MINISTERIO DE MINAS E ENERGIA
COMPANHIA DE PESUISA DE RECURSOS
MINERAIS

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

PROJECT REPORT
Brazil Investigations
(IR)BR-74

TUNGSTEN RESOURCES OF BRAZIL

U. S. Geological Survey
OPEN FILE REPORT

1974

TUNGSTEN RESOURCES OF BRAZIL

By

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ABSTRACT

Brazilian tungsten production, 85 percent of which is exported, comes almost entirely from scheelite-bearing tactites in northeast Brazil, and has reached an annual rate of about 2,000 metric tons (2,200 short tons) of scheelite concentrate with 70 percent WO_3. Scheelite ore reserves, located principally in the State of Rio Grande do Norte, are estimated to be as high as 8,300,000 tons (9,100,000 short tons) containing 0.7 percent WO_3.

Minor deposits (or those about which only minimal information is available) of wolframite, with which some cassiterite is associated, are located in São Paulo, Santa Catarina, and Rio Grande do Sul.

Both the scheelite and the wolframite deposits are considered to be late Precambrian A (620 to 900 m.y.) or early Cambrian in age.

INTRODUCTION

The principal tungsten resources of Brazil are found mainly in the State of Rio Grande do Norte in scheelite concentrations in tactites of Late Precambrian age, and also in similar occurrences in the State of Paraiba. Annual production of scheelite concentrate amounts to about 2,000 tons, 80 percent of which is won by mechanical mining and 20 percent by prospectors (garimpeiros) using primitive manual means of extraction. About 65 percent of the total production

comes from just two operations--the Brejui Mine and the Barra Verde Mine, both located on different parts of the same ore body, 8 km southwest of Currais Novos in Rio Grande do Norte.

The deposits were discovered during World War II in the course of a program of investigation of Brazil's strategic minerals undertaken jointly by the governments of Brazil and the United States. Production on a small scale was started early, but development of the deposits was slow, due largely to a lack of basic information on the geologic setting of the deposits and of reliable estimates of the magnitude of reserves in the district; the apparent lack of reserves did not encourage investment in the development of the deposits.

In the 1960s the Departamento Nacional da Produção Mineral (DNPM) and the Companhia de Pesquísa de Recursos Minerals (CPRM) jointly with the U. S. Geological Survey and the U. S. Bureau of Mines undertook a comprehensive program of investigations that included making an inventory of known deposits, geologic mapping, drilling, ore dressing tests, mill design, and a study of the mineral economics of the deposits in an attempt to develop the basic information needed to stimulate development. Upwards of 85 scheelite occurrences are known in the district, and new discoveries are being made each year. Reserve estimates made as a result of the studies are of the magnitude of 8,000,000 tons of scheelite ore containing 0.7 percent WO_3. Of potential economic value as a byproduct in the scheelite concentrates is about 0.2 percent molybdenum, mainly molybdenite. No recovery of this mineral has yet been attempted.

Acknowledgment

The writer expresses his appreciation to Frederico L. M. Barboza, geologist of the Departamento Nacional da Producão Mineral at Recife, formerly chief of the field project of geologic investigations of the northeast Brazil tungsten deposits, for reviewing the manuscript of this report and for his valuable suggestions and contribution of data to it.

TUNGSTEN RESOURCES

Production and development

The greater part of Brazilian tungsten production comes from deposits and occurrences of scheelite-bearing tactites in a district centered in Rio Grande do Norte, northeast Brazil (fig. 2) Minor deposits of wolframite in greisen zones associated with granitic intrusives are found in São Paulo, Santa Catarina, and Rio Grande do Sul (fig. 1). All deposits are of Late Precambrian or early Paleozoic age. Official production figures published by the DNPM (1972-a) and Barboza (1973) for the period 1960-1972 of concentrate containing a minimum of 70 percent WO_3 are as follows:

Table 1. Production of tungsten concentrates (minimum 70 percent WO_3) from Rio Grande do Norte for 1960-1972.

	Metric tons (1 metric ton equals 1.1 short tons)		
	Scheelite	Wolframite	Total
1960	1,410	10	1,422 ?
1961	1,029	15	1,044
1962	1,034	72	1,106
1963	463	148	609 ?
1964	319	35	354
1965	318	102	420
1966	736	22	758
1967	776	10	786
1968	1,012	--	1,012
1969	1,583	--	1,583
1970	2,204	6	2,210
1971	2,357	--	2,357
1972	1,965	18	1,983

Exploration and development of the tungsten deposits of northeast Brazil have been given a considerable boost through field projects of DNPM and CPRM, undertaken since about 1967. The purpose of these studies has been to determine the magnitude of scheelite reserves in the district, the geologic setting of the deposits, and the mineral economics of improving production from the district. The resulting better knowledge of the deposits of the northeast has stimulated the private sector to greater investment in organized mining operations. The number of active, registered mines in the district has risen from one in 1967 to seven in 1971 and, indicative of interest in exploration and mining development for tungsten, the number of exploration licenses has also increased, 16 having been issued by the DNPM in 1970-71. The mining concessions and exploration licenses issued by the DNPM, the licensing authority of the Government of Brazil, are as follows:

Tungsten mining concessions as of 1971:

	Number
Rio Grande do Sul	1
Rio Grande do Norte	7
Paraiba	1
Sao Paulo	2
Santa Catrina	1
	12

Tungsten exploration licenses issued 1970-1971:

Rio Grando Norte	16
Paraiba	4
Ceara	1
Bahia	1
Minas Gerais	1
Rondonia	14
	37

Reserves

Published official figures (DNPM 1972-a) for tungsten ore reserves are largely those for the scheelite district of northeast Brazil, as follows:

Metric tons
(1 metric ton equals 1.1 short ton)

	Proved	Probable	Possible	Percent WO_3
Rio Grande do Norte...	574,000	1,307,000	1,216,000	1.0
São Paulo.....	250,000	---	---	0.5
Santa Catarina.....	6,192	7,000	10,000	NA
	830,192	1,314,000	1,226,000	

These figures probably reflect reserves that have been registered by DNPM from reports by various concessionaires in official documentation relating to mining concessions and do not necessarily reflect figures for total reserves. Total estimated ore reserve figures published in the literature, some of them derived from results of DNPM field investigations, are listed below. In an economic analysis of the Tungsten resources of the district, the following reserve figures have been published by Barboza (1972) of the DNPM.

	Total ore reserves (tons)	Percent WO_3
Rio Grande do Norte and Paraiba	8,300,000	0.7
São Paulo	500,000	0.5 to 1.0
Santa Catarina	25,000	NA
Rio Grande do Sul	300,000	1.0
Total	9,125,000	

These estimates of tungsten reserves places Brazil in a comparable position to other countries that have substantial tungsten resources. The following are reserves of tungsten metal in selected countries, based on U. S. Bureau of Mines estimates (USBM, 1970, p. 403)

	Tons	
	Metric	Short
Brazil	90,000	99,000
China	970,000	1,067,000
Bolivia	36,000	40,000
USA	78,000	87,000
USSR	12,000	13,500
South Korea	45,000	50,000
Burma	31,800	35,000

Exports and imports

Brazil's tungsten production satisfies most of the needs of the country's industry; in 1972 only about 90 tons of metal and semi-manufactured product were imported and much of the production is exported. The following figures are published by DNPM (1972-a) on exports for the decade ending in 1971:

	Tons of concentrate with 70 percent WO_3
1961	875
1962	625
1963	796
1964	328
1965	426
1966	340
1967	420
1968	670
1969	1,408
1970	1,639
1971	2,265
1972	1,723

A consistently large percentage of Brazilian exports of scheelite concentrate went to France and the Benelux countries in the mid-1960s. In the past few years an increasing percentage has gone to the German Democratic Republic, the Federal Republic of Germany and to Sweden, the latter absorbing 50 percent of Brazilian exports in 1972. Exports to the United States gradually decreased from as much as 50 percent in 1960 to zero during the years 1966-1970. In 1972 only 2 percent of exports were to the United States (Barboza, 1972).

Brazilian exports of tungsten metal and semi-manufactured products are small and amounted to only about 90 tons in 1972.

Principal producers of tungsten in Brazil

Mineracão Sertaneja, Rua do'Brum, no. 261, 50000, Recife, Pernambuco	Cafúca Mine, Quixába Mine, Rio Grande do Norte.
Mineracão Tomás Salustino Rua Vivaldo P. de Araujo, no. 32, 59380, Currais Novos, Rio Grande do Norte	Brejuí Mine, Bomfim Mine, Rio Grande do Norte.
Bodominas, Metalurgia e Industria, Avenida General Justo, no. 307, 4 andar, 20000, Rio de Janeiro, GB	
Mineracão Nova Trento Rua Groelandia, no. 339, 88270, São Paulo, SP	Nova Trento, Santa Catarina

SCHEELITE DEPOSITS

Northeast Brazil

Location

More than 250 scheelite deposits or occurences in the State of Paraiba, Rio Grande do Norte, and Ceará (fig. 2), are scattered in an area 275 km east-west and 150 km north-south (202 by 93 mi). The majority of the deposits and most of the mining production is from Rio Grande do Norte. (Table 2, p.14).

Geologic setting of scheelite deposits

Predominantly, the scheelite deposits occur in tactite (Johnston, 1945; R. H. Nagell, written commun.), located within beds of crystallized limestone and in limestone at the contact with gneiss or schist. Most of the tactite zones are about 1 meter thick but may be as much as 10 meters thick at the limestone-gneiss contact. Scheelite is also disseminated within crystalline limestone adjacent to some

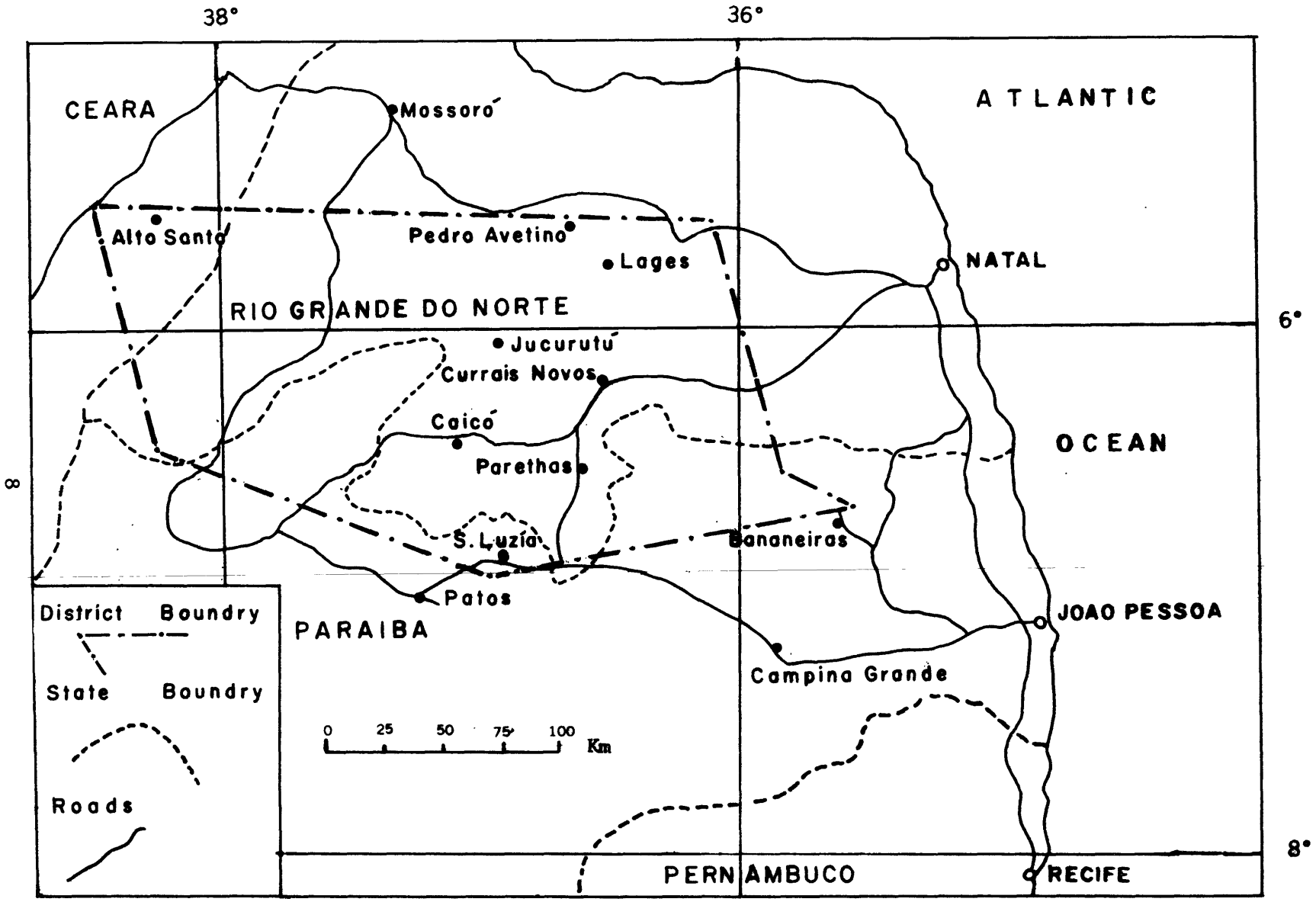

Figure 2. Location of scheelite district, Northeast Brazil

tactite zones. A few deposits have been found in gneiss having diopside as the predominant mineral, but such a host is more appropriately considered a calc-silicate rock rather than a tactite (Maranhão and Maranhão, 1971). Scheelite has been found in quartz veins in many localities in the district and in one, the Carnaubinha deposit south of Currais Novos in Rio Grande do Norte, is found not only in quartz veins, but also as breccia filling in a fracture zone. The deposit has a reserve of about 10,000 tons (11,000 short tons) of 1.75 percent WO_3 ore to a depth of 40 m (Maranhão, 1972).

The composition of the tactites varies considerably within the district, with garnet, epidote, vesuvianite, diopside, and quartz variously as the predominant mineral. Also present with scheelite are calcite, fluorite, wollastonite, zoisite, feldspar, pyrite, and sulfides of molybdenum, bismuth, and copper. Molybdenum may substitute for tungsten in the scheelite. The highest content of Mo reported is 3.0 percent, but Mo is generally about 0.2 percent in the Brejui Mine concentrate believed to be mainly in molybdenite. Other than scheelite, the molybdenite is the only mineral having economic potential in many of the deposits.

The strike length of the tactite bodies can be as much as 10 km, (6.2 mi) but generally is no more than 1,500 to 1,800 m (4,920 to 5,900 ft) in deposits having economically minable reserves.

The scheelite-bearing tactite bodies are in the Seridó Formation, the upper unit of the Ceara Group of Precambrian A (620 to 900 m.y.) age (DNPM, 1972-c). The age of the tungsten mineralization is reported (Maranhão, 1972) to be 550 m.y., of Cambrian age, or in Brazilian terminology (DNPM, 1972-b), Upper Eocambrian age.

The only tungsten deposit other than of scheelite so far described for the district is one of ferberite (de Melo, 1970) in the Municipio de Pedro Avelino (lat. 5°31', long. 36° 31') 10 km (6.2 mi) north of the Serra do Feiticeiro in northern Rio Grande do Norte. The ferberite, and associated tourmaline, occurs in one or more quartz veins as much as 70 cm in width (27.6 in.) and as impregnation in a greisen zone in metasedimentary rocks of the Ceará Group. Some small production by prospectors has been undertaken, but no information is available on the size of the deposit.

Brejui Mine

The Brejui Mine is located 8 km (5 mi) southwest of Currais Novos in Rio Grande do Norte; it is operated by Mineração Tomas Salustino, and is by far the largest and best known in the scheelite district of northeast Brazil. It is briefly described here as illustrative of the deposits in the district (DNPM, 1969).

The mine is on the southern part of a scheelite-bearing north-striking zone of tactite almost 9 km (5.6 mi) long both within limestone interbedded in gneiss and adjacent to the upper and lower limestone-gneiss contact. Tungsten in most of the 9-km length of the tactite zone is of submarginal value and only the southernmost 1,800 m (7,000 ft) contains economic concentrations of scheelite. On this part of the tactite zone, in addition to the Brejui Mine, are located the Barra Verde and the Boca de Lages mining concessions, immediately adjoining to the south. To the north of the Brejui Mine, exploration work has been done in the tactite zone in the inactive Quixabeiral mine concession. In the area of these mining concessions, the mineralized tactite zone is as much as 1,300 m (4,300 ft) wide,

and the structure is an open syncline plunging about 5° S. Scheelite is present in several tactite bodies and in limestone across the entire width of the zone, but the average grade for this width is less than 0.3 percent WO_3. The tactite layers are only about 0.5 m (1.6 ft) thick. In the Brejui mining concession the minable tactite zone is about 150 m (490 ft) wide and contains less than 1.0 percent WO_3.

Six tactite layers are present in the mine, designated A through F, of which four contain minable ore. Tactite A is the richest and most extensive layer and is at the contact of limestone and overlying gneiss. Tactite B consists of discontinuous lenticular masses of tactite within the limestone. Tactite C is at the upper contact of a discontinuous layer of gneiss that lies within the limestone, and Tactite D is at the lower contact of this gneiss with the limestone. Tactite E is weakly developed at the contact of the limestone with the underlying gneiss. Tactite F, generally barren of tungsten mineralization, lies within the lower gneiss.

Scheelite is irregularly distributed within the tactite layers and, although it may be uniformly distributed in the entire thickness of a layer, is commonly found in richer or poorer zones within the layers. The tactite bodies vary considerably in thickness, from a few centimeters to as much as 15 m (48 ft), and lie unconformably within the bedding of the limestone. Quartz-rich, scheelite-bearing tactite veins transect the limestone and appear to be fracture fillings. These are parallel to a north-trending fault set within the Brejui Mine area.

Detailed mapping and accompanying drilling of the Brejui Mine deposit along with some exploratory investigation of the adjoining mining concessions, undertaken by geologists of a joint DNPM/USGS project reveal the presence of a substantial reserve in the entire deposit, containing an average of 0.7 percent WO_3 and 0.2 percent Mo.

Brejui has been in continuous production since 1943. In the decade ending in 1972, the mine had an average annual production of 510 tons (560 short tons) of scheelite concentrate containing about 70 percent WO_3, most of which was exported. In 1971 the mine produced 1,140 tons (1,254 short tons) of concentrate (Porto, 1973). No molybdenite was produced. Milling capacity at Brejui is 300 tons of ore per 24 hour day, producing 2.5 tons of concentrate containing about 70 percent WO_3.

Production, reserves, and resources potential

In 1971 there were seven mines in operation in the tungsten district of northeast Brazil, six in Rio Grande do Norte and one in Paraiba. The production from these and from numerous unregistered operations of prospectors (garimpeiros) was 2,357 tons (2,593 short tons) of concentrate containing 70 percent WO_3, 77 percent of the production coming from the Brejui Mine (DNPM, 1972-a and Porto, 1973). ≈ 1815 t

Total ore reserves published by the DNPM (1972-a) for Rio Grande do Norte, in which the greater number of scheelite deposits are located, are estimated to be 3,097,000 tons (3,400,000 short tons) having a grade of 1.0 percent WO_3. The figure probably reflects reserves reported to DNPM by various concessionaires in official documentation relating to the six registered mines or the sixteen exploration concessions granted

in the state. Other published figures (Barboza, 1972) calculated from several years of mineral investigation in the district by a DNPM field project show a total of 8,300,000 (9,100,000 short tons) of ore containing an average of 0.7 percent WO_3, in 85 deposits in the district (72 in Rio Grande do Norte, 10 in Paraiba, and 3 in Ceará).

Information was compiled during field investigations in the region in 1967-1969 by R. H. Nagell, U. S. Geological Survey (written commun.), in which he classified 72 scheelite deposits (7 in Paraiba and the remainder in Rio Grande do Norte) according to size of estimated reserves, as shown on table 2.

Table 2. Deposits of scheelite ore averaging 0.7 WO_3 in northeast Brazil

A. Deposits reported to contain between 1,000 and 25,000 tons of scheelite ore.

Rio Grande do Norte

Name of deposit	Municipio in which located
Cabeça Vermelha	Acari
Mulunga	Ipanguacu
Bras No. 3	Jardim de Piranhas
Lagôa Rachada	Jardim de Piranhas
Morro de Santana No. 2	Jardim de Seridó
São Roque	Jardim de Seridó
Terto	Jardim de Seridó
Baixio	Jucurutú
Quixaba	Jucurutú
Riachão	Jucurutu
Pedra Vermelha	Lages
Ubuia	Lages
Vereda do Meio	Lages
Abrigo	Santana do Matos
Baixios	Santana do Matos
Bodó	Santana do Matos
Cafuca	Santana do Matos
Laranjeira	São Fernando
Santa Clara No. 1	São Fernando
Santa Clara No. 2	São Fernando
Serrote	São Fernando
Vassouras No. 5	São Fernando
Craibeira	São João do Sabugí
Quixeré	São João do Sabugí
Riacho das Pedras	São João do Sabugí
Cavalo Branco	São Rafael
Corôa Grande	São Rafael
Corôa Verde	São Rafael
Pindoba 4	São Rafael
Saco da Onca	São Rafael
Matinha	São Tomé
Morada Nova	São Tomé
Morada Nova	São Tomé
Oiticica	São Tomé
Roca 2	São Tomé
Paraiba	
Timbaúba	Frei Martinho
Goité	Santa Luzia
Riacho do Negro	São João do Espinhara

B. Deposits reported contain more than 25,000 tons of scheelite ore.

Rio Grande do Norte

Name of deposit	Municipio in which located
Carnaubinha	Acarí
Logradouro	Carnauba dos Dantas
Trapin	Cerro Corá
Barra Verde	Currais Novos
Brejuí	Currais Novos
Malhada Limpa	Currais Novos
Quixabeiral	Currais Novos
Saco dos Veados	Currais Novos
Malhada do Angico	Jardim do Seridó
Agua Fria	Jucurutú
Alto do Cão	Jucurutú
Barra de Santana	Jucurutú
Bonito	Jucurutu
Carnauba	Lages
Bomfim	Lages
Riachão do Bodó	Santana do Matos
Santa Terezinha	Santana do Matos
Ferreiro	São Rafael
Cajazeira	São Rafael
Floresta	São Rafael
Poço da Raiz	São Rafael
Malhada dos Tanques	São Tomé
Pedra Prêta	São Tomé
Pedra Prêta de Baixo	São Tomé
Serra dos Louros	São Tomé
Gupiára	São Tomé
Caçimbas	Serra Negra do Norte
Umburana	Serra Negra do Norte
Velame	Serra Negra do Norte
Riacho do Joá	Varzea
Paraíba	
Ilha Grande	Junco
Barrandão	Santa Luzía
Poço Escondido	Santa Luzía
Malhada Vermelha	São José do Sabugí

In addition three deposits are reported to contain large potential reserves of scheelite ore, but no estimates of reserves are available: The Macacos deposit in the Municipio de São Rafael, the Diniz deposit in the Municipio de Jardim de Piranhas, both in Rio Grande do Norte, and the Agua Fria deposit in the Municipio de Santa Luzía in Paraíba.

Rio Grande do Sul

Location

The tungsten resources of Rio Grande do Sul are in wolframite deposits in the tin-tungsten district of Municipio de Encruzilhada do Sul in the southern part of the State, about 135 km (85 mi) air line distance southwest of Porto Alegre.

Geologic setting of the wolframite deposits

The wolframite deposits of the Encruzilhada do Sul tin-tungsten district (Teixeira, 1937) are in the northern part of the district. The principal deposits are the Cerro d'Arvore and the Sanga Negra (Leinz and Pinagel, 1945; Guimaraes, 1945), located about 25 km (15.5 mi) west of the city of Encruzilhada do Sul. The cassiterite deposits in the southern part of the district are summarized by White (1974) in a report on the tin resources of Brazil.

The wolframite is in two sets of vertical quartz veins and in greisen in granite porphyry that intrudes metasedimentary rocks of the Porongos Group of Precambrian A (620-900 m.y.) age (DNPM, 1972-c). Wolframite is the principal ore mineral in the veins, associated with pyrite, arsenopyrite, chalcopyrite, beryl, topaz, tourmaline, and flourite. The veins are as much as 35 cm (13.8 in.) wide and 1,500 m long (4,920 ft). Cassiterite is commonly found in the granite wall rock which has been slightly greisenised to distances of 10 to 30 cm

(3.94 to 11.8 in.) on each side of the veins. The greisenized rock contains about 0.5 percent cassiterite.

Production, reserves, and resources potential

Wolframite was mined early in this century from the Cerro d'Arvore and the Sanga Negra deposits where small concentration plants were installed. Prior to 1910, production from Sanga Negra was from quartz veins 30 cm (11.8 in.) wide, mined to a depth of 30 meters (98.4 ft). At Cerro d'Arvore production was about 3 tons (3.3 short tons) of wolframite concentrate per month, which included both vein material and placer deposits. These operations appear to have closed down at about the time of World War I. Since then the deposits have been mined only on a small scale by prospectors, notably during World War II. Little exploratory or development work appears to have been done on the deposits in later years, and yet it is possible that they could become an important source of tungsten ore. Abreu (1962) reports that the wolframite deposits of the Encruzilhada do Sul district contain about 1.0 percent WO_3 and that reserves are estimated at 300,000 tons (330,000 short tons) of ore. In 1971 the DNPM reported (DNPM, 1972-a) granting concessions for one tungsten mine in Rio Grande do Sul, the only registered mine in the state. In that year no exploration licenses for tungsten were requested or issued.

São Paulo

Location

Two tungsten deposits in the southeast part of São Paulo state contain wolframite. One is the Inhandjara deposit 27 km (6.8 mi) by road west of the city of Jundiaí, 2.5 km (1.55 mi) southwest of the village of Itupeva; the other is the Serra de São Francisco deposit located 20 km (12.4 mi) southwest of the city of Sorocaba.

Geologic setting of the deposits

In the Inhandjara deposit the ore minerals are found in quartz veins that cut greisenised granite and gneiss of Proterozoic, possibly Precambrian A, age (620 to 900 m.y.). The granite stock has intruded the gneiss, and the ore control is related to the contact between the two. The veins fill two sets of fractures which trend N. 45° W., and N. 30° E. The principal ore mineral is wolframite, present in amounts as high as 1.0 percent, with minor cassiterite, associated with 4 percent topaz, rare fluorite, and an assemblage of minor amounts of sulfides including pyrite, chalcopyrite, sphalerite, galena, molybdenite, and bismuthinite, which together may constitute as much as 1.5 percent of the ore.

The deposit is reported to be of hypothermal origin (Saldanha, 1946), the rhythmic emplacement of high- and low-temperature minerals resulting in a telescoped deposit.

The Serra de São Francisco deposit is similar to the Inhandjara deposit (Saldanha and Franco, 1946) and consists of a central core of greisenised granite porphyry and bordering aplitic granite that intrudes metasedimentary rocks of Precambrian A age. The area of greisenized granite is at least 4 km (2.5 mi) long by about 1 km (0.62 mi) wide in which are numerous mineralized quartz veins and greisen zones. One prominent set of veins trends N. 20° W., and a less pronounced one trends N. 13° E. (Knecht, 1946). The wolframite occurs in varying amounts in almost all quartz veins, which are as much as 1 m wide in the greisen zones, and may be associated with sparse cassiterite and with pyrite, arsenopyrite, and chalcopyrite. Numerous tungstite occurrences are reported. No wolframite has been found as

impregnations or disseminations in the greisen (Barbosa and Maciel, 1951). As much as 5.0 percent bismuth is found as a secondary mineral associated with galena and arsenopyrite in some of the quartz veins.

Cassiterite, with molybdenite, flourite, topaz, tourmaline, and axinite is disseminated and impregnated in greisen and to a lesser extent in quartz veins with wolframite, chalcopyrite, galena, sphalerite, arsenopyrite, and topaz. In the greisen the tin values can run as high as 2.5 to 5.0 percent, the highest where tourmaline is most abundant.

Production, reserves, and resources potential

The Serra de São Francisco deposit was discovered in 1936 and the Inhandjara deposit in 1941. Economically, both are considered to be primarily wolframite deposits and secondarily, cassiterite deposits. Both have been mined in the past, though neither, it appears, is in current production (Abreu, 1962, v. II, p. 372). As of 1946, tungsten and some tin were produced at the Serra de São Francisco, and a mill treated 100 tons of ore per day. No figures are available for ore reserves; it does not appear that any extensive mineral exploration and development work has been done on the deposit. Considering the size of the greisen zone, and the extent to which it is reported to be mineralized in surface exposures, it would seem that a detailed investigation is warranted.

Mining at Inhandjara, mostly of eluvial material, was started in the early 1940's by the Sociedade de Mineracão Inhandjara, and a mill on the property produced 15 tons of concentrate per month containing 65 percent WO_3. Minor amounts of cassiterite were also produced. In the 1950's the property was acquired by the Wah Chang Corp.

which undertook exploration, development, and mining of the deposit. Production there continued until mining was closed down in about 1960. Abreu (1962) reported reserves at Inhandjara to be 500,000 m tons (550,000 short tons) of ore, containing 0.5 to 1.0 percent WO_3.

Santa Catarina

A wolframite deposit at Morro da Catinga is at the confluence of the Rio Alto Braco and Macacos Creek in the Municipio Nova Trento in the State of Santa Catarina (lat 27°17'; long 48°15') (Leonardos, 1942, p. 240; Abreu, 1973, v. II, p. 566, and Barboza, 1973).

The deposit consists of several quartz veins, maximum width of 20 cm (7.2 in.), cutting phyllite near a contact with a granitic intrusive. Some cassiterite is found in the wall rock of the veins. A minor amount of wolframite has been produced over the years from this deposit. It is reported that in 1972 (Barboza, 1973) 18 tons of concentrate was produced which contained 70 percent WO_3.

The DNPM reports (DNPM, 1972-a) a total of 23,200 m tons (25,500 short tons) of tungsten ore (no tenor given) in Santa Catarina, presumably from the Morro da Catinga deposit. The mining concession is held by the Mineracão Nova Trento, S. A. An expansion of production was to have taken place in 1973.

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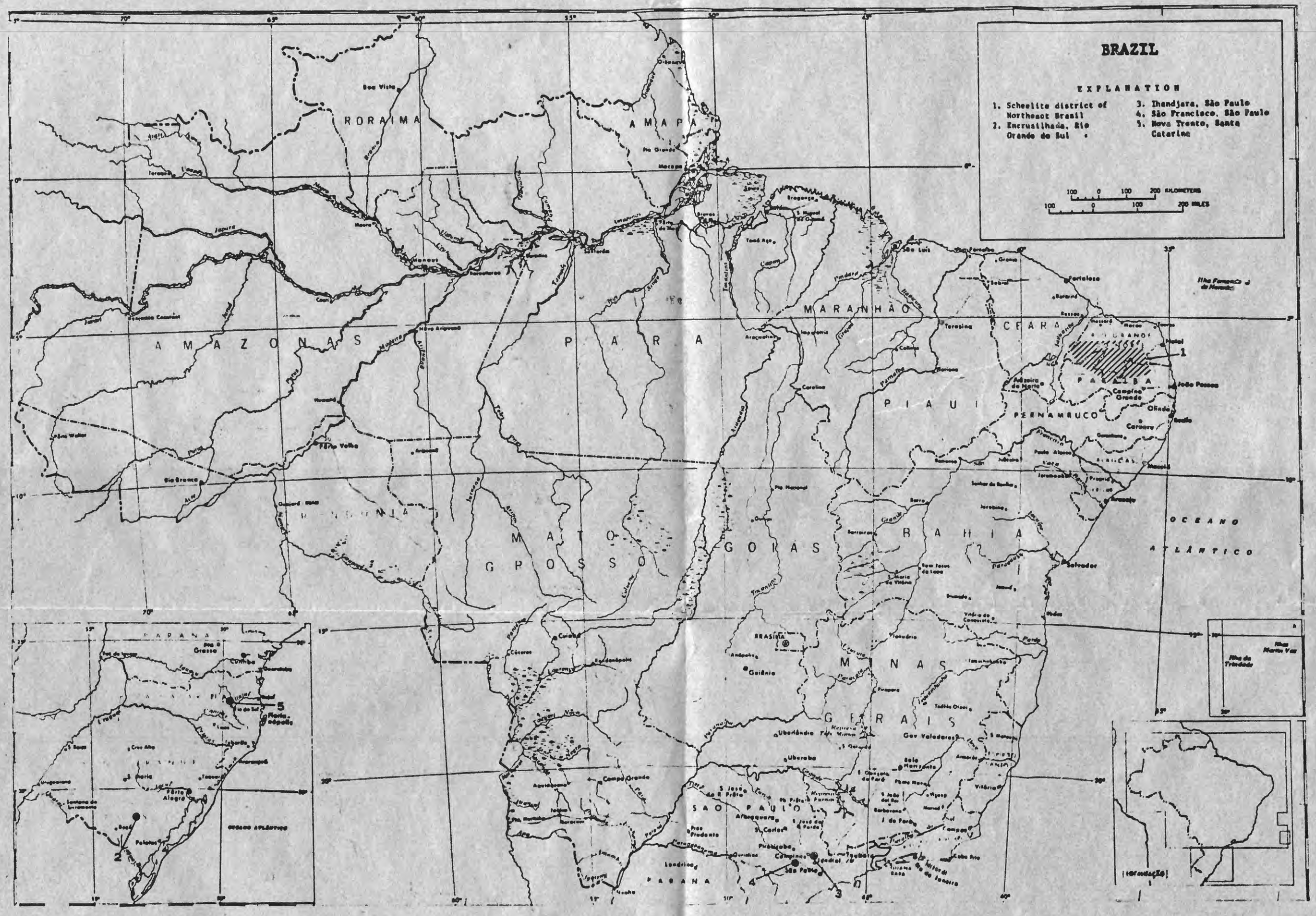

Figure 1. Location of tungsten deposits of Brazil