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500 years of mining in Brazil: a brief review[☆]

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Abstract

Upon the arrival of Portuguese settlers to Brazil in 1500, there was an obsession to find precious metals and gems. However, it took almost two centuries to find economic and abundant gold deposits in Minas Gerais. Gold and diamonds generated fabulous wealth to the Portuguese crown during the 18th century and part of the next. As the alluvial deposits were depleted, better techniques had to be employed to assure profitability, but a number of failures apparently eroded the motivation of Brazilian entrepreneurs to invest in mining during the Empire. As the population grew and the country started its industrialization process in the 20th century, the mining industry diversified intensely and became one of the six largest mineral producers in the world. Notwithstanding these achievements, it is likely that the best is yet to come, regarding gold, diamonds and other valuable minerals. © 2001 Elsevier Science Ltd. All rights reserved.

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Introduction

It is undoubtedly a very difficult task to summarize in a short paper the mining history of Brazil over the last five centuries. The country is so large, almost a continent, and its history so complex and intriguing, that any attempt of this kind will risk being a failure. Even so, the authors accepted this challenge as an opportunity to review the data collected by a host of historians and other authors who devoted themselves to investigating how, where, when, and why the Portuguese, and later the Brazilians themselves, tried to explore and transform the Brazilian riches into something useful or essential for them and for the nation.

The obstacles were enormous and daunting right from the beginning. The tropical environment was legendary and full of surprises for the early pioneers, as shown by so many historians and naturalists: a jungle hard to encroach, high daily temperatures for European standards, dampness, tropical diseases, wild animals and

poisonous reptiles, ferocious Indians, lack of infrastructure, and so on and so forth. Nevertheless, the desire to find natural fortunes or even the El Dorado changed this discomfort, risk and uncertainty into hope for rewards that the pioneers dreamed of day after day.

The first economic cycle in Brazil is due to the exploitation of redwood (“pau-brasil”) along the coast, lasting over 50 years (BRASIL Ministério das Relações Exteriores, 1969). In the second half of the 16th century the sugarcane plantations started, indicating that Portugal was really motivated to settle Brazil. For a period exceeding 150 years, sugar production accounted for almost the sole basis of the Brazilian economy. Actually, in the middle of the 17th century Brazil was the world’s largest sugar producer, and at that time the first competitors started their production in Central America and the Caribbean. The third economic cycle is more or less simultaneous to the sugarcane cycle and is due to cattle grazing, occupying vast territories in Brazil, initiating the march towards the west. Then gold gave rise to the fourth economic cycle at the end of the 17th century, after the discovery of rich alluvial deposits in Minas Gerais. For some authors, diamond is responsible for the fifth economic cycle, starting in 1729 and having lasted 140 years, until South Africa emerged as the major producer. Some authors (Pinto, 1991) concede that in the

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17th and 18th centuries, Brazil contributed ca. 50% of the world production of gold and diamond, promoting the prosperity and luxury of the Portuguese crown. At that time, the baroque art flourished in Minas Gerais, with Ouro Preto the most outstanding monument of this glorious past.

Coffee gives its name to the sixth economic cycle, and the first large-scale plantations began in 1835, after the independence of Brazil from Portugal. Finally, in the last years of the 19th century rubber production started in the Amazon, giving rise to the seventh economic cycle. After this cycle, our economy became so diversified through industrialization that it would not be adequate to define more specific cycles as such. The production of manganese in Minas Gerais was quite relevant for supplying the Allies in the First World War (1914–18). During World War II, Brazil played an important role in the supply of strategic minerals to the Allies, mainly the US and the UK. These minerals were: mica, quartz, tungsten, tantalum, zircon, beryl, manganese, and iron ore. To a certain extent, this contribution was more important than sending our troops to fight in the Italian Alps. Nowadays, Brazilian gems are eagerly sought after by foreign tourists from every corner. Brazil currently has the strongest economy of the whole of Latin America and also the leader of Mercosur, the regional trade block encompassing three neighbors — Argentina, Uruguay, and Paraguay. Its economy turned out to be so diversified that at the end of the 20th century the value of mineral production (including oil and gas) accounted for a modest 2% of GDP (Gross Domestic Product). Anyway, its importance is recognized, and it ranks among the six largest non-fuel mineral producers of the world.

The 16th and 17th centuries

Poor results

While analyzing the beginnings of mining activities in Brazil, it is essential to take into account the mercantilist character of our colonization — that is, efforts were made towards the exploitation of natural riches, based on slavery, aiming at the external market (Martins, 1984). In this framework, since the very beginning Brazilian lands appeared as potential treasures to the Portuguese metropolis, who tried to stimulate under many different forms, the discovery (and exploitation) of mineral deposits supposed to be as rich as those of Spanish America.

After Admiral Pedro Álvares Cabral officially discovered the Land of Santa Cruz in April 1500, the first Portuguese to establish a landmark in the mining history of Brazil was Martim Afonso de Sousa, a noticeable nobleman, as well as a worthy statesman. He founded the small town of São Vicente (on the São Paulo

coastline), the first settlement established by the Europeans in the whole of Portuguese America, in the year of 1531. He also tried to discover gold, silver or precious gemstones prior to his return to Lisbon (Guimarães, 1981). The plan was to confirm some news brought by four men of his cortege about the existence of abundant gold and silver mines in the Rio Paraguay region. Under his guidance three expeditions were achieved, all in 1531, to the hinterland along the coast of Rio de Janeiro, to the south of São Paulo state, and to explore Rio da Prata, farther south.

Thus, the first initiatives aiming at the reconnaissance for metals and gemstones in the Brazilian lands failed at those difficult times. Nevertheless, the desire and hope to discover mineral riches remained concealed among the inhabitants of the new colony, stimulated and supported by the Portuguese Crown, who offered promises of honors and rewards for those who found them.

In 1549, Tomé de Sousa arrived in Brazil as the first Governor General and decided to establish a new site at the coastline of Bahia, north of a small town named Vila Velha. This site was the beginning of Salvador, the first capital of Portuguese dominions in America. To achieve his plans, it was necessary to mine abundant shell deposits lining the seabed of Baía de Todos os Santos. The mining industry was inaugurated in Brazil on that day. The shells were used to make lime, used intensively in mortar and wall painting of the houses. The kilns were built at the neighboring island of Itaparica, where the burning oyster shells and coral reef pieces mixed with firewood took place.

Farther south, in Santo Amaro, on the bank of a tributary of Rio Pinheiros, in the neighborhood of the site where São Paulo is now located, some metallurgical developments took place in 1552. The origin for this was the presence of small iron ore deposits containing hematite and limonite. In spite of their small dimensions, the grade was considered to be comparable to some existing in the European continent. It is reported that Bartolomeu Fernandes, a blacksmith who arrived with the expedition of Martim Afonso de Sousa, was the pioneer of Brazilian metallurgy. This artisan was followed by others skillful in the art of fabricating farming hardware and small household tools. Some years later, Afonso Sardinha and his son developed the iron ore mine of Morro Araçoiaba, in the outskirts of Sorocaba, São Paulo state. By 1591 they had built the first steel plant in the country, having 2 kilns and capable of producing up to 100 kg of iron daily.

It would take too long in this text to describe with at least some detail all attempts made to find “precious metals and stones”, but for a general overview some of these 16th and 17th century expeditions are summarized in Table 1 (Guimarães, 1981).

Thus, during the whole of the 16th century, Portuguese settlers used funds, labor, soldiers — and craftsmen

Table 1
Expeditions to the Brazilian hinterland during the 16th and 17th centuries

Date	Chief of the expedition	Place	Mineral focus
1550	Pedro Rebelo and Miguel Henriques	Northeastern Brazil (including Pernambuco)	Gold
1522	?	Bahia (Paraguaçu river)	Minerals in general
1568	Martim de Carvalho	Jequitinhonha river	Green stones
1568	Luis Martins	Ribeira de Iguape valley	Gold
1573	Brito de Almeida	Espírito Santo (Rio Doce valley)	Emeralds and sapphires
1591	Ribeiro Dias	? Bahia	Silver
?	Dom Francisco de Souza	Hinterlands of Northeastern Brazil	Emeralds
1588–96	Belquior Dias Moréia	Bahia	Amethyst and sodium nitrate ^a
1596	Diogo Martins Cão	Bahia	Emeralds
1599	Dom Francisco de Souza	São Paulo	Gold ^{a,b}
1604–12	Belquior Dias Moréia	Bahia	Gold, silver, sodium nitrate and precious stones
1625–30	Francisco Dias D'Ávila	Northeastern Brazil	Silver and sodium nitrate
1654	?	Maranhão	? Gold
1660	?	Espírito Santo	? Gold
~1660	?	Paraná	? Gold

Source: Guimaraes (1981).

^a Successful expeditions that found the sought-after minerals.

^b In 1646, the Foundry House of São Paulo was operating, which is an indicator of gold mining activities in the hinterland of São Paulo, mainly between Iguape and Paranaguá, and in the neighborhood of the city of São Paulo as well.

of all kinds (cutters, miners, builders, and even foreign engineers — German, Flemish, Dutch, French, and Florentine) were placed or invested in expeditions and investigations, under the supervision of the governors. Unfortunately, the outcome did not meet accordingly with the efforts and expenditures. Even the most positive results lacked economic significance, both in quantity and grade of metals. The deposits were rather poor and located in remote places. Conceding quite candidly that the outcome of this century had been so disappointing, the governor General Diogo de Meneses Sequeira wrote a letter to the King stating that “your Highness should believe that the actual mines of Brazil are composed by sugar and redwood (‘pau-brasil’), very much profitable and for both the Treasury of your Highness does not spend one single cent”.

In the wake of the 17th century, more precisely on 15 August 1603, Felipe's Ordinances (Ordenações Filipinas) were announced to regulate the exploitation of mines found in Brazil. It is curious that the first mining code to be applied in our country was based on principles that, in some cases, are still in force in modern mineral legislations, e.g.:

1. the discovery may be entitled to mining rights;
2. the Treasury has the right to a fifth (“o quinto”) of the proceeds;
3. the discoverer of a gold or silver mine will be awarded another mine 4 chains in length and 2 chains wide;
4. any person will be empowered to search for a minable deposit in a third party's homestead, provided that those who find minerals will present a pledge and will pay the damage that might be imposed to the owners of that property;
5. if the mines are not started in 50 days after registration, those mines will be forfeited.

By a charter issued on 2 January 1608, Dom Francisco de Sousa was vested as Governor and Captain General of three provinces (“capitanias”): Espírito Santo, Rio de Janeiro and São Vicente. When returning to São Paulo, he brought with him two miner artisans skilled in the extraction of silver, one technician who specialized in gold veins, another artisan for selection of emeralds, two for iron ore, and two assayers for quality analyses of samples.

To replace the dynamic Dom Francisco de Sousa, who died, Salvador Correia de Sá was nominated the new Governor in 1613. Although he was said to have had former experience in the Potosi mines, he did not accomplish anything remarkable. Concerned with all these failures, the King decided to increase the legal provisions aiming at stimulating and compensating better those responsible for mining initiatives. This act was announced on 8 August 1618, and basically added to the former one:

1. the discoverer privileges will be awarded not only to Portuguese, but also to Indians and foreigners who receive a license to work on such mines;
2. the discoverers shall register their findings with the notary of the county;
3. if the mine is very profitable, the purveyor will inspect it in person and will demarcate it;
4. if the mine is weak in metals, they will not be subject to the payment of the “quinto” to the Treasury;
5. the purveyor shall inspect all the registered mines every three months, and will gather information;
6. these laws apply to metals other than gold and silver, such as copper, lead, and zinc.

Even though the new legislation was considered fav-

orable for mining, no major finding was reported, which led the King to transfer in March 1620 most of the miners living in Brazil to Monomotapa, an old indigenous district in South Africa.

In July 1674, an expedition departed from São Paulo headed by the famous Fernão Dias Pais, the “Emerald Hunter”. This adventure reached its climax in February 1681, at the basins of Rio Jequitinhonha and Rio Araguaia, where he found “green stones”. During his trip back home, the adventurer was debilitated and ill, passing away at the banks of Rio das Velhas. His son, Garcia Rodrigues Pais, continued his march to São Paulo. Some years later, an official analysis disclosed that the supposed emeralds were merely worthless green stones, according to experienced miners from India. As an irony of destiny, 300 years later, in a small town only 10 miles from Itabira, a railway station employee found small green stones classified as emeralds of high purity and nice color. For some few miles, the old pioneer did not encounter his dreamed-of emeralds.¹

The major economic outcome of this epoch was gold extraction in the Paranaguá region. It is estimated that between 1680 and 1697 the annual production was 50–80 kg, decreasing to 20–30 kg from 1697 to 1735, when the local foundry house ended its operations.

The Brazilian economic outlook at the end of the 17th century was rather dull, as a result of the depression that plagued the market, both domestic and external, caused mainly by the declining international prices of sugar and tobacco, the shortage of circulating money, and the deficit in the balance of payments. Also, the separation from Spain after several decades during which both Crowns were united (1580–1640) deeply impacted Portugal, who had to support the costs of the restoration of the Empire.

It is worth emphasizing some inherent difficulties encountered by the Portuguese in the New World. The native people living in Brazil had a culture which was not comparable to those already existent up in the Andes (the Incas), or in Mexico and Guatemala (the Aztecs and Mayas); even in the US the situation was quite different when the pioneers arrived. The Indians in Brazil had no experience whatsoever with metals. For their simple

daily life they used only quartz, chalcedony, flint and some hard rocks (granite, basalt, gabbro, and the like) to make their tools and appliances. Their pottery was simple too, decorated with red clays, and iron or manganese oxide pigments. Thus, they could not be of much help in the exploration efforts of Portuguese pioneers (Guimarães, 1981).

To stimulate the search for new riches — one of the outlets to the economic crisis — the Portuguese Crown gave the Governor João de Lencastre the royal chart dated 18 March 1694, offering new concessions to the old system:

1. concession of one among three different honour orders;
2. the status of knight; and
3. the full domain of the mines, with the only obligation to pay the “quinto”.

During the year 1698, Manuel de Borba Gato, son-in-law of Fernão Dias, offered himself to the Governor to head an expedition to Rio das Velhas and its tributaries. This caravan had enormous success, locating very rich mines in the region of Sabará, Minas Gerais state. Eventually, new perspectives to the Brazilian economy were now presented, and the entrance to the gold mines of Minas Gerais was then opened. Due to his findings, Borba Gato was awarded the title of Lieutenant-Colonel.

Another important discovery came to happen in 1699 during an expedition guided by Antônio Dias, who found nuggets of “black gold” in a district of Vila Rica (now Ouro Preto), the former capital of Minas Gerais. There were also indications that the expedition of Priest João de Faria, discoverer of Rio Grande, also reached the region of Ouro Preto, so that his name is likewise associated with the discovery of alluvial gold in Minas Gerais.

The exploratory works achieved during the 17th century at last put an end to the hopelessness caused by the failure of so many and constant searches for mines. This is credited to the persistence and intuition of paulistas (pioneers born in São Paulo state). Eventually, the alluvial gold appeared in significant amounts in the region of Ouro Preto. A new phase was then inaugurated for the Brazilian economy, labeled by historians as the Gold Cycle. The other precious or useful metals and the so dreamed precious stones did not show up in the first searches made in the Brazilian territory, either because they did not exist at the surface, they were not identified, or they did not catch the attention of the pioneers (Guimarães, 1981).

The 18th and 19th centuries

Gold

At the dawn of the most important mining period of Brazilian gold, expeditions from every corner in the

¹ During the same epoch that Fernão Dias Pais departed to Minas Gerais, in another region of Brazil the first noticeable fraud registered in the history of Brazilian mining occurred. The culprit was nicknamed Muribeca, the great-grandson of the famous Belquior Dias Moréia. He traveled to the riverhead of Rios Real and Jabiberi. In a range situated at this location he collected samples of mispickel (arsenopyrite) — a mineral bearing Fe, As, and S with color and brightness quite similar to silver — and then made a blend with old samples inherited from his great-grandfather. The false samples were delivered to a Portuguese authority as a new and valuable finding. To a certain extent, Muribeca was lucky because the ship that was carrying the samples to Portugal was shipwrecked, freeing him from severe punishment due to his intentional counterfeit.

country (São Paulo, Bahia, Pernambuco), and even from Europe took the route to the hinterland of Minas Gerais. Originally, the region of the first discoveries was characterized by sparse population, difficult access via recently opened trails, shortage of food, and a hostile environment. Notwithstanding this fact, the fascination and excitement caused by abundant gold led in 1705 to a population estimated to be between 30,000 and 50,000 inhabitants engaged in gold mining. Some were digging, others were the masters, and others were trading merchandise supporting the mining activities. Engineer Eusébio de Oliveira, based on data quoted by Calógeras, states that in the period between 1700 and 1801 an amount of 715 tonnes of gold was extracted in the province of Minas Gerais (Fig. 1).

The number of mines discovered by the unusual eagerness of pioneers was greater than expected, as shown here: Rio Pardo: 1698; ribeirão do Carmo: 1700; ribeirão Bento Roiz: 1700; Catas Altas: 1702; Serra do Caraça: 1703; Rio das Mortes: 1703; Santa Bárbara: 1704; S. João Del Rei: 1704; Rio Grande: 1704; and Pitangui: 1709.

Settlements were springing up overnight around the mine sites, transforming remote and wild places into lively towns in just 10 years or so. Thus, towns like Vila do Príncipe, Congonhas do Campo, Barbacena, Cocais, Santa Bárbara, Catas do Mato Dentro, S. João Del Rei, Paracatu, Pitangui, Campanha, Bom Sucesso de Minas Novas, Inficionado, Tamanduá, Vila Rica (now Ouro Preto), Sabará, and Carmo, all attracted avariciousness, aggressiveness, greed and other human sins generated by the gold fever, and experienced at that time a busy life, full of conflicts and adventurous moves quite common to new frontier towns.

Using the primitive process inherited from their ances-

tors, the miners used to work firstly the gold-bearing gravels and coarse sands found at the river bed, mainly because it was simple to concentrate the gold particles at the “bateia” (panner) using water from the river itself. The coarse gold was then picked out at the same place of the washing process, but to recover the fine gold required a better technique, mixing water with some fruit juice, and precipitating the gold in suspension. When the collection was not perfect, the final concentration was done in small panners made of copper, or through amalgamation (a combination of gold and mercury), followed by the separation of the two metals by volatilization — when burnt, mercury is volatilized and leaves a residuum of pure gold.

In spite of the Crown efforts to establish obligations and rights for those who extracted gold, it started to grow unruly with the smuggling of gold at the mine sites. The smuggling activity was achieved by various routes taking the gold to the coast, mainly to Bahia. Only the official production was being shipped to Rio de Janeiro. Actually, the temptation for the illegal trade of gold was great, as its price was higher in this case than that one practiced by government. This means that the smuggled gold was more profitable: firstly, because of the premium over the official price, and secondly, because of the tax evasion (they did not have to pay the “quinto”).

As a consequence of smuggling, fiscalization turned out to be more rigorous than previously. Facing the actions of more rigorous authorities and simultaneously having to contend with growing competition from newcomers arriving every day, the gold searchers decided to investigate other places out from Minas Gerais.

In 1718, Sebastião Pinheiro Raposo departed to the hinterland of Bahia and discovered gold alluvial deposits in the region of Jacobina and Rio de Contas. It is

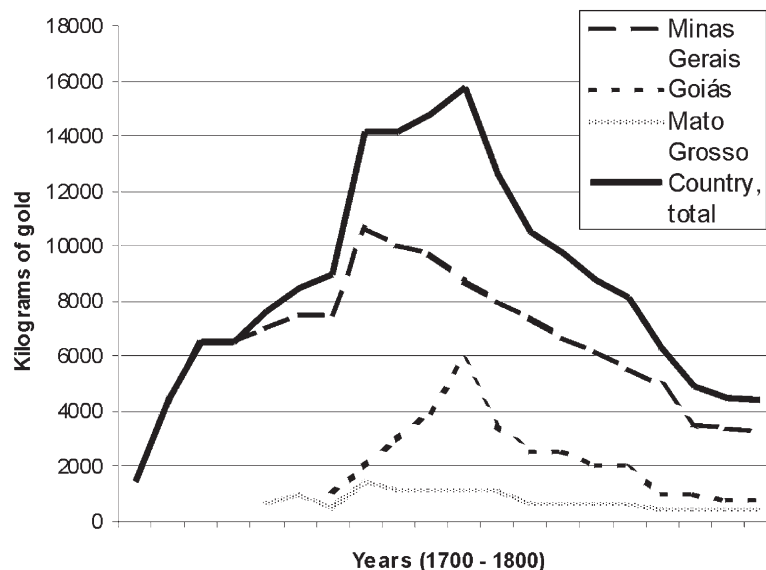


Fig. 1. Gold production in Brazil during the 18th century. The wealthiest period extends from 1739 until 1779. After Pinto (1979).

reported that the climax of the alluvial deposits in this state happened between 1718 and 1730.

In the same year (1718), an expedition headed by Pascoal Moreira Cabral left Itu (São Paulo state) in the direction of Mato Grosso. Going upstream in a tributary of Rio Cuiabá, named Coxipó Mirim, Cabral, together with his 56 men, discovered and exploited the first alluvial deposits of this new territory. In the gold race to Mato Grosso, many adverse situations occurred, marked by malaria and malignant fevers that exterminated the adventurers. In addition, the region was populated by courageous and hostile Indian tribes, responsible for two famous slaughters, the first in 1725, when 660 people were killed, and the second in 1730, with a death toll of 400 and the loss of 900 kg of gold. Nevertheless, the greedy mining in this region led to the exhaustion of the deposits in 1728.

As these mines were declining, new expeditions left for the region of the Upper Amazon, farther north, and discovered gold in Rios Madeira, Jamari, Corumbiara, and Parecis. These caravans had a twofold importance to the Portuguese: they were successful in revealing new gold deposits in the Amazon region, and also extended the Brazilian territory up to the foothills of the Andean Cordillera.

In 1719, the pioneer Manuel Correia brought 36 g of gold from the province of Goiás, situated east of Mato Grosso. Starting from this positive experience, several expeditions were organized and between 1728 and 1750 an expressive number of settlements appeared there, e.g.: Barra, Ouro Fino, Ferreiro, Anta, Santa Cruz, Guarinos, Meia Ponte, Natividade, Crixás, Água Quente, Traíras, S. José do Tocantins, S. Félix, Cavalcante, Arraias, Pilar, Conceição, Carmo, Sta. Luzia, Cocal, and Anicuns.

The climax of gold mining in Brazil in the old centuries occurred from 1739 to 1779. The leading producer was always Minas Gerais (see Fig. 1). The foundry houses of Minas Gerais — located in Vila Rica, Sabará, S. João Del Rei, and Vila do Príncipe — received the gold in powder form, weighed it, separated the “quinto” for the Crown, smelted the remaining portion in kilns, eliminated the impurities, and moulded it into bars, which were weighed and registered.

Diamonds

The Brazilian Diamond Era stretches from 1730 until 1870, when South Africa started to take the lead. Although Brazil held a virtual monopoly on diamond production for almost 150 years, it was later surpassed by Australia, Russia and several African countries, ranking now among the ten major producers.

According to Legrand (1980), it is impossible to verify the legends surrounding the discovery of the first Brazilian diamonds. Brazil and India, though thousands of miles apart, had one thing in common — the presence

of the Portuguese. It seems that a certain Sebastião Leme do Prado, who had previously lived in India, was the first to discover or, more precisely, to identify the famous stones in Brazil. This occurred in 1725, not far from the creek Morrinhos, in the present province of Minas Gerais. The crystalline stones were used as chips in card games by gold prospectors; apparently the prospectors had found many of them, but they kept only the most brilliant. Leme do Prado immediately recognized the “chips” as diamonds, but did not disclose it to others.

Brought to Lisbon two years later by Bernardino da Fonseca Lobo, who was then rewarded with the post of Captain General of Vila do Príncipe, the stones were at once shipped to Amsterdam to be appraised. The discovery was made public by the Royal House of Portugal in 1729 on the basis of a circumstantiated report by the Viceroy Lourenço de Almeida. By a decree of 8 February 1730, the diamond-yielding terrains were declared Crown property. A special district was immediately created, named Serro do Frio (“Cold Mountain”), and troops were sent to guard it. That same year “diamond washers” founded the colony of Tejuco, which a century later became Diamantina.

A second version says that the discoverer was Fonseca Lobo himself, who owned a gold garimpo in Arraial do Tejuco. He had found the stones back in 1721, then shipped them to Bahia, and later to Europe, where they were sold as coming from India. According to this legend, the Portuguese government was only told the truth in 1730, after several people made their fortunes in Brazil (Barbosa, 1991).

Still another version gives Francisco Machado da Silva the honor of finding the first Brazilian diamond in 1714. He had a gold garimpo in Machado creek, close to Tejuco.

When the wealth of the Tejuco deposits was realized, random searching began over the whole area. At that time, Minas Gerais was for the most part unexplored, and there were practically no means of communication. During the dry season from May to September, however, prospectors were able to go up the riverbed to begin searching, and they soon realized that the deposits extended much beyond Serro do Frio.

It is not possible to establish a tidy chronological record of early events, which occurred rather rapidly. A few random incidents must suffice to indicate general trends. The field of Abaeté, east of Minas Gerais and some 125 miles from Tejuco, is mentioned as early as the mid-18th century, and was the most productive. The site soon became famous and witnessed feverish days. It was here, in 1764 that a group of outlaws who had been transported to a penal colony discovered a 1680 carat stone subsequently known as the Bragança and long considered the largest diamond ever found. Even after cutting it, it would have been twice the size of the Great Mogul, then the largest stone known. Contrary to long-

accepted stories, the Bragança never belonged to the Portuguese Crown. For lack of irrefutable proof, it seems safest to conclude that this stone was not really a diamond, but probably a colorless topaz or sapphire. Still in Minas Gerais, but in the extreme northeast, the deposits of Grão Mogol in the Itacambirucu valley were opened between 1771 and 1781. Despite their impressive name, they could not rival those of Jequitinhonha,² far more interesting according to a 1792 account by Andrada, a famous Brazilian mineralogist.

Immediately following the gold discoveries in Minas Gerais, a phenomenon in the field of economics, that received the name of “Dutch disease” almost three centuries later, started to concern the government authorities. It is known that every time that riches surge overnight people become excited and regular industries are dismantled. In short, everything is suddenly subverted. In the case of gold discoveries in Brazil, this phenomenon happened in just one year. The provinces located along the coast became partly desolate, and the cultivation of plants and the production of animals (cattle-grazing and livestock) were almost abandoned. The Council of São Paulo itself, traditionally the promoter more enthusiastic about all those discoveries, was feeling as being the victim of their consequences, and did not hesitate to request the King to order to halt the work of the mines, because labor (formed by Indians and slaves) was too short. Animal husbandry was partially abandoned, and in all towns and villages the wilderness was being spread out. And even worse, all of this was occurring just in the middle of 1701 (de Vasconcelos, 1948; Simonsen, 1937).

In the 19th century, the “Chapada Diamantina” deposits in the Bahia region, east of the deep valley of Rio S. Francisco, were worked between 1830 and 1840. Their importance was due chiefly to the large deposits of “carbonados” found there. The name “carbonado” is used to describe a thick, porous aggregate of very small gray or black diamonds. They look rather like coke and

are as hard as pure diamonds. The weight of these stones, which are generally rounded in form, ranges between 30 and 40 carats, but some have been found weighing more than 1000 carats, and one discovered in 1895 weighed 3078 carats. They have a purely industrial use today, and are the toughest form of industrial diamonds; they were in great demand in the period immediately after the First World War, when their price rose steeply.

The discovery in Minas Gerais, west of Coromandel town, of the diamond fields of Rio Bagagem, a tributary of Paranaíba, also dates from the mid-19th century. Here a black slave earned not only his freedom but a pension for life after finding, in 1853, the first large Brazilian diamond whose history has been fully authenticated. Called “Estrela do Sul” (Star of the South), it weighed in its rough state 261.88 carats. A superb, pellucid stone with bluish reflections, it was cut by Coster of Amsterdam into an oval diamond of 128.8 carats, then sold to an Indian maharajah after being shown at the London Exhibition of 1862 (Legrand, 1980).

In 1857, an even purer stone was extracted from the same region, its rough weight 119.5 carats. It is known as the Dresden, after the London merchant who bought it and had it cut in Amsterdam into a pear-shaped diamond weighing 76.5 carats.

Minas Gerais was not the only part of Brazil to be worked as early as the colonial period. Areas as difficult to reach as those of Mato Grosso were also searched, and as early as the close of the 18th century, mining sites such as those northeast of Cuiabá were mentioned.

The importance of the Brazilian discoveries is reflected in the fact that within six years, from 1730 to 1735, the world diamond market exploded. Prices dropped by three-quarters. This dramatic fall can be partly explained by the sudden abundance of diamonds reaching Europe, but an ever more important factor was the belief that a source of almost unlimited wealth had been discovered in South America and that it could be easily exploited.

According to the records kept by the Portuguese government, the average annual production is shown below:

1730–1740:	20,000 carats
1741–1772:	52,000 carats
1773–1806:	27,000 carats
1807–1822:	12,000 carats

With an impressive growth in production, the Portuguese authorities had no means of avoiding clandestine mining and the illegal trade in diamonds. In 1775, a decision was made to forbid individual working in favor of farming out the business to large enterprises. The first crown partners were probably the firm of Bretschneider

² Among the countless legends associated with the diamond sites, the most famous is that of Chica da Silva, a mulatto woman who bewitched the young and wealthy João Fernandes de Oliveira. As royal administrator for the entire mining region, answerable directly to the king, Oliveira was a leading member of the local Portuguese society. Francisca da Silva, known as Chica, was the daughter of a Portuguese father, Antonio Caetano de Sá, and an African mother named Maria da Costa. A former slave of Francisco da Silva Oliveira, she had been freed by her master and was already the mother of two children when she met her future lover. The legend tells that João Fernandes was utterly dominated by Chica and submitted to every one of her whims. He built for her a vast and splendid dwelling in the heart of the country, surrounded by orchards, fountains, and waterfalls. The interior was furnished in a manner worthy of the most aristocratic residence and included a chapel and a theater — the only one of its kind authorized — where fashionable plays were performed. Such an enterprise would have ruined most men, but not João Fernandes, merely for being the administrator of all gold and diamond mining (Legrand, 1980).

brothers of Amsterdam, and the bank of Hope and Company, which specialized in large state loans.

These rent contracts can be regarded as one of the first European attempts to restrict production to maintain a stable market and prices. The farmers agreed not to employ more than 600 slaves. Actually, this restriction failed to achieve the desired aim. Because the rent was extremely high, the enterprises launched themselves into intensive production, which made it impossible to harmonize supply and demand in the market. Not until 1830, following a rise in demand, did the rough diamond again attain the price it had reached in 1700. Under such conditions, it was of little importance that during the 36 years of rent collection (1735–71) more than 50,000 carats per year were produced. Certain farmers who gained tremendous fortunes through fraudulent means were brought to court and forced to restore at least part of their profits. The Bretschneider brothers, for example, managed to achieve annual earnings of more than 2 million gold francs. On the advice of his chief minister, the Marquis de Pombal, the King refused to renew these rent contracts in 1772, and a state enterprise was created to take over the working of all gold and diamond mines. This system was still functioning in 1822, when Brazil gained its independence from Portugal (Legrand, 1980).

After a period of a certain apogee generated by the gold and diamond “rush”, mining fell in decadence. In his *Discurso sobre o estado atual das minas do Brasil* [“Discourse about the current status of the mines in Brazil”] published in 1804, Father José Joaquim da Cunha de Azeredo Coutinho, founder of the *Seminário de Olinda*, stated that “our mines of Brazil are exhausted day by day, as experience shows, several of them do not cope with the costs anymore”. The structure of this study, opened by a chapter entitled “The gold mines are deleterious to Portugal” and closed by another where it is discussed “the means by which to increase the products and the agriculture of the continent of the mines, which, incidentally, is already ruined regarding the gold” (emphasis added), indicates that mining, especially of gold, if not deleterious had become of secondary importance.

Unanimously, authors of that period emphasize the need for the modernization of the techniques employed in mineral extraction, the advancement in the training of miners, and also, the need to hire a manager who would instruct them and supervise the work. In resonance with the enlightened spirit of the time, they would appeal to science to redress the situation. At a practical level, one of the measures taken to improve the instruction of miners was the printing of two manuals on mining.³

³ They are: De Genssanne, 1801. *Mineiro do Brasil melhorado pelo conhecimento da mineralogia, e metallurgia, e das sciencias auxiliares* (Traduzido em português de ordem de S.A.R. o Príncipe Regente N.S. por Fr. José Mariano da Conceição Velloso). Lisboa, Ofic.

Another measure, of great depth and impact, was sending three graduates from Coimbra University to visit the main scientific and mining centers of Europe. The purpose of this journey taken from 1790 onwards and financed by the Royal Mints, was “to acquire by means of literate journeys and philosophical explorations, the most perfect knowledge of mineralogy and further parts of Natural Philosophy”;⁴ the students were Joaquim Pedro Frago de Sequeira from Portugal, José Bonifácio de Andrada e Silva (1763–1838) and Manoel Ferreira da Câmara de Bittencourt e Sá (1762–1835) from Brazil. The presence of two students from the Brazilian elite might be explained by the importance of Brazilian mineral deposits, despite all decadence, in the overall economy of the kingdom.

They traveled to Paris, Freiberg and Germany in general, Hungary, Bohemia, the Alps, Veneto, and Scandinavia. Back to Lisbon about 10 years later, both Andrada and Câmara were immediately absorbed by the administrative structure of the kingdom, Andrada in the metropolis and Câmara in the Diamond District (Minas Gerais).

Other developments during the 19th century

Beginning at the end of the 18th century, Portugal undertook several measures to overcome its backwardness in relation to the economical and industrial development of other European countries. José Bonifácio de Andrada, when he took office in the position of *General Intendant of Mines and Metals of the Kingdom*, aimed to overhaul mining in Portugal, recovering mines that had long been abandoned. Given the need of specialized human resources and probably based upon the experience he acquired during his study journey, he hired some technicians in Germany, who were simultaneously incorporated into the *Corps of Military Engineers* as soon as they arrived in Portugal in 1803. Among them, it is worth mentioning those who established closer links with Brazil: Wilhelm-Christian Gotthelft von Feldner (1772–1822), Friedrich-Ludwig-Wilhelm Varnhagen (1782–1842) and Wilhelm-Ludwig von Eschwege (1777–1855) (Leonardos, 1973).

The Court in Brazil from 1808 onwards did not hesitate to give continuity to those initiatives. The concerns of the important minister D. Rodrigo de Sousa Coutinho, Count of Linhares, were manifested as early as May 1808: the government founded in Minas Gerais the *Real*

Antônio Rodrigues Galhardo, 135 p.+7 estampas; and Le Febvre, 1803. *Mineiro livelador ou hydrometra* (copiado do novo tratado de livelamento de M. le Febvre, e impresso de ordem de S.A.R. o Príncipe Regente Nosso Senhor, para o uso da nação portuguesa, por Fr. José Mariano da Conceição Velloso). Lisboa, Ofic. Antônio Rodrigues Galhardo, 100 pp.

⁴ “Instrução” expedida pelo Ministro do Reino e dos Negócios Estrangeiros, Luis Pinto de Sousa. Lisboa, 31 de maio de 1790.

Fábrica de Ferro de Gaspar Soares [Royal Iron Manufacture of Gaspar Soares], whose direction was given to the Intendant Manoel Ferreira da Câmara. Some time later, in 1810, the German technicians were called to Brazil to contribute to mining and above all to iron metallurgy.

In 1811, Feldner was sent to Rio Grande do Sul to examine the newly-discovered coal mines of Rio Pardo — as he had worked as a practical miner in the coal mines of Silesia, his birth place, before leaving for Portugal. In 1814, he was charged with the survey of coal in the region around Salvador, and in 1816, in company the of Lieutenant Luis d'Alincourt, he searched for iron ores in Bahia. Varnhagen was charged with the inspection of the iron mines of Sorocaba (province of São Paulo), together with Martim Francisco Ribeiro de Andrada (Gomes, 1983). He was also supposed to verify the chance and possibilities of citizens becoming involved as shareholders in the creation of a company that would explore such deposits. Returning from his three-week journey he handed D. Rodrigo Coutinho an exploitation plan, in which he emphasized the richness of the deposits and suggested the mining company be formed between government and private shareholders in equal proportions. By means of the Royal Chart of 4 December 1810 the *Real Fábrica de Ferro de Ipanema* was created. We could add the notice of 1 October 1811 recommending the creation of companies to exploit mines with the use of appropriate machinery (Ellis, 1985).

However, due to reasons of another order, the administration of Ipanema factory was handed to Swedish miners led by Carl Gustav Hedberg, who by technical incompetence, as it seemed, instead of producing steel, only wasted money (von Eschwege, 1979; Gomes, 1983); Varnhagen was then called to recover the Ipanema factory in 1814 (Gomes, 1983), when the Swedish mission was definitely dismissed.

Eschwege was in charge of “commissions of Royal Service” in Minas Gerais. In terms of iron metallurgy, he went beyond the inspection of ores and iron mining, founding an iron steel company: *Fábrica Patriótica do Prata* [The Prata Patriotic Factory] in Congonhas do Campo, Minas Gerais, constituted by a stock company in which he and Count of Palma (D. Francisco de Assis Mascarenhas) were shareholders. The construction of the factory began at the end of 1811, and the first steel smelt came out on 12 December 1812.

A rapid assessment of iron metallurgy initiatives undertaken in this epoch reveals the persistence of a problem already mentioned for the preceding centuries: lack of qualified technical personnel, both in the management of the work as well as its execution. In 1813, an article by José Bonifácio continued to present the same complaints of previous years: “today there is such blindness and lack of zeal about this subject that few people among us are capable of taking profits of the advantages

that the regular exploration of our mines and a good metallurgical management will produce” (de A. e Silva, 1813).

This constant insistence on the improvement of mining, especially through the adequate training of professionals, following the suggestion of the creation of “mineralogical and metallurgical schools” presented by Câmara in 1803, would reappear several times before it became reality in 1876, when the School of Mines of Ouro Preto was founded. However, the professionals issued from this School found it difficult to find jobs, certainly reflecting the evolution of mining in 19th century Brazil.

In the period between 1824 and 1889, essentially only British capital was invested in mining activities, mostly in Minas Gerais, and it represented a little over 4% of the total investment in the country. A final balance of these investments shows a net result of one great success (the St. John Del Rey Mining Co.), one of mediocre performance and fourteen failures (Libby, 1991). And the case of success, an absolute exception, is due to the conjugation of three factors — the richness of the Morro Velho deposit (Fig. 2), exceptional management with the introduction of technological innovations, and the establishment of a powerful political network in the country, which protected and promoted the interests of the company (Eakin, 1986).

The reports of the Ministers of Agriculture, Commerce and Public Works, to whom the mineral matters were subordinated, between 1862 to 1881 always mention the same problems, apparently with difficult solutions. The ministers agreed unanimously that “the mineral kingdom of the empire rivals in strength and variety the majestic flora and rich fauna” (BRASIL Relatório do Ministro da Agricultura, Comércio e Obras Públicas relativo ao ano de 1867, p. 54), “which Providence so freely blessed upon it” (BRASIL Relatório do Ministro da Agricultura, Comércio e Obras Públicas relativo ao ano de 1865, p. 27). But they complain, first, of the legislation that dealt with the subject: “the legislation which we inherited from Portugal, besides being incomplete, given that only deals with gold and diamond mining, is so complicated because all the acts that regulate such matters are not reunited in the existing law collections that it is almost impossible to undertake any study on this subject” (BRASIL Relatório do Ministro da Agricultura, Comércio e Obras Públicas relativo ao ano de 1862, p. 26). An attempt to solve it, which was undertaken in fact under the Republican government, was authorized by law 1.507 of 26/09/1867, which commanded a large revision of all legal dispositions aimed at regulating the administration of mines (BRASIL Relatório do Ministro da Agricultura, Comércio e Obras Públicas relativo ao ano de 1865, p. 27).

Besides legal problems, some others, interconnected, rendered difficult the growth of this industry “that has a promising future, maybe not a remote one” (BRASIL

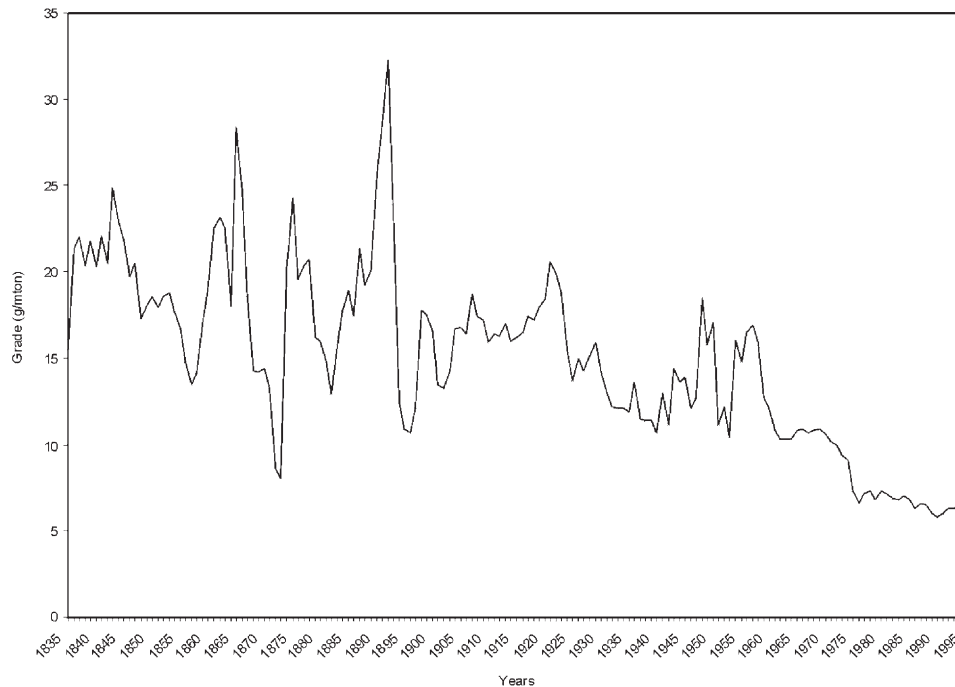


Fig. 2. Declining grades in gold mining after 160 years of exploitation. In the period from 1834 to 1994, St. John Del Rey Mining experienced wide fluctuations in grade in its mines, varying from 16.5 g of gold per metric ton at the beginning to 6.5 g/ton in 1994. The peak (32.3 g/ton) was observed in 1892. In the long range, grades are always declining. Every old mining district in the world faces the same problem. To counteract this trend, mining companies use new and better technologies to offset the declining grades and improve their productivity. Data from *Mineração Morro Velho* (1996), the successor of St. John Del Rey Mining in Nova Lima, Minas Gerais.

Relatório do Ministro da Agricultura, Comércio e Obras Públicas relativo ao ano de 1868, p. 27). In short, these problems were the precariousness of the means of communication, technically non-qualified personnel and the lack of capital, serious obstacles in a field that requires huge investments, with high risks and long term return.

The journal of the Ouro Preto School of Mines, *Annaes da Escola de Minas* [Annals of the School of Mines] reached a diagnostic identical to that reached by the government. A paper by the teacher Armand de Bovet in 1883 about the mineral industry in Minas Gerais pointed to “difficult and expensive transport”, the technical precariousness and also the greed of the owners of concessions, who “install half a dozen of hammers and hire 3 or 4 workers, not so much as to exploit the mine, but above all not to let the concession expiring before selling it to a foreign company” (de Bovet, 1883).

The establishment of the first Brazilian Geological Survey [Comissão Geológica do Brasil] in 1875 could be seen as a possibility for change in this panorama. However, it lasted only until 1877, closed due to financial reasons. The institutions founded later following the same institutional model, namely the Geographical and Geological Commission of São Paulo (in 1886) and the Brazilian Geological and Mineralogical Survey (in 1907), were mainly subordinated to coffee economy interests, so that improvements for the mining sector remained subsidiary in an overall appraisal.

The 20th century

The main events related to mining in the 20th century could be listed as such (BRASIL Departamento Nacional da Produção Mineral, 1995; Machado, 1989):

- 1904 — The book “As Minas do Brasil e sua Legislação”, by Pandiá Calógeras, is published.
- 1907 — Serviço Geológico e Mineralógico do Brasil (Brazil’s Geological and Mineralogical Survey) is inaugurated in Rio de Janeiro.
- 1932 — Bolsa de Mercadorias da Bahia is informed after an oil discovery at Lobato.
- 1934 — Departamento Nacional da Produção Mineral (DNPM) is created.
- A modern Código de Minas (Mining Code) is awarded by the government.
- 1938 — Conselho Nacional do Petróleo is created.
- “Presidente Vargas”, the largest Brazilian rough diamond (726.6 carats), is found in Minas Gerais (Leinz, 1939); see Table 2 and note 5).

⁵ “Presidente Vargas” was, in 1938, the fourth largest rough diamond in the world (now it is the sixth, after the discovery of Star of Sierra Leone — 968.9 carats, and Woyle Rietema — 770 carats). Supposedly, P. Vargas was sold at a price of ca. US\$141,000 to an American buyer (data from Leinz, 1939). At that time, such a price was roughly equivalent to 120 kg of gold (now this diamond would be worth US\$1,090,000 using the current gold price — March ’99).

- 1941 — Companhia Siderúrgica Nacional is inaugurated.
- 1942 — Companhia Vale do Rio Doce is created through the “Washington Agreements”.
- 1953 — The Congress establishes the monopoly on oil exploration, production, and refining; Petrobrás is created.
- 1956 — President J. Kubitschek creates the Campanha de Formação de Geólogos (CAGE), to organize the first geology courses in Brazil.
- 1960 — Ministry of Mines and Energy is created, after 18 years of attempts in Congress.
- 1967 — The First Ten-Year Master Plan is awarded. The Mining Code suffers major changes, separating again surface and subsurface rights. Discovery of the huge iron ore reserves in Carajás range, state of Pará.
- 1969 — Companhia de Pesquisa de Recursos Minerais (CPRM) is created to boost mineral exploration in Brazil.
- 1970 — Project Radam is created to survey the Amazon using radar imagery for the first time.
- 1974 — Discovery of the first large offshore oilfield in Brazil — Garoupa, at Campos basin.
- 1976 — Centenary of School of Mines of Ouro Preto, Minas Gerais.
- 1980 — The Second Ten-Year Master Plan is awarded.
- 1988 — A new Constitution is awarded by Congress, changing the treatment of foreign capital in mining.
- 1994 — The Multiyear Plan for the Development of the Mineral Sector is published.
- 1995 — Amendment to the Constitution removes the articles against foreign capital majority in mining projects.
- 1998 — The project for creation of Agência Nacional de Mineração (ANM) starts to be discussed openly to replace DNPM.

What was the response in our times to all the exploration efforts, so to say *blood, sweat and tears*, of all the pioneers and dedicated people who devoted their lives searching for gold and diamonds in Brazil during the last 500 years? Part of the answer is embodied in the statistical data presented by Companhia de Pesquisa de Recursos Minerais (CPRM) (BRASIL Companhia de Pesquisa de Recursos Minerais, 1997). In 1997, the figures for gold were as follows:

Active mines	38
Abandoned mines	120
Active garimpos	604
Abandoned garimpos	583
Deposits	67
Prospects	675
Total sites	2087

For diamond, CPRM gives the following data:

Active mines	15
Abandoned mines	3
Active garimpos	365
Abandoned garimpos	293
Deposits	18
Prospects	98
Total sites	792 ⁶

Thus, today's reaction of prospectors to gold production is more positive than that related to diamond. Why is it so? First, gold is much more scattered than diamond in the Brazilian territory, extending from the extreme northern boundary to the southernmost, and from east to west as well. The source of alluvial gold covers a larger portion of the country than the diamond sources — the concealed kimberlite pipes. Secondly, gold is by and large much easier to trade than diamond, due to the quasi-monopoly controlled by De Beers through the Central Selling Organization (CSO), headquartered in London. CSO is the famous trader of diamonds, advocating the principle of “single market channel” aiming to stabilize prices in the diamond international market. This circumstance is taken into account similarly by garimpeiros and organized mining companies. Anyway, Brazil's diamond potential seems to be greater than the above statistics indicate. It should be remembered that this country has reportedly produced more than 50 stones weighing over 100 carats each (Table 2). This is an enviable record by any criteria. Will the international companies currently exploring in Canada and Australia extend their operations to Brazil? Since the early '80s dozens of kimberlites were found and investigated in Brazil, from north to south. Their potential is still rather obscure, but the riches already shown in the alluvial deposits are a crude reality. Why not bet some chips in Brazilian diamonds?

Regarding garimpos (artisanal mining), in 1994 DNPM estimated the existence of over 2000 active garimpos for precious metals and gemstones in the whole country, showing a population of ca. 400,000 garimpeiros. For the sake of comparison, mining companies employed about 86,000 people, excluding oil and gas, and nuclear minerals (BRASIL Departamento Nacional da Produção Mineral, 1994). Garimpo production from 1980 to 1993 may have reached the significant amount of 700 tonnes. There are estimates that smuggling derived from all of these garimpos could be in the order

⁶ Abandoned mines are an issue of serious concern for the environment of developed countries. In Brazil, the 1988 Constitution brings an article establishing the owner's obligation to restore the minesite. However, the solution to the problems originated by old abandoned mines and garimpos has unfortunately been delayed. Pressure from the local communities and NGOs is gradually increasing.

Table 2

The largest rough diamonds found in Brazil. From 1937 to 1943 ten stones weighing over 200 carats each were found in west Minas Gerais

	Name	Date of finding	Weight (carats)	Place
1.	None	1739	165.5	Rio Abaeté, MG
2.	Regente or Bragança	1798	144.0	Rio Abaeté, MG
3.	Empress Eugenia	Late 18th century	100.0	Diamantina, MG
4.	Estrela do Egito	1859	ca. 250.0	West MG
5.	Estrela do Sul	1853	254.5	Rio Bagagem, Estrela do Sul, MG
6.	Dresden	1857	122.5	Rio Bagagem, Estrela do Sul, MG
7.	None	1867	105.5	Água Suja, Romaria, MG
8.	Goiás	1906	300.0	Rio Veríssimo, Catalão, GO
9.	Estrela de Minas	1909	179.5	Água Suja, Romaria, MG
10.	Jalmeida	1924	109.5	Rio Bandeira, tributary of rio das Garças, MT
11.	None	1925	195.0	Abadia dos Dourados, MG
12.	Abaeté	1926	238.0	Rio Abaeté, MG
13.	Cruzeiro do Sul	1929	118.0	Rio Bagagem, Estrela do Sul, MG
14.	Coromandel I	1934	180.0	Rio Preto, Abadia dos Dourados, MG
15.	Coromandel V	1935	141.0	Coromandel, MG
16.	Coromandel III	1936	228.0	Rio Sto. Inácio, Coromandel, MG
17.	Tiros II	1936	198.0	Rio Abaeté, Tiros, MG
18.	Tiros III	1936/1937	182.0	Rio Abaeté, Tiros, MG
19.	Patos	1937	324.0	Rio São Bento, Quintinos, MG
20.	Minas Gerais	1937	172.5	Rio Santo Antônio do Bonito, Coromandel, MG
21.	Carmo do Paranaíba	1937	245.0	Carmo do Paranaíba, MG
22.	Estrela do Sul II	1937	140.0	Rio Abaeté, MG
23.	Presidente Vargas	1938	726.6	Rio Santo Antônio do Bonito, Coromandel, MG
24.	Tiros I	1938	354.0	Rio Abaeté, Tiros, MG
25.	Tiros IV	1938	173.0	Rio Abaeté, Tiros, MG
26.	Abadia dos Dourados	1938	104.0	Rio Dourados, Abadia dos Dourados, MG
27.	Darci Vargas	1939	460.0	Rio Santo Antônio do Bonito, Coromandel, MG
28.	Charneca I	1940	428.0	Charneca, rio Santo. Inácio, Coromandel, MG
29.	Coromandel IV	1940	180.0	?
30.	Coromandel VI	1940	400.5	Rio Santo Antônio do Bonito, Coromandel, MG
31.	Governador Valadares	1940	108.0	Tributary of rio Bagagem, Estrela do Sul, MG
32.	Independência	1941	107.0	Rio Tijucu, Ituiutaba, MG
33.	Diário de Minas	1941	375.0	Rio Santo Antônio do Bonito, Coromandel, MG
34.	None	1941	176.0	Rio Paranaíba, Catalão, GO
35.	Vitória I	1942	261.0	Rio Santo Antônio do Bonito, Coromandel, MG
36.	Vitória II	1943	328.0	Rio Santo Antônio do Bonito, Coromandel, MG
37.	None	1944	170.0	Estrela do Sul, MG
38.	Brasília	1947	176.0	Rio Preto, Abadia dos Dourados, MG
39.	João Neto	1947	201.0	Buriti, rio Paranaíba, Catalão, GO
40.	Bonito I	1948	346.0	Rio Santo Antônio do Bonito, Coromandel, MG
41.	Presidente Dutra	1949	408.0	Rio Douradinhos, Coromandel, MG
42.	None	1950/70	100.0	Campina dos Pupos, Telêmaco Borba, PR
43.	J. Kubitschek	1954	174.5	Rio Bagagem, Estrela do Sul, MG
44.	None	1954	108.0	Estrela do Sul, MG
45.	None	1970/80	112.0	Canoas, MG/SP
46.	Charneca II	1971	107.0	Rio Santo Inácio, Coromandel, MG
47.	Charneca III	1971	105.0	Rio Santo Inácio, Coromandel, MG
48.	None	1972	132.0	Rio Santo Antônio do Bonito, Coromandel, MG
49.	None	1979	115.0	Rio Indaiá, Cedro do Abaeté, MG
50.	None	1982	277.0	Fazenda Natália Vilela, Coromandel, MG
51.	Princesa do Carmo do Paranaíba	1986	165.0	Rio São Bento, Carmo do Paranaíba, MG

Source: Barbosa (1991).

of US\$2 billion per year. This means a value between 20% and 30% of the official Brazilian mineral production (excluding oil and gas). The average annual income for each garimpeiro is estimated to be US\$2000.

It is acknowledged that garimpos mean an escape (or informal tax haven) to mitigate high unemployment of unskilled labor in the large urban centers or in areas suffering drought problems. In addition, DNPM does not

have the administrative means to control the activities of 400,000 garimpeiros, most of them scattered in the Amazon jungle.

Final remarks

Only with the advancement of science, mainly in the second half of the 20th century, has it become possible to understand the remarkable differences between the metallogenesis of Brazil and its Andean neighbors. From a geological standpoint, the terrains of older age (Precambrian) predominate in Brazil, commonly in the 3900–600 million years range, that is, from Archean to late Proterozoic. In contrast, the terrains of major occurrence in the western part of South America belong to the Phanerozoic age, thus having less than 600 million years.

In general terms, one could observe that in Brazil there is a conspicuous predominance of siderophile (Fe, Co, Ni, Cr) and lithophile (Al, Mn) elements, whereas in the Andean Cordillera the chalcophile (Cu, Pb, Zn, Cd, Hg) elements are more abundant in the vast majority of mines and economic deposits. Some authors investigated thoroughly the relations between geochemical features, typology of the deposits, and its geochronology, encompassing the major deposits occurring in all the continents, including South America (Meyer, 1985; Barley and Groves, 1992; Veizer et al., 1989). Another interesting reality, also dependent on the geological differences shown by those countries, is related to the vulnerability of Andean countries to seismic waves and to volcanism, something which is absent or negligible in the Brazilian territory. In fact, the younger age of the Cordillera (Mesozoic and Tertiary) implies the incomplete consolidation of these terrains, creating an exposure similar to the phenomena often experienced by the west coast of the US and Japan. In the crystalline shields that constitute most of our territory there was healing of mobile belts, thus acquiring a greater stability.

From the status of a very obscure mineral producer at the end of the 19th century, Brazil is now a major mineral producer, accounting for 83 different minerals and sales exceeding US\$14 billion (1997) (BRASIL Departamento Nacional da Produção Mineral, 1999). The oldest geological terrains (Precambrian) produce iron, manganese, tin, nickel, copper, chromium, cobalt, lead, zinc, asbestos, graphite, quartz and, especially, gold and gems. In the more recent geological formations comprising the Phanerozoic, there are important deposits of oil and gas, niobium, bauxite (aluminum), fertilizers, diamond, agata, amethyst, industrial minerals (kaolin and others), uranium, coal and peat. On the one hand, this endowment allows Brazil to have surplus reserves of asbestos, bauxite, beryl, chromium, fluor spar, gold, quartz, graphite, iron ore, kaolin, lithium, magnesite, manganese, niobium, rare-earths, talc, tantalum, and tin.

On the other hand, Brazil is a net importer of coking coal, cobalt, copper, diamond (powder), lead, molybdenum, oil and gas, platinum and PGM, potash, silver, sulfur, titanium, vanadium, and zinc (Calaes, 1995; Machado, 1995). Exports of primary mineral goods, intermediate and manufactured goods reached US\$11.3 billion (1997). Imports, ditto, were worth US\$11.7 billion. Therefore, mineral trade showed a deficit of US\$400 million.

A difficult exercise was made to assess the cumulative production of gold and diamond in Brazil from the Colonial times up to the year 2000. The best possible figures are shown in Table 3.

The gold resources to be exploited in the future are estimated in the range of 30,000 tonnes, comprising uneconomic resources under current prices, costs, and technology, and also undiscovered resources, based on metallogenetical models. For diamond, it is much more difficult to assess resources due to its peculiarities and extremely low contents in mineralized rocks. One crucial issue is to investigate more thoroughly the potential of the Brazilian kimberlites. Hopefully, undiscovered diamond resources may be a good surprise, considering our historical record (Table 2).

What major developments took place due to the leading actors in the mining sector? Departamento Nacional da Produção Mineral (DNPM), created back in 1934, has experienced chronic problems regarding staffing and

Table 3
Cumulative production of gold and diamonds in Brazil from colonial times up to the year 2000

<i>Gold production in Brazil^a</i>	
Years	Tonnes
Colony (1700–1821)	939
Empire (1822–1889)	161
Republic (1890–2000)	1872 ^b
Total	2972
<i>Diamond production in Brazil^c (gems and industrial diamonds)</i>	
Years	Thousand carats
1728–1947	6066
1948–1957	1934
1958–2000	14,438 ^b
Total	22,438

^a The estimates of gold production were based on several sources: *Colony*: Pinto (1979) and Guimarães (1981); *Empire*: Guimarães (1981) and Abreu (1973); and *Republic*: Guimarães (1981), BRASIL Departamento Nacional da Produção Mineral (1994), BRASIL Departamento Nacional da Produção Mineral (1997), Ferraz (1998); projected figures (1998–2000) were estimated by I.F. Machado.

^b Projected figures from 1998 to 2000.

^c The estimates of diamond production (gems and industrial diamonds) were based on Abreu (1973), and several issues of Anuário Mineral Brasileiro (DNPM), Sumário Mineral (DNPM), Minerals Yearbook (USBM); projected figures (1998–2000) were estimated by I.F. Machado.

budgeting. Responsible for geological mapping of the whole country, preliminary exploration, gathering and analysis of statistical data, and awarding of mineral permits for exploration, and mining concessions for extracting minerals, it combined the tasks of the US Geological Survey, US Bureau of Mines, and Bureau of Land Management in one single institution. Only in 1969 were its responsibilities split with CPRM, this latter being onwards in charge of geological mapping, mineral exploration, and survey of hydrological data. The overall project planning, however, remained in the hands of DNPM until recently. Its maximum prestige occurred in two different periods — 1942–45 and 1957–70 — and after that it never recovered. The first one is marked by World War II, when a comprehensive program was achieved through co-operation between Brazilian and American scientists and engineers. Dozens of important projects about major mining districts were achieved by this hard-working team. The second period resulted from the awareness of government policymakers that it would be desirable to promote a new growth phase of the mining industry. This growth would meet not only the domestic demand, but also would generate surplus for export. The award of a new mining code that boosted the mineral production, and a very comprehensive appraisal of our mineral potential (First Ten-Year Master Plan) belong to this fruitful period. Systematic studies on the mineral economy of Brazil also started at this period. In spite of those efforts, the oil embargo imposed by the Arabs on the world economy in 1973 would change definitively the international demand for minerals, and with it the highly optimistic Brazilian expectations. Regarding mineral exploration, the '80s are considered the “lost decade”, as the expenditures suffered a significant drop and the situation worsened after the 1988 Constitution. Following the extinction of IUM (sole tax for minerals) and the restraints imposed by the new Constitution to foreign capital, DNPM faced a long period characterized by political and financial problems. Even changing its administrative nature to the status of “autarquia”, more independent than the former situation, this did not help DNPM to revitalize itself.

Companhia de Pesquisa de Recursos Minerais was born in 1969, aiming to boost mineral exploration in Brazil, considered to be lagging behind other countries. Some policymakers stated that the '50s saw the mineral boom in Canada, the '60s in Australia, and the '70s would certainly be in Brazil. Unfortunately, the 1st Oil Shock in 1973 meant a shift in international mineral industry policies, directing investment money to safer countries (Canada, Australia, and South Africa). Unfortunately, CPRM was penalized by this change, and then the growth indices in exploration and production suffered a significant drop since those times. Anyway, CPRM has diversified its activities (GIS, land management) and accomplished a remarkable number of

important projects, supplying valuable data (geological, GIS, geochemical, and geophysical) to the private sector, as well as the public sector. In addition, CPRM privatized over 20 mineral deposits (gold, coal, peat) in the last decades.

Companhia Vale do Rio Doce was established mainly because the Brazilian government signed the “Washington Agreements” during World War II, with the US and the UK desperately needing to import iron ore from Brazil to build their war machines and armaments. The original target was to produce 1,500,000 tonnes of iron ore, but this was only accomplished in 1952 (Machado, 1989). In 1997, CVRD produced 117 million tonnes (ore and pellets), and exported 80 million tonnes (Ferraz, 1998). Diversifying into aluminum, manganese, phosphate rock, potash, gold, pulp, steelmaking, and kaolin, its revenues exceeded US\$2.5 billion in 1997. It is the largest Brazilian exporter, as a single company, bringing more foreign earnings than any transnational operating in Brazil. That is why it was considered the “crown jewel” of the Brazilian Privatization Program (Machado, 1997).

Petrobrás was always criticized by Brazilian right-wing politicians, industrialists, and economists, who preferred that oil production would remain in the hands of the private sector. Starting very modestly, it produced 3000 barrels a day in May 1954 (see Petrobrás history in Machado, 1989). Now it produces over 1,000,000 barrels a day, mainly from offshore fields, supplying half the domestic consumption. Investing more heavily in R&D than a typical Brazilian company, Petrobrás has developed a sophisticated technology to explore in a deep water environment. It is the largest enterprise in Latin America (revenues of US\$25.901 billion in 1998) and is eagerly desired to be privatized. Many people and organizations oppose this idea, but the government will likely do it when a new economic crisis occurs.

Nuclear minerals were submitted to several government agencies created during the 20th century (Comissão Nacional de Energia Nuclear, Companhia Brasileira de Tecnologia Nuclear, Nuclebrás, and others), but nowadays they have lost their high profile as was the case in the middle of the 20th century. The issue of nuclear energy in Brazil was downgraded when other countries started to question the safety problems of nuclear plants around the world (Three Mile Island, Chernobyl, and others). Currently, Brazil has just one plant in operation (Angra 1), responsible for less than 1% of the electrical energy generated in this country.

Trying to summarize in a few words the accomplishments of Brazilian companies, both private and state-owned, in the 20th century, the authors add some comments:

1. The legacy of gold and diamond mining from past centuries did not influence the behavior of our

entrepreneurs in a desirable fashion. Even though Brazil was a leading producer of gold and diamond since the first half of the 18th century, this did not create a tradition in our businessmen's minds. Maybe mining is considered too risky an endeavor for the typical Brazilian entrepreneur, in contrast to the assessment made by Americans, Canadians, Australians, Chileans, and Peruvians. There are clear indications of this possibility. Several large Brazilian mining companies or conglomerates do not spend millions of US dollars per year in exploration projects. They would prefer to acquire operating mines from third parties or show up in privatization auctions backed by banks and pension funds. Even CVRD (the giant iron ore exporter) waited almost 50 years to start a diversification program into gold production. And CVRD was geographically in the very core of centennial gold mines in Minas Gerais state. Regarding diamonds, the behavior of our entrepreneurs was still more frustrating. There is currently more excitement about diamonds in Angola than in Brazil. No venture capital is originated here to tackle these promising possibilities. Junior companies come from abroad to fill the gap. Thus, to the best of our knowledge there is indeed a risk-aversion culture hindering our geological potential;

2. The fuel-minerals desperately needed by our economy had to be produced and backed by the presence of the Brazilian State, either as a monopoly (the example of Petrobrás), or in the form of generous fiscal incentives (the case of coal). The size of the oil and gas industry, coupled with the presence of powerful foreign competitors, was always frightening to our conservative entrepreneurs. The only exceptions were marked by tiny oil refineries located in Rio de Janeiro, and Rio Grande do Sul;
3. Some initiatives driven by the talent of our private companies led to the production of iron ore, manganese, niobium, bauxite, aluminum, cassiterite, tin, nickel, zinc, magnesite, and scheelite. However, they were more comfortable producing cement, lime, phosphate rock, graphite, talc, granite, marble, clay, sand, and crushed stone. All of the latter are commodities with a very low technological content. When high risk appears, then we have the figure of the *garimpeiro* extracting quartz, feldspar, mica, clay, cassiterite, tantalite, and gems of all kinds, from very heterogeneous deposits, and last but not least, gold and diamonds, both famous for their extremely low grades;
4. It would be hard to imagine the performance of the mining industry in the 20th century without the participation of state mineral enterprises like CVRD and Petrobrás. Both are present at the gallery of the most admired corporations, and have had a strong influence upon several generations of engineers, geologists, and other professionals;

5. When the 1988 Constitution was amended in 1995, a host of opportunities were opened to joint ventures between Brazilian and foreign companies. It is foreseeable that this arrangement will be very promising for the growth of the mining industry in the coming years. The major contribution of the foreign company will surely be technology plus market channels. The expansion of the Brazilian domestic market would be a leverage for most industries, but this depends on the improvement of income distribution at the lower levels of our society.

Lastly, the establishment of Agência Nacional de Mineração (new agency responsible for awarding exploration permits and mining concessions) in the near future is expected to bring a better functioning of government in its relationship with industry. It is highly desirable that the public sector (federal and state governments) improves its legal framework and administrative procedures regarding environmental protection of mining sites, following a universal trend. However, very stringent measures could scare away some foreign companies. For the well-being of present and future generations, sustainable mining shall be the motto for the 21st century.

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