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MINERAL INVESTMENT ALTERNATIVES FOR BRAZIL - AN ECONOMIC ANALYSIS

by

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ABSTRACT

This thesis evaluates several aspects of the Brazilian mineral-extracting sector, and focuses on public investment policy alternatives in this sector's development.

The contribution of Brazil's mineral industry to the national economy represents less than 2 percent of GNP and only 0.3 percent of total employment, but the industry is more important in terms of exports; commodities of mineral origin accounted for 16 percent of the total export value in 1979.

Brazil's mineral production and export is highly concentrated on iron ore. This concentration will not tend to change in the short run, since iron ore continues to lead in investments. While Brazilian mineral exports are concentrated on primary goods, mineral imports are concentrated on manufactured products, since the country lacks mineral processing capabilities. With the current trend of investment, this dependence on foreign sources for manufactured products is expected to be alleviated in the next ten years.

Governmental investments play an important role in the sector. Unfortunately, the current government mineral policy has not given enough emphasis to geological and

technological research, nor to improvement in the technical competence of the work force.

The formulation of a mineral policy in order to develop the sector should consider both the macroeconomic objective, i.e., growth, and the microeconomic objective, i.e., efficiency. The accomplishment of these objectives requires some governmental implementation planning such as financial strategy, direct incentives, and the integrated action of the mineral sector within itself and with other sectors of the economy.

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Dedicated to Anezia,

my Mother.

CHAPTER 1

INTRODUCTION

Brazil's economy in real terms grew by 6.3 percent in 1978 and 6.5 percent in 1979, compared with the 4.7 percent rate in 1977. The Gross National Product (GNP) in current prices increased to U.S. $161 billion in 1977, U.S. $189 billion in 1978, and U.S. $209 billion in 1979. The rate of inflation in 1978 was 39 percent, the level of recent years, but increased to 54 percent in 1979. In 1980 the rate of inflation reached 110 percent (FGV, 1981).

The Government was developing policies to reduce the trade deficit that surged in 1979 by limiting imports and reducing inflation by restraining the spending by Brazil's many public companies. At year end 1980, it was not apparent how these policies would affect the priorities and investment programs in the mineral sector.

In January 1979 the National Monetary Council adopted resolutions to initiate a significant liberation of the Brazilian trade system. The principal decision was to phase out certain export subsidies and the 360-day 100 percent import deposit requirement. At the same time, the Government intended to accelerate the pace of exchange rate adjustments while continuing the crawling peg system.

However, in December 1979, a "maxi-devaluation" of 30 percent was announced, a deviation from the crawling peg exchange rate system for the first time in over ten years, giving a total devaluation in 1979 of 103 percent.

After achieving an overall trade balance in 1977, Brazil had a trade deficit in 1978 of U.S. $1.0 billion which increased to U.S. $2.7 billion in 1979. Although total exports increased in value from U.S. $11.9 billion in 1978 to U.S. $15.2 billion in 1979, imports grew faster, increasing from U.S. $12.9 billion in 1978 to U.S. $18.0 billion in 1979. Oil and other fuel imports increased in value by over 50 percent from U.S. $4.5 billion in 1978 to U.S. $6.9 billion in 1979. In spite of deficits in 1978 and 1979, the World Bank projects a trade surplus of almost U.S. $5 billion for Brazil by 1985 (USBM, 1981b). Manufactured goods are expected to become the leading export sector, growing from 24 percent of Brazil's total export in 1976 to 37 percent of exports in 1985. This growth in Brazil's output of manufacturers will place a strong demand on the country's mineral industries.

The primary purpose of this thesis is to present a pragmatic approach to public investment policy alternatives in the development of the Brazilian mineral extracting sector.

The study is divided into two parts. In the first part, the objective is to evaluate the present conditions of the mineral sector, pointing out its major aspects and identifying obstacles to its economic development. The second part presents a suggestion for mineral policy alternatives and recommendations.

The methodology employed in this thesis involves an analysis of the current mineral environment and discussion of related statistical indices.

Chapter One presents the purposes, scope, cited literature, and outline of the thesis. It also introduces the methodology used for analysis. Chapter Two discusses the market aspects, including mineral production, international trade, domestic consumption, and price evolution. Chapter Three develops a survey of the mineral investment climate. It gives a view of the human resources and on-the-job training programs supported by the Government. It also analyzes the competitiveness of the mining industry, social profitability, the major enterprises and the trends of investment during the period 1972-1979. Chapter Four covers the Government's role in mineral development, describing the fiscal and financial incentives, and the Government's goals. Chapter Five summarizes the thesis presentation and conclusions. Chapter Six presents some recommendations

for mineral policy alternatives. A reference bibliography follows.

Data sources used in the presentation and analysis were primarily supplied by the Departamento Nacional da Producao Mineral (DNPM), Empresas Nucleares Brasileiras (NUCLEBRAS), Cia. de Pesquisa de Recursos Minerais (CPRM), Conselho Nacional de Pesquisa (CNPq), and Fundacao Getulio Vargas (FGV). All the data presented are the most recent available. Petroleum and natural gas are excluded since these minerals have a distinct governmental orientation in Brazil.

Processed and manufactured minerals studied here include metals and alloys, steel products, cement, fertilizers, chemical products, and coke. Where necessary, values have been converted from Brazilian cruzeiros to U.S. dollars at the average rate of Cr$ 14.138/U.S. $1.00 in 1977, Cr$ 18.063/U.S. $1.00 in 1978 and Cr$ 26.870/U.S. $1.00 in 1979. For effective comparison, all the presented values are at 1979 prices. The values in Brazilian cruzeiros were readjusted by the average "ORTN" of the year, and converted to equivalent United States dollars at 1979 average rate exchange. "ORTN" is a "National Treasury Readjustable Obligation" by which the government offsets the adverse effects of inflation, through nominal readjustments.

CHAPTER 2

MARKET ASPECTS OF THE MINERAL SECTOR

This chapter describes the mineral market of Brazil with respect to production, international trade, price trends and indices, and the comparison of geological reserves and production to the value of apparent consumption.

2.1. Brazilian Mineral Production

The total value of Brazilian mineral production (MP), exclusive of oil and natural gas, contributed about 1.2 percent to the value of the Gross National Product (GNP) in the period 1977-1979 (Table 2.1). This small share does not reflect the importance of the mineral sector in the national economy, since it supplies essential inputs to the economic development of the country.

Tables 2.2 and 2.3 show the composition of the value of mineral production in the period 1977-1979.

Brazilian mineral production is very concentrated; about 80 percent of its value is due to production of only ten ores. The special position of iron ore production should be observed in that it accounts for about 30 percent of the total value of mineral production. Altogether,

TABLE 2.1

BRAZILIAN MINERAL PRODUCTION AND GROSS NATIONAL PRODUCT, 1977-1979.

Year	Mineral Production (MP) (a U.S. 10^6			Gross National Product (GNP) (b U.S. 10^6		$\frac{MP}{GNP} \times 100$
	current prices	1979 prices	% p.a.	current prices	1979 prices	
1977	2,036	1,980		161,388	156,993	1.3%
			13			
1978	2,386	2,247		188,716	177,746	1.3%
			16			
1979	2,597	2,597		209,133	209,133	1.2%

Sources: (a DNPM, 1978, 1979, 1980, Anuario Mineral Brasileiro

(b FGV, 1981, Conjuntura Economica, Fev. 1981, pp. II.

TABLE 2.2

RELATIVE COMPOSITION OF THE MINERAL GROUPS

(by value) 1977-1979

Group	1977 %	1978 %	1979 %
1. Nonmetallic	51.0	47.0	41.3
2. Metallic	42.9	43.6	45.9
2.1 ferrous	37.2	36.1	36.2
2.2 nonferrous	4.1	4.6	7.1
2.3 precious	1.5	2.8	2.5
2.4 nuclear	0.1	0.1	0.1
3. Energy (coal)	3.8	4.4	6.7
4. Fertilizers	1.1	2.2	4.3
5. Gems and diamonds	1.2	2.0	1.8

Source: DNPM, 1978, 1979, 1980, Anuario Mineral Brasileiro

TABLE 2.3

COMPOSITION OF THE VALUE OF MINERAL PRODUCTION

BY GOODS, 1977-1979

Ore	1977 %	1978 %	1979 %
1. Iron Ore	28.8	29.4	28.7
2. Crushed and ornamental stone	20.1	16.7	14.6
3. Limestone	13.2	15.1	9.4
4. Coal	3.8	4.4	6.7
5. Niobium	3.3	2.1	4.3
6. Phosphate Rock	1.1	2.1	4.3
7. Salt Rock	4.3	4.0	3.4
8. Tin	2.7	3.5	3.4
9. Sand	1.6	1.5	2.6
10. Gold	1.4	2.6	2.5
11. Others	19.7	18.6	20.1

Source: DNPM, 1978, 1979, 1980, Anuario Mineral Brasileiro.

about 40 percent of the value of mineral production is comprised of steel ores, mostly for foreign markets. Another 30 percent is materials for construction (crushed and ornamental stone, limestone, clay, sand, and asbestos), with a large domestic market.

The rank of Brazil's production in 1979 and its reserves of minerals relative to total world figures is presented in Table 2.4.

TABLE 2.4

BRAZIL'S MINERAL RANK IN A

WORLD CONTEXT (by tonnage), 1979

Minerals	Production	Reserves
Columbium	1st	1st
Beryllium	1st	Not available
Tantalum	2nd	5th
Iron Ore	3rd	2nd
Rare Earths	3rd	4th
Manganese	4th	5th
Gem Stones	5th	Not available
Feldspar	7th	4th
Tin	8th	7th
Tungsten	8th	12th
Magnesite	10th	6th
Bauxite	10th	6th
Rutile	No world production data	1st
Thorium	Not available	6th
Quartz Crystal	Not available	Very large reserve
Mica	Not available	Very large reserve

Source: USBM, 1981, Mineral Commodity Summaries.

2.2. International Trade

Table 2.5 shows the international transactions of the mineral sector, compared with all Brazilian international trade in the years 1978, 1979, and 1980. Table 2.6 shows the main mineral goods in Brazilian international trade in 1979.

The value of mineral product exports (primary and manufactured goods) constituted 11 percent, 14 percent, and 16 percent, respectively, of all Brazilian exports in 1977, 1978, and 1979; the mineral product imports accounted for 17 percent, 16 percent, and 14 percent, respectively, of all Brazilian imports in the same years (DNPM, 1978, 1979, 1980a). These data evidence the importance of the mineral sector in the Brazilian economy.

The import/export ratio has been decreasing; it was 1.49, 1.09, 1.04, respectively, in 1977, 1978, and 1979. This ratio means that for each U.S. dollar exported, Brazil had to import U.S. $1.49, U.S. $1.09, and U.S. $1.04 in mineral products in these years.

The composition of mineral goods traded internationally indicates that while the Brazilian exports are composed mostly of primary goods (ore), 74 percent in 1977, 65 percent in 1978, and 59 percent in 1979, the imports consist mostly of manufactured mineral products, 76 percent

TABLE 2.5

BALANCE OF MINERAL GOODS TO TOTAL

BRAZILIAN EXPORTS AND IMPORTS, 1977 - 1979

(based on 1979 FOB prices)

Year	Item	Mineral Goods[a] (in U.S. 10^6) Primary (a)	Manufactured (b)	Total (c)=(a)+(b)	All Products[b] (in U.S. 10^6) (d)	Mineral Participation (c/d) %
1977	Export (X)	982	353	1,335	11,756	11%
	Import (M)	-472	-1,517	-1,989	-11,662	17%
	Balance (X)-(M)	510	-1,164	- 654	94	-
1978	Export (X)	1,100	583	1,683	11,899	14%
	Import (M)	- 530	-1,309	-1,839	-12,862	14%
	Balance (X)-(M)	570	- 726	- 156	- 963	16%
1979	Export (X)	1,474	1,020	2,494	15,244	16%
	Import (M)	- 768	-1,829	-2,597	-17,961	14%
	Balance (X)-(M)	706	- 809	- 103	- 2,717	4%

Source: a - DNPM, 1978, 1979, 1980, Anuario Mineral Brasileiro.
b - FGV, 1981, Conjuntura Economica, Fev. 1981, pp. XXXVIII.

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TABLE 2.6

BRAZILIAN MINERAL SECTOR BALANCE OF EXPORTS AND IMPORTS IN 1979 (FOB)

Mineral Substances	Ore		Manufactured Minerals		Total	
	U.S.$1,000	%	U.S.$1,000	%	U.S.$1,000	%
FERROUS ORE	1,303,589	184.7	322,921	41.5	1,636,510	1,630.0
Cobalt	- 556	-.1	-17,269	-2.1	- 17,825	- 17.7
Chromium	1,148	.2	- 695	-	453	.5
Iron Ore	1,287,650	182.4	399,745	49.5	1,687,395	1,680.7
Manganese	51,681	7.3	- 499	-	51,182	- 7.7
Molybdenum	-56,557	8.0	- 4,081	- .6	-60,638	- 60.4
Niobium	14,721	2.1	- 167	-	14,554	12.1
Nickel	-	-	-32,781	-4.0	-32,781	28.4
Tungsten	5,502	.8	-4,767	- .6	735	.7
Vanadium	-	-	-6,565	- .8	- 6,565	-6.5
NONFERROUS ORE	- 79,214	-11.2	-476,548	-58.9	-555,762	-553.2
Aluminum	9,460	1.3	-152,868	-18.9	-143,408	-142.8
Antimony	- 1,403	- .2	- 2,562	- .3	- 3,965	- 3.9
Copper	100	.1	-353,770	-43.8	-353,670	-352.3
Lead	- 31,553	- 4.5	13,075	1.6	- 18,478	- 18.4
Mercury	-	-	- 1,419	- .2	- 1,419	- 1.4
Tin	- 54,788	- 7.8	69,752	8.6	14,964	14.9
Titanium	- 2,246	- .3	- 9,340	- 1.1	- 11,586	- 48.8
Zinc	1,216	.2	- 38,022	- 4.7	- 36,806	0.6
Others	-	-	- 1,394	- .1	- 1,394	- 1.1
PRECIOUS ORE	- 56,418	- 8.0	- 68,589	- 8.5	-125,007	-125.7
Gold	- 56,117	- 8.0	- 13,562	- 1.7	- 69,679	- 69.4
Platinum	- 301	-	- 3,944	- .5	- 4,245	- 4.2
Silver	-	-	- 51,083	- 6.3	- 51,083	- 50.9
NUCLEAR ORE	- 318	- .1	- 3,262	- .4	- 3,580	- 2.7
Beryllium	275	-	- 3	-	272	.2
Zirconium	- 722	- .1	- 2,229	- .3	- 2,951	- 2.9
Others	129	-	- 1,030	.1	- 901	-
INDUSTRIAL ORES	- 16,238	- 2.3	-100,122	-12.3	-116,360	-113.1
Asbestos	- 12,537	- 1.8	1,863	.2	- 10,674	- 10.6
Barite	1,628	.2	- 2,817	- .3	- 1,189	1.7
Crushed stone[a]	8,819	1.2	- 21	-	8,798	8.8
Graphite	1,384	.2	- 25,416	- 3.1	- 24,032	- 23.9
Gypsite	- 23	-	- 9	-	- 32	-
Fluorite	- 60	-	- 4,012	- .5	- 4,072	- 4.1
Kaolin	2,556	.4	-	-	2,556	2.5
Limestone	169	-	6,419	.8	6,588	6.6
Magnesium	18,543	2.6	- 28,827	- 3.6	- 10,284	- 10.2
Rock Salt	- 1,564	- .2	- 50,934	- 6.3	- 52,497	- 52.3
Sand Clay	- 277	-	- 5,942	- .7	- 6,219	- 6.2
Sulfur	- 38,279	- 5.4	- 252	-	- 38,531	- 38.4
Others	3,403	.5	9,826	- 1.2	13,229	13.1
GEMS AND DIAMONDS	31,686	4.5	- 629	- .1	31,057	30.9
Diamonds	- 7,214	- 1.0	- 3	-	- 7,217	- 7.2
Precious Stone	38,900	5.5	- 626	- .1	38,274	38.1
FERTILIZERS	-173,887	-24.6	-491,290	-60.7	-665,177	-662.4
Nitrogenous	-	-	-158,463	-19.6	-158,463	-157.8
Phosphate	- 24,520	- 3.5	-329,340	-40.7	-353,860	-352.4
Potash	-149,367	-21.1	- 3,487	- .4	-152,854	-152.2
FUELS	-303,433	-43.0	- 1,549	- .2	-304,982	-303.8
Coal, lignite, etc.	-303,433	-43.0	- 1,549	- .2	304,982	-303.8
OTHERS	44	-	-	-	44	-
TOTAL	705,813	100.0	-809,068	100.0	-103,255	100.0

a) This includes crushed and ornamental stones.

Source: DNPM, 1980, Anuario Mineral Brasileiro.

1977, 71 percent in 1978, and 70 percent in 1979 (Table 2.5). This fact reflects the lack of intensification of mineral processing within Brazil. It also reveals the disadvantageous situation of the country: the average value of imported chemical products is about six times the average value of exported mineral primary goods; the average value of imported metals and alloys is about 40 times the average value of exported mineral primary goods (CNPq, 1980).

Iron ore, in addition to its important participation in mineral production, about 30 percent, leads the mineral goods exports; it is among the three first products in all Brazilian exports (CACEX, 1980). About 80 percent of iron ore produced is sold in the foreign market. In 1979, these sales constituted 87 percent of the export value of primary mineral commodities; the exports of manufactured iron products constituted 81 percent of manufactured mineral exports. The value of iron ore exports and steel manufactured products (steel and chemical products) was 14 percent of the total value of Brazilian exports in 1979 (DNPM, 1980 a). Because of this heavy concentration, the commercial balance of the mineral sector oscillates in the same pattern as the world steel industry does. A crisis in this industry can adversely affect the entire Brazilian mineral structure. A World Bank study (USBM, 1981b) projects iron ore exports

from Brazil to increase to U.S. $5.7 billion in 1985, based on the assumption of a recovery in world steel production and a marked increase in iron ore prices.

Among the exports of primary mineral commodities in 1979, the most important in terms of value, in addition to iron ore, were: manganese 4.0 percent, precious stone 2.7 percent, magnesite 1.3 percent, niobium 1.0 percent, bauxite 0.8 percent, and crushed and ornamental stones 0.6 percent (DNPM, 1980a). With initial shipments in August 1979, Brazil became an exporter of bauxite for the first time in recent history.

In the last decade, Brazil has become an important world producer and exporter of ferroalloys. Exports of a variety of ferroalloys have increased sharply from about 21,000 tons in 1971 to about 172,000 tons in 1979. During 1979 the United States was considering the need to apply a countervailing duty against the imports of Brazilian pig iron (USBM, 1981b).

In 1979 the group of manufactured mineral products exports, other than steel products, included: tin 6.9 percent, aluminum 2.3 percent, lead 1.6 percent, copper 1.5 percent, tungsten 1.3 percent, and cement 1.2 percent.

The main importers of Brazil's minerals and mineral-related commodities in 1979 were: Japan, United States,

West Germany, Argentina, Italy, United Kingdom, Zaire, Colombia, Belgium-Luxembourg, and France (DNPM, 1980a).

Trade between Brazil and Mainland China reached an historic level of U.S. $52 million in 1979, compared with U.S. $9 million in 1976. This trend is expected to accelerate in future years and Brazil can then replace Cuba as China's main trading partner in Latin America. In November 1978, a first-ever ministerial-level trade mission from Brazil visited China. Under the five-year trade agreement signed, Brazil is to export iron ore, pig iron, and steel products in exchange for Chinese petroleum. Brazil agreed to supply China with 2.5 million tons of high grade iron ore during 1979 and 1980 (USBM, 1981b) and began negotiations for a long-term agreement covering the next 10 to 15 years. Brazil hopes to satisfy 15 percent of China's iron ore needs.

The country's main suppliers of mineral products were: United States, West Germany, Venezuela, Canada, and South Africa (DNPM, 1980a).

Imports of minerals in 1979 represented the following percentage of total mineral primary goods: coal 39.5 percent, potash 19.5 percent, molybdenum 7.4 percent, gold 7.3 percent, cassiterite 7.1 percent, sulfur 5 percent, lead 4.1 percent, phosphate rock 3.5 percent, and asbestos 1.6 percent (DNPM, 1980a).

Imports of mineral-related commodities in 1979 represented the following percentage of total manufactured mineral goods: ferroalloys and steel products 23.3 percent, metallic copper 20.2 percent, phosphate fertilizer 18.1 percent, aluminum 9.6 percent, nitrogenous fertilizers 8.7 percent, sodium salt 3.2 percent, and silver 3.0 percent (DNPM, 1980a).

2.3. Price Trends and Indices

The large fluctuations in the price of mineral goods bring a serious risk factor to the entrepreneur in this sector. This situation tends to become even more severe in a period of rising inflation that changes all relative prices constantly (as happens in Brazil).

Table 2.7 shows the price index evolution of various segments of the mineral sector, compared with the evolution of the General Price Index (inflation) and the ORTN evolution in the period 1969-1980. All the mineral price indices, except that for fertilizers, grow at a lower rate than the General Price Index, that is, at an average of 30 percent of the inflation rate.

The growth rate of the mineral price index, although it includes significant increases in the price of oil during this period, is still lower in relation to the inflation rate and to the ORTN rate; it is also lower than that of manufactured mineral goods. This occurs even though the weight utilized for the price of oil in the Price Index of the Mineral Extracting Industry is the highest one. From this, it can be concluded:

1) If the oil price is removed from the Price Index of the Mineral Extracting Industry, it can be expected that the

TABLE 2.7

GROWTH RATE OF PRICE INDICES, 1969 - 1979 (in %)

Growth Rate	Primary Products Mining Extractive[a]	Manufactured Minerals				General Price Index[a]	ORTN
		Limestone and silicates	Iron, Steel and derivative products	Non-ferrous metals	Ferti-lizers		
1969/79 total	831	1,153	1,001	877	1,046	1,277	905
average/yr	25	29	27	26	32	30	26
1969/70	7	16	21	16	7	20	19
1970/71	12	17	18	- 1	10	20	20
1971/72	15	18	14	11	31	17	20
1972/73	8	14	16	20	21	15	14
1973/74	20	28	39	38	133	29	21
1974/75	59	37	33	10	26	28	30
1975/76	33	38	25	73	5	41	30
1976/77	32	42	36	12	25	43	36
1977/78	24	37	32	17	30	39	32
1978/79	49	37	43	85	62	54	40

a - Both price indices, Mining Extractive and General Price Indices, include the price of oil and natural gas.

Source: FGV, 1978, 1981, "Indices Economicos," Conjuntura Economica, Set. 1978, Fev. 1981, pp. 149 and 261-265.

index will show a more irregular behavior, actually reflecting large fluctuations in the mineral commodity price and its low growth rate. For instance, in 1978-1979, the Price Index of the Mineral Extracting Industry grew at 49 percent p.a., while the price of imported oil alone grew at 88 percent p.a. In addition, the exchange devaluation rate variation of 49 percent p.a. increased this effect.

2) The intensification of mineral processing tends to lead toward price stability. According to economist Kalecki (1954), in the short run, the prices of raw materials show greater fluctuations than the price of finished products, since the variations in the price of raw materials are determined, mainly, by changes in the demand, while the variations in the latter are determined by changes in operating cost. In the case of raw materials, including mineral commodities, a relatively large period of time is needed in order to increase the supply. Thus, in the short term, an increase in demand leads

> to a decrease in stock and, consequently, to a price rise. The initial shift can be intensified by including a speculative element. These commodities are normally standardized and are subject to quotations from the commodities exchange. An increase in demand, again, leads to a price rise and is often followed by a secondary demand of a speculative character. This becomes a graver problem when the production balances the demand in the short run.

The vertically integrated large industrial firms are more capable of upholding their prices. Another point which should be noted is that of the transfer-price manipulations of the transnational companies. In Third World Countries, the development of mineral resources is carried out mostly by vertically integrated multinationals, with only the phase of mining done in the host country and the bulk of the processing, refining, and manufacturing based on the mineral commodities is carried out in the industrial countries. The strategy of profit maximization sometimes leads to such methods as biased transfer pricing (overvaluing imports and undervaluing exports). Thus, the foreign company reduces the profit it makes in the

host country and therefore its local income tax, as well as the tax on dividends sent to foreign owners. The sending of profit to the foreign owners is accomplished by the low price of the goods rather than money.

The Brazilian government controls the sending of profits outside the country by foreign enterprises, since it is concerned that in the long run the flow of money outside the country can be greater than the inbound flow; i.e., a net loss of financial resources to the country. Brazil uses a progressive tax system: the sending of dividends abroad, the amount up to 12 percent of the total foreign capital registered (including the internal investments) is taxed at a rate of 25 percent. If a larger share is sent abroad, there is an increase in the tax charged, up to a rate of 60 percent when the profit sent exceeds 25 percent of the total capital (Margueron, 1979). Thus, the current Brazilian legislation does not prohibit the sending of profit, but tries to make reinvestment in the country more attractive.

2.4. Value of Apparent Consumption

The value of apparent consumption in the mineral sector for the period 1977-1979 is shown in Table 2.8, assuming that there were no changes in stock by the end of the year.

The mineral production is important for export: the proportion sold to foreign trade was 50 percent in 1977, 55 percent in 1978, and 57 percent in 1979.

Unfortunately, there are no data regarding the value of manufactured mineral products in order to analyze their apparent consumption.

2.4.1. Balances: "Geological Reserves Versus Apparent Consumption" and "Production versus Apparent Consumption"

The balance of "Geological Reserves versus Apparent Consumption" developed by CPRM (left half of Table 2.9) shows the following:

(1) 31 abundant substances of which the following eleven have importance in the world reserve panorama: barium, chromium, niobium, quartz, aluminum, iron, titanium, fluorite, manganese, tantalum, and tungsten.

TABLE 2.8

VALUE OF APPARENT CONSUMPTION OF MINERAL COMMODITIES, in 1977 - 1979 (at current prices)

Items	1977 US 10^6	%	1978 US 10^6	%	1979 US 10^6	%
Production	1,980	135	2,247	134	2,597	137
Export	- 982	-67	-1,100	-66	-1,474	-78
Import	472	32	530	32	768	41
Total Consumption	1,470	100	1,677	100	1,891	100

Source: Tables 2.1 and 2.5.

TABLE 2.9

BALANCES: GEOLOGICAL VERSUS APPARENT CONSUMPTION AND PRODUCTION VERSUS APPARENT CONSUMPTION

Geological Reserves (1977) vs. Apparent Consumption (1986)			Mineral Substances	Production vs. Apparent Consumption (1979)		
Abundant >25 Yrs.	Sufficient 10-25 Yrs.	Scarce <10 Yrs.		Surplus	Sufficient	Deficit
X			Aluminum[a]		X	
	X		Antimony			X
	X		Arsenic			X
	X		Asbestos			X
X			Barium[a]			X
X			Bentonite			X
X			Beryllium[a]		X	
		X	Bismuth[a]			X
X			Bromine		X	
	X		Cadmium[a]			X
X			Chromium[a]	X		
		X	Cobalt[a]			X
		X	Coking Coal			X
	X		Corundum		X	
		X	Copper[a]			X
	X		Crushed and ornamental stones	X		
	X		Diamonds			X
	X		Diatomite			X
X			Dolomite			X
X			Fluorite			X
X			Gemstone	X		
	X		Graphite			X
		X	Gold[a]			X
	X		Gypsite		X	
		X	Iodine		X	
X			Iron ore[a]	X		
X			Kaolin		X	
	X		Kyanite		X	
		X	Lead[a]			X
X			Lignite		no consumption	
	X		Limestone		X	
X			Lithium			X
X			Magnesium[a]	X		
X			Manganese[a]	X		
		X	Mercury[a]			X
X			Mica			
		X	Molybdenum			X
X			Nickel[a]			X
X			Niobium[a]	X		
		X	Nitrates		no production	
X			Oil Shale		no production	
X			Phosphate			X
		X	Platinum			X
X			Potash			X
X			Quartz	X		
X			Rock Salt		X	
	X		Sand		X	
		X	Silver[a]			X
X			Sulfur			X
X			Talc		X	
X			Tantalum[a]		X	
X			Thorium			X
X			Tin[a]			X
X			Titanium[a]			X
X			Tungsten[a]	X		
	X		Uranium[a]		no production	
	X		Vanadium[a]			X
X			Vermiculite			X
	X		Zinc[a]			X
	X		Zirconium[a]			X
31	17	12	TOTAL	9	14	33

a - In terms of ore of these metals

Source: Left half: CPRM, 1978, Reservas Geologicas e Consumo Mineral.
Right half: Original data from DNPM, 1980, Anuario Mineral Brasileiro.

(2) 17 sufficient substances including asbestos, antimony, limestone, diamond, gypsite, zirconium, and zinc.

(3) 12 scarce substances: bismuth, metallurgical coal, cobalt, copper, iodine, gold, lead, mercury, molybdenum, nitrates, platinum, and silver.

This balance shows the geological reserves more in terms of mineral potential than in terms of identified reserves. For example, the reserves of beryllium, oil shale, and lithium are considered abundant in this balance, although geological studies have not been developed for quantifying reserves. On the other hand, although gold is classified as scarce, there are many gold deposits in Brazil which are not measured.

The comparision between the geological reserves and the consumption of mineral substances has been very useful in the process of deciding among the various investment alternatives in mineral exploration within Brazil.

In order to elaborate on the balance production versus internal demand the concept of internal consumption utilized here should be considered:

$$P - X + M = C$$

where P = production

X = exports

M = imports

C = apparent consumption

Thus,

surplus production: $P > C \Rightarrow X > M$

sufficient production: $P = C \Rightarrow X = M$

deficit production: $P < C \Rightarrow X < M$

Based on this concept, the balance of mineral commodities "Production versus Apparent Consumption" (Table 2.9) shows the following results:

(1) Only nine substances have surplus production; that is, the production exceeds consumption, generating surplus exports greater than the imports: chromium, crushed and ornamental stone, iron ore, gems, magnesium, manganese, niobium, quartz, and tungsten.

(2) Fourteen substances show sufficient production to meet domestic consumption: aluminum, beryllium, bromine, kaolin, kyanite, corundum, gypsite, iodine, limestone, mica, rock salt, talc, sand, and

tantalum. All these substances, except for bauxite, have as typical characteristics low unit values and ease of extraction.

(3) Thirty-three substances show deficit production in relation to domestic demand. In this class are the nonferrous ores, fertilizers, diamonds, and coking coal. These substances, because of their high unit value, have a significant share in mineral demand and Brazilian imports.

(4) Lignite is not internally demanded and shale oil has not been developed yet, although it is a potential reserve of oil. The nitrates in Brazil are supplied from the cracking of imported oil, and their production is sufficient to meet internal consumption. Uranium has not yet been mined.

While in the balance of the geological reserves versus consumption, forty-eight substances are considered abundant or sufficient, only tweny-three substances have surplus or sufficient production in relation to domestic consumption. The mineral substances that show abundant or sufficient reserves but deficit production are asbestos, antimony,

arsenic, barium, bentonite, cadmium, diamonds, diatomite, dolomite, tin, fluorite, phosphate, graphite, nickel, potash, titanium, vanadium, vermiculite, zinc, and zirconium.

The fact that some abundant or sufficient mineral substances in terms of reserves show deficient production is due to the lack of available local technology in order to process the domestic ores and/or to manufacture finished products from them. As examples, the technological difficulties in mining the potassium salts in Carmopolis, the supply of nickel from the siliceous ore in Goias, getting sulfur from the pyrites, and obtaining the sulfuric acid from the pyrites and gypsite can be cited. The operating firms face many problems in attempting either to adapt national raw materials to imported technological processes, or by the foreign mineral product, as happens with metallurgical coal, to be mixed with the domestic ore in order to fulfill the specifications requirement of the imported process. Besides the technological problems, such economic reasons as the following have prevented the adequate mining of reserves: lack of financial resources for investing in complex mine-plants, control of supply by oligopolistic firms, noncompetitive extracting costs, and high risks or lack of local infrastructure.

By amplifying the analysis of the balance of production versus consumption for all manufacturing of mineral products (metals, alloys, steel products, chemical products, cement, fertilizers, coke, etc.), one can get a broader picture of the mineral sector. Comparison between the data on production and consumption shows deficit production, that is, exports are lower than imports, as formerly defined, for almost all mineral goods. From this comparison, it is clear that the following mineral products are inadequately produced in Brazil:

(1) Ferrous goods - cobalt, chromium, manganese (the lack is in chemical products, not the alloys), molybdenum, nickel, tungsten, and vanadium.

(2) Nonferrous products - aluminum, antimony, arsenic, copper, mercury, and titanium.

(3) Precious minerals - gold, palladium, platinum, and silver.

(4) Nuclear materials - lithium and zirconium.

(5) Industrial minerals - corundum, fluorite (high purity products), industrial diamonds, and rock salt. Due to the difficulty of analyzing the various final products, the following industrial minerals have

not been included in this balance: asbestos, bentonite, bromine, kyanite, diatomite, dolomite, gypsite, graphite, iodine, mica, quartz, talc, and vermiculite.

(6) Fertilizers - phosphate, nitrogenous compounds, and potash.

(7) Energy sources - products from coal (coke).

Only iron (as metal and alloys), lead, niobium (as FeNb alloy), tin, asbestos, and limestone (cement) show a surplus in production. These data reveal the lack of mineral industrialization and technological development within the country. Brazil is not self-sufficient for almost every final product of mineral goods, even for those considered locally abundant: chromium, tungsten, aluminum, magnesium, beryllium, lithium, and fluorite. This situation is extremely disadvantageous to Brazil, because the country:

(1) must purchase in foreign currency,

(2) cannot achieve price stability of final goods, and

(3) cannot generate the value added which would occur if raw materials were processed into final products in Brazil.

Many factors lead to the low degree of industrialization

within Brazil, but the most important is the lack of financial resources for stimulating the industries involved, which generally require high investments due to sophisticated technology and/or high optimum operation scale. The metallurgic and cement industries can be cited as examples of capital-intensive mineral processing activities.

Another problem is the lack of adequate labor to carry on an intensive mineral processing activity in Brazil. Human resource availability is briefly discussed in the next chapter, as well as investments in physical capital.

CHAPTER 3

INVESTMENT CLIMATE IN THE MINERAL SECTOR

This chapter surveys the trends of investment in human resources and physical capital by the mineral sector, focusing on on-the-job training programs supported by the government and in investments in prospecting, exploration, mine development, technological research, and processing plants.

3.1. Human Resources

According to DNPM (1980a), the number of people involved directly in areas of mining (excluding MME, PETROBRAS and NUCLEBRAS personnel) amounted to 75,511 in 1979 (Table 3.1). The mineral commodities absorbing the greatest labor force were the mining and processing of iron ore (16 percent), coal (14 percent), limestone (9 percent), mineral water (7 percent), and crushed and ornamental stone (5 percent).

If the personnel of the direct administration and state enterprises of the Ministry of Mines and Energy (MME) are added, the labor force of the mineral sector (including exploration, mining, and processing) is about 130,000 people, corresponding to 0.3 percent of the

TABLE 3.1

PEOPLE UNDER CONTRACT IN THE BRAZILIAN MINERAL SECTOR - 1979[a]

Items	In Mines		In Plants		Total	
	People	%	People	%	People	%
Higher Education	1,363	2.4	363	2.0	1,726	2.3
Mining Engineers	418	0.7	103[b]	0.6	521	0.7
Geologists	314	0.6	35	0.2	349	0.5
Others	631	1.1	225	1.2	856	1.1
Others	56,085	97.6	17,700	98.0	73,785	97.7
Technical personnel	1,294	2.2	662	3.7	1,956	2.6
Blue collar workers	48,325	84.1	15,614	86.4	63,939	84.7
Support personnel	6,466	11.3	1,424	7.9	7,890	10.4
TOTAL	57,448	100.0	18,063	100.0	75,511	100.0

a - It excludes MME, PETROBRAS, and NUCLEBRAS personnel.

b - Metallurgical engineers.

Source: DNPM, 1980, Anuario Mineral Brasileiro

economically active population of Brazil.

In the modern theory of economic growth, the problem of production maximization, at any moment in time, can be considered in general terms as a question of allocation of aggregate resources between the factors of labor and physical capital.

The importance of adequate formation of skilled workers in the development of mining industrial projects cannot be overestimated. The emphasis on human resources, on technological sophistication, and on increasing the level of education and training in the mineral areas, permits speeding up the process of adoption of technological innovations, and carrying out the industrialization of mineral goods with greater productive efficiency. Unfortunately, the mineral sector has been feeling the lack of specialized courses of intermediate and higher education in Brazil's educational system.

There are about 4,000 geologists in Brazil, most of whom graduated only recently. For comparison, in the United States the number is 250,000 and in the U.S.S.R. it is 600,000 (Margueron, 1979).

There are now fifteen schools teaching geology in Brazil, graduating an average of 350 to 400 technicians per year (Margueron, 1979).

The Ministry of Mines and Energy (MME) manages through Cia. Auxiliar de Empresas Eletricas Brasileiras (CAEEB) the program of "Planning of Formation and Development of Higher Education" PLANFAP (Plano de Formacao de Aperfeicoamento de Pessoal de Nivel Superior) with the objective of training and promoting the development of competent personnel in mineral and energy areas. Since the beginning of implementation of this program (1970) to 1980, PLANFAP has organized 148 courses and seminars, in which 4,191 people participated: 977 employees of MME (CNP, DNAEE, DNPM), 1,659 employees of entities linked to MME (CAEEB, CPRM, CVRD, ELECTROBRAS, NUCLEBRAS, and PETROBRAS), 522 recipients of scholarships, and 1,033 employees of private enterprises.

CAEEB, in charge of the mineral coal policy is also responsible for the training of people specializing in coal.

The mining industry is constantly faced with new technical problems which represent health threats to its workers. Examples are health problems associated with deep mining, where extremely high temperatures and humidities are encountered; the use of laser beams; high speed mining machines; recovery of ore conglomerates from the sea floor. In order to attract employees to mineral

activities, the industry should provide working environments relatively free from accident and disaster hazards and the ravages of occupational diseases. It should also concern itself with the social problems of the miners' families, such as unavailability of adequate medical care.

3.2. Physical Capital

Every industry possesses some distinguishing economic characteristics that influence the decisions of the firms involved. The mining industry has some distinctive aspects that give rise to specific economic action. These aspects include, among others, the following:

(1) Large capital investment and long lead periods before the benefits from the investment can be realized. Mining is capital-intensive. The asset-per-employee ratio is high, and the sales-per-dollar invested ratio is low.

Capital investment decisions in the mining industry are important because large sums of capital are involved. In addition to substantial capital investment for the development of deposits, extensive development of the economic infrastructure (such as energy, water, transportation, habitation, etc.) is sometimes required due to the location aspects of potential reserves. Thus, mineral activity requires large-scale production in order to yield competitive costs.

(2) Exhaustion of its principal asset - the ore body - as a result of its operations.

(3) Uncertainty in the measure and valuation of the ore deposits. The mining firm cannot accurately determine, in advance and detail, the quantity and quality of the material in the ore deposit. Also, after a mine has been established, there may be an unexpected end to the profitable life of the property due to:

(a) Geological features that may cut off the ore body.

(b) Decline of the ore body.

(c) A sharp decline in the metal content of the ore.

Therefore, accurate measurement and valuation of an ore deposit is subject to a wide margin of error. The risk associated with this uncertainty has an effect on the exploitation and development of such properties.

(4) Uncertainty due to the economic and political factors; large price variability, and uncertainty with respect to operating cost and fiscal policy, etc.

(5) Recyclable nature of metals. The constantly increasing stock of secondary materials (scrap) serves as a reservoir

for industrial requirements and places a ceiling on the price to which a new metal can rise without meeting competition from these secondary sources. While metals vary a great deal in the extent to which they can be recycled, they all possess a type of permanency which is absent in the products of manufacturing and agriculture.

(6) High risk associated with the mining venture. Mining ventures are well known as risky investments. This reputation is well deserved due not only to the inherent technological risks encountered with mines, but to its capital-intensive nature and long lead time, as discussed under (1).

Hence, the variety of risks inherent in the mining industry requires high rates of return on total investment in order to compete with alternative investments and to attract private investors.

3.2.1. Competitiveness of the Mining Industry

The competitiveness of the Brazilian mining industry

can be analyzed using the average profitability ratios of the major enterprises in each sector of the Brazilian economy in 1977, 1978, and 1979. These ratios reveal how effectively the different sectors of the economy performed:

(1) Return on Net Worth: measures the rate of return on the stockholder's investment.

(2) Profit Margin on Sales: gives the profit per dollar of sales.

The individual ratios, which are shown in Table 3.2, give a reasonable idea of the performance of the mining industry in these three years. The ratios of Profit Margin on Sales are within the average range of the economy, about 12 percent, but those of Return on Net Worth show the lowest results among the sectors: 9 percent in 1977 and 1978 and 12 percent in 1979 (FGV, 1978, 1979, 1980). Comparing these ratios to those of the subsector "Trade" (39 percent in 1977, 29 percent in 1978 and 1979) which shows the best performance, it is evident how much the mining industry falls short (FGV, 1978, 1979, 1980). These poor results for mining are directly attributable to the excessive investment required and to the large variability in prices,

TABLE 3.2

PROFITABILITY RATIOS OF CORPORATIONS, 1977 - 1979

Activities	Percent						Number of Enterprises		
	Profit / Net Worth			Profit / Sales					
	1977	1978	1979	1977	1978	1979	1977	1978	1979
TOTAL	20	20	24	12	13	12	439	413	500
1. AGRICULTURE	9	16	62	9	21	38	7	6	5
2. INDUSTRY	21	19	25	13	12	12	331	313	340
2.1 Mining extractive	9	9	12	12	13	12	10	10	5
2.2 Manufacturing	27	23	25	10	9	8	248	226	281
Non-metallic ores	27	21	19	16	15	12	29	22	29
Metallurgy	20	15	19	10	9	9	47	42	36
Mechanics, electric material and communications	29	30	23	10	12	7	40	33	39
Transportation material	27	30	26	9	10	6	21	20	29
Chemical, pharmaceutical products, plastics, soaps, etc.	30	24	23	11	10	7	42	40	44
Textiles, clothes, shoes	29	20	35	14	10	14	18	15	27
Food, liquor, beverages and tobacco	31	25	34	8	6	8	33	31	52
Others	17	15	24	9	8	12	18	23	25
2.3 Construction	34	29	27	15	11	8	38	44	29
2.4 Industry services - public utilities	14	13	25	33	38	44	35	33	25
3. SERVICES	16	26	21	9	14	11	101	94	155
3.1 Financial activity/others	17	31	31	22	27	46	39	35	91
3.2 Trade	39	29	29	5	4	3	30	30	37
3.3 Transportation and communication	9	25	13	15	34	17	32	29	27

Source: FGV, 1978, 1979, 1980, "Principais Indicadores Empresariais," Conjuntura Economica, Set. 1978, Set. 1979, Set. 1980.

affecting the revenue flow.

It is hard to attract investors to an activity that, in addition to its adverse characteristics with respect to investment capital, lead time and risks, presents real price decreases and consequently very low rates of return on investment.

It should be noted that the indicators analyzed were based on the results of the major mining enterprises which were beneficiaries of economies of scale which lead to lower operating costs and greater profit margins. It is reasonable to assume that small- and medium-sized enterprises show profitability ratios lower than those of large enterprises.

From a macroeconomic point of view, the mineral sector provides high social profitability. Huge social benefits come from the discovery and mining of new reserves. A major part of the benefits of the discovery is external to the enterprise that developed the mineral activity or even to the mineral sector as a whole. The benefits attributed to these investments cannot be wholly captured by the profits of the mineral sector, even if it is a monopoly. Some of the benefits are transferred to the consumers as lower real prices and, hence, more quantity demanded. This, in time, will benefit

relatively more the enterprises with high demand for minerals that will benefit from decreases in their real costs, resulting in (a) increased profit and (b) long-run reduction in end-product prices to the consumer.

In addition to the effect of the increased mineral supply, there are the effects of increased demand for mining production factors. Since mineral projects require a large amount of goods and services, they lead to an increased demand which stimulates the growth of various other sectors.

Significant benefits are reduction of unemployment or subemployment and, most important for the case of Brazil, introduction of population and settlement into the previously unoccupied areas where minerals occur.

A mineral project sometimes promotes the socioeconomic development of the area, providing new infrastructure conditions that generate additional benefits. Local consumer markets are expanded, the quality of the job market is improved, and fiscal revenues are increased. The latter provides added capacity for supplying public goods.

From the facts presented, the great social benefits of mineral activity are evident, and mineral policy should be directed to eliminate the current disequilibrium between private and social profitability. Only in this

way can private investment in the mining sector be made attractive.

3.2.2 The Major Enterprises in the Mining Sector

The total number of enterprises in Brazil authorized to operate in the minerals area is 4,550 (CNPq, 1978). They have the size and principal activity distritution as indicated in Table 3.3.

Enterprises with capital stock under U.S. $520,000 (micro and small enterprise) account for 92 percent of the total number of enterprises and are essentially of two kinds:

(1) Domestic private sole proprietorships or family partnerships with small production or without production, but with concessions for exploration of one or more areas, and

(2) Subsidiaries of large corporations (mainly foreign owned) with their exclusive activity resulting from exploration concessions. These enterprises are increasingly interested in becoming involved in areas which have a high potential

TABLE 3.3

DISTRIBUTION OF THE MINING ENTERPRISES

ACCORDING TO THE SIZE AND ACTIVITY IN 1977

(at 1979 Prices)

Size (by capital stock)	Principal Activity	Number of Enterprises	Percent of Total
Micro Enterprise (under $26,000)	Exploration	3,500	78
Small Enterprise (from $26,000 to $520,000)	Exploration/ Mining	651	14
Medium Enterprise (from $520,000 to $1,565,000)	Mining and Processing	165	3
Large Enterprise (over $1,565,000)	Mining and Processing	234	5
TOTAL		4,550	100

Source: CNPq, 1978 - Listagem das Empresas de Mineracao.

for mineral ore, such as in Amazonia.

The creation of numerous small enterprises is due to the requirement of the Mining Code that each enterprise can apply for a maximum of five exploration concessions for each mineral substance. Some changes in this article (Article 26) of the Mining Code are being studied.

The medium enterprises in the mining sector (totalling 165) are characterized as private domestic enterprises which deal mainly in traditional products such as limestone-cement, crushed stone, clay, and coal (CNPq, 1978).

The large enterprises (comprising 234 firms) deal in mining and processing of metallic ores as well as limestone-cement (CNPq, 1978). These enterprises are vertically integrated.

The largest mining enterprises are shown in Table 3.4. Note the high value of the investments in the mining of metallic minerals, concentrated in iron ore (CVRD, SAMARCO, MBR, and SAMITRI). The dominant position of Cia. Vale do Rio Doce (CVRD), a corporation under the jurisdiction of the Ministry of Mines and Energy, is remarkable.

The vertically integrated enterprises, which operate from mining to end product (metal, cement, paper, etc.) are classified into the final products subsector instead.

TABLE 3.4

THE MAJOR MINING ENTERPRISES IN 1979

Enterprise	Net Worth U.S.$10^6
1. Cia. Vale do Rio Doce - CVRD	1,731
2. Samarco Mineracao S.A.	331
3. Mineracoes Brasileiras Reunidas - MBR	193
4. Amazonia Mineracao S.A.	173
5. SAMITRI S.A. Mineracao Trindade	135
6. Mineracao Rio Norte S.A.	121
7. ICOMI - Ind. Com. Minerios S.A.	109
8. Mineracao Morro Velho S.A.	109
9. Cia. Niquel Tocantins	86
10. VALEP - Min. Vale Paranaiba S.A.	81
11. Empr. Bras. de Mineracao S.A. - EMB	75
12. Serrana S.A. Mineracao	46

Source: FGV, 1980 - Conjuntura Economica - Set. 1980.

Among these, the main enterprises are:

(1) Iron ore - steel: Cia. Siderurgica Nacional, Cia. Belgo - Mineira, and Cia. Acos Especiais Itabira.

(2) Bauxite - aluminum: Aluminio do Brasil S.A. and Cia. Brasileira de Aluminio.

(3) Niobium and FeNb alloy: Cia. Brasileira Metalurgia e Mineracao.

(4) Zinc ore and zinc metal: Cia. Mineira de Metais.

(5) Phosphate - fertilizer: Ultra-fertil S.A.

(6) Chemical products - Industria Carboquimica Catarinense (coal and chemical products), Cia. Nacional de Alcalis (sodium carbonate), and Salgema Industrias Quimicas S.A. (salt).

(7) Limestone - cement: Cia. Cimento Portland Itau and Cia. Cimento Portland Rio Branco.

(8) Magnesite - (mining and industrialization): Magnesita S.A.

(9) Kaolin and paper products: Aracruz Celulose S.A.

The study made by CNPq (1980) analyzes the composition of the capital of the main mining enterprises in 1977. The results are shown in Table 3.5.

This study states:

(1) Enterprises with governmental capital are concentrated in ferrous metals (iron and manganese). Some new governmental projects are being developed in the area of fertilizers and copper.

(2) Enterprises with foreign capital deal mainly with nonferrous ores and nonmetallic ores (exclusive of coal) and also have meaningful participation in iron and manganese production. They control, often in oligopolistic situations, the production of various minerals. Foreign capital is concentrated in the production of lead (and its by-product, silver), nickel (100 percent), asbestos, gold, niobium, and chromite.

The government has examined measures to increase the participation of Brazil's private sector in mineral development. Toward this end, the Ministry of Mines and

TABLE 3.5

COMPOSITION OF CAPITAL SOURCES IN MINING ENTERPRISES DURING 1977

Source of Capital	Net Worth			
	Metallic Ores		Nonmetallic Ores	
	Ferrous	Nonferrous	Coal	Others
Private-domestic (%)	.5	40.8	61.8	21.2
Governmental (%)	78.5	1.2	38.2	5.0
Foreign (%)	21.0	58.0	-	73.8
Total	100.0	100.0	100.0	100.0
Size of sample	n/a	24	9	13

Source: CNPq, 1980, Setor Mineral e Politica Tecnologica, 1974-1978.

Energy reactivated, in April 1979, the Conselho Superior de Mineracao, which it had created in 1965. It was decided that no state company could request an exploration license (other than for petroleum or uranium, under monopoly control) without having first consulted private companies. It also decided to restrict the future operations of CVRD. In the Serra dos Carajas region, for example, CVRD would be required to limit itself to iron ore exploration, while private initiative would be applied in the exploration of copper, gold, lead, zinc, and manganese. As another example, the government was considering reducing CVRD's 60 percent ownership in the Valesul aluminum project to 40 percent. The Ministry of Mines and Energy also announced that fertilizers would be the next group in which state participation would be reduced.

Table 3.6 shows the main governmental enterprises in mineral planning, development, and exploration, together with the main private service enterprises in mineral exploration. The Cia. de Pesquisa de Recursos Minerais provides mineral exploration services for itself and also sells these services to others.

TABLE 3.6

THE MAIN ENTERPRISES IN MINERAL EXPLORATION

DURING 1978 (at 1979 Prices)

Enterprises	U.S. 10^6	Net Worth Percent
Governmental Enterprises (own exploration)	88	73.0
CPRM-Cia. de Pesq. de Rec. Minerais	51	42
Metais Minas Gerais-METAMIG	14	12
Metais Goias S.A. - METAGO	14	12
Petrobras Mineracao S.A. - PETROMIN	8	6
Rio Doce Geologia Min. S.A.-DOCEGEO	1	1
Private Enterprises (consultants)	33	27.0
UNIGEO - Geologia e Mineracao S.A.	12	10
Aerofoto Cruzeiro - S.A.	9	7
Terrafot S.A. - Ativ. Aerolevantamentos	8	7
Prospec. S.A. - Geologia Prosp. Aerofot.	3	2
Geofoto S.A.	1	1
TOTAL	121	100

Source: Visao, 1979 - Quem e Quem na Economia Brasileira, Ago. 1979

3.2.3. Governmental Investments in Prospecting and Exploration in Brazil

During the period 1974-1979, investments in prospecting and exploration by the Departamento Nacional da Producao Mineral (DNPM) through its programs RADAMBRASIL, Geology and Basic Mapping, Prospecting and Ore Evaluation, and Others (see Table 3.7), totaled U.S. $408 million (DNPM, 1978-1980a). Comparing these investments with the amount spent to cover the deficit in the commercial balance of the mineral sector in 1979 (U.S. $103 million as given in Table 2.6), one can conclude that the expenditure for mineral exploration through six years by the government amounted to only 4 times the deficit in the mineral commercial balance for just one year (DNPM, 1978-1980a). Such a comparison reveals the modest extent of the government's investment in exploration, in spite of the importance of the mineral sector in the national economy.

TABLE 3.7

GOVERNMENTAL INVESTMENTS (DNPM) IN PROSPECTING AND EXPLORATION, 1974-1979 (at 1979 Prices)

Year	U.S. 10^6
1974	57
1975	56
1976	86
1977	74
1978	84
1979	51
TOTAL	408

Source: DNPM, 1978-1980 , Anuario Mineral Brasileiro

3.2.4. Investments by Mineral Enterprises During 1972-1979

Table 3.8 shows that the mineral enterprises emphasized investment in plants and in mine development during the period 1972-1979.

Examination of Table 3.9 reveals that 41 percent of the total investments of mineral enterprises were devoted to iron (U.S. $820 million). This was broken down as follows: plants, 68 percent (U.S. $555 million); mine development, 27 percent (U.S. $224 million); exploration, 3 percent (U.S. $25 million); and technological research, 2 percent (U.S. $17 million) (DNPM, 1973-1980a). This composition of the resource allocation in the mineral sector is due to the fact that the big corporations are concentrated in the mining of iron ore.

Other minerals of interest during the period 1972-1979, from the point of view of investment, are phosphate, with over 11 percent of total investments; limestone, 8 percent; copper, 8 percent; coal, 4 percent; asbestos, 3 percent; tin, 2 percent; nickel, 2 percent; tungsten, 2 percent; gold, 2 percent; manganese, 2 percent; zinc, 2 percent; kaolin, 1 percent; and magnesite, 1 percent (DNPM, 1973-1980a). The investments in phosphate, zinc, nickel, kaolin, and magnesite were concentrated in plants and the investments in copper, limestone, coal, gold,

TABLE 3.8

INVESTMENT IN MINERAL ACTIVITY BY MINERAL ENTERPRISES, in 1972 - 1979 (at 1979 Prices)

Nature of Investment	U.S. 10^6	Percentage
Exploration	160	8%
Mine Development	808	40%
Technological Research	34	2%
Plants	999	50%
TOTAL	2,001	100%

Source: DNPM, 1973-1980 , Anuario Mineral Brasileiro.

TABLE 3.9

INVESTMENTS IN MINERAL SECTOR BY ENTERPRISE

FROM 1972 - 1979 (at 1979 prices)[a]

Items	Exploration		Mines		Technological Research		Plants		Total	
	U.S.10^3	%	U.S.10^3	%	U.S.10^3	%	U.S.10^3	%	U.S.10^3	%
FERROUS ORES	46,317	28.8	281,834	34.9	19,628	58.0	617,163	61.8	964,942	48.2
Chromium	1,075	0.6	8,053	1.0	358	1.1	3,335	0.3	12,821	0.6
Iron	24,651	15.4	223,710	27.7	16,677	49.2	554,612	55.5	819,650	41.0
Manganese	10,575	6.6	17,173	2.1	1,014	3.0	5,964	0.6	34,726	1.7
Niobium	1,112	0.7	3,438	0.4	363	1.1	10,959	1.1	15,872	0.8
Nickel	2,941	1.8	9,432	1.2	101	0.3	29,632	3.0	42,106	2.1
Tungsten	5,963	3.7	20,028	2.5	1,115	3.3	12,661	1.3	39,767	2.0
NONFERROUS ORES	48,447	30.2	162,402	20.0	4,711	13.8	58,885	5.9	274,445	13.7
Aluminum	4,062	2.5	15,486	1.9	2,380	7.0	7,031	0.7	28,959	1.4
Copper	23,854	14.9	103,304	12.8	153	0.5	24,724	2.5	152,035	7.6
Lead	2,383	1.5	4,977	0.6	4	0.0	2,667	0.3	10,031	0.5
Tin	12,876	8.0	27,782	3.4	26	0.1	1,881	0.2	42,565	2.2
Titanium	367	0.2	159	0.0	1,560	4.6	4,659	0.5	6,745	0.3
Zinc	4,905	3.1	10,693	1.3	589	1.7	17,923	1.8	34,110	1.7
PRECIOUS ORES	13,658	8.5	30,933	3.8	203	0.6	484	0.1	45,278	2.3
Gold	13,658	8.5	27,948	3.5	203	0.6	484	0.1	42,293	2.1
Silver	-	-	2,985	0.3	-	-	-	-	2,985	0.2
NUCLEAR ORES	551	0.3	207	-	157	0.5	1,048	0.1	1,963	0.1
Beryllium	341	0.2	22	0.0	-	-	-	-	363	0.0
Zirconium	41	0.0	25	0.0	-	-	-	-	66	0.0
Other	169	0.1	160	0.0	157	0.5	1,048	0.1	1,534	0.1
INDUSTRIAL ORES	24,335	15.3	217,247	26.9	3,549	10.4	112,214	11.2	357,345	17.9
Asbestos	816	0.5	43,786	5.4	-	-	23,029	2.3	67,631	3.4
Barite	294	0.2	671	0.1	183	0.5	547	0.1	1,695	0.1
Clay and Sand Clay	993	0.6	10,296	1.3	625	1.8	9,370	0.9	21,284	1.1
Crushed Stone	572	0.4	4,866	0.6	86	0.3	2,595	0.3	8,119	0.4
Fluorite	702	0.4	2,750	0.3	57	0.2	1,758	0.2	5,267	0.3
Gypsite	126	0.1	2,264	0.3	-	-	461	0.1	2,851	0.1
Kaolin	514	0.3	6,650	0.8	200	0.6	18,715	1.9	26,079	1.3
Limestone	12,622	7.9	112,243	13.9	1,767	5.2	36,245	3.6	162,877	8.1
Magnesite	2,701	1.7	7,855	1.0	183	0.5	9,935	1.0	20,674	1.0
Rock Salt	898	0.6	12,323	1.5	-	-	-	-	13,221	0.7
Other	4,097	2.6	13,543	1.7	448	1.3	9,559	1.0	27,647	1.4
GEMS AND DIAMONDS	3,425	2.1	9,804	1.2	4	0.0	3,216	0.3	16,449	0.8
Diamonds	1,720	1.1	7,141	0.9	4	0.0	253	0.0	9,118	0.5
Precious Stone	1,698	1.0	2,653	0.3	-	-	2,963	0.3	7,314	0.3
Other	7	0.0	10	0.0	-	-	-	-	17	0.0
FERTILIZERS	6,643	4.2	31,572	4.0	5,514	16.3	190,217	19.0	233,946	11.7
Phosphate	3,815	2.4	27,106	3.4	5,514	16.3	190,217	19.0	226,652	11.3
Potash	2,828	1.8	4,466	0.6	-	-	-	-	7,294	0.4
FUELS	4,338	2.6	58,604	7.3	131	0.3	8,781	0.9	71,854	3.6
Coal, lignite, etc.	4.338	2.6	58,604	7.3	131	0.3	8,781	0.9	71,854	3.6
OTHER	12,835	8.0	15,216	1.9	27	0.1	6,901	0.7	34,979	1.7
TOTAL	160,549	100.0	807,819	100.0	33,924	100.0	998,909	100.0	2,001,201	100.0

a - Figures exclude investment in uranium as well as in petroleum and natural gas.

Source: DNPM, 1973-1980, Anuario Mineral Brasileiro.

asbestos, and tin were concentrated in mine development. About 60 percent of all investments during the period were done by governmental mineral enterprises, mainly in iron ore, phosphate, and copper.

During 1979, the highest amount invested was in aluminum-bauxite (40 percent), followed by coal (11 percent), iron ore (8 percent), nickel (6 percent), limestone (5 percent), rock salt (5 percent), diamonds (3 percent), niobium (3 percent), magnesium (2 percent), asbestos (2 percent), gold (2 percent), and tin-cassiterite (2 percent). For the period 1980-1981, investment funds would be devoted to iron ore (17 percent), limestone (13 percent), tungsten (11 percent), copper (11 percent), asbestos (6 percent), cassiterite (4 percent), bauxite-aluminum (4 percent), phosphate (4 percent), coal (4 percent), and zinc (4 percent) (DNPM, 1980a).

The total foreign direct investments and reinvestments in the mineral sector during the period 1975-1979 (see Table 3.10) amounted to U.S. $1,459 million (DNPM, 1979, 1980a).

The type of investments in exploration, mine development, technological research, and processing plants are discussed below.

TABLE 3.10

FOREIGN DIRECT INVESTMENTS AND

REINVESTMENTS IN MINERAL INDUSTRY

(at 1979 prices)[a]

Year	U.S. 10^6
1975	209
1976	292
1977	307
1978	279
1979	372
TOTAL	1,459

a - Original value was inflated by the U.S. Consumer Price Index.

Source: DNPM, 1979, 1980 , Anuario Mineral Brasileiro

Exploration. Exploration is defined as the set of operations which aim to delineate ore body, that is, to determine the location, grade, extent, amount or quality of a mineral deposit. Exploration requires investments in: core drilling; assaying; engineering fees; geological fees; exploratory shafts; pits; drifts; etc. Such investments, totaling U.S. $160 million during 1972-1979, represented only 8 percent of the total invested in the mineral sector.

The major investments in exploration by mineral enterprises were concentrated in metals: iron (15 percent), copper (15 percent), gold (9 percent), tin (8 percent), manganese (7 percent), tungsten (4 percent), and zinc (3 percent). For nonmetals, notable investments were made in the exploration for limestone (8 percent), coal (3 percent), phosphate (2 percent), and gems and diamonds (2 percent) (DNPM, 1973-1980a). It should be observed that about 40 percent of these investments were developed by governmental enterprises; for example, the investments in iron ore, copper, gold, and phosphate.

The average investment in exploration made by mineral enterprises in the period 1972-1979 is about U.S. $20 million/year and the average governmental investment, in period 1974-1979, in this area corresponds

to U.S. $68 million/year, i.e., only 2.4 times greater than private investments (DNPM, 1973-1980a). Obviously, the kind of exploration performed by government is very different from that developed by mineral enterprises. While governmental investments are directed to general basic exploration, due to high financial outlays, risks, and to social interest, investments by the private sector are concentrated in applied specific exploration.

Mine Development. The investments in mine development by mineral enterprises are aimed at the improvement of the mining process, increase of production capacity, construction of required infrastructure, and new projects. Such investments, amounting to about U.S. $808 million during the 1972-1979 period, represented 40 percent of the total invested by enterprises. They were distributed as follows: iron (28 percent), limestone (14 percent), copper (13 percent), coal (7 percent), asbestos (5 percent), gold (4 percent), tin (3 percent), manganese (2 percent), zinc (1 percent), magnesite (1 percent), chromium (1 percent), and other (21 percent) (DNPM, 1973-1980a). Governmental enterprises were responsible for about 40 percent of these investments.

Technological Research in Ore Processing. These investments include all expenditures for research aimed

at improvement of the processing of mineral goods. As previously noted, such investment is not attractive to the enterprises; it amounted to U.S. $34 million during the period considered, representing only 2 percent of the total investment in the mineral sector (DNPM, 1973-1980a). This fact is basically due to the high financial outlays and risks involved. The governmental mineral policy has not adequately emphasized research on ore processing, in spite of its incontestable importance to sector development.

The investments for research in mineral technology done by enterprises in this period were concentrated in iron ore (49 percent), phosphate (16 percent), aluminum (7 percent), limestone (5 percent), titanium (5 percent), tungsten (3 percent), manganese (3 percent), clay and sand clay (2 percent), and zinc (2 percent). This reflects the emphasis given to development of steel plants, to the metallurgy of nonferrous ores, and to fertilizers. About 65 percent of these investments were made by governmental enterprises (DNPM, 1973-1980a).

Most of the technological research on iron ore refers to development of mines, especially the project of direct reduction using the domestic coal.

In the case of phosphate, for which domestic reserves,

although not of high grade, are considered abundant, the research done was directed at finding methods for ore concentration. Brazil has already reached a good technological level in the processing and concentration of phosphate rocks. There are some difficulties in the production of phosphoric acid and in the obtaining of fertilizers from domestic phosphate rocks. The ICC (Industria Carboquimica Catarinense) produces sulfuric acid and phosphoric acid from the pyritic wastes derived from coal processing. The phosphoric acid plant presently utilizes imported phosphate rocks, but ICC is studying the problems of using domestic phosphate rocks.

Brazil is in sixth place in the world in terms of reserves of bauxite (USBM, 1981a), but research made for this ore processing is insignificant. Such a fact can be understood by examining the technological structure utilized in the country. Three international groups (Alcan, Alcoa, and Pichiney) own the production technology used in aluminum plants in Brazil (Alcan, Alcominas, and C.B.A.).

The major research on titanium is related to anatase. Brazil, although in second place in the world in terms of reserves of titanium (USBM, 1981a), does not utilize them since most are in the form of anatase. The main technology used worldwide is for the development of rutile

and ilmenite.

The research on manganese was quite successful, concentrating on development of reserves of Urucum in the State of Mato Grosso, which have a high grade of alkaline.

The research done on zinc seeks a process that allows the development of sulphate and oxidized ore of the reserves in the State of Minas Gerais.

The research done on coal, the second most common mineral good imported by Brazil (excluding petroleum), examines the processing of domestic coal, in the sense of reducing the grade of ash and sulfur. It is aimed at utilization of domestic coal in the process of direct reduction of iron ore. The domestic steel plants presently use only 20 percent of domestic coal and 80 percent imported coal.

The research on copper (the mineral good most commonly imported by the country, excluding petroleum), explores the concentration of sulfate ore in Bahia and the processing of the oxidized ore in Rio Grande do Sul State.

The research done on nickel is aimed at development of the silicate ores in the States of Goias and Minas Gerais.

The project on production of sulfuric acid from pyritic wastes derived from coal processing in the State of Santa Catarina and the project for obtaining sulfur from bituminous schists, by-product of oil production, continue. Little research has been performed on tin, lead, molybdenum, and magnesium.

The Brazilian Niobium Institute (Instituto Brasileiro de Niobio) was established in 1979 in Sao Paulo State. Supported by the government, the Institute develops technology that expands use of columbium from Brazil's extensive deposits.

Processing Plants. These investments include funds spent for improving the productive process, obtaining greater efficiency, increasing the productive capability and design and construction of new projects. During the period under consideration the investment in processing plants, U.S. $999 million, represented 50 percent of the total investment made by mineral enterprises, reflecting a strong preference for this type of investment (DNPM, 1973-1980a). Resources were devoted to processing plants for iron ore (56 percent), phosphate (19 percent), limestone (4 percent), nickel (3 percent), copper (3 percent), asbestos (2 percent), kaolin (2 percent), zinc (2 percent), tungsten (1 percent), niobium (1 percent), magnesite (1 percent), coal (1 percent), and others (5 percent). In this kind of investment, state

capital is predominant, with more than 70 percent involving state enterprises.

3.2.5. Main Current Investments

This subsection describes the recent major targets of mineral investments in Brazil.

Aluminum-Bauxite. The major recent event was the start-up in June 1979 of the Trombetas Bauxite project in the Amazon Basin in the State of Para by Mineracao Rio do Norte S/A (MRN), a consortium of domestic and foreign companies led by CVRD. Construction of the project began in April 1976. Under plans for the Trombetas project, full capacity is expected to be reached in 1982 at 3.35 million tons of bauxite (USBM, 1981b).

Engineering studies and cost estimates were completed on the Paragominas bauxite project of Mineracao Vera Cruz S/A, a joint venture of the Rio Tinto Zinc Corporation and CVRD, which acquired a 36 percent interest in 1977. The project, located near the town of Paragominas in the State of Para, is designed to produce 4 million tons per year of dry beneficiated bauxite (USBM, 1981b).

According to studies by Brazil's Ministry of Mines and Energy, consumption of aluminum is expected to increase. Total demand for aluminum is expected to reach 1.1 million tons in 1989, while domestic primary supply

would increase to almost 940,000 tons (MME, 1981). Planned expansion of current plants and new projects such as those of Valesul and Albras would not be sufficient to eliminate Brazil's dependency on imports of aluminum ingot in the foreseeable future.

Valesul Aluminio S/A (Valesul), under the control of CVRD, was to start up its new 87,000-ton-per-year aluminum plant in Santa Cruz, State of Rio de Janeiro, at the revised date of 1981. Aluminio Brasileiro S/A (ALBRAS) will start operations in 1983, reaching 320,000 tons of aluminum by 1987 (USBM, 1981b).

Columbium. Companhia Brasileira de Metalurgia e Mineracao (CBMM) embarked on a major expansion program at its Araxa complex in Minas Gerais State. Metallurgical facilities for converting increased concentrate output to ferrocolumbium will expand accordingly (USBM, 1981b).

Copper. Brazil's dependency on foreign sources was expected to be alleviated by the mine, smelter, and refinery project of Caraiba Metais S/A, scheduled to begin in late 1981, the Camaqua mine, and the refinery project of Eluma S/A, scheduled for 1982. It is projected that capacity to produce primary and secondary copper would increase up to 465,000 tons by 1987, at which time Brazil's foreign dependency would be reduced to 26 percent (USBM, 1981b).

Rio Doce Geologia e Mineracao S/A (DOCEGEO), the geological exploration unit of CVRD, reported the discovery of an important copper deposit near CVRD's large unexploited iron ore deposit at Carajas in the State of Para. Information available as of the end of 1979 indicated the existence of ore bodies containing more than one billion tons of ore with an approximate average content of 1.0 percent copper and 0.4 percent grams of associated gold per ton (ABC, 1980).

Iron Ore and Steel. In 1979 Brazil's total installed capacity for producing beneficiated iron ore amounted to 136 million tons, or 70 percent of Latin America's capacity. This capacity may increase to 200 million tons per year by 1985 (USBM, 1981b).

The steel industry of Brazil continued its leading position in Latin America, accounting for 50 percent of the region's steel output. With the expanded projects engaged, the production capacity of crude steel is expected to increase from 14 million tons to 17 million tons by mid-1980 (USBM, 1981b).

Manganese. Construction of a new iron and manganese mine by Mineracao Corumbaense Reunida Ltda. was scheduled for completion in 1980 at Corumba, Mato Grosso, near the Bolivian border. Annual output was expected to be 3

million tons of iron ore with an iron content of 50 to 68 percent and 500,000 tons of manganese ore with a metal content averaging 46 percent (USBM, 1981b).

Seven countries, Brazil, India, Gabon, Ghana, Upper Volta, Morocco, and Zaire, meeting recently in Libreville, Gabon, declared their interest in an international agreement on manganese to guarantee fair prices and to stabilize the market (USBM, 1981b).

Nickel. The project of Empresa de Desenvolvimento de Recursos Minerals "CODEMIN" S/A, in the State of Goias, is scheduled for full production in 1982, with 5,000 tons per year of nickel in the form of ferronickel (USBM, 1981b).

Early in 1979, Companhia Niquel Tocantins (CNT), a subsidiary of the Brazilian-owned Votorantim group, initiated operation of its new electrolytic plant at Sao Miguel Paulista in the State of Sao Paulo. Initial capacity of 5,000 tons per year of high-purity nickel is expected to increase to 10,000 tons per year in 1981. CNT also initiated a plant to produce basic nickel carbonate at Niquellandia, Goias, with a capacity of 20,000 tons per year in 1981 (USBM, 1981b).

Tin. The government is attempting to make Brazil a factor in the world tin market. Through CVRD, it

plans to pool the activities of small privately owned tin mining units operating in Roraima, Para, and Goias, and to centralize research and development costs, planning, and marketing. The Minister of Mines and Energy authorized a study of the ramifications of a reopening of the Rondonia tin district, the main producing area with the only significant mechanized operations, to "garimpeiros" (individual prospectors).

Titanium. Mineracao Vale do Paranaiba S/A (VALEP), a phosphate-producing subsidiary of CVRD, is developing the Tapira deposits, which consist of anatase in association with phosphate, columbium, and rare-earth minerals. VALEP considers construction of a plant to produce 60,000 tons per year of titanium dioxide pigment. Titanio do Brasil S/A (TIBRAS), Brazil's only titanium pigment producer, announced plans to double production at its Bahia plant to 50,000 tons per year of pigment by 1982, which would meet Brazil's domestic demand, estimated at 50,000 tons per year (USBM, 1981b).

Nonmetals. In its report covering 1978, DNPM reported substantial increases in the reserves of several nonmetallic ores: Kyanite (270 percent), agalmatolite (148 percent), lithium (amblygonite) (133 percent), barite (114 percent), feldspar (55 percent), diatomite

(50 percent), calcite (45 percent), talc (35 percent), and graphite (35 percent) (DNPM, 1979).

Cement. Brazilian cement plant programs remain active. Lone Star Industries Inc. and La Farge S.A., leading cement industries in the United States and France, respectively, entered into an agreement to combine their cement operations in Brazil and to construct a 700,000-ton-per-year plant at Cantagalo, northeast of Rio de Janeiro (USBM, 1981b).

Fertilizer Materials. In 1979, seven companies had a combined installed capacity of 790,000 tons per year of P_2O_5. Domestic demand is projected to grow to 1.8 million tons of P_2O_5 in 1983, while domestic supply will expand to 1.5 million tons (DNPM, 1980b).

Petrobras Mineracao S/A (PETROMIN) is moving forward on schedule to develop the potash deposits at Carmopolis in Sergipe State. The project is designed to produce 500,000 tons of potassium chloride with start up in 1982. Brazil imports 100 percent of its demand for this mineral (DNPM, 1980b).

Coal. Plans are being made to quintuple coal production by 1985 under a National Coal Promotion plan given second priority below alcohol (USBM, 1981b).

Oil Shale. In 1979 PETROBRAS received presidential authorization to construct the first stage of a commercial oil shale plant at Sao Mateus do Sul, Parana State. Start up is expected by 1984. Initially it will produce 22,800 barrels per day of fuel oil and 450 tons per day of sulfur. In the second phase, 112,000 tons per day of oil shale will be processed to extract 51,000 barrels per day of crude synthetic oil (USBM, 1981b).

CHAPTER 4

GOVERNMENT'S ROLE IN MINERAL DEVELOPMENT

4.1. Taxation Policies

In Brazil the yearly income tax is calculated as 30 percent of taxable income for any kind of enterprise.

There are some tax treatments of mineral project costs and incomes that differ in several aspects from the treatment of general nonmineral investment costs and incomes.

Mining activity has only one tax, called the Sole Tax on Minerals (I.U.M.) and the percentage used varies according to the ore mined. Besides the operational and financial costs, the following can also be treated as expenses (Franca, 1977): depreciation of assets, amortization of specified expenditures, and depletion of mineral resources.

Depreciation. Depreciable capital items for income tax purposes include: head frame, hoist, mining equipment and machinery, improvements and buildings, etc. The depreciation rate, expressed in percentage, corresponds to dividing the value by the number of years of an asset's useful life. If the probable period of mine extraction is less than the period of the asset's useful life, the annual depreciation can be calculated based on the volume of annual production

in relation to the total volume of reserve.

Amortization. There are two groups of capital expenditures that can be amortized, according to the law: (a) The cost of the acquisition of rights (such as mineral rights), the existence of which is limited, or the cost of assets the utilization of which has a limited legal period. These costs are amortized during the existence of rights acquisition. (b) The costs of pre-operational organization, of scientific or technological research (if it were opted by their capitalization); the costs of mine development and expansion of industrial activities; the operational costs and charges computed as an asset during the initial phase of the enterprise's operation. These costs should be amortized over a period of more than five years.

Hence, by Brazilian legislation the mineral right acquisition is recovered annually through amortization.

Depletion. This is a kind of fiscal incentive: the mining enterprise can deduct a cost which is 20 percent of gross income (percentage depletion) during the first ten years of mining each reserve. The value of ore mined considered as gross income is the same value considered for application of the Sole Tax on Minerals.

The government intends to create a specific allowable percentage of gross income as a deduction. Based upon

the priority of ore and minerals being mined, this specified percentage will be raised and the mineral rights tax deduction will hold for a longer period.

4.2. Incentives

The most efficient mechanism to develop a sector is through attractive profitability rates. In order to surpass the obstacles for getting resources due to adverse characteristics of the mineral sector (cited in subsection 3.2), the minimum rate of return in the mineral sector should be greater than in the other sectors. Only in this way does the mineral sector have the ability to compete with alternative investments. Unfortunately, in Brazil, without attractive profitability rates, mineral activity has not prospered, and, given the high social benefit of the mineral industry, the government should balance the current disequilibrium among the sectors through stable incentives.

4.2.1. Fiscal Incentives

The Grupo Executivo da Industria de Mineracao (GEIMI) was created in 1968 for the purpose of analyzing and conceding fiscal incentives to mineral enterprises. These incentives are (DNPM, 1980a):

- Reduction of the Tax on Imports for equipment, not manufactured in Brazil;
- Reduction of the Tax on Industrialized Products (I.P.I.) for mineral activities, subject to the

Sole Tax on Minerals (I.U.M.)

Besides these incentives conceded by GEIMI and the one of percentage depletion (Subsection 4.1 above), there are other fiscal incentives (DNPM, 1980c) such as:

- Reduction of Sole Tax on Minerals (IUM) for ore exported;
- Increase in valuation of the mineral rights included in the assets of the mining enterprises based on domestic inflation. (This value includes the money expended in obtaining and exploring the rights.)
- Exemption of total or partial income tax in projects located in areas subjected to a special program of development.

Other kinds of stimulants are being studied by the Ministry of Mines and Energy to widen the incentives (DNPM, 1980c); these include:

- Exemption of income tax during determined periods, based on the priority of the project;
- Exemption of all taxes during a limited period for production of ore which can be substituted for imported material or increased exports; and,
- Total exemption of Tax on Imports for equipment not manufactured in Brazil used in mine ores, in the category directly above.

Although these incentives being studied are reasonable, some of them exclusively benefit the large corporations of the mineral sector. As mentioned in subsection 3.2.2, these enterprises constitute only 5 percent of the total enterprises of the sector. The fiscal incentives, in order to reach the objective of sector development should be wider, benefit especially the small- and medium-sized enterprises, and encourage their growth.

4.2.2. Financial Incentives

The program of financial assistance to mineral exploration instituted by the federal government in 1970 has been managed by Cia. de Pesquisa de Recursos Minerais (CPRM).

This program has two kinds of financing (CPRM, 1979):

(1) With risk clause: if after the mineral exploration the project fails, there is no obligation to repay the loan.

(2) Without risk clause: even if the results of mineral exploration are negative, the lender has to repay the loan.

The financing conditions are (CPRM, 1979):

- The real interest rate varies from between 3 and 8 percent p.a., according to the priority of the ore.

- A nominal revaluation is made each quarter according to the variation of the ORTN to offset the inflation effects.
- In the case of financing with the risk clause, the total loan should be multiplied by a risk coefficient that varies between 0.01 and 2.10, and this amount should be added to the original debt.
- Maximum total period of amortization is 20 years.
- The time for beginning the payments of principal plus interest is the end of the fourth year.

During the eleven years of the existence of this program, the entrepreneurs have not felt very attracted by these incentives offered by the government. Some factors can be cited as obstacles to the development of this program: bureaucratic procedures, the short time for beginning to repay the loan, and high financial costs. The nominal revaluation through ORTN, besides introducing an uncertainty variable relative to the future, increases the financial costs very much. According to subsection 2.3, the rate of growth of the ORTN has been greater than the rate of growth of the Mineral Price Index.

Comparing the financing conditions of agriculture and of

the mineral sector, the disadvantageous position of the latter can be seen. The nominal readjustments of agricultural financing are predetermined and fixed, or sometimes are a fixed percentage of the ORTN growth rate.

Any incentive policy for the mineral resources sector will be successful if it brings the sector into harmony with the other sectors. The Brazilian mineral sector experiences low profitability ratios (12 percent p.a. in 1979) and, on the other hand, high financing costs; in 1979 the variation in ORTN alone was 40 percent; in 1980, it was 54 percent.

Some studies for changing the mineral financing conditions are now being carried out in order to bring its costs in line with those conceded to the agricultural sector, (MME, 1981). These changes are:

- Increase the time for beginning the payment of principal plus interest;
- Increase the total period of amortization;
- Create "ore money", that is, the debtor has the alternative to repay the loan in ore instead of money, with its value predetermined at the time of the financing contract; and,
- Consider the governmental branches giving

guaranty to mineral financing according to the value of the reserves.

With the establishment of ore money, some points should be observed. CPRM, the lender organ, in receiving the payment of a loan in the form of physical units, will be absorbing the risk of price variations during the period of amortization. It will be very difficult to predetermine a fair ore price over a period of 20-25 years, considering the constant price fluctuations of mineral products, one of the characteristics of the sector. Another risk to be absorbed by CPRM is that of commercialization of products received.

From the point of view of the marketing of mineral goods, CPRM will begin to operate not only as an enterprise that will demand the mineral goods, through the receiving of amortization, but also as a supplier enterprise where it sells its stocks. Naturally, CPRM will make conditions for the establishment of a policy of "buffer stock" of ores, and thus become capable of influencing the market prices.

From the point of mining enterprises, the hypothesis of paying amortization in physical units will bring some advantages on one hand, and some disadvantages on the other:

- The great advantage will be that the enterprise will have a captive market for a part of its production, and in this way will pay its loan, besides that of reducing its commercialization costs. These advantages will increase in periods when price decreases below the price predetermined by the contract.
- The great disadvantage for the mining enterprise will be the competition of CPRM in selling the ore and the possibility of CPRM influencing the ore price.

4.2.3. Other Incentives

When projects are in the national interest, reductions of tariffs and service charges for public utilities can be conceded.

The reduction of electric power tariffs conceded to the aluminum industry had as an objective the stimulation of the regional consumption of electric power in the north of Brazil, to help the development of an industry (that is, the electric power consumer) and to promote the regional development.

There are some regional programs directed by

ministries other than the Ministry of Mines and Energy which benefit directly various mineral projects, such as the "Programa de Apoio a Industrializacao do Nordeste" (Program to Support Northeast Industrialization). This program promotes several priority projects (Langoni, 1975) as follows: a steel plant in Itaqui, State of Maranhao, development of the iron ore reserves of Serra dos Carajas, State of Para, and copper mining and processing in the State of Bahia.

The success in the development of these projects, besides their contribution to the spatial decentralization of the industrialization in the Northeast Region (until now restricted to Recife (PE) and Salvador (BA)), generates positive externalities in terms of development of infrastructure (transportation, energy, and communications), adequate supply of outputs and enlarged consumption market.

4.3. Goals of the Mineral Sector

A mineral policy for the decade of the 1980's should be integrated into macroeconomic planning, considering the interdependence among the sectors.

The Third National Plan of Development, III PND (MC,D.O., 1980) presents a broad view of the economic development, for the period 1980-1985, setting objectives to reach and looking to provide consistency between the supply and demand of goods in all sectors. Thus, the III PND gives a criterion for minerals goods to be produced internally, through the structural impact that the goals of production will generate in the whole Brazilian economy. It is fundamental to have in mind the notion of derived demand caused by the goals of the sectors related to the mineral sector. The goal of the automobile industry carries to the program of nonferrous metals, the goal of agricultural production leads to the program of fertilizers consumption, and the cement goals, programmed from the global impact of goals plan, lead to the program of limestone production, and so on.

The major orientations outlined by the III PND to the mining and exploration for the period 1980-1985 are:

- To expand and diversify production through intensification of geological and technological

research, and the increase of horizontal and vertical integration of the activities.

- To mobilize to the maximum the potentialities, inclusive of those in the North and West-Center Regions, where the elimination of bottlenecks (that result from the lack of economic and social infrastructure) is imperative for mining feasibility.
- To improve the Brazilian position in the internal supply of mineral goods, especially of those that are energy sources (for instance uranium and coal), and those which show good prospects for export, or those which are able to substitute for the import of strategical minerals such as copper and nickel.
- To harmonize the development of activities considering the protection of the environment.
- To support and stimulate the research of sea and underground resources, and the scientific and technological development adapted to the mineral resources of the country.

- To increase the productivity of existing activity, thus causing better internal prices and greater international competitiveness.
- To give preference to the projects which have already started or to which money is already committed, adjusting their goals and deadlines to the effective resources availabilities.
- To support the small and medium-sized producers, with the objective of propitiating them fair remuneration and opening perspectives of growth and modernization of their activities. The emphasis on a better organization of production and on the markets of high value (such as gold and precious and semiprecious stone from the various regions) deserves special attention.
- To pass adequate mineral legislation to accommodate modern Brazilian reality and its perspectives.

CHAPTER 5

SUMMARY AND CONCLUSION

The small relative participation of the value of mineral production in the value of Gross National Product (one percent) does not reduce the importance of the mineral sector to the Brazilian economy and to its development. In addition to its conventional role of supplier of basic inputs, the mineral activity has relevant participation in the international trade (more than 10 percent of all Brazilian exports and imports) and high social profitability.

The Brazilian mineral production is highly concentrated; about 70 percent of its value is composed by ores for steel or for construction.

Iron ore has held the position of leader, representing about 30 percent of the value of Brazilian mineral production and 87 percent of exports of mineral commodities and 81 percent of manufactured mineral exports in 1979. Thus, the commercial balance of the mineral sector fluctuates in the same pattern of the world steel industry and this fact does not tend to be changed in the short run, since iron ore continues to lead investments, totaling 41 percent of the total investments made by mining enterprises during

the period 1972-1979.

Brazilian imports in the mineral sector, in 1979, were concentrated on manufactured products: ferroalloys and steel products, metallic copper, phosphate fertilizer, metallic aluminum, and nitrogenous fertilizers. It can be concluded that Brazil will be able to meet most of its own demand, with the exception of copper and nitrogenous compounds, recalling the national reserves of iron, phosphate, and bauxite, which are considered abundant (according to Table 2.9), and the current trend of investments developing in Brazil, i.e., the current increase in steel capacity, the fertilizer projects, and the bauxite-aluminum projects.

Mineral activity has a high social profitability, but the current economic situation in Brazil, acceleration of the inflationary process, reduction in mineral price, and low rate of return on mineral investments, has not stimulated the private investments in mineral projects. About 60 percent of the mineral investments during 1972-1979 were made by state enterprises.

There is a concentration of mineral production by large enterprises that benefit from vertical integration structure, capability for holding up their prices, economies of scale, and lower operating costs. All these factors

lead to the elimination of potential competitors.

The incentives given to the mining enterprises do not accomplish their objective of developing the sector. Some of these benefit exclusively large corporations and they need to be wider to benefit the small and medium enterprises, in particular, and for making their growth feasible. The program to offer financial support to the mineral sector costs a great deal and has some bureaucratic procedures which complicate it.

All these difficulties cited have been obstructing the expansion of the mineral sector. The small and medium enterprises feel these problems more deeply and find it hard to carry out any attempt for expansion and growth.

The industrialization of mineral goods has been revealed as one of the vulnerable points of the mineral sector. It is difficult to measure the level of industrialization in Brazil; although independent of any more accurate empirical verification, there are some arguments strong enough to indicate that the level of industrialization of mineral goods is low and dependent on imported technology. This is demonstrated as follows:

- The predominance of primary mineral goods with low aggregate value (given the small technology incorporated) in Brazilian

exports is notable. On the other hand, the predominance of manufactured mineral goods in the Brazilian imports (subsection 2.2) can be observed.

- In the balances of primary mineral goods "Production versus Apparent Consumption" (Table 2.9), 33 mineral substances show deficient production in relation to consumption. From the 60 sustances analyzed, 48 are classified as having abundant or sufficient reserves. The major reason for this is the lack of domestic technology for the ore processing and/or its industrialization (subsection 2.4.1).
- In the balance of manufactured mineral goods (metals and alloys, steel products, cement, chemical products, fertilizers, coke, etc.), only iron, lead, niobium, tin, asbestos, and limestone (cement) show a surplus in production. Brazil, thus, seems to be dependent on almost all final mineral products, even on those considered abundant: chromium, tungsten, bauxite, magnesium, beryllium, lithium, and fluorite (subsection 2.4.1).

- There is an underinvestment in technological research in the country. During the period 1972-1979, the investments of enterprises in development of mineral technology, about U.S. $34 million, represented only 2 percent of total investment in the mineral sector (Subsection 3.2.4). The factual evidence suggests that the transplant of imported technology to the Brazilian mineral area has sometimes generated problems due to the lack of adequate technology for the type of ore existent in the country.

The governmental mineral policy has not given enough emphasis to basic research (geological and technological). This activity is, in general, a long-run investment that requires high financial resources, which often exceed in magnitude the capacity of the enterprise and have a highly uncertain character. Beyond the question of success or failure in a given period of time, results cannot be completely foreseen from neither the qualitative point of view (what will actually be found) nor the quantitative point of view (magnitude benefits). Thus, given the high social benefits of the research, the government should act directly in basic research, general and

specific, and stimulate through incentives the private sector to carry out applied research of general as well as specific character.

The adequate formation of skilled workers speeds up the process of adoption of technological innovation, the industrialization of mineral goods, and great productive efficiency. Unfortunately, the mineral sector has been feeling the lack of specialized courses of intermediate and advanced levels in the Brazilian educational system.

The basic needs of the Brazilian mineral sector can be summed up as the lack of both financial and human resources. In order to attract private resources to the sector, it is essential to increase the profitability of these investments, placing them in a position of competitiveness with other sectors and bringing it into correspondence with the high risks and high social profitability involved. Formulation of a well-defined mineral policy integrated with other sectors of the economy could accomplish this purpose and obtain the largest goal-expansion of the sector.

CHAPTER 6

RECOMMENDATIONS

The formulation of a mineral policy should involve two broad goals: the macroeconomic objective is growth of the sector and the microeconomic objective is improved efficiency of mining enterprises.

The accelerated growth of Brazilian mineral production should be mainly of manufactured goods in order to supply the domestic market and, whenever possible, substitute domestic goods for imports and promote export goods coming from minerals in abundant reserves. The tools that work to produce growth are huge investments in the basic cycle of the mineral sector, from the mineral exploration to the industrialization phases, and on-the-job training programs.

The efficiency goal involves the structure of the market, namely the elimination of the inequities of the oligopolistic structure, and expansion at the enterprise level. The tools for efficiency are strengthening the power of small and medium-sized companies to compete, and effective management, marketing, productivity, etc., at the enterprise level.

Assuming that investments should be made in minerals

and small and medium-sized companies should be strengthened questions then arise concerning how to finance the operation and make the growth of those enterprises feasible. Both these requirements involve some governmental implementation planning, such as financial strategy, direct incentives, and the need for coordination of government and the enterprises.

6.1. Priority Investments

Table 6.1 presents a brief list of the major capital investment priorities, from the point of view of import substitution and increased exports. This table was developed based on the inadequacies in the basic cycle of mineral activity, verified from the balances presented in Subsection 2.4.1. This is an attempt to detect the real Brazilian needs, from the definition of reserves to the construction of plants, in order to determine allocations of financial resources in the mineral industry. It is naturally impossible to solve all the difficulties and supply all the needs at once; however, the industrialization projects linked to the possibility of substituting for imports based on available reserves deserve special attention.

TABLE 6.1

MAJOR CAPITAL INVESTMENT NEEDS IN THE BASIC CYCLE OF MINERAL ACTIVITY

Nature of Investment	For Imports Substitution	For Increased Exports
Geological Research	coking coal, sulfur, molybdenum, lead copper, diamonds, gold	manganese, tungsten, magnesite, chromium, and ores of pegmatitic sources (inclusive of precious and semi-precious stones)
Technological Research	coal, potash, sulfur, molybdenum, cobalt, titanium, phosphate, nickel, and development of by-products, rejects, waste, and recycling	beryllium, chromium
Mining	cassiterite, scheelite, pegmatite, copper, bauxite, phosphate, gold, tantalium, diamonds, asbestos, fluorite, nickel, lithium, vermiculite, zinc, and zirconium	chromium, iron, gems, magnesium, manganese, niobium, crushed and ornamental stones, quartz, tungsten, beryllium, limestone, gypsite, kaolin, and talc
Industrialization	iron, aluminum, tin, zinc, chromium, magnesium, tungsten, lithium, fluorite, fertilizers, and limestone	niobium, iron, precious and semi-precious stones, chromium

Source: Table 2.9.

The investment in exploration, technological research, mining, and industrialization and in human resources is discussed below.

Geological Research. Basic geological research, both general and specific, acts as an efficient tool for long-run growth; it is fundamental to make the functions of DNPM's geological services effective in detailed and systematic ways. Greater investment should be made in the government's geological surveys in order to produce an up-to-date geological map of Brazil. It is necessary to study allocation of financial resources for geological research. Such studies should be based on the potential demand for each mineral good, forecasting the production necessary for meeting the demand and, from this, determining the mineral reserve necessary to generate that level of production.

More efficient incentives should be created to stimulate participation in exploration by mineral enterprises, since the current incentives have not accomplished the objective of attracting private resources.

In the list of priority mineral substances for exploration investment (Table 6.1), two mineral substances, in particular, deserve special attention: coking coal, import of which represents almost 40 percent of primary

mineral goods imports, and gold, reserves of which have very good prospects in Brazil.

Technological Research. Technological research is one of the essential points in the mineral sector development. Since the benefits derived from research do not always accrue to the firm performing the research, one solution is government support of research, either through performing research directly or by financing it by various means.

The participation of the private sector in applied research should be stimulated by the government in two ways. Indirectly, the government should invest in education, since without a minimum number of technicians, it is impossible to seriously develop adequate research for a sector. The government should also create a "research group of the mineral sector" which would serve as an intermediate element between the universities (producers of basic or more general applied research) and the enterprises. It should be observed that, in order to stimulate the private sector to invest, even in applied research, the patent is an indispensable tool.

The research recommended in Table 6.1 to reduce imports should be applied to the following projects:

- coking coal from the reserves in the south of the country;

- potassium from reserves of Carmopolis (SE), from salt ponds, and from industrial residuals;
- sulfur from shists, from coal, from oil shale of Irati, and from industrialization of gypsum;
- molybdenum from the ores of uranium;
- cobalt as a by-product of nickel;
- titanium from anatase; and,
- phosphate and nickel from the silicate ore in Goias.

With respect to increasing exports, the two projects should be directed toward processing of beryllium metal from ore and the technological problems of purifying chromite.

Besides the research cited in Table 6.1, there is a need for two types of technological studies:

(1) for better development of the by-products from ore (silver as a by-product of lead and gold, cobalt as a by-product of the ores of nickel, molybdenum from the ores of uranium); and,

(2) development of minerals from waste and from recycling (lead, nickel, zinc, magnesium, aluminum, copper, etc.).

Mining. In addition to the development of ores for which potential reserves are considered abundant (cited in Table 6.1) special priority should be given to:

(1) The mineral projects in which investments have already been, or are being, made: Projeto Trombetas (bauxite), Carajas (iron ore), Vale do Curaca (copper), Patos de Minas (phosphate), Niquelandia (nickel), Carmopolis (potash), and to the National Coal Program. The Projeto Carmopolis deserves special priority since its reserves have already been measured, and some investments in the technology of its extraction have already been made. Brazil imports 100 percent of its needs of potassic fertilizers.

(2) Provinces and/or mineral districts already known: Provincia Estanifera de Rondonia (cassiterite), Provincia Scheelitifera do Nordeste (Scheelite), Provincia Pegmatiticas do Leste e Nordeste do Brasil and Provincia de Carajas (gold, copper, nickel, manganese,

and cassiterite). This latter province needs geological study to define its potential tonnage.

(3) In the mining of reserves of mineral products which have a high unit of value (as suggested by the III PND): gold, tantalium, diamonds, and precious and semi-precious stones.

Industrialization. Manufacturing facilities are needed for almost all mineral goods. Brazil has been dependent on the foreign market, even for manufactured mineral products for which geological reserves are considered abundant and which present no technological problems for their industrialization: iron, tungsten, tin, aluminum, lithium, and fluorite. With the current trend of investment, this situation will tend to change in the next two decades with respect to iron, tin, and aluminum, at least.

Human Resources. Progress in the mineral sector depends greatly on the solution of technical and economic problems. The complexity of mineral supply and demand operations requires for the solution of these problems continuing research attention and the employment of highly trained specialists in almost all fields of science, technology, and policy making. The implications

are clear: in the final analysis, the process of education and training is vital for minerals to play a dynamic role in the modern industrial economy.

6.2. Governmental Implementation Planning

The government policy for attracting resources to the mineral sector and getting the efficient structure of the market and, consequently, to accomplish the macroeconomic and microeconomic goals, is discussed below. This policy includes the financial strategy, the government support of the sector through direct incentives, and the integrated action of the mineral sector itself and with other sectors of the economy.

6.2.1. Financial Strategy

Debate arises over the extent to which it is desirable to permit or even encourage private foreign investment.

Considering the difficulties for attracting private domestic resources to mineral activity and the importance of economic policy in relation to the tripod composed of domestic private, domestic-state, and foreign enterprises, some observations, especially for the phases of mining and industrialization of mineral goods, are presented.

Several countries, following the example of the Arabian nations, try to enhance and to preserve their natural resources. The value of these resources, even in their natural state, tends to rise as far as the expectancy

of scarcity increases. It may be that technology overcomes the problem of current scarcity, but, in any event, there will be a lag period, during which the value will increase. The multinational enterprises seem willing to accept, to a certain extent, the rules of participation in these adjustments in value. Some competition among these enterprises can be noted. Brazil, although dependent for some raw materials, owns vast reserves of others, and should enhance them and try to increase, whenever possible, its bargaining power.

The most recommended strategy in investments linked to raw materials and natural resources that involve high investments is the joint venture, in which the domestic capital is a major participant and has control of decisions. The great contribution of multinational enterprises to the less developed countries is capital and technology transfer.

The joint venture could operate in unoccupied areas in mining and industrialization of abundant mineral resources in the Brazilian soil, such as bauxite, iron, niobium, kaolin, manganese, cassiterite, potassium, tungsten, oil shale, etc. Other alternatives would be joint ventures that would operate, on foreign soil, in mine and industrialization of ore in which Brazilian reserves are recognizably scarce: copper, coking coal,

lead, sulfur, molybdenum, and vanadium.

On the other hand, the possibility of priority incentives to the domestic enterprises should be kept in mind. Not only on the basis of nationalism, although for some this is a reasonable argument, but because, from the point of view of national economy, with all other conditions equal, the national enterprise is always preferable. This is sometimes true, even if there is an initial disadvantage, when a long-run strength is expected. In this case, the thesis of infant industry can be perfectly invoked.

Another interesting form of collecting resources for mining industry projects would be through putting stock on the market. From the Research Report approved by DNPM and the favorable study about economic feasiblity of the project, and with permission of specific legislation, GEIMI would have a patent letter (right) to sell stock in the market up to the total value of the investment needed.

6.2.2. Direct Incentives

From the point of view of the philosophy of development, the incentives represent an interesting tool with which the economy can meet social goals of the participation of private domestic enterprise. The efficiency

of incentives comes from their impact on alternative profitability of several investments; their fundamental consequence is to shift investment from one sector to another. In the case where several sectors are receiving incentives, these beneficiary sectors began to compete among themselves; so, when incentives to a determined sector is instituted, the total benefits offered to other sectors and the scale of social priorities should be considered. Budget allocations should be remunerated on a competitive basis. A permanent protectionist scheme is not efficient. After a predetermined time, when the mineral enterprise or project can support itself, state funds should be removed and diverted to other priority projects.

The current legislation relating to the mineral sector should be reviewed and reformulated to deal adequately with modern Brazilian reality and to accelerate the existing fiscal mechanisms.

Looking for attractive financial resources for the programs of mineral development, some forms of incentives, besides those currently being studied by MME (cited in Subsection 4.2.1) can be considered which are similar to those developed by Margueron (1979):

(1) Partial exemption of income tax for reinvestment in mining, such as exploration, mining development, purchase

of equipment, etc., as happens in Peru.

(2) Indefinite extension of the deduction for the enterprises' losses, as occurs in South Africa, the United Kingdom, and New Zealand.

(3) Applying the deduction to all types of revenue, instead of only during the period of the useful life of the mine, for the costs of mine development. This kind of incentive is offered by the United States, Japan, New Zealand, and France.

(4) Total and immediate depreciation of investments in infrastructure of the mineral project (exploration, development, and mineral production). This depreciation should be deducted from the revenue of the mining industry complex and any deduction not utilized during the year could be deducted in subsequent years, with nominal readjustment. This incentive is offered by South Africa and New Zealand.

(5) Exemption of income tax for the first ten years of the operation of enterprises producing scarce minerals, with Brazilian capital control, such as happens in Iran,

Indonesia, Saudi Arabia, and Mexico, and formerly, in Canada and Chile.

(6) Total exemption of income tax for ten years, for reopening mines closed for at least five years, as is offered by Mexico.

(7) Government grants to domestically owned enterprises with mineral rights for investments in geology and mining engineering destined to define and verify feasibility of methods of mining scarce ores.

(8) Special incentives to domestic enterprises that produce abroad the ores lacking in Brazil; to private domestic consulting enterprises in the mineral sector; to enterprises leasing equipment for mineral exploration and production (with the objective of increasing the profitability of small and medium enterprises).

(9) Special programs of assistance and incentive to the mineral producer to support of infrastructure (such as energy, roads), technical assistance, and support from branches of government specializing in mineral technology in development and improvement of mineral processing.

(10) Reduction of the Import Tax and other taxes (IPI, ICM) on the purchase of assets for export and import substitution projects.

(11) Acceptance from the several financial institutions, besides the Banco Nacional de Desenvolvimento Economico - BNDE that has already operated in this way, of the measured mineral reserves as a real collateral of mineral financing. This kind of security is accepted by almost all countries in the world.

Some changes in the program of financial assistance to mineral research, besides those being studied currently (cited in Subsection 4.2.2.), should be made:

Implicit Costs: an accurate study of the documentation required for asking for a loan is needed, reducing the bureaucratic procedure, and accelerating the contracting process.

Explicit Costs: the nominal readjustment of the debtor balance would utilize the Mineral Industry Price Index, exclusive of the oil price of the index. This method of readjustment is more compatible with the mineral price oscillations than the current ones.

Exploration Supervision: one other important topic that should be examined is government control of the exploration service of the debtor enterprise, without creating more bureaucracy. Some types of services that utilize expensive equipment (such as drills and laboratory equipment) and for which there are specialized companies, would not be performed directly by the debtor enterprise, but subcontracted with the specialized firm. This proposition, on the one hand, would reduce the necessary capital investment, and would create one more way to control the work (since the subcontracted company might send montly services reports and results to the financing agency) and, on the other hand, would enlarge the work market for the consulting firms in mineral exploration.

Another strategic tool worth examining accurately for the development of the mineral sector is a price policy for the natural resources. This is vital not only for the private profitability of the sector, but also as a social benefit mainly for the less developed countries.

It is necessary to create a research group for studying and elaborating a policy pricing and on ore commercialization, both long and short run. These should include:

(1) Creation of a mining-industry complex, vertically integrated, and stimulate the creation of joint ventures whenever financial resources are inadequate, as cited in Subsection 6.2.1.

(2) Guarantee minimum prices and, consequently, the creation of "buffer stocks". The substitution of import projects could be guaranteed a minimum price equal to the c.i.f. price of imported products which do not lead to social loss.

6.2.3. Integration

In order to accomplish the proposed goals, DNPM, the organ of mineral planning and coordination, has the primordial action. DNPM functions as a supervisor of mining enterprises (registry, control of exploration area, granting of exploration concessions and of mining decrees, control of exploration, mining works, and health and security in the mines) and should also effectively stimulate mining, through the development of large and small scale geological mapping, and geochemical and geophysical investigation, diffusion of geological information, and encouragement of mineral technological

development (basic ore processing projects, research into mining and methods engineering).

In the area of mineral economy, DNPM should study the technical, economic, and financial aspects of mineral goods, their resources, reserves, and economic development, and should set specific goals for each mineral product through investment policies, incentives, taxes, and financing policies. Finally, DNPM would develop special studies of the necessary infrastructure for the mineral sector, in order to promote mining and mineral transformation projects.

The efforts toward integration of the mineral sector are unquestionably necessary. Past experiences show, unfortunately, that efforts which are spasmodic or disjointed are never satisfactorily completed.

An important priority is good information flow among the several participants, private and government, that allows a fast and free access to the data. One broad filing system should be developed for systematically keeping the rock samples, geochemical rocks, and drilling samples, etc. The analytical results thus made available produce sensible savings of time and money. The centralization and systematization of the data in DNPM, so that

it is easily available, comprises fundamental necessity for integrated planning of the mineral sector.

Infrastructural support (transportation, energy, labor, education, communication, technology, etc.), owned by other sectors of the economy and other ministries, is essential for the strengthening of the mineral sector.

The expansion of mineral activity is related not only to the total integration of the sector, but also to the integration of all the sectors of the economy, to coordinate the goals of the mineral industry with the goals of the other industries of the economy, and vice-versa.

SELECTED BIBLIOGRAPHY

Anders, G., Gramn, P., Maurice, C., and Smithson, C., 1980, The Economics of Mineral Extraction, New York, Praeger.

Associacao Brasileira do Cobre, 1980, Informativo ABC, Sao Paulo, ABC.

Barreto, Y. C., 1979, Base Fisica para o Desenvolvimento Brasileiro no Setor Mineral, Rio de Janeiro, CPRM.

Carteira de Comercio Exterior, 1980, Anuario Estatistico, Rio de Janeiro, CACEX - CIEF, MF.

Companhia Auxiliar de Empresas de Energia Eletrica, 1981, Atividades do PLANFAP, Rio de Janeiro, CAEEB.

Companhia de Pesquisa de Recursos Minerais, 1978, Reservas Geologicas e Consumo Mineral, Rio de Janeiro, CPRM.

_____, 1979, 1980a, Programa de Assistencia Financeira a Pesquisa Mineral, Rio de Janeiro, CPRM.

_____, 1980b, Moeda Mineral, Rio de Janeiro, CPRM.

Conselho Nacional de Pesquisa, 1978, Listagem das Empresas de Mineracao, Novembro 1978, Rio de Janeiro, CNPq.

_____, 1980, Setor Mineral e Politica Tecnologica, 1974-1978, Rio de Janeiro, CNPq.

Departamento Nacional da Producao Mineral, 1973-1980a, Anuario Mineral Brasileiro, Brasilia, DNPM-MME.

_____, 1980b, Balanco Mineral Brasileiro, Brasilia, DNPM,MME.

_____, 1980c, II Plano Decenal de Mineracao - Diretrizes Basicas - 1981-1990, Dez. 1980, Brasilia - DNPM - MME.

Doellinger, C., and Cavalcanti, L., 1975 - Empresas Multinacionais na Industria Brasileira, Rio de Janeiro, IPEA - S.P.

SELECTED BIBLIOGRAPHY (continued)

Franca, L.A.P., 1977, Lavra e Beneficiamento, Aspectos Economicos, Rio de Janeiro, Projeto FGV/CAEEB/PLANFAP - MME.

Fundacao Getulio Vargas, 1978, "Resultado das Sociedades Anomimas em 1977 - Grupo Extrativo Mineral ' (Tabela III - 3 - 1 - 3)", and "Indices Economicos Nacionais (1970/1977)", Conjuntura Economica, Set. 1978, Rio de Janeiro, F.G.V., pp. 149 and 261-265.

_____, 1979, "Resultado das Sociedades Anonimas em 1978 - Grupo Extrativo Mineral (Tabela 5.3.1.3), Conjuntura Economica, Set. 1979, Rio de Janeiro, F.G.V., pp. 98.

_____, 1980, "Principais Indices Empresariais em 1979", "Indices Economicos Nacionais - 1977/1979", and "As 500 maiores empresas segundo a classificacao por patrimonio liquido, 1979 (Tabela 5)", Conjuntura Economica, Out. 1980, Rio de Janeiro, F.G.V., pp. 22, 78, 80 and 110.

_____, 1981, "Renda e Produto Nacional - 1976-80 (Tabela 1)", "Evolucao da Taxa de Cambio, 1972-80 (Tabela 5)", "Balanca Comercial, 1972-80, (Tabela 8)" and "Evolucao do Valor das ORTN - 1972-80 (Tabela 22)", Conjuntura Economica, Fev. 1981, Rio de Janeiro, F.G.V., pp. II, XXXV, XXXVIII, and LII.

Girvan, N., 1976, Corporate Imperialism: Conflict and Expropriation, New York, M.E. Sharp, Inc.

Herfindahl, O., 1974, Resource Economics - Selected Works, Washington, Resources for the Future, Inc.

Kalecki, M., 1954, Teoria da Dinamica Economica, Rio de Janeiro, R.J.

Klass, M., Burrows, J., and Beggs, S., 1980, International Minerals Cartels and Embargoes, New York, Praeger.

Laby, W.C., 1980, Market Structure, Bargaining Power, and Resource Price Formation, U.S.A., Heath and Company.

SELECTED BIBLIOGRAPHY (continued)

Laing, G.J.S., 1977, Effects of State Taxation on Mining Industry in Rocky Mountain States, Colorado, CSM.

Langoni, C.G., 1975, A Economia da Transformacao, Rio de Janeiro, Livraria Jose Olympio.

Margueron, C., 1979, Subsidios para uma Politica Mineral para o Brasil, Rio de Janeiro, IBRAM.

McNicol, 1978, Commodity Agreements and Price Stabilization, U.S.A., Heath and Company.

Ministerio das Comunicacoes, Fev. 13, 1980, "III Plano Nacional de Desenvolvimento,"Diario Oficial, Brasilia, MC.

Ministerio das Minas e Energia, 1981, Modelo Mineral Brasileiro, Brasilia - MME.

Seely, W. Mudd Series, 1976, Economics of the Mineral Industries, New York, AIME.

U.S. Bureau of Mines, 1981a, Mineral Commodity Summaries, Washington, USBM/USDI.

_____, 1981b, Minerals Yearbook - Area Reports: International, 1978-79, Vol. II, pp. 166-190.

Visao, 1979, Quem e Quem na Economia Brasileira, Ago. 1979, Rio de Janeiro, R.J.