point of view, as well as regarding their mechanical properties, through which their industrial utilization is determined. The easier it is to fray out and the softer and more resistant it is, so much the better is its quality.

The main marketable asbestos varieties are: chrysotile, crocidolite, amosite, anthophyllite, tremolite and actinolite.

Chrysotile, which is deemed the main source of asbestos, is responsible for about 85% of the world consumption, eaving the remaining consumption to crocidolite and amosite.

The utilization of asbestos depends upon its fibrous and flexible quality and upon the fact that it is not combustible.

According to the dimension of its fibre (short and long), asbestos has a large variety of uses. The long fibre quality is used in the production of uncombustible fabrics and thermic insulators. The short fibre quality is used as raw material for the manufacture of pipes, water tanks, tiles and plain or corrugated asbestos cement sheeting. It is also used in the production of insulating paints, resistant filters and chemical compounds, stuffing for various products and in the automobile industry, for the manufacture of gaskets, clutch disks, etc.

2 - RESERVES

The proved, probable and possible reserves of asbestos ore existing in Brazil, amounted in 1970 to about 6,000,000 tons, of variable grades, between 2.5% and 6.5%.

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The major Brazilian reserves of crisotile asbestos are located in Goiás, where the great deposit of Canabrava, a SAMA (S.A. Mineração de Amianto) concession, in the Municipality of Uruaçú, is outstanding. These reserves, estimated at about ..... 2,300,000 tons of fibres with a recoverable grade of 5%, of which 2,013,000 tons (394,000 proved t, 803,000 probable t and 816,000 possible t) are located in Uruaçú and the remaining tonnage in Barro Alto and Pontalina, besides highly favourable prospects in Niquelândia.

The State of Alagoas has mineral reserves, of amphibole type, estimated at 3,000,000 tons., with an average 5% grade, among which the deposits of Campestre-Batalha region are outstanding.

There are also small asbestos reserves in Minas Gerais (São Domingos do Prata, Rio Pomba, Nova Lima, Caratinga, Bonfim, Caeté, Jacuí) and in Bahia (Poções).

3 - MARKET

The Brazilian production of asbestos ore and asbestos fiber showed the following results from 1960 to 1971, according to data from the I Brazilian Mineral Yearbook, 1972 - DNPM:

a) ASBESTOS ORE PRODUCTION

YEAR	TONS
1960	97,616
1961	117,602
1962	85,894
1963	131,674
1964	107,394
1965	107,531
1966	154,127
1967	133,927
1968	171,487
1969	211,191
1970	376,063
1971	473,000

b) ASBESTOS FIBER PRODUCTION

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YEAR	TONS
1960	2,858
1961	2,685
1962	2,740
1963	2,673
1964	2,420
1965	2,145
1966	3,053
1967	3,911
1968	5,454
1969	10,423
1970	14,908
1971	19,197

Since July 1967, when its production virtually accounted for the whole asbestos fiber produced in Brazil, the Canabrava Mine, in the State of Goiás, has been reaching higher levels each year and presents the following evolution:

YEAR	TONS
1967	1,000
1968	4,000
1969	9,000
1970	13,000
1971	17,000

Source: S.A.M.A.

The Brazilian asbestos production has been supplying an irrelevant part of the domestic consumption, thus bringing about an expenditure of a few million dollars for the obtention of this raw material in the foreign market.

Notwithstanding the asbestos reserves already under exploitation and those recently discovered, and in spite of the growth experienced by its production in the last few years, the prevailing situation remains the same, as regards dependence of the Brazilian market on foreign suppliers, and asbestos holds the second place in the schedule of industrial mineral

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imports, only surpassed by sulfur.

The table hereunder provides a view of Brazilian asbestos imports in the period 1967/1971:

YEAR	t	US$
1967	17,504	3,938,130
1968	27,586	6,430,103
1969	20,703	4,698,404
1970	23,413	5,745,060
1971	23,614	5,972,438

Source: CACEX
CIEF

During the period under discussion, foreign currency expenditure, reached about US$ 26,784,000 which means about 42% more than the outlay in the five year from 1962/66.

Notwithstanding the trend of growth that has been prevailing in asbestos imports, it is expected that with the increase of the output capacity of SAMA - S.A. Mineração de Amianto - which is the largest Brazilian producer - Brazil ' will become, in the near future, self-sufficient as regards asbestos, thus getting free from the transactions with foreign suppliers, that have heavily burdened its balance of payments.

B E R Y L

Beryl, containing 11.5 - 13.5% of beryllium oxide, is the most important beryllium mineral. No more than a few years ago, when the presence of bertrandite ($H_2O.4BeO.2SiO_2$) was discovered in rhyolitic tuffs granitic pegmatites with beryl were the only significant source of this element.

The extreme hardness and other physical properties of beryl provide its hyaline varieties with the characteristics of gems. Outstanding among them is the transparent beryl, of an intense green coloration, known as emerald, one of the most valuable precious stones. The other beryls ranking as gems are the aquamarine, with a blue coloration, the morganite, from pale to bright rose, and the golden yellow varieties, the heliodor, and the colorless variety, the goshenite.

As the Brazilian production comes only from the "garimpos" (primitive mining) no control is exercised thereon. Foreign sales data are deemed to be production data. In the period 1967/1971, emerald and aquamarine exports showed the following evolution:

Emeralds

I - Raw

YEAR	Kg	US$
1967	221	352,310
1968	324	384,733
1969	1,480	1,727,871
1970	724	1,114,463
1971	2,339	1,764,442

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II - Lapidated

YEAR	Kg	US$
1967	2.619	53,183
1968	4.963	141,368
1969	8.151	389,482
1970	15.538	730,962
1971	77.688	2,248,514

Aquamarine

I - Raw

YEAR	Kg	US$
1967	643	179,948
1968	185	130,020
1969	666	256,135
1970	659	391,125
1971	2,510	744,756

II - Lapidated

YEAR	Kg	US$
1967	2.216	37,561
1968	4.602	64,030
1969	15.215	256,192
1970	39.958	456,636
1971	63.152	964,838

Source: CACEX

Beryl ranks also as light metal by reason of its low specific weight (1.85), and finds its major applications in nuclear and military engineering under the metallic form, in nu clear reactors and in ceramic parts for the electronic industry under the form of oxide, and in a large number of equipments under the form of beryl-copper alloy.

The main world producers of beryl are Brazil, Argentina, India, Moçambique, Republic of South Africa and the URSS, and among them Brazil is the main supplier.

In Brazil, the beryl production comes from pegmatite regions of Minas Gerais, Bahia and Borborema Plateu, located in the States of Rio Grande do Norte and Paraíba.

The world production of beryl has been extremely fluctuating, and this is reflected in our exports. Though Brazil is the main world producer of beryl, it is a raw material that has not been as yet utilized for processing and the whole production is directed to the foreign market.

Brazilian beryl exports in the period 1967/1971 reached the following values:

YEAR	t	US$ 10^3
1967	1,310	475
1968	2,078	856
1969	3,596	1,656
1970	3,333	1,463
1971	2,501	1,028

Source: CACEX

Though exports have dropped in 1971, they virtually doubled as compared with the beginning of the period, 1967.

Beryl exports will probably go on at a growing rate. Beryl consumption is intended for rather sophisticated uses but it is expected that this sophistication shall be adopted by more and more countries in the development stage.

Many applications of said metal are still in a preliminary phase, and it is most probable that its consumption in countries now in the industrialization stage will expand at the same rate of the expansion that occurred in the USA.

Brazil's position is excellent, with the possibility of participating in the world market not only with sales of beryl but also, if economic conditions are favourable, with sales of the corresponding metal, thus ceasing to be a mere ore exporter to become a metal exporter.

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C H I N A C L A Y

1. FIELDS OF APPLICATION

China clay has at present many industrial applications, and new ones are constantly being discovered. Its value resides in its natural properties, such as chemical inertia, whiteness, low conductivity of heat and electricity, little abrasion susceptibility, softness to touch, dispersion in water, reinforcement characteristics, and others, which make it essential as raw material in certain industrial sections.

Industries using china clay differ enormously as to the requirements arising out of their particular needs. Some of them require a material comparatively free of impurities, and are rather unconcerned as to colour; others, require exceptionally bright china clay, or specific granulation, and there are still those where the low quality china clay is indicated. However, for most applications, the modern trend is to obtain standard products from a group of mines, with a variety of instrumental controls to keep up the desired properties.

So as to substantially expand the market and at the same time to comply with the strictest industrial specifications, china clay producers have invested large sums in the widening of their production line. For such purpose, they intensify their research programs, including the development of new qualifications through new mixtures and chemical processes.

Generally speaking, china clay is used at present mainly for the manufacture of:

1.a - White ceramic

From a historical point of view, china clay has been mostly used in ceramic, and this is probably even now its best known application, though its use in the paper industry is more widespread.

Domestic and sanitary ware, electric insulators, refractory materials (the later little known in Brazil) use china clay in their manufacture, particularly because of its chemical inertia, dimensional stability, electrical properties and high melting point.

1.b - Paper

In the paper industry, china clay is used as charge and as coating clay. In both cases, its addition aims at an improvement in the paper surface for printing purposes, as regards homogeneity, whiteness, brightness and smoothness and specially opacity.

1.c - Rubbers and plastics

China clay are the inorganic charges most frequently used in the vulcanized rubber and plastic industries, specially because it reduces the manufacturing cost, and increases the organic resistance to abrasion.

1.d - Paints

China clay is used in the production of paints because it is chemically inert and insoluble in the system, having a high coating power and a low cost. Its addition to thermo-plastic and thermoset masses produces smoother surfaces, more attractive finishing, good dimensional strability and a high resistance to chemical attack. It is also used as suspension agent and diluent.

1.e - Other uses

In the textile, adhesive, fertilizer and insecticide industries. There are also many substitutes for china clay, some of them yelding a better performance, as opposed to others. In certain fields, however, as in the manufacture of paper, for instance, china clay remains almost unsurpassable. Its sucess in the last years is due to its low unit value, which makes it competitive in most fields, once production costs are controlled. It is also to its advantage that china clay is very adaptable to modern techniques of industrial dressing, which enables manufacturers to offer a much wider line of product specifications.

Advances in other technologies have brought about a marked trend to more sophisticated qualifications of china clay intended for specific markets, and this has opened some areas and expanded the existing ones.

At present, American and British producers rule over the field and consequently hold the most profitable part of the market which is paper. This leadership may be partially due to the good quality of the deposits, for otherwise progress made since the last world war would have been impossible. Such deposits, though it is almost impossible to measure their exact extension, contain still enormous reserves, which ensure many more years of production. In future, however, we shall probably see the number of first class china clay sources gradually multiplied.

2. RESERVES

Brazil has deposits of primary and secondary china clay distributed through several of its States, as follows:

Rio Grande do Sul (Rio Prado, Encruzilhada do Sul, Guaíba, Gravataí).

Paraná (Campo Largo, Araucária)

São Paulo (São Paulo, Guarulhos, Perus, Franco do Rocha, Santo Amaro, Parnaíba, Itapecerica da Serra, Embu, and many others).

Minas Gerais (Juiz de Fora, Bicas, Mar de Espanha, Matias Barbosa, Rio Preto, Andradas, etc.)

Rio de Janeiro (Valença, Sapucaia, Sumidouro, Magé, Barra do Piraí and Rezende).

Espírito Santo (Pau Gigante)

Bahia (Vitória da Conquista, Camaçari)

Sergipe (Porto da Folha, Riachuelo).

Pernambuco (Recife, També)

Paraíba (Santa Luzia, Campina Grande)

Rio Grande do Norte (Parelhas, Equador)

Ceará (Gal. Sampaio, Russa, Quixeramobim, Serra do Baturité, Serra do Félix)

Pará (Belém)

Amazonas (Manaus, Nova Olinda) and Federal Territory of Amapá.

Our largest actually known reserves are situated in the Territory of Amapá and in the States of Minas Gerais and São Paulo, and account for about 95% of the total.

These reserves are distributed as follows:

10³t

STATES	PROVED	PROBABLE	POSSIBLE
Amapá	44,506	10,323	-
Minas Gerais	8,747	2,208	1,203
São Paulo	3,822	2,902	2,602
Outros	2,104	4,155	66,283
Total	59,179	19,588	70,088

Source: I - Brazilian Mineral Yearbook - 1972 - DNPM

With the intensification of mineral exploration in Brazil, new prospects are now being opened for the substantial increase of the number of known china clay deposits. If recent estimates are confirmed, the deposits discovered in the North of Brazil alone will triple our reserves.

3. MARKET

The consumption of china clay products according to fields of application in some consumer centers of the world, is distributed as follows:

SECTORS	USA	UNITED KINGDOM	CZCHECOSLOVAQUIA	DENMARK	SPAIN
Paper	60%	75%	77%	35%	23%
Refractories	15%	-	11%	41%	40%
Ceramic	5%	18%	12%	7%	22.5%
Rubber	12%	-	-	-	-
Fertilizers	3%	7%	-	-	-
Others	5%	-	-	-	4.5%
Cement	-	-	-	17%	10%

As can be noted, the general trend is for the predominance of china clay utilization in the manufacture of paper, followed by refractories and ceramic.

The present Brazilian production, besides being irrelevant in the world context, is predominantly made up of low qualification material (for ceramic). This accounts for our growing imports of china clay products of higher qualification, chiefly for use in the paper industry.

Over 50% of our high grade china clay imports come from the United States and the United Kingdom. In 1970, we imported 2,812 t from the United States (US$ 123,900) and 292 t from the United Kingdom (US$ 32,650).

Our exports, comparatively small, are chiefly made up of material for the ceramic industry and others. They are normaly bound for Uruguai, Argentina, Chile and others.

Domestic consumption of china clay in São Paulo, according to use, was around 86% ceramic, 12% paper and 2% rubber and others.

Paper used about 5,000 to 7,000 t per year (1960). At the present, however, after the extraordinary development of the paper industry, about 40,000 t of china clay are employed (1970).

The following table shows production, imports, exports and domestic consumption as a whole, production including china clay "in natura" as well as processed china clay, while imports and exports refer only to processed products:

Year	Production (t)	Imports		Exports		Domestic Apparent Consumption (t)
		Quant (t)	Value (US$)	Quant (t)	Value (US$)	
1960	135,093	124	15,026	110	2,705	135,107
1961	155,007	405	40,211	337	10,167	155,075
1962	156,282	198	21,538	100	2,300	156,380
1963	139,019	237	26,103	200	4,500	139,056
1964	146,988	111	11,053	722	16,600	146,377
1965	139,852	94	15,252	1,405	51,126	138,541
1966	230,411	480	43,245	700	22,834	230,191
1967	233,490	919	85,754	960	24,800	233,449
1968	291,506	1,751	154,022	1,425	44,747	291,832
1969	339,108	2,364	219,535	800	25,437	340,672
1970	400,037	6,235	548,345	1,503	50,965	404,769
1971	227,694	6,947	736,445	2,180	106,630	232,461

CHROMIUM

Chromium is a white brilliant metal, extremely hard and resistent to atmospheric agents.

One of its most appreciated qualities is that of conferring to ferro-carbon alloys where it is present (special steels) a great resistance to corrosion.

The prime cromium ore is chromite. According to its composition, chromite is classified under 3 types, corresponding to its applications:

a) metallurgical type, with a high grade of Cr and a relationship Cr:Fe above or around 3:1;

b) refractory type, with a high grade of Cr_2O_3 and a low grade of Fe and SiO_2;

c) chemical type, with a high grade of chromiun, a low grade of silica and the least possible amount of alien substances.

The metallurgical type is mainly used in the production of ferro-chromiun and in special alloys of hard an tenacious steel for the manufacture of tools, in combination with tungstene, molybdenum and cobalt.

The refractory type is used in the manufacture of brick designed for the facing of furnaces used in the production of steel, non-ferrous metals, glass and cement.

The chemical type is used under the form of salts in the textile industry, for leaching tints, dyes and oxidating agents.

Metallic chromiun is chiefky used in the chrome- plating of hardware.

In Brazil, the major chromiun ore deposits are located in Bahia (Campo Formoso and Santa Luzia) and Goiás (Cromínia, Piracanjuba, Hidrolândia, etc.).

Minor deposits occur in Amapá, Minas Gerais, Ceará, etc.

As a rule, Brazilian chromite has a low Cr grade, and ranks as the refractory type.

The present chromite reserves are distributed as follows:

TYPE/LOCATION	PROVED	PROBABLE	POSSIBLE	GRADE
METALLURGICAL TYPE	84,300	249,000	1,247,700	
Bahia	80,000	240,000	1,242,000	40% Cr_2O_3 Cr/Fe ≅ 2.5
Minas Gerais	4,300	9,000	5,700	30-48% Cr_2O_3 15-20% Fe
REFRACTORY TYPE	10,000	3,000	16,000	
Goiás	10,000	3,000	16,000	25-48% Cr_2O_3 12-30% Al_2O_3
CHEMICAL TYPE	1,042,000	85,700	460,000	
Bahia	1,042,000	85,700	460,000	Cr/Fe < 1,5 Cr_2O_3 ≅ 10%
NON-SPECIFIED	400,000	3,000	1,400,000	
Bahia	400,000	3,000	1,400,000	3.5 < Cr/Fe < 5.1

Source: DNPM

CPRM

The Brazilian chromite production presented itself as follows in the five-year period 1967/1971:

YEAR	TONS
1967	23,393
1968	30,484
1969	38,407
1970	73,455
1971	319,502

Source: DNPM

The total chromite of the chemical type is used up by Bayer Indú trias Químicas S.A., in Belfort Roxo, Rio de Janeiro, the only Bra zilian consumer. So, any increase in the production of this con centrate, as regards the home market, depends directly upon Bayer's increase in consumption.

Chromite of the metallurgical type is used by FEBRASA for the production of ferro-chromium, and the amount produced is insufficiente to meet the demand of the domestic market, for which reason it is necessary to import chromite within the specifica tions required by the technology adopted here.

On the other hand, chromite produced in Brazil, with different specifications from those required by the present Brazilian technology, is exported as a result of the great demand there of in the foreign market.

For the purpose on meeting the growing requirements of Brazilian industry, we made use of imported ferro-chromium with a low carbon grade, while exporting the ferro-chromium with a high carbon grade produced here and not used by the domestic market, but in great demand abroad.

As regards metallic chromium, the Brazilian industry still depends upon importation, since there are no facilities for chromium reduction in this country.

CHROMIUM STATISTICS

BRAZILIAN IMPORTS OF CHROMITE

YEAR	10^3t	US$	US$/t
1967	6,193	243,995	39,40
1968	7,181	305,606	42,56
1969	7,324	353,790	48,31
1970	8,245	460,169	55,81
1971	16,688	872,230	52,27

Source: CACEX
CIEF

BRAZILIAN EXPORTS OF CHROMITE

YEAR	10^3t	US$	US$/t
1967	45	1,710	38,00
1968	55	2,233	40,60
1969	-	-	-
1970	160	3,680	23,00
1971	5,750	140,800	24,49

Source: CACEX

BRAZILIAN PRODUCTION OF FERRO-CHROMIUM

YEAR	t
1967	1,617
1968	3,642
1969	2,221
1970	3,296
1971	10,186

Source : DNPM

BRAZILIAN IMPORTS OF FERRO-CHROMIUM

YEAR	10^3t	US$	US$/t
1967	789	284,965	361,17
1968	1,598	522,304	326,85
1969	1,456	476,840	327,50
1970	1,665	803,885	482,81
1971	1,986	1,091,971	549,83

Source: CACEX
CIEF

BRAZILIAN EXPORTS OF FERRO-CHROMIUM

YEAR	10^3t	US$	US$/t
1967	60	13,026	217,10
1968	65	14,085	216,69
1969	390	80,150	205.51
1970	2,320	462,478	199,34
1971	2,109	494,647	234.54

Source: CACEX

BRAZILIAN IMPORTS OF METALLIC CHROMIUM

YEAR	10^3t	US$	US$/t
1967	22	46,135	2,097.05
1968	15	29,263	1,950.87
1969	12	21,181	1,765,08
1970	15	35.954	2,396.93
1971	16	53,131	3,320.69

Source: CACEX
CIEF

CPRM

C H R Y S O B E R Y L

Orthorhombic, bypyramidal mineral found in flattened crystals, the faces or which are vertically streaked, often geminated and thus acquiring an hexagonal appearance.

Judging by its formula, $B_e Al_2 O_4$ (Beryllium and aluminium oxide), one might have the impression that chrysoberyl is a member of the spinel group, but owing to the small size of the beryllium ion, chrysoberyl has a contracted structure, of a lower symmetry than the spinels.

Due to being an extremely hard mineral (8.5), with a glassy brightness, and green, brown and yellow hues and sometimes a red colour under transmited light, chrysoberyl is a highly appreciated GEM, especially in the varieties: Alexandrite (of an emerald-green color and high pleochroism) and Cymaphane,or Cat's Eye, (which shows, when polished, an opalescent brilliance and a luminous, narrow and long streak on the polished surface, changing its position at each movement given to the gem.).

Chrysoberyl is a rare mineral. It occurs on granitic rocks, on pegmatites and on mica schist, being also secondarily found in river sands and gravel.

Chrysoberyl, with gem qualities, is rarely found in the United States, but some occurrences were determined in Oxford County, Maine; in Haddam, State of Connecticut; in Greenfiedl, State of New York, and in Colorado.

The most remarkable deposits of chrysoberyl are to be found in Ceylon, the Ural Mountains and Brazil.

In Brazil, chrysoberyl has its source in the pegmatites and alluviums of Eastern and Northeastern Minas Gerais, especially in the municipaly of Teófilo Ottoni. Faisca Plantation, District of Águas Formosas (Minas Gerais), property of Mr. Otto Ziemmer, is the place where the largest deposits of chrysobel occur in Brazil, being in alluviums and deposited as a result of erosion and decay of the pegmatites.

Chrysoberyl is a precious stone, and the common stones of a greenish yellow color are comparatively cheap. The varieties alexandrite and cat's eve, however, are highly valuable.

The name chrysoberyl means golden beryl. The name cymaphane derives from two Greek words meaning where and appear, as an allusion to the effect produced on the polished surfaces of such stones. The name Alexandrite was given as a tribute to Alexander II, of Russia.

Because it is an accessory mineral in the pegmatites, it is impossible to know the existing reserves of the stone.

BRAZILIAN EXPORTS OF CHRYSOBERYL (CAT'S EYE)
I - Cat's Eyes, RAW

YEAR	KG	US$
1966	6	14,090
1967	10	57,264
1968	3	23,868
1969	6	21,155
1970	16	7,367
1971	18	32,041

Source: CACEX

II - CAT'S EYES, LAPIDATED

YEAR	KG	US$
1966	0,021	4,809
1967	0,505	27,083
1968	0,100	4,515
1969	0,469	7,267
1970	2,589	42,310
1971	2,146	57,883

Source: CACEX

CPRM

C O A L

Brazilian coal has stirred up a growing interest during the last few years, due to being a strategic raw material. As an immediate consequente, its exploration has been intensified to the known reserves, which will have to meet the demand of the domestic market, now in significant evolution.

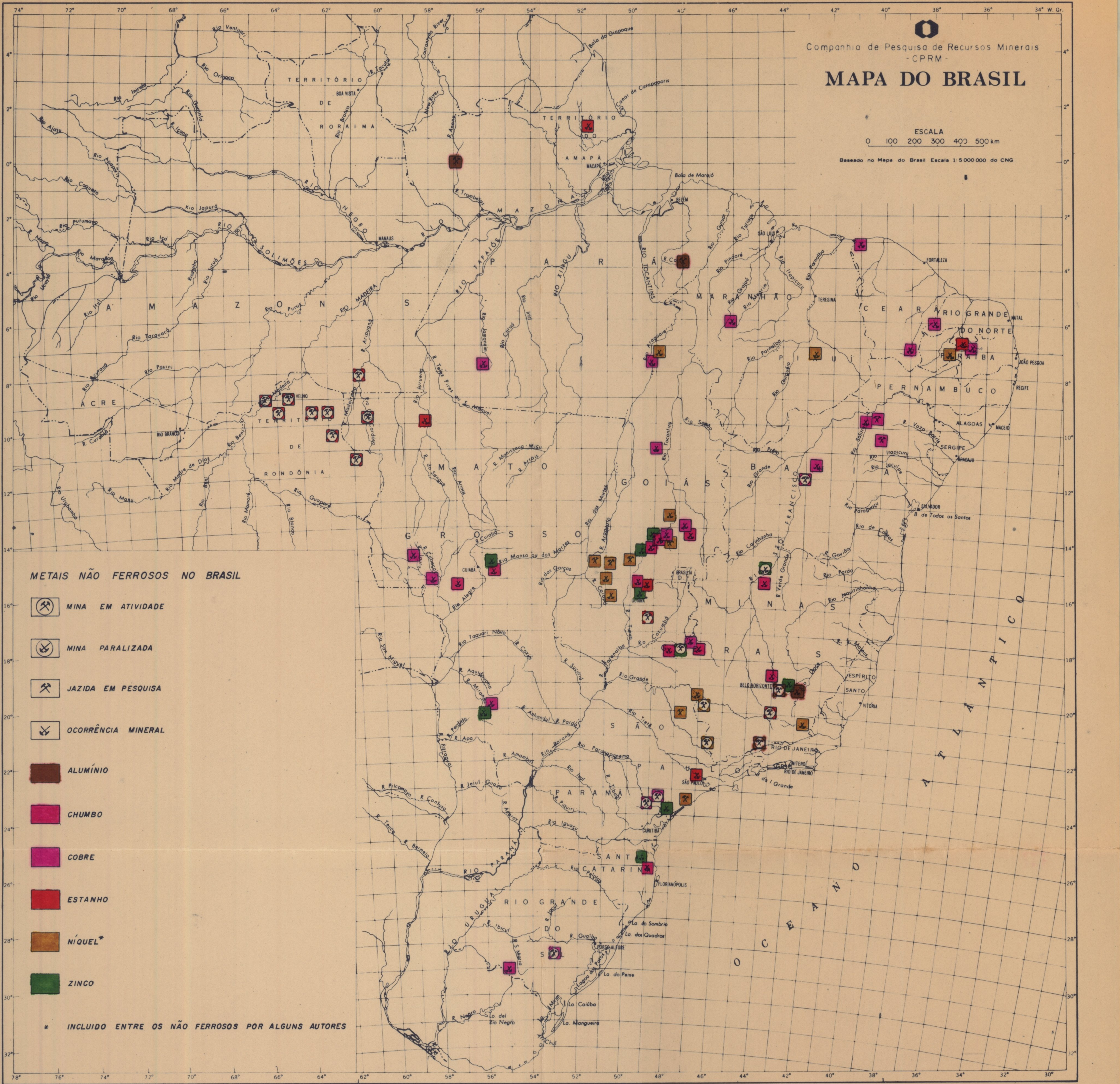
Owing to its high ash and sulfur contend, and because it has no cokifying properties, most of Brazilian coal is used in thermoelectricity generation, as a complement to hydroeletric power, while only a fraction of Santa Catarina coal makes it possible to obtain metallurgical coke.

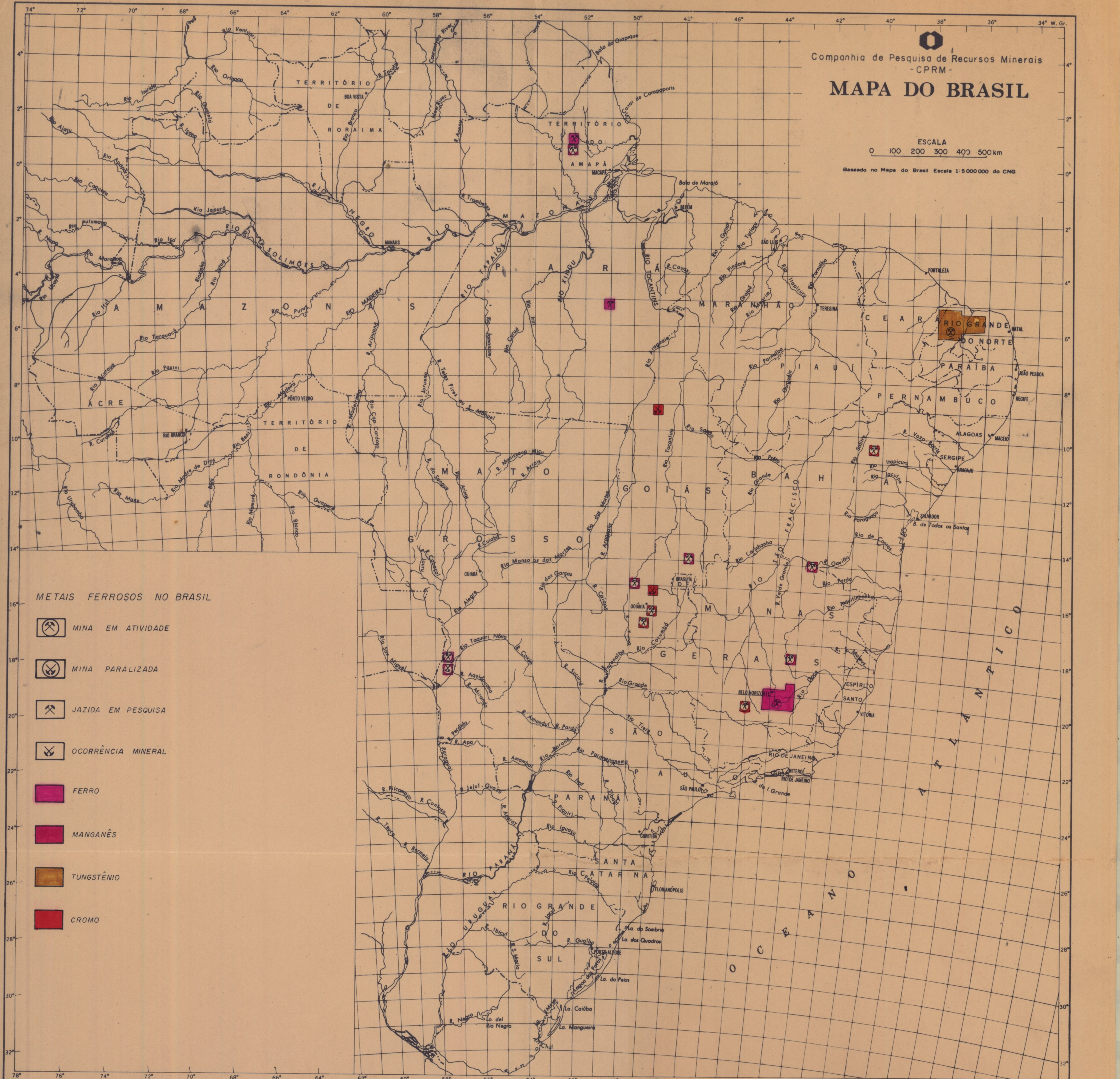
This raw material recently found in Rio Grande do Sul a new market based on the production of sponge iron. The coal that was formerly used only in thermoelectric power plants will be utilized, unmixed, for the direct reduction of iron ore, in a metallurgical plant localized at a distance of 50 kilometers from Porto Alegre. This steel plant (Aços Finos Piratini S.A.) will start operations in June 1973.

Deposits and Reserves

Coal deposits economically exploitable are all localized in Southern Brazil, in the Paraná Sedimentary Basin. The existing coal seams occur in the Rio Bonito Formation, from Medium Permian age.

The table hereunder shows the reserves of such deposits.


Companhia de Pesquisa de Recursos Minerais
-CPRM-
MAPA DO BRASIL
ESCALA
0 100 200 300 400 500 km
Baseado no Mapa do Brasil Escala 1:5 000 000 do CNG
METAIS NÃO FERROSOS NO BRASIL
MINA EM ATIVIDADE
MINA PARALIZADA
JAZIDA EM PESQUISA
OCORRÊNCIA MINERAL
ALUMÍNIO
CHUMBO
COBRE
ESTANHO
NÍQUEL*
ZINCO
* INCLUIDO ENTRE OS NÃO FERROSOS POR ALGUNS AUTORES
TERRITÓRIO DE RORAIMA
TERRITÓRIO DO AMAPÁ
AMAZONAS
PARÁ
MARANHÃO
PIAUÍ
CEARÁ
RIO GRANDE DO NORTE
PARAÍBA
PERNAMBUCO
ALAGOAS
SERGIPE
BAHIA
ACRE
TERRITÓRIO DE RONDÔNIA
MATO GROSSO
GOIÁS
MINAS GERAIS
ESPÍRITO SANTO
RIO DE JANEIRO
SÃO PAULO
PARANÁ
SANTA CATARINA
RIO GRANDE DO SUL
OCEANO ATLÂNTICO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OCORRÊNCIA MINERAL
FERRO
MANGANÊS
TUNGSTÊNIO
CROMO
AMAZONAS
PARÁ
MARANHÃO
CEARÁ
RIO GRANDE DO NORTE
PARAÍBA
PERNAMBUCO
PIAUÍ
BAHIA
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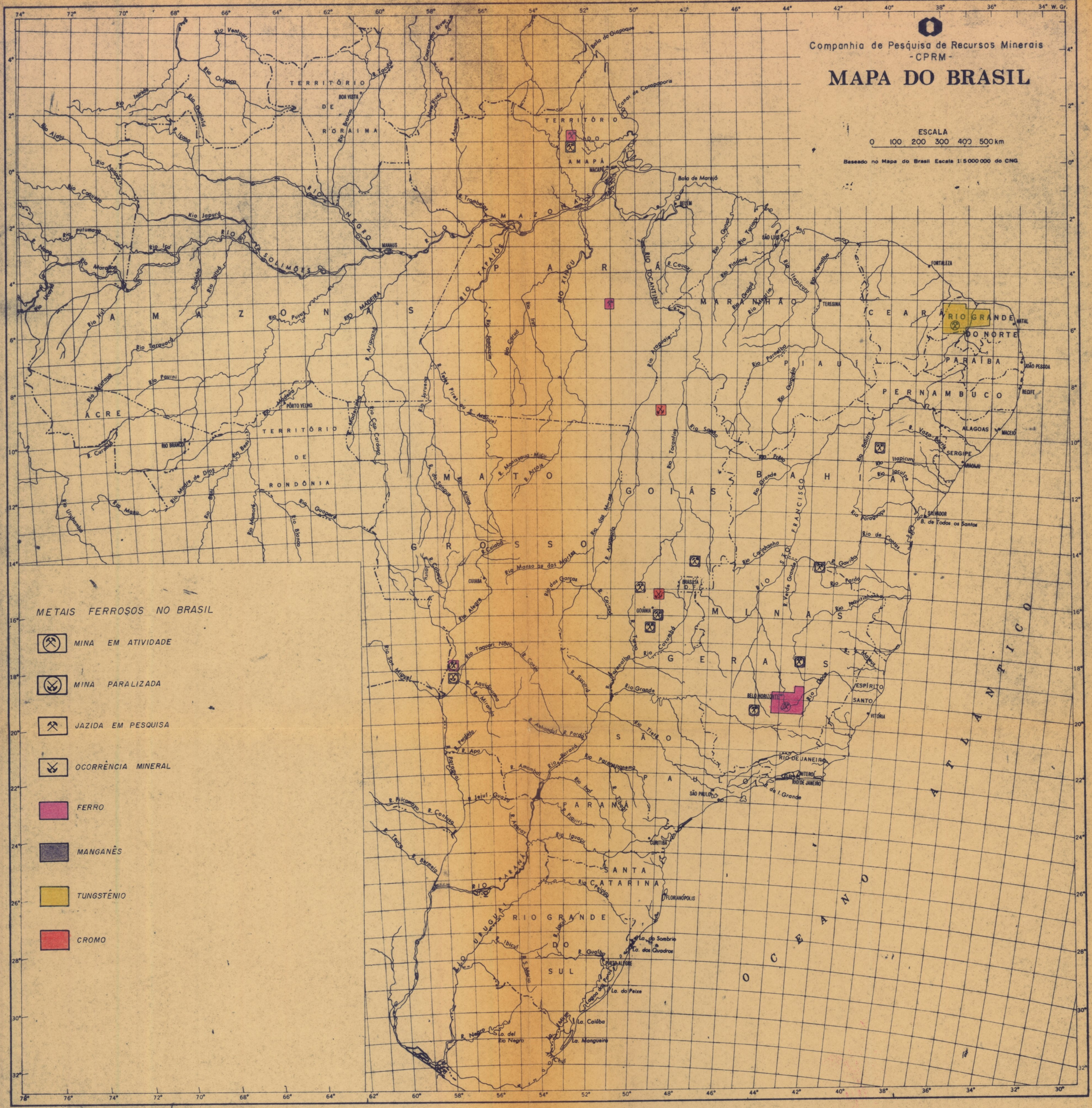
SÃO PAULO
PARANÁ
SANTA CATARINA
RIO GRANDE DO SUL
ACRE
TERRITÓRIO DE RONDÔNIA
TERRITÓRIO DE RORAIMA
TERRITÓRIO DO AMAPÁ
ESPÍRITO SANTO
OCEANO ATLÂNTICO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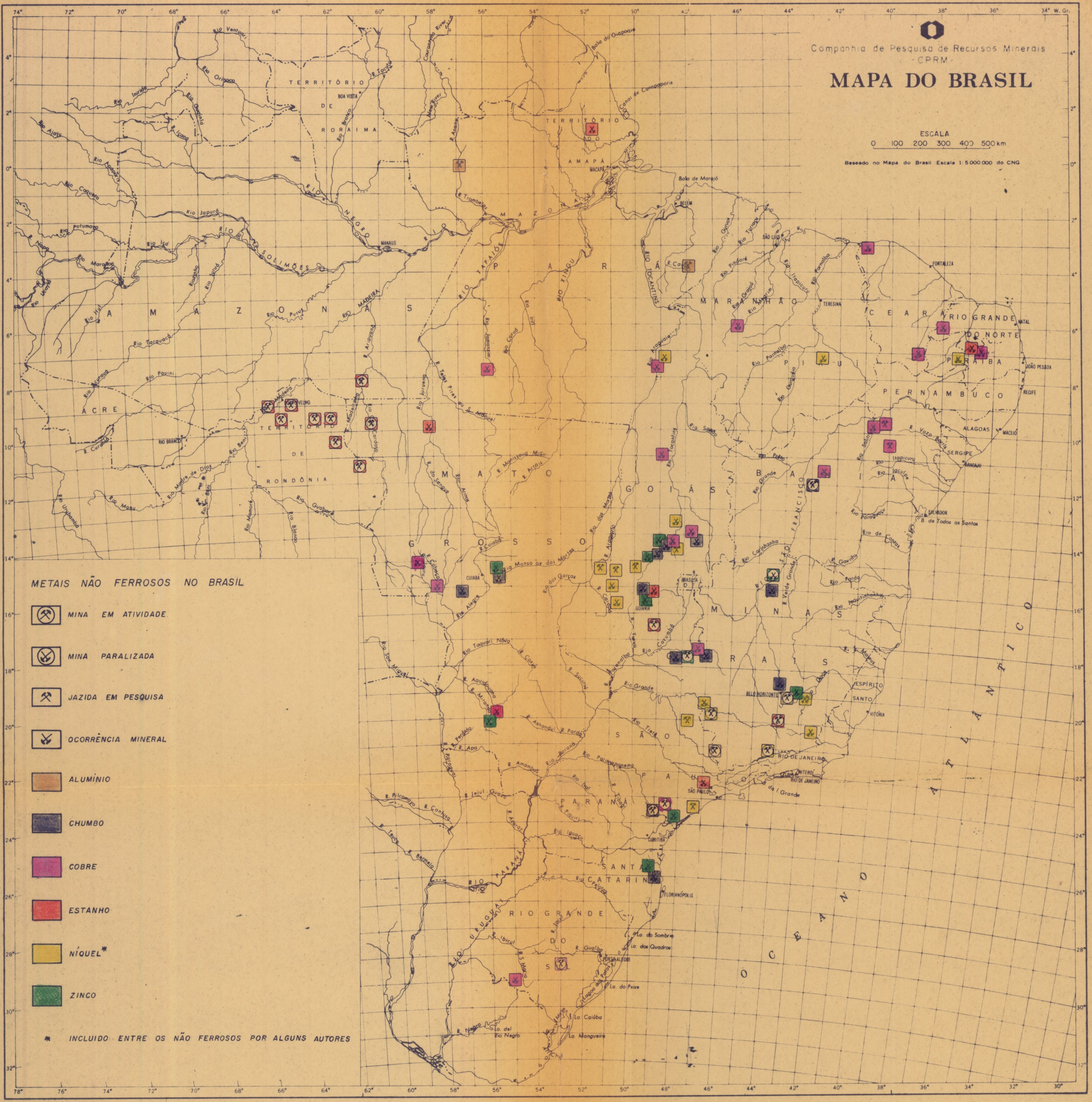

Companhia de Pesquisa de Recursos Minerais
-CPRM-
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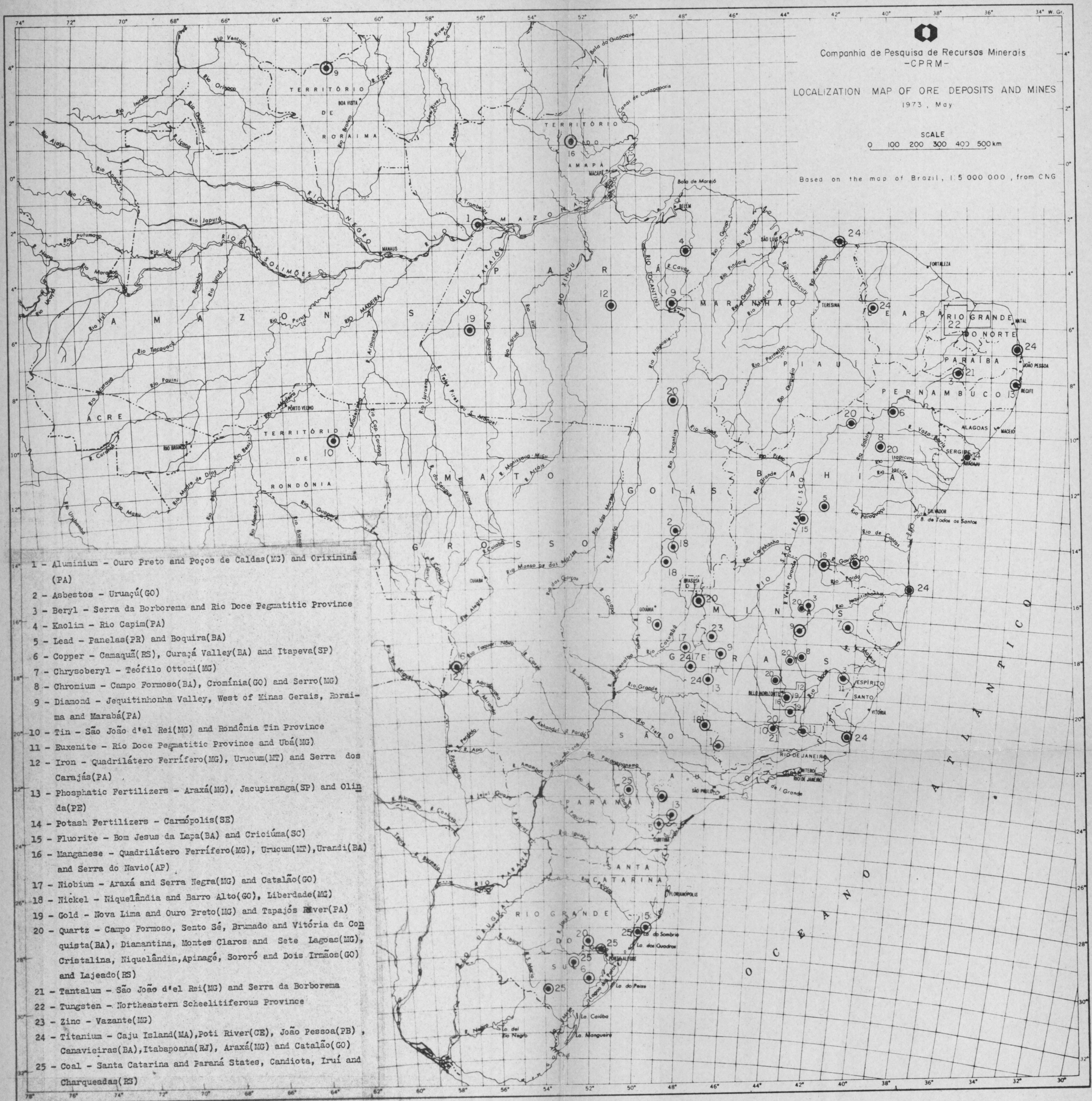
Companhia de Pesquisa de Recursos Minerais
-CPRM-
LOCALIZATION MAP OF ORE DEPOSITS AND MINES
1973, May
SCALE
0 100 200 300 400 500 km
Based on the map of Brazil, 1:5 000 000, from CNG
1 - Aluminium - Ouro Preto and Poços de Caldas(MG) and Oriximiná (PA)
2 - Asbestos - Uruaçú(GO)
3 - Beryl - Serra da Borborema and Rio Doce Pegmatitic Province
4 - Kaolim - Rio Capim(PA)
5 - Lead - Panelas(PR) and Boquira(BA)
6 - Copper - Camaquã(RS), Curaçá Valley(BA) and Itapeva(SP)
7 - Chrysoberyl - Teófilo Ottoni(MG)
8 - Chromium - Campo Formoso(BA), Cromínia(GO) and Serro(MG)
9 - Diamond - Jequitinhonha Valley, West of Minas Gerais, Roraima and Marabá(PA)
10 - Tin - São João d'el Rei(MG) and Rondônia Tin Province
11 - Euxenite - Rio Doce Pegmatitic Province and Ubá(MG)
12 - Iron - Quadrilátero Ferrífero(MG), Urucum(MT) and Serra dos Carajás(PA)
13 - Phosphatic Fertilizers - Araxá(MG), Jacupiranga(SP) and Olinda(PE)
14 - Potash Fertilizers - Carmópolis(SE)
15 - Fluorite - Bom Jesus da Lapa(BA) and Criciúma(SC)
16 - Manganese - Quadrilátero Ferrífero(MG), Urucum(MT), Urandi(BA) and Serra do Navio(AP)
17 - Niobium - Araxá and Serra Negra(MG) and Catalão(GO)
18 - Nickel - Niquelândia and Barro Alto(GO), Liberdade(MG)
19 - Gold - Nova Lima and Ouro Preto(MG) and Tapajós River(PA)
20 - Quartz - Campo Formoso, Sento Sé, Brumado and Vitória da Conquista(BA), Diamantina, Montes Claros and Sete Lagoas(MG), Cristalina, Niquelândia, Apinagé, Sororó and Dois Irmãos(GO) and Lajeado(RS)
21 - Tantalum - São João d'el Rei(MG) and Serra da Borborema
22 - Tungsten - Northeastern Scheelitiferous Province
23 - Zinc - Vazante(MG)
24 - Titanium - Caju Island(MA), Poti River(CE), João Pessoa(PB), Canavieiras(BA), Itabapoana(RJ), Araxá(MG) and Catalão(GO)
25 - Coal - Santa Catarina and Paraná States, Candiota, Iruí and Charqueadas(RS)
AMAZONAS
PARÁ
MARANHÃO
PIAUÍ
GOIÁS
BAHIA
MATO GROSSO
MINAS GERAIS
SÃO PAULO
PARANÁ
SANTA CATARINA
RIO GRANDE DO SUL
OCEANO ATLÂNTICO

MB-28

CPRM

COAL RESERVES IN SOUTHERN BRAZIL

STATE	DEPOSIT	ESTIMATED TOTAL RESERVE (t)
RIO GRANDE DO SUL	Candiota	600,000,000
	Hulha Negra	100,000,000
	São Sepé	7,000,000
	Irui	330,000,000
	Leão-Butiá	80,000,000
	Arroios dos Ratos	Depleted
	Charqueadas	1,000,000,000
	Gravataí	15,000,000
Subtotal	8	2,132,000,000
SANTA CATARINA	Santa Catarina	700,000,000
Subtotal	1	700,000,000
PARANÁ	Rio Tibagi	6,000,000
	Rio do Peixe	18,000,000
	Ibaití	1,400,000
	Wenceslau Braz	90,000
	Barbosas	600,000
Subtotal	5	26,090,000
TOTAL	14	2,858,090,000

Source: DNPM and CPRM

CPRM

Coal Exploration

It is a long time since Ministry of Mines and Energy agencies and mining companies have been carrying out coal explorations.

The areas covered by such explorations are distribuited as follows:

a - Southern Brazil Region - Explorations were carried out in this area by DNPM, CPCAN, miners, and in recent years by CPRM.

As result of such explorations, the above mentioned 14 deposits were identified, some with well defined reserves and others requiring complementary surveys for their complete appraisal.

b - Western Piauí Region - In the Eastern flank of the Parnaíba Sedimentary Basin several coal occurrences were found, displayed on thin sems (less than ten centimeters thick), included in the Poti Formation, of Mississipian age.

Field surveys and drilling work carried out by DNPM and Petrobrás have not revealed so far the existence of areas possessing economically exploitable coal seams. CPRM is putting into effect an exploration project in this area.

c - Tocantins-Araguaia Region - Thin coal seams occur also in the Western flank of the Parnaíba Sedimentary Basin (including areas of the States of Goiás, Maranhão and Pará), inserted in the Piauí Formation, of Pennsylvanian age. CPCAN carried out prospection in this area, results of which were fruitless, since no economically exploitable seams were revealed.

d - Rio Fresco Region - In this area of the State of Pará prospections were made by CPCAN and the Institute for the Social and Economic Development of Pará - IDESP, and anthracitous coal was found in thin seams, within the Rio Fresco Formation.

The results of such prospections led to the conclusion that the depositional conditions are unfavourable to the occurrence of economically exploitable coal.

e - Alto Amazonas Region - Lignite layers of slight thickness occur in this area, within the Pebas Formation, of Tertiary age. Prospections made by CPCAN reached the conclusion that the occurrence has no economic significance.

Besides these regions, there are some known deposits in other areas of this country, all of them of restricted significance and of small scale.

Coal Market

The total production of Brazilian coal is used by thermo electric power plants or in the production of coke for the steel industry.

The present market for steam coal is on the order of 1.6 million tons/year, and its trend is to remain almost stable, with small increments due to the expansion already existing of thermoelectric power plants.

Based on the program of the steel industry expansion, metallurgical coal will have a growing demand, with the following planned evolution (CNP), in million tons:

1972 - 2.3
1976 - 4.3
1980 - 6.7

The participation of domestic metallurgical coal in the market is now on the order of 35% (0,8 millions tons) and will probably be 20% (1.3 million tons) by 1980.

CPRM

COAL - STATISTICS

I - COAL PRODUCTION

YEAR	RAW COAL (t)	METALLURGICAL COAL(t)	STEAM COAL (t)
1964	3,246,106	595,557	1,186,616
1965	3,371,364	616,043	1,353,986
1966	3,665,651	674,929	1,458,080
1967	4,338,787	760,139	1,534,929
1968	4,827,590	792,661	1.571,654
1969	5,127,351	810,812	1,626,213
1970	5,171,637	785,190	1,276,096
1971	5,665,887	819,910	1,678,453

Source: CNP (National Oil Councel)

II - METALLURGICAL COAL IMPORTS

YEAR	TONS	US$	US$/t
1964	1,351,992	24,472,048	18,10
1965	1,047,809	18.435,202	17,59
1966	1,744,425	29,459,914	16,89
1967	1,537,475	24,703,182	16,07
1968	1,408,282	23,040,011	16,36
1969	1,921,382	30,548,535	15,90
1970	1,988,624	41,163,973	20,70
1971	1,721,017	42.462,032	24,67

Source: CACEX, CIEF

COPPER

The great industrial development that Brazil has been undergoing brought about a substantial increase in the home consumption of copper .

Domestic requirements are virtually met by imports. Oil is the only item that surpasses copper in our importation schedule of mineral goods .

In the three years from 1969/1971, the cost of copper purchases abroad amounted to US$ 230,605,000 .

Domestic requirements of copper are also met by the scarce home production and by the recovery of scrap .

Home production comes from the mines of Camaquã (Rio Grande do Sul) and Santa Bandina (São Paulo) and has oscillated around 5% of the domestic consumption .

In Camaquã (Rio Grande do Sul), copper is exploited by Cia. Brasileira de Cobre. In Caçapava do Sul, Rio Grande do Sul , the ore has an average grade of 1.4 and is concentrated into grades varying from 35% to 36% of Cu.. The concentrate is sent over to Itapeva (São Paulo) where it is transformed into blister copper with a metallic grade of 98%, and goes on from there to Utinga(São Paulo), to the Laminação Nacional de Metais (National Metal Lamination), to be refined through electrolytical processing and transformed into cathode with a 99.2% grade of Cu .
Known Brazilian reserves are about 96 million tons , with an average grade of 1.07%, equivalent to 1,020 thousand tons of metal . Out of this total, about 75 million tons are located in Bahia,12,0 million in Rio Grande do Sul and the remaining 9 million in Minas Gerais, Ceará and São Paulo .

Brazilian copper consumption has been substantially increasing, chiefly as a result of industrial development .

The production of Camaquã mine (Rio Grande do Sul) has been increasing, and it is expected that the production of metallic copper will reach 12,000 tons by 1975 .

Taking into account the inclusion of Caraíba Project in the copper production line, with an antecipated production of .. 70,000 tons by 1975, it should be expected that by then home production would fully meet home consumption, thus lightening the burden on the Brazilian importation schedule.

However, from 1975 on, the problem of shortage in respect of domestic requirements would persist, and again there would be need of resorting to the foreign market to meet them .

Anyway , the benefits of the above project would bring about only a temporary solution of the copper problem in Brazil.

Actually, one must keep in mind that copper consumption is a consequence of the economic development of a nation, and that there will always be the need to expand the production capacity of such metal in accordance with the development of the country, to prevent its commercial balance from being burdened by heavy imports .

COPPER STATISTICS

I - IMPORTS

YEAR	TONS	US$	US$/t
1963	48,592	33,630,608	692,10
1964	28,181	21,286,787	755.36
1965	23,237	26,579,211	1,143.83
1966	43,644	67,391,362	1,544.12
1967	36,959	43,201,764	1,168.91
1968	50,772	61,256,145	1,206.49

YEAR	TONS	US$	US$/t
1969	48,299	61,531,620	1,273.97
1970	53,482	83,749,336	1,565,94
1971	72,311	85,323,898	1,179,96

SOURCE : CACEX

II - PRODUCTION

YEAR	TONS
1963	2,000
1964	2,000
1965	3,000
1966	3,000
1967	1,800
1968	3,500
1969	3,700
1970	4,643
1971	5,100

SOURCE: CEBRACO (Brazilian Copper Center)

CPRM

III - APPARENT CONSUMPTION OF COPPER IN BRAZIL

YEAR	PRODUCTION (t)	SCRAP RECOVERY(t)	IMPORTS (t)	APPARENT CONSUMPTION(t)
1963	2,000	6,000	48,592	56,592
1964	2,000	12,000	28,181	42,181
1965	3,000	14,000	23,237	40,237
1966	3,000	24,000	43,644	70,644
1967	1,800	21,000	36,959	59,759
1968	3,500	25,000	50,772	79,272
1969	3,700	26,500	48,299	78,499
1970	4,643	28,800	53,482	86,925
1971	5,100	31,200	72,311	108,611

SOURCE : CEBRACO (Brazilian Copper Center)

IV - SECTORIAL DISTRIBUTION OF COPPER CONSUMPTION

YEAR	ELECTRICITY %	MECHANICS %	CONSTRUCTION %	OTHERS %	TOTAL %
1963	51	22	15	12	100
1964	54	21	13	12	100
1965	55	23	10	12	100
1966	53	26	9	12	100
1967	56	23	10	11	100
1968	58	24	9	9	100
1969	58	25	8	9	100
1970	59	24	8	9	100
1971	58	24	8,5	9,5	100

SOURCE : CEBRACO (Brazilian Copper Center)

CPRM

DIAMOND

The diamond is the most important of the precious stones, and only in modern times has it been used for industrial purposes. Its value depends upon its hardness, its luster, due to its high refractive index and its fire, produced by a strong diffraction of light forming the colours of the spectrum. As rule, the most valuable stones are the flawless ones, which are colorless or have a bluish-white colour.

Industrial diamonds are those which, due to their color, or structural defects, or size, or shape, are not considered as gems and are thus designed for industrial use, for cutting, milling, drilling, wire-drawing, abrasion, etc.

About 95% of the world production of diamonds comes now from the African continent. The Belgian Congo has been for a long time the largest producer, with alluvium deposits that provide more than 50% of the world supplies. These Congo diamonds are mostly of the industrial type and represent about 13% of the total value of diamonds produced.

There are several regions in Brazil where diamonds are extracted, in the great majority of cases by rudimentary mining methods.

In the vicinity of Marabá, along the river Tocantins, we find one of the main diamond-bearing districts of this country. Exploitation there is made by primitive mining (garimpagem)since the thirties, with ups and downs in production, reaching up to 20 and even 30 thousand yearly carats, equivalent to 10% of the domestic production. Outstanding among mining sites are Canal do Jaú, São Pedro, Canal do Piranheira, Poço and Canal do Valentim, etc.

Diamonds produced in the Tocantins region are of a very good quality, so that 55% of the stones are fit for lapidation.

The continuity attending the extraction of diamonds in the region, since 1938, as well as the great number of still virgin alluvial lenses attest the potentiality of deposits lying in the Tocantins area.

The most important diamond-bearing district of Brazil is located in the Jequitinhonha river basin, north of the State of Minas Gerais. Its exploitation includes different activities, from the use of powerful floating dredges, which account for 60% of production, till the use of rudimentary mining methods, which account for 40% of the 100,000 carats/year production.

It is estimated that in Western Minas Gerais another 120,000 carats/year were added to the above mentioned production of 100,000 carats/year, so that the aggregate production amounts to 220,000 carats/year.

Besides those two important regions, other centers of lesser importance are located in the municipalities of Gilbués and Monte Alegre, in Piauí, where diamonds are primitively prospected, starting from the mesozoic paleochannels; in several rivers of Mato Grosso; in the alluviums of the river Tibagí, in Paraná, where surveys are being carried out in an area of more than 4,000 square kilometers, aiming at the possible location of kimberlithic chimneys.

In 1970, Brazilian production was estimated at 320,000 carats with a pithead value equivalent to US$ 7,9 millions.

E U X E N I T E

Euxenite is a niobium-titanate with tantalum and rare earths (yttrium, erbium, cerium and uranium). A pseudo-orthorhombic mineral, commonly massive and rarely crystalline.

Its hardness is 6.5, it is infusible, brownish black in color, and makes up a dimorphic series with polycrase.

Euxenite occurs in pegmatites, as an accessory mineral, in several localities of Norway, Finland, Greenland, United States, Canada and Australia.

In Brazil, it occurs in the States of Espírito Santo, Paraíba, Rio Grande do Norte, in the districts of Trombas and Formoso in the State of Goiás. However, the primary euxenite occurrences in Brazil are to be found in the pegmatitic province of Vale do Rio Doce, Minas Gerais, chiefly in the Santa Clara plantation, in Pomba; Vargem Grande, Juiz de Fora; Brejaúba, district of Conceição, and Sta. Maria do Suassuí.

FERTILIZERS

In the last few years, the domestic market of fertilizers has been presenting a considerable expansion, not only virtue of the economic growth, but also as a result of well-planned efforts on the part of the large companies engaged in the output of producer goods and fertilizers. There is also the effort of government and credit agencies, trying to make farmers aware of the benefits brought about by a regular and adequate fertilizing of the soil, towards the improvement of crop profitability rates.

To meet its domestic requirements, Brazil now imports all the potassium used here, about 50% of the phosphates and approximately 95% of the nitrogen.

These imports presented themselves as follow, in the period 1967/1971:

BRAZILIAN IMPORTATION OF FERTILIZERS

SPECIFICATION	1967		1968		1969		1970		1971	
	t	US$10³	t	US$10³	t	US$10³	t	US$10³	t	US$10³
PHOSPHATES										
- Dregs of dephosphoration	6,991	221	12,188	387	8,457	275	7,998	266	9,205	313
- Ammonium phosphates	65,031	4,799	109,258	8,086	142,076	9,866	248,506	16,333	289,714	19,330
- Dicalcic phosphate	802	78	6,021	407	4,647	318	5,259	365	1,801	153
- Calcined calcium phosphates	1,177	79	100	8	-	-	-	-	1,400	133
- Natural calcium phosphates	225,345	4,216	327,008	6,147	310,120	5,175	428,158	6,783	611,467	8,946
- Natural phosphates	100	9	2,800	83	-	-	-	-	0	0
- Calcium superphosphate grade $P_2O_5 <$ 22%	18,514	618	14,730	493	11,946	409	25,306	776	19,553	644
- Calcium superphosphate grade $P_2O_5 \geq$ 22%	83,105	4,703	101,491	5,364	101,053	5,289	198,049	9,667	254,617	12,955
	401,065	14,723	573,596	20.965	579,099	21,332	913,276	34,190	1,167,757	42,474
NITRATES										
- Ammonitrates	148	10	234	18	-	-	-	-	-	-
- Calcic cyanamide	60	6	200	20	1,698	167	225	27	375	46
- Ammonium nitrate	2	2	2	2	1,002	99	1	1	1	1
- Calcium nitrate	277	18	436	26	309	19	494	28	452	26
- Natural sodium nitrate	27,162	1,539	25,346	1,419	34,843	1,958	23,711	1,359	23,692	1,365
- Synthetic sodium nitrate	-	-	494	41	-	-	1,770	96	70	7
- Urea	35,660	3,271	48,765	3,739	64,903	4,603	132,281	7,227	95,075	4,910
- Ammonium sulphate	303,358	12,610	418,858	14,808	451,042	14,794	697,224	15,712	516,107	10,308
- Ammonium sulphonitrate	10,767	565	13,300	598	9,995	424	10,435	403	10,100	399
	377,434	18,021	507,635	20,669	563,792	22,064	866,141	24,853	647,952	17,062
POTASSICS										
- Potassium chloride	221,505	7,917	296,435	9,930	317,873	10,427	491,699	17,446	574,308	24,636
- Potassium nitrate	-	-	-	-	-	-	2,631	264	-	-
- Potassium nitrophosphate	-	-	-	-	-	-	-	-	279	87
- Double sodium nitrate and impure potassium	9,715	680	6,340	432	17,166	1,124	7,662	500	8,610	590
- Magnesium and potassium sulphate	300	14	790	32	2,315	92	625	27	908	39
- Potassium sulphate	5,086	283	10,173	544	12,702	703	16,280	957	9,000	528
	236,606	8,894	313,738	10,938	350,056	12,346	516,897	19,194	593,395	25,880
OTHERS	267	29	1,274	113	2,111	334	6,162	540	1,222	353
TOTAL	1,015,372	41,667	1,396,243	52,685	1,495,058	56,076	2,304,476	78,777	2,430,326	85,769

SOURCE: CACEX
CIEF

As implied by data presented, the Brazilian fertilizer demand has displayed a continuous growth, which will probably become accentuated in the next few years.

The great development anticipated in agriculture, which will probably have its rates of growth greatly increased as a result of government measures, may bring the consumption of fertilizers to the following levels, as regards nutrients contained therein:

YEAR	POTASSIUM 10^3t	PHOSPHATES 10^3t	NITROGEN 10^3t
1975	371	646	515
1980	514	931	942

The identification of extensive reserves of sylvinite and carnallite in Sergipe opened new prospects for the production of potassic fertilizers in Brazil. The use of these reserves will make possible not only the supply of the home market but also the winning of the foreign market, thus bringing about a good yield of foreign currency. A home market of at least 500 thousand tons of K_2O anticipated for 1980 makes it possible to give immediate reality to this weighty industry.

As to phosphated fertilizers, notwithstanding explorations under way in this country, so far there is no precise definition concerning their future position. There are some prospects in Araxá, Minas Gerais, but the problem continues unsettled.

For nitrogen fertilizers prospects are encouraging, especially in view of the installation of the petrochemical poles of São Paulo and Bahia.

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F L U O R I T E

Fluorite, chemically CaF_2 (calcium fluoride)is the major source for the obtention of fluor. It has a wide range of utilization in the steel, metal and ceramic industries, due to its exceptional qualities as melting agent.

It is also used in the plastic industry, in the production of gasoline with a high octane number, in the obtention of oxygenated water out of sodium peroxide, etc.

Brazilian fluorite reserves are on the order of 1,270,000 t of good quality ore, with grades varying from 75 to 85% of CaF_2, which after primary washing and grainsize classification reaches the grade of 90% CaF_2.

Known ore deposits are mostly located in the State of Santa Catarina, aggregating 14 units, equivalent to about 1,200 thousand proved tons of ore.

Brazil has its place among the great fluorite producers of Latin America, coming next only to Mexico, before Argentina and Chile, and holding the 16th place in the world compass.

During the period 1967/1971, Brazilian fluorite production showed forthright growth, as may be seen by the table hereunder:

YEARS	t
1967	10,292
1968	15,685
1969	33,308
1970	36,568
1971	56,011

Source: DNPM

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The companies Mineração N.S. do Carmo and Mineração Santa Catarina account for about 90% of the Brazilian fluorite supply. Both operate in the municipality of Morro da Fumaça, a region of excellent understructure (good roads and availability of electric power) and good natural conditions(great thickness of veins and high purity of the ore) which make an intense exploitation possible.

In terms of foreign trade, Brazil from an importer up to 1963, became an exporter in the last ten years.

Data hereunder refer to Brazilian fluorite exports in 1969, 1970 and 1971, since quantities marketed for foreign trade in the preceding years were so unimportant as to deserve no mention.

YEARS	t	US$	US$/t
1969	10,337	320,452	31,00
1970	20,650	609,150	29,50
1971	22,095	929,830	42,08

Source: CACEX

As a result of the domestic demand of fluorite, mainly due to the steel and aluminium industries, as well as to the implantation of new chemical plants that are consumers of such mineral, the domestic demand has been showing since 1970 a great diversification that presents a trend to grow.

CONSIDER (Steel Council) anticipates, through the National

Steel Plan, that by 1977 the Brazilian steel production will be on the order of 12 million tons. The consumption of fluorite, in this field alone, will probably oscillate then between 36,000 and ..... 48,000 tons.

Its is also expected that in 1977, owing to the expansion plans of aluminium producing companies, requirements of fluorite will increase also in this area.

So, in 1977, as a result of the above mentioned expansion plans, it is expected that the domestic demand of fluorite will reach 60,000 t and by the end of the seventies will go on to 70,000 t per annum.

Reference should also be made to the growing interest shown by the foreing consumer market, primarily represented by the American and Japanese industries, in respect of Brazilian fluorite. Pursuant to agreements already executed, nearly the whole of Brazilian fluorite exports is designed for Japan, though such exports are limited by Government rules to 20,000 t/year. Studies are now going on regarding the liberation of export quotas for the "chemical grade" type of fluorite.

The government policy has been directed to the fostering and amplification of reserves, as well as to the restriction of exports, in view of the supply of the domestic market and the potentiality of present known reserves.

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G O L D

Gold was one of the first metals used by man. The supply-demand relationship in respect of gold differs from all the others mineral goods, by reason of its important function as the actual unit of international monetary standard .

Though gold is a rare element, it occurs widely distributed in nature, by small quantities . It is more commonly found in veins and has a genetic relationship with the siliceous types of igneous rocks .

Metallic gold has the following distribution according to use :

Jewelry	75.00%
Currency	7.00%
Electronics	6.50%
Odontology	6.25%
Decoration and others industries	5.25%

Gold occurs in nearly all Brazilian States, but the domestic supply meets only about 70% of the requirements of the home market. Our known and proved gold reserves are :

Morro Velho (MG) with 84 tons of metallic gold,

Mina da Passagem (MG) with 371 tons of metallic gold ,

Mina de Canavieiras (Bahia) with 95 tons of metallic gold .

Besides the above, there are "garimpos" gold bearing areas primitively exploited known to exist in Minas Gerais, Goiás Mato Grosso, Pará, Bahia, Paraná, Amazonas, Amapá, Roraima and Rio Grande do Sul .

As to production it has been almost constant and distributed approximately as follows in the last few years :

Mineração Morro Velho S.A.	5.4 t/year
Other mining ventures	0.5 t/year
"Garimpo" (in mid Tapajós River)	3.4 t/year
Other "garimpos"	0.7 t/year
T O T A L	10.0 t/year

This value corresponds to o.6% of the world's gold production.

As to the Brazilian market in the last few years, the following table shows its position:

G O L D (TONS)						
	1966	1967	1968	1969	1970	1971
PRODUCTION	10.00	10.00	10.00	10.00	10.00	10.00
IMPORTS	0.02	0.70	2.55	1.22	3.79	4.25
APPARENT CONSUMPTION	10.02	10.70	12.55	11.22	13.79	14.25

SOURCES : MME and CACEX

The apparent consumption projection indicates an average world yearly growth of 5% (according to the Minig Journal of April 16, 1971), which may be applied to Brazil, with the following figures as a result :

YEAR	GOLD(tons)
1972	15.00
1973	15.75
1974	16.50
1975	17.30
1980	22.00

As we have seen, the proved reserves of metallic gold in Brazil totalize no more than 550 tons , but as compared with present explorations this value may easily be doubled, or reach a much higher tonnage .

On the other hand, gold reserves contained in gold bearing alluviums which exist in several Brazilian States, in riverbeds and riverbanks, in the placers of fluvial terraces and in the gravel of mountain slopes are centainly significant .

An illustrative example may be found in the fact the mounthly production of gold in 1966, in the "garimpos" of the mind Tapajós region, amounted to about 300 Kg (three hundred kilograms) of gold .

This value in itself, as compared to the production of mining companies, is already comparatively high, let alone if we consider that the exact figure of gold production in the "garimpos" is virtually unknown owing to the difficulty of controlling the movements of gold from the areas of secondary deposits up to those of consumption .

According to the Mining Journal (April 16,1971) the evolution anticipated for gold prices was displayed as follows :

YEAR	DOMESTIC MARKET	FOREIGN MARKET			
	US$/g	US$/g		US$/ounce	
		maximum	minimum	maximum	minimum
1966	1.118	1.125	1.125	35.00	-
1967	1.074	1.125	1.125	35.00	-
1968	1.353	1.545	1.207	48.07	37.55
1969	1.557	1.409	1.128	43.85	35.10
1970	1.415	1.266	1.122	39.40	34.90
1971	1.397	1.333	1.205	41.50	37.50
* 1975		1.45		45.00	
* 1980		1.65		50.00	

* SOURCE: Mining Journal - April 16,1971

However, due to the recent international monetary crises, gold reached US$ 100,00 per ounce, according to quotation of the London Stock Exchange in May 1973 .

Price evolution shows that the domestic price tends to drop as a result of rationalization of exploitation while international prices tend to rise . This certainly favors the absorti on by the scarcely supplied home market of all and any increase in the supply of domestic producers .

I R O N

Iron mining is the primary extractive industry of Brazil. Brazil has approximately 1/4 of the world's known iron ore reserves and holds the second place in the world, next only to the URSS.

In variable quantities and qualities, iron ore virtually occurs in all Brazilian States, but three great ferrous areas are outstanding:

1. Ferrous Quadrilateral - Minas Gerais - Almost all the iron ore produced in Brazil is extracted from this area. Proved and probable reserves amount to about 10 billion tons of ore with an average grade of 64% Fe. Possible reserves reach around 30 billion tons, of which 2/3 are made up of rich itabirites having a thoroughly workable concentration, about to be carried out by CVRD.

2. Urucum - Mato Grosso - Proved and probable reserves in this area are of 2.5 billion tons of high grade hematite, while possible reserves reach the figure of 30 billion tons.

3. Carajás - Pará - The ore from the Serra de Carajás deposit is of an excellent grade. Proved reserves there amount to about 1.6 billion tons with the average grade of 64% Fe, and estimates are that these reserves amount to 70 billion tons of ore with a variable grade of 35% to 69% Fe.

With the purpose of mining and marketing the ore of the above deposits, a company was created under the name of Amazônia Mineração S.A., made up by the association of CVRD (51% of the capital) and Cia. Meridional de Mineração (49% of the capital).

Besides having one of the world's largest reserves of iron, Brazil is also one of the world's largest producers.

According to estimates of the U.S. Bureau of Mines, to a production of approximately 740 million tons of iron ore in 1971, Brazil participated with almost 40 millions, next only, in the free world, to the United States (80 millions), Australia (54 millions), France (54 millions) and Canada (43 millions).

It is reckoned that the production of URSS and Communist China will have surpassed the Brazilian production.

The domestic production of iron ore, in the period 1967/1971, displays the following results:

YEAR	10^3t
1967	21,723
1968	24,532
1969	27,571
1970	36,381
1971	37,676

Source: DNPM

About 1/4 of the production is absorbed by the home market and what remains is exported.

In view of the National Steel Plan, which aims at reaching 20 million tons of steel by 1980, it will be necessary to have roughly a fourfold increase of raw material production for the

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steel industry. It is estimated that the domestic consumption of iron ore will then reach 28 million tons.

Iron ore is the second primary Brazilian exportation product, next only to coffee, andthere are quite optimistic prospects that within a short time it will come to represent the largest source of foreing currency for this country.

It has already become traditional that iron ore is the grand exportation mineral product of Brazil, with an outstanding position in our foreing trade relations.

Foreing sales of iron ore, from 1967 to 1971, showed the following evolution:

Year	t	US$	US$/t
1967	14,279,231	102,782,727	7.20
1968	15,049,735	104,450,298	6.94
1969	21,477,576	147,391,114	6.86
1970	28,061,393	209,562,388	7.47
1971	31,020,373	237,327,342	7.65

Source: CACEX

From 1967 to 1971 there was an increase of 117.2% in the total iron ore exported, equivalent to a higher increase in the acquisition of foreing currency, about 131% as a result of the increase of the average ton price, which rose from US$ 7,20/t in 1967 to US$ 7.65/t in 1971.

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This improvement in the average price of iron ore comes about when a change is occurring in the world market as regards the characteristics of demand, especially in respect of physical properties.

Technology has been requiring a greater demand of iron ore types with the most varied physical properties, thus diversifying the trend so far prelavent, according to which only grain size was taken into account.

There appears a trend towards a reduction of large sized ore consumption and an increase in the demand of fine ores in general, as well as towards the advent of the very fine ores under the form of pellets.

Following the development of the international market, Brazil, through CVRD, has great expansion plans, according to which it is anticipated that in 1974 the domestic capacity of iron ore pellet production will be of 8 million tons per year.

Such fact will contribute to keep Brazil in the position of one of the world's largest producers and exporters of iron ore, capable of meeting the growing world demand of pelletized ore.

There are also good prospects for the itabirites, which so far have not been put to use. CVRD will probably produce itabirite concentrates in the form of pellets, with an average grade of 64% Fe. The plant was inaugurated by the end of 1972 and will probably be producing, by the end of 1974, 20 million tons of itabirite concentrates.

Prospects for the marketing of iron ore are excellent, having in view, above all, that the world production of steel will probably reach, before the end of the seventies, 1 billion annual tons.

Brazil will then probably participate with a substantial portion of the demand, and there are strong possibilities that exports shall reach within the seventies about 100 million tons of iron ore.

LEAD

Lead is one of the prime metals of the non-ferrous group, and it is one of the six metals of widest use in modern industry.

Its consumption in Brazil has been growing in accordance to the industrialization of the country, and its demand structure is displayed as follows:

Battery manufacture	52%
Lead alloy, plates and tubes	19%
Cable coatings	14%
Pigments	4%
Ammunition	3%
Steels	2%
Other applications	6%

Pursuant to survey made by experts of the Lead and Zinc Institute, the domestic consumption of lead will probably follow the growth of the automobile industry, thus creating an ever greater dependence on the foreign market.

At present, the primary production of lead, allied to a small importation, has been meeting the domestic demand of such metal quite satisfactorily. However, our consumption tends to acquire a new vigor as a result of the expansion antecipated in the automobile industry, to wich lead is closely associated.

In the period 1966/68, we imported 23,800 tons of metallic lead amounting to US$ 6,699,000, while in the following three year period, 1969/71, 22,376 tons were imported, at a cost of US$ 6,540,000.

The main deposits under exploitation in this country are located in Panelas (Paraná) and Boquira (Bahia).

Boquira provides about 80% of the lead production in this country. Its production has been increasing since 1955, when operations started. Lead reserve of these deposits amount to about 2.2 million tons, with an average Pb grade of 8.8%, wich is equivalent to about 197 thousand tons of metal content.

If we take into account that production in a scale compatible with the requirements of the home market will probably bring about the consumption of an yearly average of 350 thousand tons of ore, the known reserves will be unsufficienty by the end of the seventies. Prospecting work is needed for the discovery of new deposits capable of ensuring future supplies for a longer period.

At present, two companies produce lead in the country: Cia. Brasileira de Chumbo - COBRAC, with its plant in Santo Amaro da Purificação (Bahia) and Plumbum S.A., with its facilities in Adrianópolis (Paraná).

In 1971, the two plants produced 25,737 tons of the metal, of which 19,711 by COBRAC and 6,026 tons by PLUMBUM.

The operational capacity of the two companies, amounting to about 30,000 tons per annun, is sufficiente to supply the home market, but this is not the case because the concentration mill of Boquira has its capacity of concentrate production in a higher level than metallurgical requirements, while in Panelas the capacity of metal production is higher than the capacity of ore concentration. In Boquira, there is an excess of 1,500 tons of concentrates per year, which might be used up in Panelas. The expansion of the Santo Amaro da Purificação plant and the intensification of exploration work in the Boquira region are been studied at present, aiming at the increase of known reserves up to a level that may justify the investments to be made in such expansion.

Assuming that the other sections of lead consumption in this country follow the growth of the automobile industry, it is to be expected that by the end of the seventies Brazil will have doubled its present consumption.

LEAD STATISTICS

I - IMPORTS

YEAR	TONS	US$	US$/t
1961	13,556	2,978,503	219,72
1962	8,082	1,600,961	198,09
1963	15,839	2,943,842	185,86
1964	4,216	1,022,005	242,41
1965	2,171	768,808	354,13
1966	5,554	1,738,859	313,08
1967	6,513	1,856,000	284,97
1968	11,763	3,104,456	263,92
1969	12,669	3,735,035	294,82
1970	1,382	472,378	341,81
1971	8,325	2,332,766	280,21

Source: CACEX

II - PRODUCTION

YEAR	TONS
1961	12,578
1962	13,346
1963	16,970
1964	15,500
1965	15,500
1966	17,477
1967	17,161
1968	16,135
1969	18,497
1970	19,451
1971	25,737

Source: CDI (Ministry of Trade).

MANGANESE

Manganese ore, together with iron ore, make up the couple of giants of Brazilian mineral exportation and are included among the 10 primary products, sales of which bring the largest amounts of foreign currency into the country.

About 95% of the manganese used in the world is consumed in the steel industry, so that its consumption is determined by the degree of the steel industry operation.

In Brazil, manganese ore reserves have not been totally appraised as yet, but it is estimated that they amount to 150 million tons.

Proved reserves are on the order of 40 million tons, distributed as follows:

STATE	10^3t	GRADE
Amapá	26,400	>30% Mn
Mato Grosso	4,221	45 - 47% Mn
Minas Gerais	4,234	32 - 40% Mn
	4,990	20% Mn
Bahia	453	40 - 45% Mn
Espírito Santo	173	33 - 35% Mn
Amazonas	15	>40% Mn
TOTAL	40,486	

The Territory of Amapá stands out as the largest producer. In Mato Grosso (Urucum), the ore has a high ferrous grade, and this brings difficulties to its exploitation. Minas Gerais provides the manganese ore used at home, though the exploitation is scarcely mechanized.

In Amapá, at Serra do Navio, occurs the all-out activity connected with manganese. The mine is directed by ICOMI, that exports all the ore produced.

Brazil stands out as one of the largest world producers of manganese ore, together with Gabon, India and the Republic of South Africa.

According to DNPM data, Brazilian production of manganese ore in the last few years showed the following results:

YEAR	10^3t
1967	1,300
1968	1,914
1969	2,374
1970	2,732
1971	2,377

More than half of this production is sold abroad, and sales have been significantly growing, so as to reach the following values in the period 1967/1971:

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YEAR	t	US$	US$ t
1967	542,017	13,959,461	25.75
1968	1,123,909	24,124,650	21.46
1969	860,619	17,077,402	19.84
1970	1,588,079	30,592,043	19.26
1971	1,797,039	37,705,914	20.98

Source: CACEX

In the period surveyed, exports increased by 231.5%, corresponding to a lesser increase in the yield of foreing currency, which was 170%, since the average price per ton dropped from US$.. 25.75 in 1967 down to US$ 20.98 in 1971.

Brazil enjoys an excellent position as exporter of manganese ore, though exports are still insufficient to invest the country with a leadership compatible with its reserves and its possibilities of production and marketing.

A great effort is under way in this country towards a technological development that shall insure the use of low grade ores. Improvement is sought as to efficiency in production, transportation and shipment, so as to make it possible that any drop in prices shall be offset by more than proportional exportation volume.

Prospects of Brazilian manganese ore are excellent. The operational stant of the world's first manganese pelletizing plant, with a production capacity on the order of 280,000 yearly tons, will make Brazil's position even stronger in the international

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market, as manganese ore exporter.

The manganese pelletizing method represents a pioneer industrialization of the ore, so that Brazilian offers the world market a type of product with unique characteristics, which will be most advantageous to the country from a technological and economic standpoint, since the pellets make it possible to put to good use the ore fines which was formerly of difficult commercial application. The pellets present moreover advantages of weight, size, grade and quality uniformity.

So, Brazil will go on to export a halffinished product, with a 60% grade of metallic manganese, which will obtain better prices and will consequently propitiate a higher yield of foreing currency.

N I C K E L

Though it has been known since ancient times, nickel is a metal to which industial application was given only on the next -to-last decade of the nineteenth century; when France started producing ferro-nickel alloys .

High technological development has brought about the possibility of an ever growing diversification of nickel, which is now used in large scale .

The major nickel source is now to be found in sulfide ores (Pentlandite), due to the facility of extraction and metal - lurgical processing . However, the rapid depletion of known world reserves is expected within at most 40 years, so that attention is been centered on silicate ores, reserves of which seem inexhaustible .

In Brazil, known reserves are of silicate ore type, processing of which, for the obtention of metallic nickel, is much more difficult and costly than the sulfide ones .

Garnierite, however, an ore that has so far been identified in this country, though of comparatively low grade, may be economically processed and is more appropriate for the production of ferro-nickel . This is actually the trend of modern metallurgy: the production of ferro-nickel alloys for the industrialization of nickel silicates, through smelting in electric furnaces .

In modern industry, nickel has been finding more and more applications, increases of which are associated with higher rates of nickel utilization, such as the typical case of high grade nickel alloys .

The structure of nickel world demand has the following behavior :

Stainless steels	41%
High grade nickel alloys	14%
Bronze and copper alloys	4%
Nickel-plating	13%
Construction alloy-steels	11%
Cast iron and steel	9%
Others	8%
TOTAL	100%

Ferro-nickel is produced and exported by Brazil, whereas heavy imports of metallic nickel are prevalent .

In the period 1966/1968, 3,073 tons of metallic nickel were imported, amounting to US$ 8,697,000 , while from 1969/1971 such imports reache 3,941 tons, causing a foreign currency drain of US$ 15,313,000 , which means that in the latter period the cost of nickel imports was virtually doubled .

Two companies now produce ferro-nickel in this country, making use of the silicate ore of our deposits, proved reserves of which are on the order of 48 million tons, with an average grade of 2.2%, or the equivalent of 1,055,000 tons of metal content.

Morro do Níquel S.A., which has its plant in Pratápolis (Minas Gerais), has available reserves on the order of 6 million tons, with an average grade of 1.8% , and is the major Brazilian producer of ferro-nickel . Its production capacity is of 2,500 tons of nickel, contained in the ferro-nickel .

Cia. Nickel do Brasil has a small metallurgical plant in Liberdade (Minas Gerais), where reserves amount to about 7 million tons of 1.6% grade ore . Its ferro-nickel production is very low, amounting to about 7% of the total produced here .

In 1971, the joint production of the two companies rea-

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ched 10,528 tons of ferro-nickel, equivalent to 2,593 tons of nickel content .

Ferro-nickel produced here, besides supplying the domestic market, is also designed for the foreign market. 15,101 tons of ferro-nickel were exported from 1969 to 1971, equivalent to 4,222 tons of Ni content, which brought in foreign currency amounting to US$ 13,645,000 .

Sales abroad have been exceeding domestic sales. An average of 1/3 of the production is absorbed in this country, while the remaining production is placed abroad .

Brazilian backwardness in nickel production, as compared with other countries, is due, among other factors, to the undevelopment of modern nickel extraction technologies, applied to the silicate ore, and to the fact that we did not obtain in time the Canadian or French know-how, which were the only ones available for the processing of this kind of ore .

The uncertainties of the international market and the comparatively small domestic consumption, amounting to about .... 2,500 tons, have also contributed, up to date, to discourage business men who aim at investing large amount of capital for the implantation of industrial compound designed to industrialize here an ore of difficult processing .

Cia. Morro do Niquel carried out research work aiming at the obtention of metallic nickel and nickel salts, and reached the conclusion that production is not economically feasible unless it amounts to a minimum 3,000 yearly tons, which exceeds the present domestic consumption .

Cia. Níquel Tocantins (Grupo Industrial Votorantim) is already taking action towards obtention of the metal after complying with understructure requirements in Niquelândia (Goiás), and plans to install a plant with the annual nickel production capaci ty of 10 thousand tons .

In Niquelândia (Goiás) is located the largest nickel deposit known in this country, with reserves estimated at 25 million tons of average 2.5% grade ore, equivalent to 625,000 tons of nickel content .

Also in Goiás, in Barro Alto, there is another nickel deposit as rich as if not richer than Niquelândia deposit, where prospection carried out has shown excellent possibilities .

In São Paulo a pilot plant has been installed to carry out the necessary tests with the Niquelândia ore .

The operational start of the São Felix hydroelectric power plant, in the neighborhood of the deposit, will provide the electric power needed by metallurgy . Research is also planned in respect of a process for the obtention of copper, which occurs in association with nickel and cobalt in said ore .

According to research work by experts of the Industrial Development Council (CDI), the home consumption of nickel will probably reach, by 1975, about 3,000 tons, which according to estimates of DNPM experts, may have doubled by 1980 . Once the domestic demand is met, the nickel produced here may reach the foreign market, which is potentially made up by the Latin American countries that now put forth a huge effort towards industrialization .

Investments that are being applied for the implantation of nickel mineral-metallurgical compounds in the Western world point out to a general expectancy by producers of a substantial and progressive growth of nickel demand .

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IMPORTS OF METALLIC NICKEL

YEAR	TONS	US$	US$/t
1961	954	1,980,029	2,075,50
1962	1,214	2,582,659	2,127.40
1963	683	1,587,319	2,470.45
1964	682	1,575,380	2,309.94
1965	563	1,350,605	2,398.94
1966	906	2,138,391	2,360.25
1967	924	2,665,273	2,884,49
1968	1,243	3,893,062	3,131.99
1969	1,007	3,509,444	3,485.05
1970	1,425	6,141,773	4,310.02
1971	1,509	5,661,328	3,751.71

FERRO - NICKEL

YEAR	PRODUCTION		EXPORTS		
	Fe-Ni (t)	Ni contend (t)	Fe-Ni (t)	Ni contend (t)	US$
1966	3,620	1,048	755	267	399,281
1967	4,161	1,062	2,678	677	1,959,175
1968	3,780	1,034	1,531	397	1,303,273
1969	4,271	1,156	2,129	672	1,939,084
1970	10,956	2,780	7,400	1,934	7,908,213
1971	10,523	2,593	5,572	1,616	3,798,005

SOURCE: CDI (Ministry of Trade)

Mod. 002

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N I O B I U M

Niobium is a metal that was first commercially used in the sixties .

It is a strategic metal, which is now mostly employed in the spacial industry and in atomic reactors, as protection against uranium radioactivity. It is also used in the production of highly resistant structural steels for civil construction, naval industry, automobile industry, and others .

Its grand application is that of component element in mettallic alloys designed for the manufacture of turbines for aircraft and space-craft .

The main types of niobium ore are columbite and pyrochlore.

Brazil is world's largest niobium ore producer, with a participation of approximately 65% .

Domestic reserves are estimated at 3.8 million tons of metal, content, which amounts to about 60% of the niobium reserves of the world .

Areas where the major reserves are to be found are those of Barreiro (Goiás), among which the reserves of the city of Araxá are the largest in the world .

As the Nigerian reserves have reached a stage of depletion, Brazil appears as one of the major suppliers of such mineral.

Niobium mining and metallurgy in Brazil are carried out by Cia. Brasileira de Metalurgia e Mineração, which after processing in its Barreiro plant, transport the ore as concentrate of pyrochlore and as ferro-niobium .

Data regarding the domestic production of pyrochlore and columbite concentrates in the period 1966/1971 are those pro vided by exports, presented as follows:

I - PYROCHLORE CONCENTRATE

YEAR	t	US$ 10^3
1966	3,870	4,166
1967	2,725	2,878
1968	2,861	3,032
1969	5,741	6,145
1970	8,500	11,075
1971	1,640	1,960

SOURCE : CACEX

II - COLUMBITE

YEAR	t	US$ 10^3
1966	59	95
1967	101	222
1968	63	170
1969	69	127
1970	41	117
1971	63	171

SOURCE : CACEX

The great world consumers are:

USA	20%
Canadá	15%
United Kingdom	13%
Sweden	10%
Japan	10%

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In 1970, notwithstanding a drop in the American niobium consumption, this was offset by an increase of consumption by Japan and the East European countries, where demand was high, particularly for utilization in highly resistant structural steels .

The reduction os imports by USA, the great world consumer and our major customer, are due to fatcs connected with the steel depression and to the cutting down of budgetary itens for the spacial industry . The United States were thus compelled to resort to their own stocks, and this reflected on our exports .

Prospects at medium term are the very best for niobium, especially on account of its growing application in the manufacture of structural steels .

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QUARTZ - ROCK CRYSTAL

Rock crystal in a large scale is found in almost every Brazilian State. The expression rock crystal is applied to hyaline quartz mainly used in the fields of electronics, ceramic, metallurgy in the glass industry and as an important artificial abrasive.

Quartz, together with its semi-precious varieties — amethyst, citrine, agate, rose-quartz and opal - is one of the most abundant minerals of Brazilian territory, and is produced in a large scale through "garimpagem".

At the time of the II World War, rock crystal, by its piezoelectrical characteristics, or the propriety of certain crystals to produce electricity as an effect of pressure exercised on conveniently sliced blades, was widely sought and produced in Brazil, by reason of Brazil being the only allied country capable of supplying the "war effort"demand.

So, Brazil has the virtual monopoly of piezoelectrical quartz, while our occurrences of rock crystal are classified under the following types: veins, pegmatites, alluvial and elluvial deposits.

Minas Gerais, Goiás, Bahia, followed by the Northeastern States and Espírito Santo, are responsible for the highest production of this mineral asset in Brazil.

In Minas Gerais, rock crystal has been exploited in the Central part of the State, starting from Pitanguí, through Diamantina and Montes Claros, up to the Northeastern part of the State, where numerous deposits are found in Serra do Cabral, Minei

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ra and Itacambira, São João da Chapada, Buenópolis, Gouveia, etc.

In Goiás, rock crystal has been exploited in the whole Northern region and in the central area, as for instance in Cristalina.

In Bahia, rock crystal deposits occupy the Northern part of Chapada Diamantina, comprising the municipalities of Santa Sé, Xique-Xique, Barra do Mendes, Campo Formoso, Vitória da Conquista, Seabra, Gentio de Ouro, and so forth.

It is noteworthy that part of Brazilian rock crystal exports are designed for the manufacture of synthetic quartz, industrially produced by means of physicochemical methods which make it possible to have growth of crystals out of quartz fragments.

Mod. 002

BRAZILIAN EXPORTS OF MINERAL GOODS OF THE SILICA GROUP

SPECIFICATION	1967		1968		1969		1970		1971	
	Kg	US$ 10^3	Kg	US$ 10^3	Kg	US$ 10^3	Kg	US$ 10^3	Kg	US$ 10^3
* QUARTZ OR ROCK CRYSTAL	3,422	2,102	3,598	1,974	3,826	2,474	5,910	3,040	4,725	2,638
AGATES										
Raw	471,130	143	571,454	157	595,077	184	904,109	299	791,267	362
Lapidated	688	10	834	2	992	4	84	2	2,438	9
AMETHYSTS										
Raw	19,191	219	28,785	275	87,099	615	88,254	640	250,438	1,020
Lapidated	57	39	16	48	70	107	103	286	192	339
CITRINE										
Raw	5,418	272	2,000	357	2,701	768	6,112	1,452	14,930	1,767
Lapideted	8	9	20	10	25	19	65	120	165	162
OPALES										
Raw	7	10	0	0	19	61	44	78	222	52
Lapidated	0	1	-	-	3	23	2	33	3	71

* ton
Source : C A C E X

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SILVER

The most requested metal next to gold is silver, which has the second place in the scale of ductility and malleability and is a first rate heat and electricity conductor.

Silver has a wide application in the electrical, electronic and chemical industries and is also used in the plating of ornamental objects.

Another wide application is found in medicine and photography, under the form of bromide.

In Brazil there are no deposits with silver ore as the main extraction product. Domestic production comes from the lead refinings of the Plumbum-Cobrac deposits and from the gold of Morro Velho Mine, and is thus a by- product of these mining operations.

Brazilian production presented the following results in the period 1967/1971:

YEARS	PLUMBUM-COBRAC (Kg)	MORRO VELHO (Kg)	TOTAL (Kg)
1967	15,846	978	16,824
1968	13,963	1,162	15,125
1969	10,288	951	11,239
1970	10,209	899	11,108
1971	18,451	957	19,408

These figures virtually represent 95% of the Brazilian production, of which the remaining part comes from the "garimpos", there being no available information thereon.

However, as production is insufficient, Brazilian industry makes use of the foreign market to meet a growing demand of silver.

In the period from 1967 to 1971, Brazilian imports were distributed as follows:

YEARS	Kg	US$	US$/Kg
1967	30,548	1,443,010	47,24
1968	33,356	2,442,967	73,24
1969	38,196	2,392,634	62,64
1970	53,437	3,191,383	59,72
1971	60,403	3,256,307	53,91

Source: CACEX
CIEF

Brazil has been esporting small quantities of raw or half-wrought silver, powdered silver alloys for tooth fillings and raw or half-wrought plates.

Major importing countries have been the United States and Mexico, small quantities being also exported to Spain and Ireland.

Such exports behaved as follows in the period 1967/1971:

YEARS	Kg	US$	US$/Kg
1967	24	1,348	56,17
1968	13	1,480	113,85
1969	100	5,783	57,83
1970	2,441	124,079	50,83
1971	2,164	141,720	65,49

Source: CACEX

A survey of the preceding tables shows that apparent consumption behaved as follows in the last five years:

YEARS	PRODUCTION (Kg)	IMPORTS (Kg)	EXPORTS (Kg)	APPARENT CONSUMPTION (Kg)	PARTICIPATION PROD/ CONS. %
1967	16,824	30,548	24	47,348	35,53
1968	15,125	33,356	13	48,468	31,21
1969	11,239	38,196	100	49,335	22,78
1970	11,108	53,437	2,441	62,104	17.89
1971	19,408	60,403	2,164	77,647	25,00

The conclusion is that Brazil still depends upon nearly 75% of foreign supplies to meet the country's requirements, so that an intensification of prospection and exploitation of lead and gold

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reserves is needed to provide an increase in the silver production, besides which the zinc deposits of Vazante and Januária, in the North of Minas Gerais, also represent promising areas.

The CPRM (Mineral Resources Exploration Company)has been carrying out the following projects in silver promising areas:

Montalvânia Project - Minas Gerais

Januária/Itacarambi Project - Minas Gerais

Bahia Project

Southeast São Paulo Project

Bambuí Geochemistry Project

There are also silver prospects in Amazônia and Pará, in the following localities:

Municipality of São Félix do Xingú

Municipality of Alenquer and the Region of mid-Tapajós River.

T A N T A L U M

Tantalum was used in the beginning of the century for the manufacture of filaments designed for electric bulbs. Considering its resistance to the corrosive action of acids, it is used in the manufacture of equipments for chemical laboratories; in surgery,.for plates and skull sutures; in some steels and carbides, for cutting tools; in electronic tubes and in super-alloys for nuclear application and aero-spatial use.

The major tantalum minerals are the isomorphic series columbite-tantalite, which varies in its composition, from columbite $(Fe,Mn) Nb_2 O_6$, up to tantalite $(Fe,Mn)Ta_2O_6$; the series microlite-pyrochlore, essentially made up of compound tantalum, columbium, sodium and calcium oxides, combined with hydroxyl and fluor ions; fergusonite, euxenite, djalmaite samarskite and several other mineral compounds.

The prices of tantalite concentrates are quoted on the basis of 60% of tantalumpentoxide content. The prices of tantalum concentrate and metal have widely and frequently varied during the last 20 years. Since 1970 and up to the year 2000 it is expected that the price of the metal will remain comparatively steady, due to the progressive technological advances, the competition between the great producers of the raw material and a more uniform and sure supply of such material.

The world production of tantalum for the countries of the free world, in 1970, was about 1.8 million pounds of concentrate (816 t), with approximately 650 thousand pounds of metal (295 t).

The primary producers of tantalum concentrate are: Brazil, Australia, Moçambique, Congo (Kinshasa) and Brazilian concentrate exports to the United States reached in 1970 170,000 pounds (77.1 t), equivalent to 17% of the American imports, while in 1969 exports amounted to 253,000 pounds (115 t), representing 26% of USA's concentrate imports. The decrease was due to the large Canadian production in the year 1970.

In Brazil, tantalum minerals are found in the pegmatites of the Northern part of Minas Gerais, in the municipalities of Utinga, Ubá, Pomba, Muriaé and Araxá. It occurs also in the pegmatitic sub-province of Borborema, in Northeastern Brazil (eastern part of Pernambuco, with penetration into Rio Grande do Norte and part of Ceará), in the Federal Territory of Amapá and in Bahia, in the municipalities of Vitória da Conquista and Ibambé.

Tantalite holds a good position in the Brazilian picture of mineral goods expórtation.

The total of foreign currency obtained in the period 1967/1971 from foreign sales of this mineral was US$ 9,271,241, evolution of the exportation beig as follows:

Year	Kg	US$	US$/Kg
1967	204,925	2,071,138	10.11
1968	271,624	2,389,219	8.80
1969	203,220	1,404,550	6.91
1970	208,823	1,562,117	7.48
1971	289,951	1,844,217	6.36

Source: CACEX

So far, Brazil has no organized exploitation of tantalite. It occurs in association with columbite, and nearly all its exploitation is being carried out by means of "garimpagem", substantially affected by price oscillations of the international market.

Tantalite has its place among the minerals expected to have a growing world demand.

The largest consumer of Brazilian tantalite is the United States, while Canada is our major competitor.

The trend towards the participation of tantalite produced here in the world market is highly favorable, and a growing foreign currency income is expected from its sales abroad.

T I N

Tin serves manifold purposes, in its metallic form, as well as through its compounds.

The steel, can, electric material, mechanic, automobile, sanitary ceramic, and dairy industries, as well as many others, have been consuming tin, systematically and in growing quantities.

In Brazil, the first attempt at tin exploitation started in the State of Rio Grande do Sul. Later, its development spread through the Northeast, Minas Gerais, Goiás, Amapá and Rondônia.The discovery of extensive cassiterite deposits in Rondônia, which compete with the largest in the world, brought about substantial changes to the domestic scene in respect of tin.

Present reserves stretch out through an area of about 14 thousand square kilometers and account for over 90% of recent years production.

Tin producers in this country are the following important firms: Cia. Estanífera do Brasil (CESBRA), Cia Industrial Amazonense (CIA), Best-Metais e Soldas S.A., Cia Industrial Fluminense and Mamoré Mineração e Metalurgia S.A.

CESBRA, BEST AND CIF jointly founded CIA-Cia. Industrial Amazonense - in Manaus, for the purpose of processing reduction of the ore in Rondônia. Said firms were encouraged not only by the fiscal incentives of SUDAM (Amazonian Superintendence) as by the possibility of putting to good use the great advantages of being near the ore source. This will save the cost of transporting the cassiterite, which so far had been contributing to raise price of the metal.

CIA - Cia. Industrial Amazonense - has definite expansion plans, and intends to have its production capacity doubled by the end of 1974, reaching then 4,800 yearly tons.

There is at present idle tin production capacity in this country, owing to the fact that the domestic production of cassiterite is still small.

The supply of the ore by Brazilian producers began virtually since 1966, when our imports started dropping.

Up to 1970, cassiterite mining in Rondônia was made by "garimpagem", and such primitive mining, accounted for 80% of the production.

As such kind of exploitation has a definitely predatory character, the Minister of Mines and Energy, by Administrative Order n. 195, of April 15, 1970, prohibited it and limited the authority for exploiting mineral deposits in Rondônia to mining companies with mechanized equipment.

However, most firms did not get ready in due time for this new phase, so that production of cassiterite in Rondônia dropped since then.

The result was that plants installed here had to resort to the foreign market for cassiterite, and 1,423 tons of the ore were imported in 1971, at a cost of US$ 2,702,000.

The situation will probably be straightened out as from the current year, after the installation of the mechanized equipment.

Besides the empirical methods employed in mining up to 1971 and the distances from the mineral areas to the tin processing and metallurgical centers, the lack of understructure had been the strongest hindrance to large scale development of cassiterite mining in Rondônia.

The establishment of understructural conditions, especially in respect of electric power and roads, has been the object of constant attention on the part of the appropriate authorities.

In 1971, domestic consumption of tin was estimated at

2,000 tons, production was 3,043 t., imports 11 t and exports 1,054 t.

The home demand has preserved the same order of magnitudes, while the foreign market shows expansion and absorbed about 35% of Brazilian production of the metal in 1971.

Tin domestic demand has the following structure:

Steel industry	50%
Automobile industry	20%
Manufacture of cans and containers	15%
Miscellaneous (including electric and electronic, naval, railway and other industries)	15%

Fundamentally, the domestic consumption of tin is supported by the production of tinplate. Prospects regarding the increase of domestic consumption of the metal are excellent, in view of the expansion plan of Cia. Siderúrgica Nacional, which used in 1970, for the production of tinplate alone, about 1,520 tons of tin. By 1975, such consumption will probably reach 2,600 tons of tin, as C.S.N. is due to produce 400,000 tons of tinplate.

Based on the growth of the factors that account for most ot the country's tin consumption, viz., tinplate and the engineering and electrical industries, demand is estimated at the following values:

1972 - 4,500 tons
1973 - 5,000 tons
1974 - 5,500 tons

Brazil has the necessary conditions to become a great tin exporter. Ever since 1969, 420 tons of the metal had been exported, and in 1971 such exports reached 1,054 tons.

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At the same time, the foreign purchases of the metal have being reduced, though there was a slight increase of imports in 1971, owing to the above mentioned drop in the domestic production of cassiterite. The trend is that imports shall be reduced to nothing, bringing about a great economy of foreign currency, on the one hand; on the other hand, there are prospects of increased exports, which will bring important amounts of foreign currency into the country.

The international market offers excellent prospects for the tin produced here, in view of the fact that from 1975 on the production of Malaysia, a great producer, will probably undergo an average annual drop of 4.3%, and its production will drop to a level around 73,000 tons.

Another favourable factor for the placement of our tin in the international market is that Brazil is not a participant of the IV International Tin Agreement, which came into force on June 30 1971, thus being under no obligation in respect of exportation quotas or prices established by the agreement administration.

TIN STATISTICS

I - IMPORTS

YEAR	TONS	US $	US$ t
1961	25	65,873	2,634.92
1962	11	37,977	3,425.45
1963	8	29,156	3,644.50
1964	5	18,201	3,640.20
1965	2	9,196	4.598.00
1966	4	15,759	3,939.75
1967	8	35,888	4,486.00
1968	11	42,007	3,818,82
1969	8	33,252	4,156,50
1970	7	35,234	5,033.43
1971	11	50,490	4,590.00

Source: CACEX
CIEF

II - EXPORTS

YEAR	TONS	US$	US$/t
1968	5	17,373	3,474.60
1969	420	1,552,819	3,697.19
1970	1,068	4,052,643	3,794.61
1971	1,054	3,750,885	3,558.71

Source: CACEX

CASSITERITE

I - IMPORTS

YEAR	TONS	US$	US$/t
1961	2,178	3,588,993	1,647.84
1962	1,873	4,109,278	2,193.93
1963	2,990	6,810,112	2,277.63
1964	937	2,449,921	2,614.64
1965	1,203	3,913,327	3,252.97
1966	237	809,630	3,416.16
1967	1	613	613.00
1968	30	73,950	2,465.00
1969	390	585,466	1,501,19
1970	-	-	-
1971	1,423	2,701,796	1,898.66

Source: CACEX
CIEF

II - PRODUCTION

YEAR	TONS
1960	241
1961	711
1962	1,000
1963	1,603
1964	1,116
1965	2,833
1966	2,632
1967	2,675
1968	3,298
1969	3,713
1970	5,421
1971	3,453

Source: DNPM

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TIN

(contained in the produced and imported cassiterite)

YEAR	TONS
1960	1,506
1961	1,667
1962	1,690
1963	2,702
1964	1,252
1965	2,532
1966	1,867
1967	1,767
1968	2,194
1969	2,665
1970	3,578
1971	3,043

Source : DNPM

T I T A N I U M

1 - Fields of application

Titanium is a light metal, tenacious and resistant to corrosion. In certain cases it may be an excellent substitutive for steel , as happens in metallic structures requiring little weight as compared to resistance .

The use of metallic titanium has been increased in the last few years, in proportion to the development of the technology required for its obtention and consequent reduction of its production costs . Its application has been outstanding in ultrasonic aircraft, armaments, spatial rockets, submarines, nuclear reactors and many others .

The primary titanium ores are rutile and ilmenite, but others may be listed, by reason of their specific applications and growing economic importance .

a) - Rutile

Its utilization aims, as primary goals, to the obtention of titanium dioxide pigments by means of the hydrochloric process, the coating of welding rods and it is considered the most important raw material for the obtention of metallic titanium .

Half of the rutile world production is designed for the production of pigments, 25% are designed for the production of metal, 20% for welding, with the utilization of the remaining portion in alloys, ceramic, glass fibre, and so on .

b) - Ilmenite

Ilmenite is the primary raw material for the obtention of titanium dioxide designed for the production of white pigments, largely applied for industrial purposes, due to their high coating power and to the fact that they are unalterable . Nearly all the il menite produced is designed for the paint, varnish and lacker industries . A lesser percentage is used for the manufacture of paper, and the remaining portion is consumed by the rubber,ceramic, plastics, and other industries .

c) - Titanite

Source of titanium to be used as paint pigment .

d) - Anatase

Being a material with iron grade(40 to 45%) its utiliza tion may perhaps be made through a process used in Canada, by means of which, besides a concentrate and a slag with high grades of titanium, first rate pig iron is obtained .

e) - Others

Though only rutile and ilmenite are now being mined, there are also great quantities of other noteworthy ores, such as titanium-magnetite, perovskite, leucoxene and brookite, with possibilities of short-term economic exploitation . So, Brazil may become in future a big titanium producer .

2 - R e s e r v e s

Inaccurateness as to data on the domestic reserves of titanium ore are quite extensive .

Rutile deposits are little known, though one of them stands out in Ceará, with a proved reserve of 400,000 t, according to the I Brazilian Mineral Yearbook , of 1972 . In the same State, at Poti riverhead, in the municipality of Independência, rutile deposits were discovered, with an estimated reserve between 50 and 100 thousand tons .

In Goiás, rutile deposits are distributed throughout nearly all the Center and South municipalities of the State and in the region called Mato Grosso Goiano . Occurrences are also known in Xambioá, Campos Belos and a quite promising deposit in the place called Morro da Estrela, in the municipality of Porto Nacional.

The major occurence known in Goiás is located near the alkaline intrusions of Catalão, the reserves beeing estimated at 162,750,000 tons of ore, with a grade above 10% of $Ti\ O_2$.

In the surroudings of the same area, comprising the areas of Araxá, Patos, Uberaba and Catalão , it was found that there is a reserve of more than 1.5 billion tons of a material containing an average of 13% of $Ti\ O_2$ and a high grade of iron, 40 to 45%: anatase . However, the technology for its utilization has not been determined as yet .

It is noteworthy that there are very few large rutile bearing alluviums in Goiás, reserves consisting mainly in innumerous small deposits along valleys and riverbeds (Rio das Almas, Corumbá, Veríssimo, Paranaíba, Caipó, Vermelho, Santo Antonio, Meia Ponte, Araguaia and many others) .

The large known reserves of the Tapira region, in the State of Minas Gerais, may become an enormous titanium source .

The distribution of titanium minerals in Tapira is made in a area of approximately 3 x 3 kms . It is a residual lateritic formation, about a 100 meter thick .

GENERAL TABLE OF TiO_2 RESERVES IN TAPIRA DISTRICT

RESERVES IN TONS		
PROVED	PROBABLE AND POSSIB.	TOTAL
956,625,500(12.10%)	516,075,000(12.60%)	1,472,700,500(12.30%)
325,253,000(16.19%)	194,570,000(17.07%)	519,823,000(16.51%)
67,830,000(21.87%)	64,825,000(21.30%)	131,855,000(21.59%)

Note: Grades in brackets refer to weighted average values .

According to the National Commission of Nuclear Energy, ilmenite reserves of the deposits localized at the mouth of Paraíba do Sul river, in the State of Rio de Janeiro, up to Barra do Riacho, in the State of Espirito Santo, are on the order of .... 750,000 tons.

Layers of ilmenitic sands are known in the beaches and in the quaternary lowlands of the municipality of Paranaguá .

Ilmenite appears with a very fine grain and contains about 13% zirconite .

Ilmenite reserves in the State of Paraná, in the form of sands, along the coast, are on the order of 2 million tons .

In Alagoas, in the municipality of Piaçabuço, abundant titanium reserves were identified in the proximity of the São Francisco river mounth, and it was also found that the sand of said river contain large quantities of ilmenite and rutile .

Also deemend extensive are the deposits of Barra de Itabapoana, in Espírito Santo, and Cumuruxatiba, in Southern Bahia . However, up to the present, there is no news of figures thereon .

3 - Production, Foreign Trade and Apparent Domestic Consumption

Ilmenite and part of the rutile produced of Brazil are the result of monazite production, and may be considered as a by-product thereof .

The production of ilmenite concentrates, according to CNEN and MIBRA data, in the period 1966/1971 was the following :

YEAR	TONS
1966	13,519
1967	19,106
1968	17,881
1969	20,184
1970	21,144
1971	9,894

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The drop of production in 1971 occurred as a result of the operational stoppage of the Cumuruxatiba plant .

As to ilmenite and ferro-titanium, there were only imports in 1970 and 1971 :

YEAR	TONS
1970	10,109
1971	10,160

Export occurred only in 1961 and 1966 :

YEAR	TONS
1961	20
1966	10

Brazilian consumption of titanium pigments obtained out of ilmenite has been met by importation, which presented the following figures in the period from 1966 to 1971 :

YEAR	TONS
1966	9,920
1967	9,468
1968	15,307
1969	16,212
1970	18,307
1971	16,946

Domestic rutile production is unimportant, because its occurrence near the nuclear minerals makes miners uninterested in view of probable restrictions from CNEN regarding rutile associates . Most the production comes from "garimpos" , and no figures are available thereon .

To comply with the domestic rutile demand, in view of our low production, we have to make use of ore imports, on which figures are the following :

YEAR	TONS
1966	446.0
1967	1,211.5
1968	805.0
1969	1,104.8
1970	1,061.0
1971	1,364.3

Source : CACEX

Rutile consumption , around 1,000 annual tons, has the following percentual application, according to the different sections :

67% in ferrous alloys
2% in non-ferrous alloys
31% in other areas .

In Brazil, up to date, there is no industry for the manufacture of pigments from rutile .

4 - Prospects

Up to date, domestic requirements of titanium pigments obtained out of ilmenite have been met by imports . With the installation of TIBRÁS, Brazil will require approximately 53,000 tons of ilmenite, for an initial capacity of 22,000 tons of pigment in 1973 .

Considering the great demand of pigment and TIBRÁS being now the only producing plant in South América, an increase is anticipated in 1974, and 1975 to 30,000 and 44,000 tons of pigment, respectively, thus giving rise to a Brazilian ilmenite demand by TIBRÁS, as hereunder, according to its consumption anticipation:

YEAR	TONS
1973	53,000
1974	106,000
1975	106,000

At medium term, however, it is to be expected that we shall cease importing pigment, on account of the TIBRÁS anticipated production, but we shall go on importing ilmenite, its major raw material . But there are good reasons to believe that the large investments made by RIB (Rutilo e Ilmenita do Brasil) and the large number of prospections made by said company, our imports , both of ilmenite and rutile, will not continue at long term, since there are good prospects for our reserves .

T U N G S T E N

Tungsten is a metal with a vast field of application, primarily used in the manufacture of hard steels, and also in the electric and electronic industries (filaments, contacts, electrodes for welding, and so forth).

The extreme hardness of tungsten carbide points to its utilization in the coating of items resistant to a high degree of friction, such as bits used in the drilling of rocks.

In the last few years, the use of tungsten alloys has been increased in the propulsion structures of rockets and missiles.

The primary tungsten ore is scheelite. The main Brazilian deposits are located in the Northeast, and one of the best surveyed deposits is that of Brejuí, in the municipality of Currais Novos (Rio Grande do Norte) with a reserve of 2,969,200 t of ore with 21,981 t of tungsten content. There are about 224 occurences of tungsten minerals in Rio Grande do Norte, 109 in Paraíba and 4 in Ceará.

The reserves of tungsten ore of the Northeastern region amount to 9,208,665 t, with 44,362 t of recoverable W, mainly distributed through the States of Rio Grande do Norte and Paraíba.

Exploitation of wolframite, another tungsten ore, comparatively rare in proportion to the other minerals, is carried out in the State of Santa Catarina. According to surveys made by the company that exploits the ore in this region, it is estimated that the reserve is on the order of 20 to 25 thousand tons, in the concession area alone.

Brazilian production of tungsten concentrate, with a minimum grade of 70% WO_3, coming nearly all from Northeastern Region, showed the following results in the period 1967/1971:

YEARS	TONS
1967	630
1968	766
1969	876
1970	995
1971	1,480

Source: DNPM

At present, two problems affect the development of Brazilian production:

The first is related to scheelite in the Northeast, production of which is mostly designed for the foreign market. This makes it highly dependent on international quotations, which undergo wide fluctuation, according to political tensions, formation or liberation of the stock pile by the North American government, export quotas of the largest world producer, which is Communist China, overall expansion level of the United States and Western Europe economics, and so forth. So, the instability of sales and purchase prices of scheelite represents one of the main obstacles to the effort towards production increase of the mines, and makes it a quite risky business.

The second impediment is related to the difficulty prevailling in Brazil for the refining of tungsten in accordance with modern technology and to the lack of a well defined consumer market. The fact that much of the Brazilian industrial complex is made up of unquestionably obsolete equipaments and machinery makes it impossible to employ tools of a metal as hard as tungsten. A case in point is the existence of innumerable lathes that can only be operated with hard steel tools and not with tungsten carbide bits. On the other hand, the process of tungsten refining is highly complex and requires a "Know-how" that would have to be acquired abroad. The process is developped in 3 main stages: the production of ammonium paratungstate, followed by the production of tungsten oxide (powder) and finally that of tungsten carbide (hard metal). According to experts, it would be feasible to arrive at the powder production, but it would be very difficult to reach the stage of turning out a final product within the quality standards required by the foreign market. It is expected, however, that in the second half of this decade there shall already be adequate conditions for the undertaking.

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Z I N C

The great industrial development undergone by Brazil has contributed towards a constant expansion of zinc consumption and towards an outstanding position of zinc in the Brazilian industrialization process. The fact has brought about large expenses in foreing currency for the acquisition of the metal abroad, since domestic production is unsufficient to meet the demand.

In the period 1969/1971, 150,436 tons of zinc and its alloys were imported, giving rise to foreign currency expenditure amounting to US$ 48,798,000, namely 26% more than in the three previous years, 1966/1968, when the cost of buying 121,217 tons was US$ 38,633,000.

Brazilian demand of zinc has the following structure:

Galvanization	45%
Pigments and salts	20%
Zinc alloys	17%
Copper alloys	8%
Plates	3%
Other applications	7%

Such structure shows that the largest domestic zinc consumers are the industries producing zincified plates and galvanoplastics. Zinc is also largely used under the form of alloys, such as bronze and brass, in the manufacture of weapons, ammunition and anti-friction metals, and this makes it the object of high strategic interest.

While the world consumption of zinc grew at an average yearly rate of 3% in the period from 1931 to 1968, the average Brazilian rate of growth was 7.2% per annum.

At present, two companies produce metallic zinc in Brazil: Cia. Industrial e Mercantil Ingá and Cia. Mineira de Metais, with an available production capacity of 18,400 annual tons. In 1971, the joint production of these two companies reached 16,266 tons, of which a contribution of 4,266 from the former company and of 12,000 from the latter.

This production represented 24.3% of the current apparent domestic consumption, which is estimated at 67,000 tons. In the appraisal of domestic consumption the recovery of scrap zinc was not taken into account, due not only to the fact that it is small, but also to the unavailability of figures to appraise it.

The silicified nature of our zinc ore has made it so far difficult to obtain the metal.

The only deposit now under exploitation is that of Vazante, in Minas Gerais, where the main mineral ore exploited is calamine.

Besides the nature of the ore, understructural factors has been responsible for the laggin behid of the zinc home production. Upon construction of the hydroelectric power plant of Tres Marias, Minas Gerais, the Cia. Mineira de Metais, concessionaire of the Vazante deposit, undertook to install a metallurgic plant dimensioned for 20,000 tons, with the initial capacity of 10,000 t/year of electrolytic zinc, of 99.9% purity. This company starded operating in 1969, and produced in 1970, 7,500 tons of metals and in 1971, 12,000 tons. An expansion is also antecipated for 50,000 t/year, depending on market conditions.

The home product, expecially in view of the high cost of electric power, sulfur, fuel and other production factors necessary to the metallurgy of zinc, costs more than the imported metal.

It should be noted also that, besides having a small actual production capacity, the companies concerned operate at idle capacity.

Zinc enjoys now customs protection, but even so domestic producers find it difficult to place the metal in the domestic market, where consumers claim that our product does not meet consumption specifications.

Another influential factor is the fact that our plants are not prepared for large scale production that may give them access to the international market under competitive conditions.

It is expected that in proportion to the stimulation of Minas Gerais production and to the achievement of a better technology for the dressing of Brazilian ore, better conditions will prevail in this country for the economy of foreing currency, since larger portions of consumption will then be satisfied by domestic production.

ZINC STATISTICS

I - IMPORTS

YEAR	TONS	US$	US$/t
1961	32,877	8,986,481	273.34
1962	42,790	10,613,989	248.05
1963	39,353	10,029,491	254.86
1964	31,056	10,505,994	338.29
1965	32,017	12,809,070	400,07
1966	41,644	14,403,616	345.87
1967	36,452	11,344,294	311.21
1968	43,121	12,885,134	298.81
1969	55,724	16,990,471	304.90
1970	44,025	14,598,553	331.60
1971	50,687	17,208,516	339.51

Source: CACEX
CIEF

II - PRODUCTION

YEAR	TONS
1965	49
1966	1,344
1967	1,729
1968	3,507
1969	3,967
1970	12,500
1971	16,266

Source: DNPM