COMPANHIA DE PESQUISA DE RECURSOS MINERAIS – CPRM

GEOLOGICAL SURVEY OF BRAZIL

COAL IN THE STATES OF RIO GRANDE DO SUL AND SANTA CATARINA

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DEPARTAMENTO DE RECURSOS MINERAIS

COAL IN THE STATES OF RIO GRANDE DO SUL AND SANTA CATARINA

Telmo Süffert

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TECHNICAL TEAM

Geology and Mineral Resources Manager
Luiz Fernando Fontes de Albuquerque

Mineral Resources Supervisor
Sérgio José Romanini

Execution
Mining Engineer Telmo Süffert

Typing
Cláudia Rejane B. Prates
Gualtério Souto Cássia

Editing
Pedro da Silva

Digital Recording/Illustrations
Ademir Evandro Flores

S946 Süffert, Telmo

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Cover: Location of the main cover deposits in Rio Grande do Sul and Santa Catarina

SUMMARY

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1
Introduction

Coal resources identified in Brazil surpass 32 billion tons and are located in the region covered by rocks in the Paraná Basin, in the States of Rio Grande do Sul (RS) and Santa Catarina (SC) and, secondarily, in the States of Paraná (PR) and São Paulo (SP).

The Brazilian deposits of major importance are eight: Sul-Catarinense (SC), Santa Terezinha, Chico Lomã, Charqueadas, Leão, Iruí, Capané and Candiota (RS).

Companhia de Pesquisa de Recursos Minerais – CPRM, which carried out intensive mineral research on coal in the 70's and 80's, is the principal responsible party for the present level of knowledge of our reserves, and owns 105 Prospection Permits, corresponding to an equal number of areas located in seven of those deposits.

In this review, CPRM areas showing the most favorable exploitation perspectives are presented, based on the quantity and quality of coal reserves, extraction facilities, location, infra-structure and transportation availability, which make them a priority for negotiation of their mineral rights.

Consequently, 48 areas have been selected, located in 13 deposits (see Annex), several of which may have more than one mine, thus permitting their negotiation with more than one interested party.

Neighboring areas to those presented herein and not included in this document, are liable to be aggregated to them to form marginal mineral units thus allowing greater utilization of the deposits.

The most relevant aspects are taken into account on each one of the deposits. The reserves are presented by each granted area (by Departamento Nacional da Produção Mineral – DNPM Process No.).

Calculated ore reserves for each Mining Unit, Block or Prospection Permit are summarized in Table I.

Table I - Calculated reserves shown in the Final Exploration Reports

Deposit	Item	Mining Unit, Block or Area	MD + ID + IF	Reserves (in 10^6 tons)		
				Measured	MD + ID + IF IN Sections with low Overburden	
						OBS:
Candiota	3.1	Seival II	383,913	136,262	309,407	(x)
	3.2	Arroio da Pitangueira	465,672	114,116	284,910	(x)
	3.3	Arroio dos Vimes	490,646	56,020	130,411	(x)
	3.4	Estância da Glória	231,463	12,953	≥76,000	(x)
Capané	4.1	Arroio Capané	42,192	27,912	11,811	(xx)
Iruí	5.1	Cordilheira	113,662	15,655	–	
	5.2	Dom Marcos	4,252	1,280	1,250	(xxx)
Leão	6.1	"C", "D" e "E"	484,010	273,260	–	
	6.2	"G"	148,050	79,410	–	
	6.3	Leão Leste	100,895	24,335	–	
Chico Lomã	7.1	"D"	339,957	161,038	–	
	7.2	Adjacents Areas	45,758	3,422	–	
Sul-Catarinense	8.1	Morro dos Conventos	55,23595	9,603	–	

Obs: MD – Measured Reserve
ID – Indicated Reserve
IF – Inferred Reserve

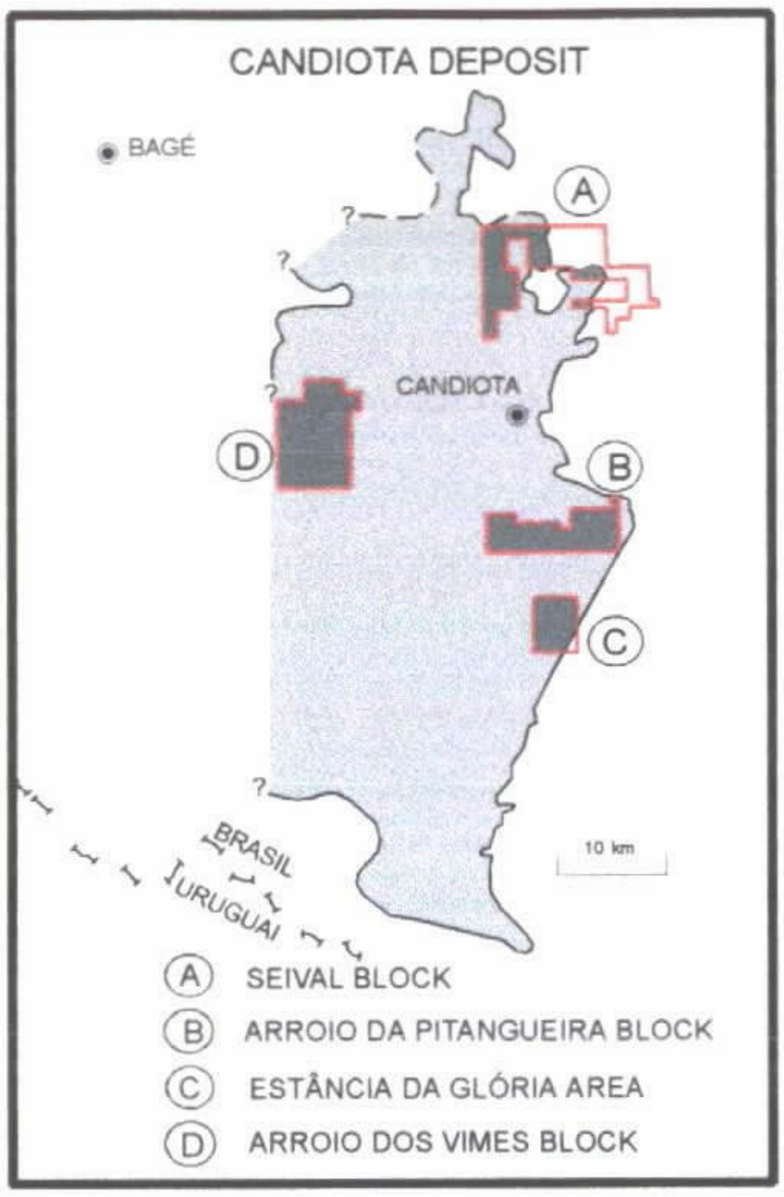
(x) – Overburden up to 50m
(xx) – According to Pre-Feasibility Study
(xxx) –Overburden up to 30m

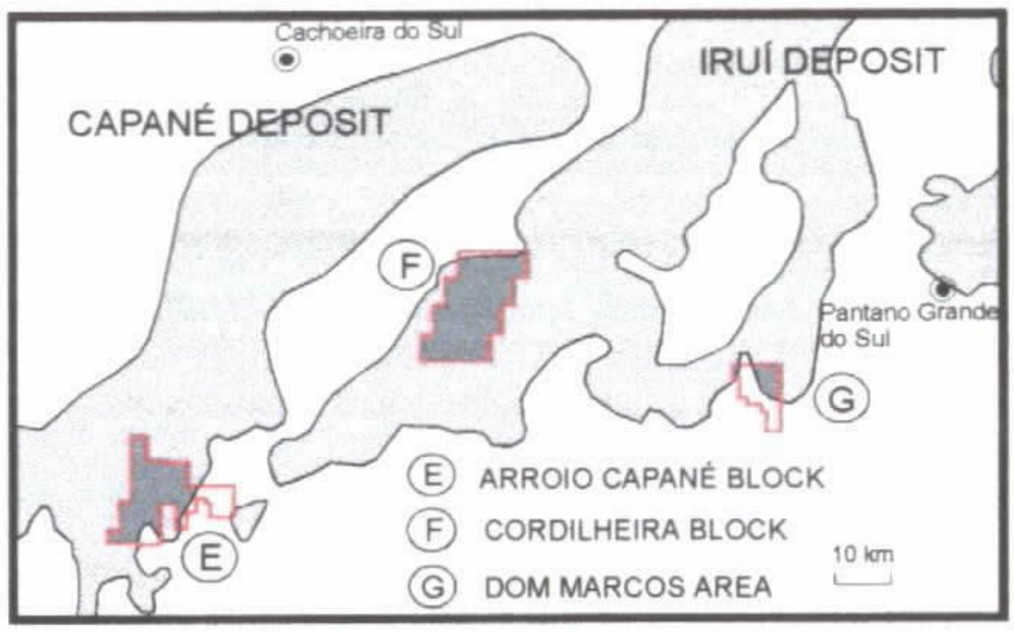
2
Selected Deposits

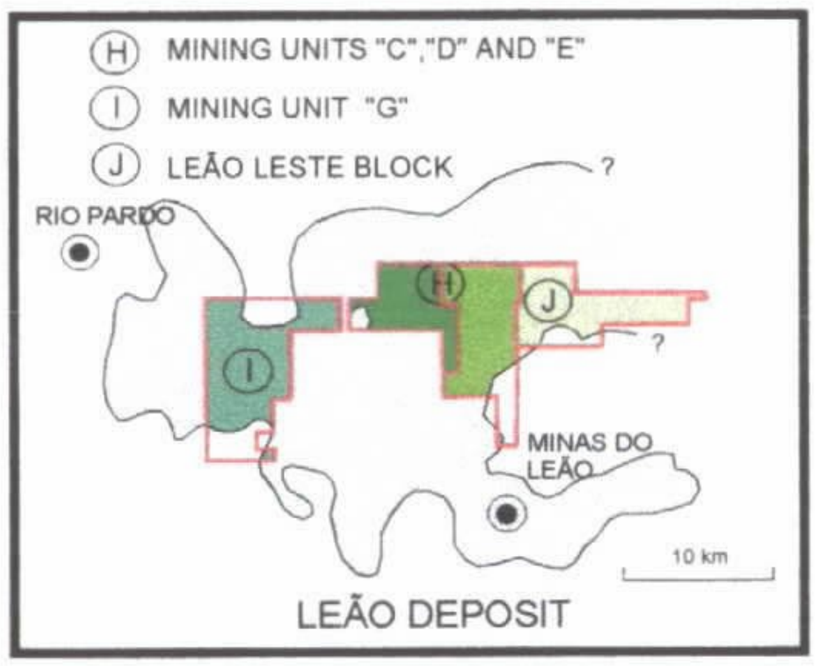
According to Figures 1 and 2, the deposits are presented by geographical order, from to SW to NE:

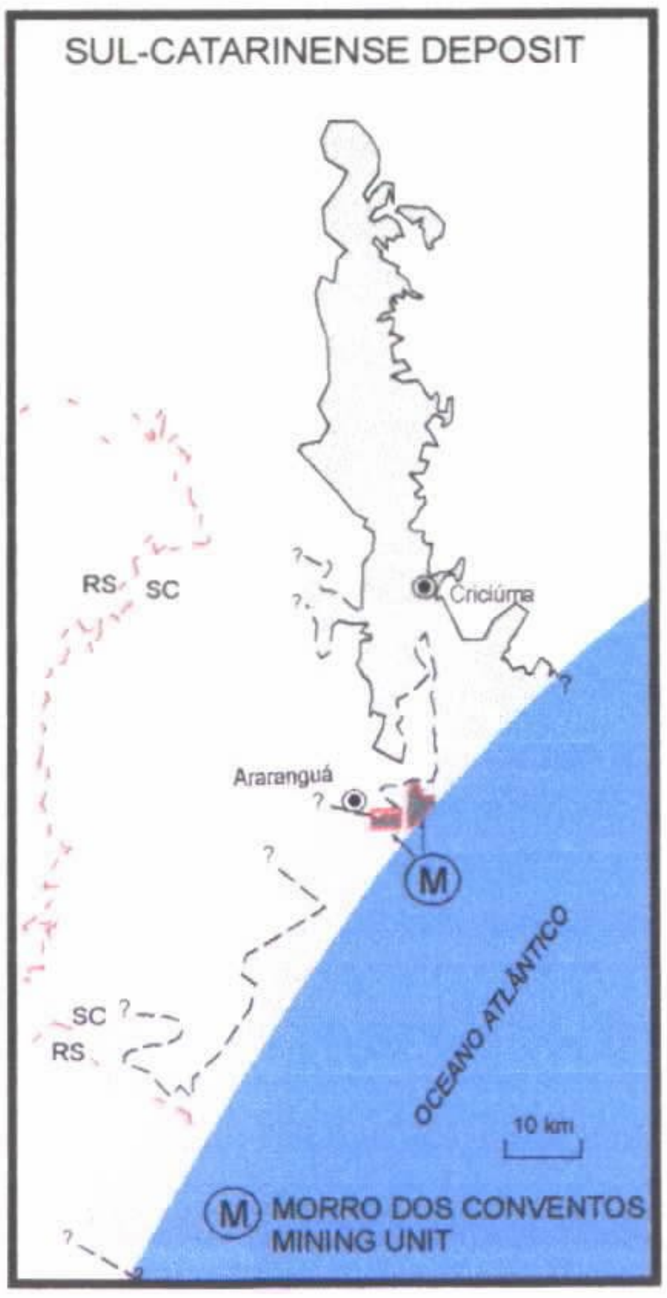
- CANDIOTA – Seival II, Arroio da Pitangueira, Arroio dos Vimes and Estância da Glória Blocks;
- IRUÍ – Cordilheira Block and Dom Marcos Area;
- CAPANÉ – Arroio Capané Block;
- LEÃO – Mining Units "C", "D" and "E", Mining Unit "G" and Leão Leste Block;
- CHICO LOMÃ – Mining Unit "D";
- SUL-CATARINENSE – Morro dos Conventos Mining Unit.

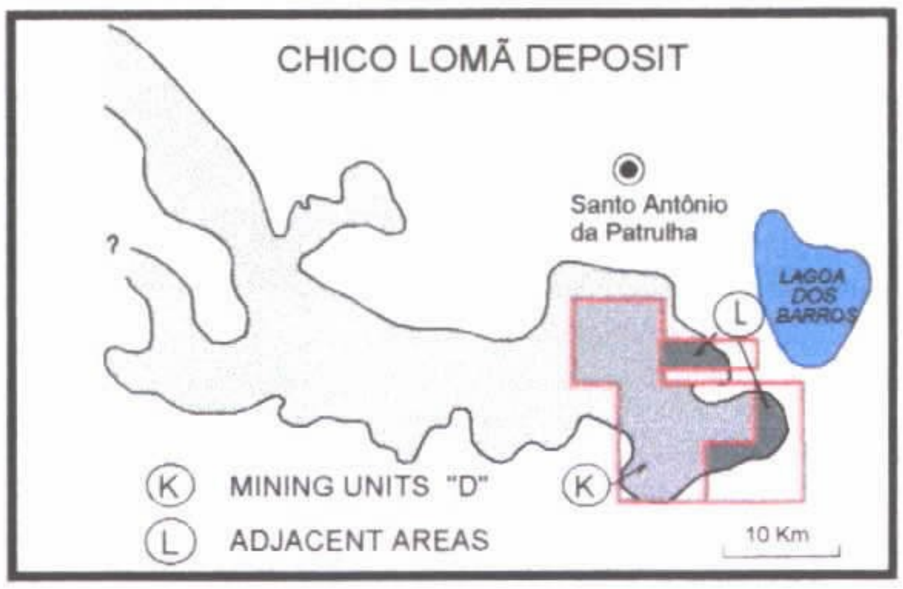
Figure 1 – Location of the Main Coal Deposits in the States of Rio Grande do Sul and Santa Catarina











Coal deposit

Area available for negotiation

Town of regional importance

Figure 2 – Location of the Blocks presented

3
Candiota Deposit

3.1 Seival II Block

3.1.1 Location

As shown in Figure 3, this Block is located in the northeastern border of the Candiota deposit, Municipality of Candiota, its center being about 12 km to the north of the town of Candiota. It comprehends four prospection areas, corresponding to DNPM Processes Nos. 810.454/79, 810.455/79, 810.456/79 and 810.458/79. The Exploration Report has already been approved by the Ministry of Mines and Energy (MME). The block is crossed by BR-292 road and by RFFSA railroad.

3.1.2 Level of Knowledge

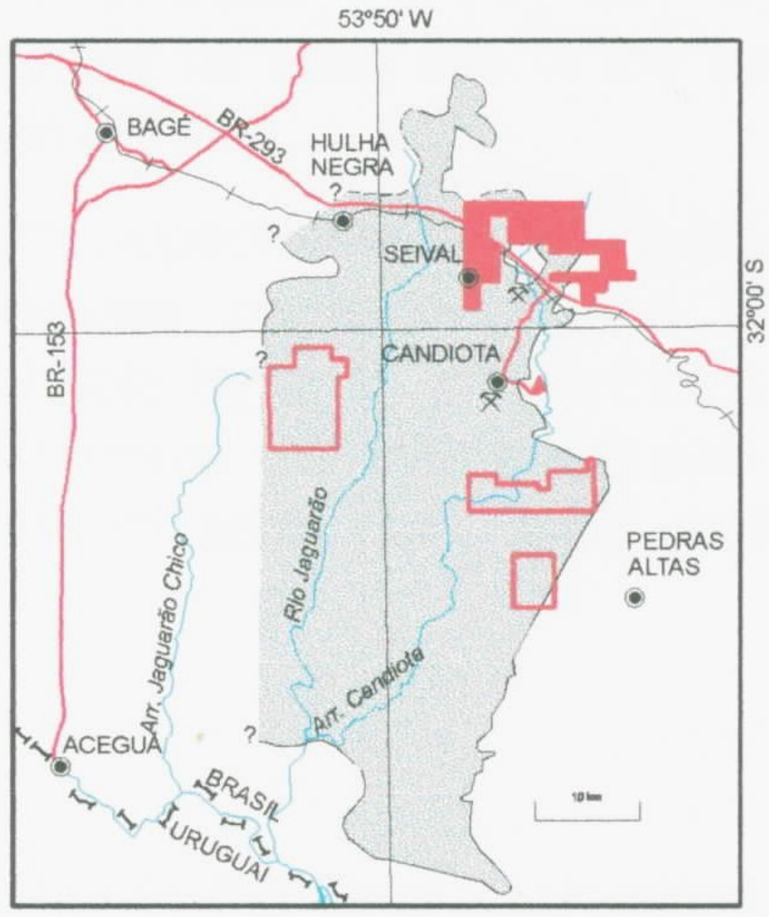
Thirty four drillings have been carried out in the areas, in addition to several others in their vicinity, with an average spacing of about 1 km in the sections considered positive for coal. This permitted more than 99% of the reserves to fall into the *Measured* and *Indicated* categories.

The volume of work carried out and the amount of ore testings and assays are sufficient to evaluate extraction conditions and select the most favorable sections; naturally, detailed planning of open pit exploitation will need closer drilling grid.

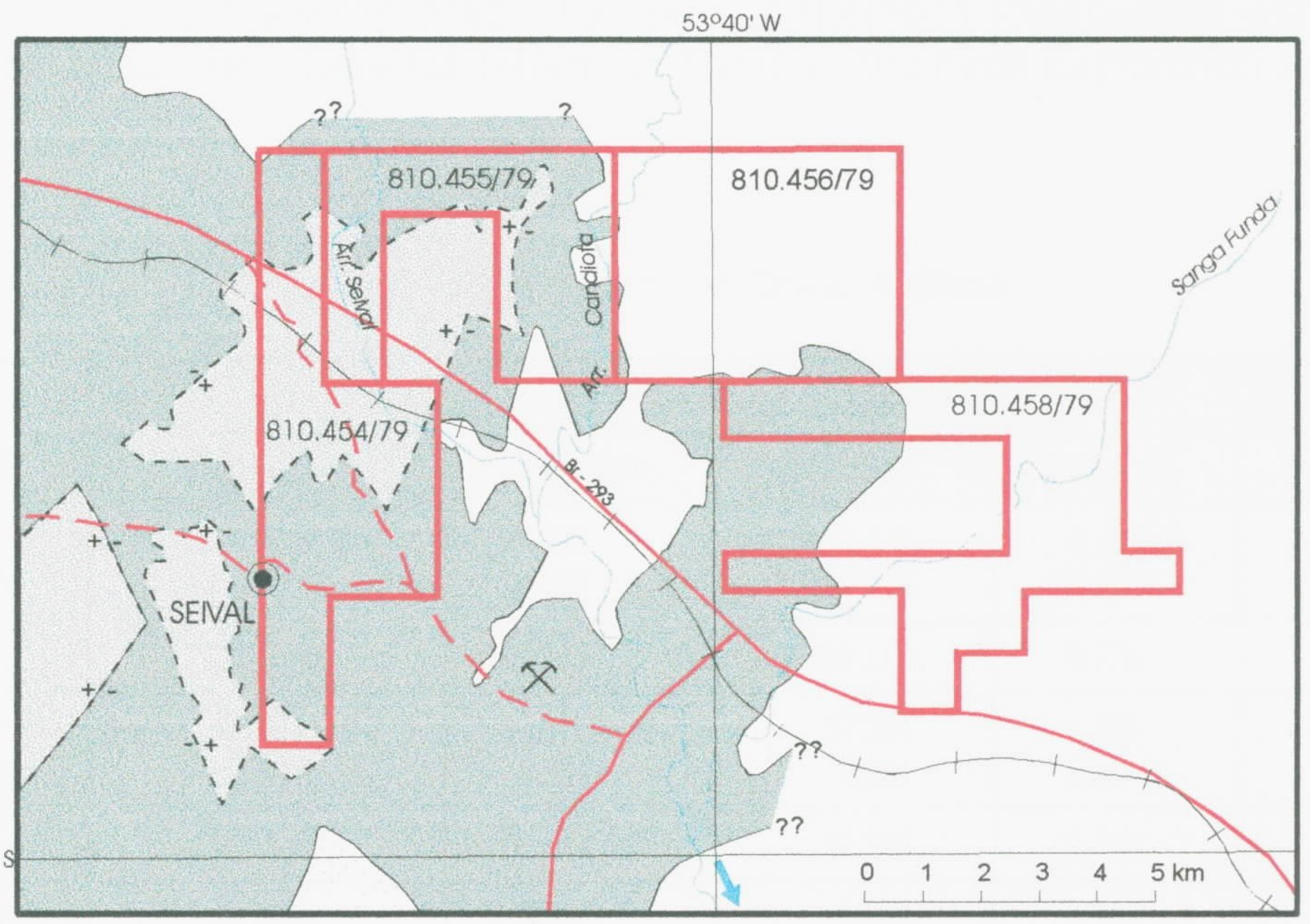
3.1.3 Deposit Features

In the Candiota Deposit, in addition to the coal seam with the same name, which is more important (divided into two levels – Candiota Upper Level (Candiota Banco Superior – CBS) and Candiota Lower Level (Candiota Banco Inferior – CBI), by a siltic horizon), up to nine upper coal seams have been co-related (from CS_1 to CS_9 in an increasing order) and up to nine lower seams (from CI_1 up to CI_9 in a decreasing order).

Index Map



Location Map



Simplified Map of the Deposit

Town

Paved road

Unpaved road

Railroad

Drilling

Area available for negotiation

Coal deposit

50 m isopach overburden over the Candiota seam

CNMC mine

Thermo-eletric power plant

Figure 3 – Candiota Deposit . Seival II Block

In the Seival II Block, these have been found from the CS_7 seam to the CI_5 seam, within a usual vertical interval between 30 m and 35 m. Of these, the CS_3, CS_1, CI_5 seams are only represented by thin beds; the estimated reserves for each one of the remaining ten coal seams run between 10 Mt and 80 Mt (million of tons).

In a preliminary analysis, an overburden 50 m isopach line has been drawn over the CBS seam. The sections under smaller thickenesses, corresponding to 78.5% of the reserves, have been considered potentially exploitable by open pit methods. Naturally, the method and exploitation equipments will determine the overburden/ore ratio maximum values, the minimum exploitable thickness of each coal seam and greater or smaller facility for a selective mining.

3.1.4 Reserves "in situ"

Coal reserves in the lying coal seams presented in the Final Exploration Report and approved by DNPM are in Table II. In addition to the classification by area and by category, the parcels potentially exploitable by open pit methods (overburden with less than 50 m) are also described. Detailed tables are found in the Final Exploration Report.

Table II - Reserves in the Seival II Block

DNPM Process Nº		Reserves in 10^6 tons			
	Overburden	Measured	Indicated	Inferred	Total
810.454/79	< 50 m > 50 m	67,239 30,624	113,638 36,498	0,278 0,000	181,155 67,122
	Sub-Total	97,863	150,136	0,278	248,277
810.455/79	< 50 m > 50 m	19,062 7,384	57,205 0,000	1,896 0,000	78,163 7,384
	Sub-Total	26,446	57,205	1,896	85,547
810.456/79	< 50 m	5,721	9,631	0,564	15,916
	Sub-Total	5,721	9,631	0,564	15,916
810.458/79	< 50 m	6,232	27,856	0,085	34,173
	Sub-Total	6,232	27,856	0,085	34,173
Total	< 50 m > 50 m	98,254 38,008	208,330 36,498	2,823 0,000	309,407 74,506
	Total	136,262	244,828	2,823	383,913

From the reserves under less than 50 m thick overburden, the most important portions are in the CBS seam (upper level of the Candiota seam) with 59.168 Mt, representing 19.1% of the total, and in the CS_7 coal seam with 41.572 Mt, representing 13.4% of the total. The remaining parts are in the CS_6, CS_5, CS_4, CS_2, CBI (lower level of the Candiota seam), CI_2, CI_3 and CI_4 seams.

3.1.5 Quality

Similarly to the rest of the Candiota deposit, the coal in Seival II Block fits in the category of "Non-Coking High Volatile C Bituminous Coal" of the ASTM classification. Its ROM has an average content close to 52%, sulphur content below 2%, and High Calorific Value (on dry basis) close to 3,300 cal/g.

Similarly to Companhia Riograndense de Mineração – CRM and Companhia Nacional de Mineração Candiota – CNMC mines, both nearby and in the same deposit, treatment of the coal in the Block under study is possible in order to obtain a more saleable product , averaging from 35% to 40% ash content (with yields above 40% in the seams CS_7 CS_4 and CI_3) and/or a middling with quality similar to the product consumed by the local thermo-electric power plants. The theoretical yields vary from seam to seam; referential values, calculated from the average of the core drilling assay results, are shown in Table III.

Table III – Theoretical Yelds based on the Total Coal Seams

Coal seam	Yields	
	C_{35}	C_{50}
CS_7	46%	93%
CS_6	23%	67%
CS_5	13%	44%
CS_4	47%	100%
CS_2	32%	73%
CBS	32%	87%
CBI	36%	85%
CI_2	13%	44%
I_3	42%	95%
CI_4	30%	72%

3.1.6 Utilization

The coal presently exploited by CRM is used in its raw form in the Presidente Médici thermo-electric power plant. The coal produced by CNMC, also not treated, is mainly used in the cement manufacture.

Conclusive studies on a industrial scale already exist, showing the technical and economic feasibility of treating the coal of the Candiota deposit, thus obtaining a better product, with 3,700 to 4,200 cal/g, capable of supplying a regional market and a middling of about 3,300 cal/g to be used in the cement industries nearby or in the Presidente Médici thermo-electric power plant. CRM has a 100t/h of ROM washing plant and concluded a project for a larger heavy media cyclone plant.

Coal of the Seival II Block may be used for the same purposes, with variable yields according to the selected seams and sections.

3.1.7 Division of the Area

A medium/large capacity open pit mine needs from 30 to 100 million tons of reserves. The four Prospection Permits under study have, each one of them, in a increasing order, 15, 34, 95 and 248 million tons of reserves of coal. The comparison of these numbers results in the difficulty in dividing the Block into technically and economically coherent Mining Units without abandoning the division by Prospection Permits. Thus, the eventual division of the Block depends on the amount of reserves required by the interested miner and on DNPM's approval, authorizing the sub-division of the prospected areas.

3.2 Arroio da Pitangueira Block

3.2.1 Location

As shown in Figure 4, this block is located at the eastern border of the Candiota deposit. It comprehends parts of the municipalities of Hulha Negra and Pinheiro Machado. However, the nearest urban center is the recently emancipated town of Candiota, located 10 km north of the Block. This town is accessed by paved highways and by railroad from Bagé and Pelotas; local access is made by unpaved municipal roads.

The Block is formed by three prospection areas, corresponding to DNPM Processes Nos. 814.965/74, 814.966/74 and 814.967/74. The Exploration Report has already been approved by the Ministry of Mines and Energy – MME.

3.2.2 Level of Knowledge

Twenty drillings have been carried out in the prospected areas, with an average spacing of 1 km in the sections of smaller depth. As a result, the Exploration Report provided to DNPM, in the section with an overburden with less than 50m under the Candiota Seam, defined more than 98% of the reserves within the categories Measured + Indicated; in the deeper sections this proportion decreases to 91%.

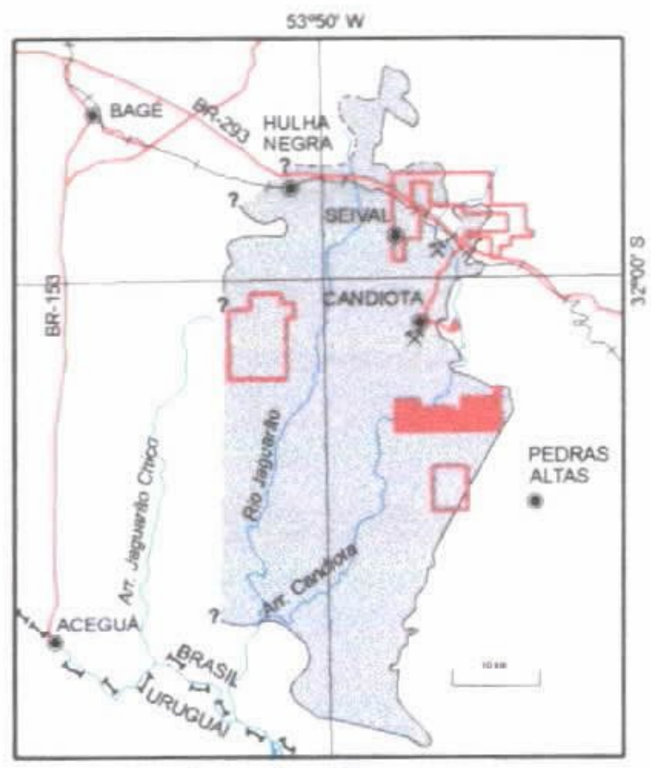
Later on, about a dozen of drillings were carried out, in order to obtain more details about the deposit.

The depth of the research and the amount of technical tests and assays are sufficient to evaluate extraction conditions and select the most favorable sections; naturally, the detailed planning for an open pit mine will demand closer drilling.

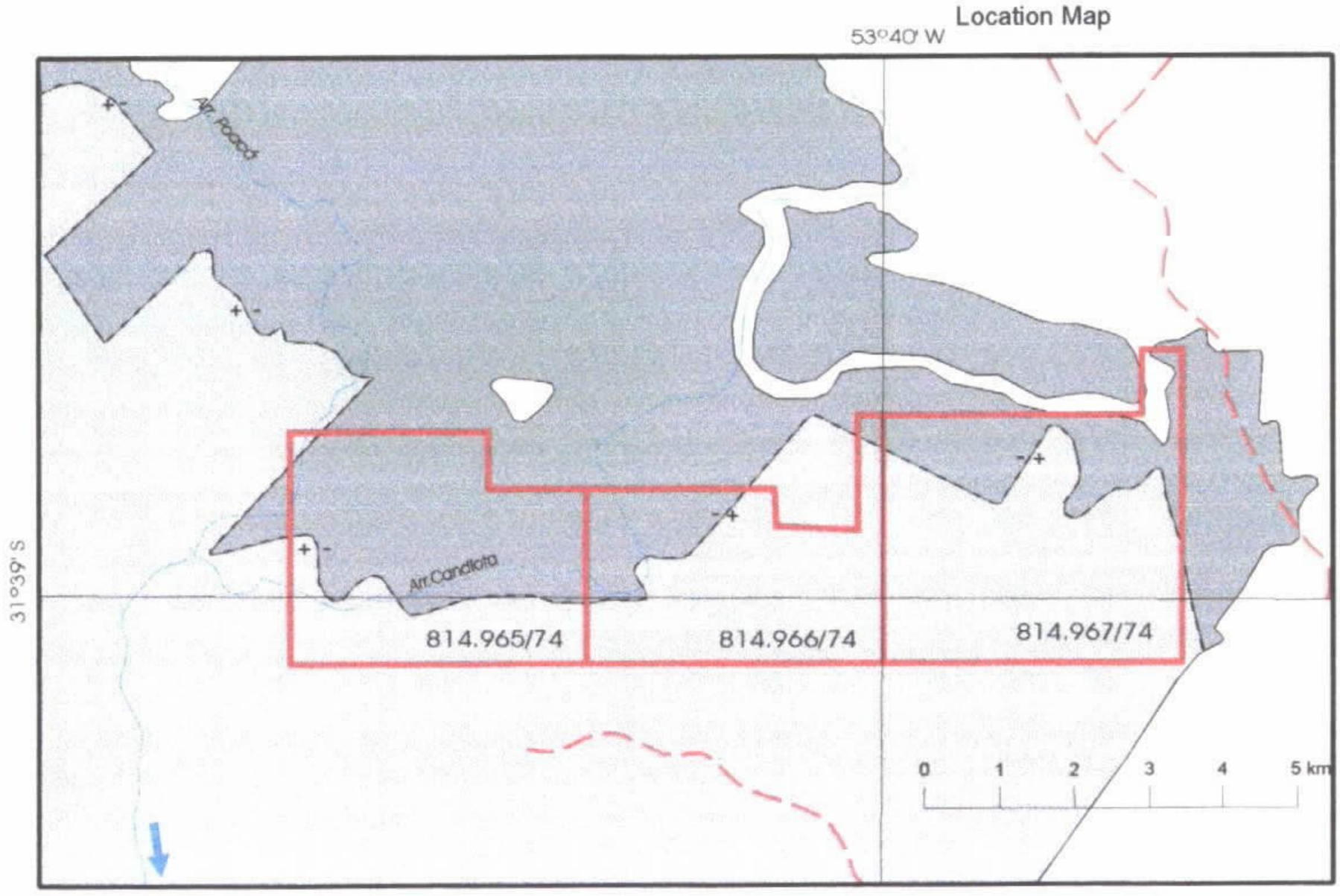
3.2.3 Deposit Features

In the Arroio da Pitangueira Block, within a usual depth of about 30 m from seam CS_5 to CI_7, reserves have been found. Of these, the majority is represented by thin beds; only seams CS_2, CBS, CBI, CI_2, CI_3 and CI_4 have sufficient thicknesses to justify exploitation. Due to the reduced thicknesses of the intercalated barren horizons, the groups CBS + CBI and CI_3 + CI_4 have been assembled for calculation of their reserves and will probably also be assembled during mining.

Index Map



Location Map



Simplified Map of the Deposit

- Town
- Paved road
- Unpaved road
- Railroad
- Drilling
- Area available for negotiation
- Coal deposit
- 50m isopach overburden over the Candiota seam
- Coal mine
- Thermo-eletric power plant

Figure 4 – Candiota Deposit. Arroio da Pitangueira Block

Normal faults, of small displacement, are present and dividing in echelon blocks the SSW dipping homocline.

In a preliminary analysis, a 50 m thickness overburden isopach line has been drawn over the CBS coal seam. The sections with smaller overburden thicknesses, corresponding to 61.2% of the reserves, have been considered potentially exploitable by open pit methods. Naturally, the method and exploitation equipments will determine the overburden/ore ratio maximum values, the minimum exploitable thickness of each coal seam and greater or smaller facility for a selective mining. At the prefeasibility stage, delimitation of open pit exploitable sections can be more precisely established.

3.2.4 Reserves "in situ"

Calculated reserves in the Final Exploration Report were subject to small changes by DNPM, but such changes apparently result from errors in the transcription of the data.

The calculated values presented in the Final Exploration Report, detailed by categories (measured/indicated/inferred), by Prospection Permit (3) and by overburden thickness (< 50m and >50m), are shown in Table IV, totaling 465.672 Mt.
The amounts of reserves totaling 467.056 Mt, according to DNPM's approval of the Exploration Report, are shown in Table V.

Table IV - Reserves in the Arroio da Pitangueira Block calculated in the Final Exploration Report

DNPM Process Nº	Overburden	Reserves in 10^6 tons			
		Measured	Indicated	Inferred	Total
814.965/74	< 50 m	51,549	107,664	0,000	159,213
	> 50 m	0,000	20,842	1,678	22,520
	Sub-Total	51,549	128,506	1,678	181,733
810.966/74	< 50 m	9,418	42,845	2,368	54,631
	> 50 m	19,612	67,356	5,261	92,229
	Sub-Total	29,030	110,201	7,629	146,860
810.967/74	< 50 m	21,480	46,330	3,256	71,066
	> 50 m	12,057	44,402	9,554	66,013
	Sub-Total	33,537	90,732	12,810	137,079
Total	< 50 m	82,447	196,839	5,624	284,910
	> 50 m	31,669	132,600	16,493	180,762
	Sub-Total	114,116	329,439	22,117	465,672

Table V - Reserves in the Arroio da Pitangueira Block approved by the DNPM

DNPM Process Nº	Reserves in 10^6 tons			
	Measured	Indicated	Inferred	Total
814.965/74	51,549	128,506	1,678	181.733
814.966/74	29,030	111,201	7,629	147.860
814.967/74	33,537	90,732	13,194	137.079
Total	14.116	330.439	22.501	467.056

The differences between the two calculations were:

- With regard to the indicated reserves for the area No. 814.966/75, the Final Exploration Report gives a total of 110,201,000 tons and the value approved by DNPM was 111,201,000 tons, with an exact difference of 1,000,000 tons.
- With regard to the indicated reserves for the area No. 814.966/75, the Final Exploration Report gives a total of 110,201,000 tons and the value approved by DNPM was 111,201,000 tons, with an exact difference of 1,000,000 tons.

Addition of the two differences makes the total of the approved reserves for the group of the three areas 1,384,000 tons higher than the total of the calculated reserves shown in the Final Exploration Report.

Of the reserves under an overburden with less than 50m, 187.111 Mt, representing 65.7%, are in the two horizons of the Candiota seam (CBS + CBI), the remaining reserves being distributed between seams CS_2, CI_2, CI_3 and CI_4.

3.2.5 Quality

Similarly to the rest of the Candiota Deposit, the coal in the Arroio da Pitangueira Block fits in the category of "Non-Coking High-Volatile C Bituminous Coal" of the ASTM classification. Coal of the seams CBS + CBI will probably have a better average quality than CRM's present product, with an average ash content near 48%; the coal of the seams CI_2 and CI_3 + CI_4 will probably have an average close to 54%. The Calorific Value varying, inversely to the ash contents, will probably be between 3,100 and 3,500 cal/g; the sulphur contents, below 2% in the ROMs, will probably decrease to less than 1% in the eventually treated products.

Theoretical yields vary from seam to seam; referential values, estimated from the averages of the drilling core assays are shown in Table VI.

Table VI - Theoretical yields based on Total Coal Seams

Coal Seams	Yields	
	C_{25}	C_{50}
CBS + CBI(1)	41%	100%
Cl_2	No data available	75%
$Cl_3 + Cl_4$ (2)	38%	85%

Obs. (1): Barren horizon between seams not considered
(2): Barrem horizon between seams considered

3.2.6 Utilization

Coal of the Arroio da Pitangueira Block can have the same uses mentioned in item 3.1.6, with variable yields depending on the selected seams and sections.

3.2.7 Division

Using the same line of thinking to that outlined in item 3.1.7, the division of this block into two or three sub-units can also be admitted.

3.3 Arroio dos Vimes Block

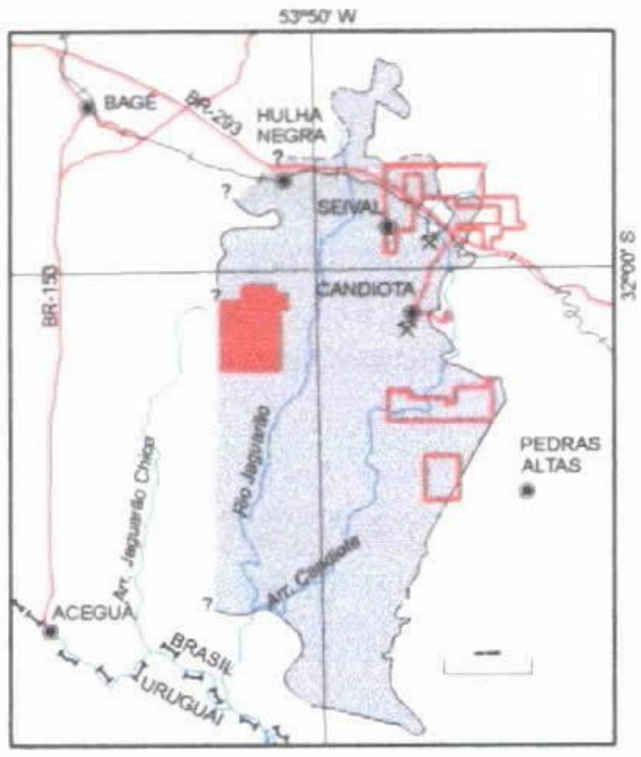
As shown in Figure 5, this Block is located at the west border of the Candiota Deposit and comprehends eleven prospection permits. The Report presented has already been approved by DNPM. Of these areas, three of them, corresponding to Processes Nos. 810.025/84, 810.026/84 and 810.031/84, contain coal under a low overburden cover, thus permitting open pit mining.

The reserves of these three priority areas have been calculated by depth's strip, separating the parts under an overburden with less than 50m (potentially exploitable by open pit methods) from those deeper strips (whose exploitation is foreseen to be underground). The calculated values presented in the Final Exploration Report, amounting to 490.646 Mt of coal in the seam, are shown in Table VII:

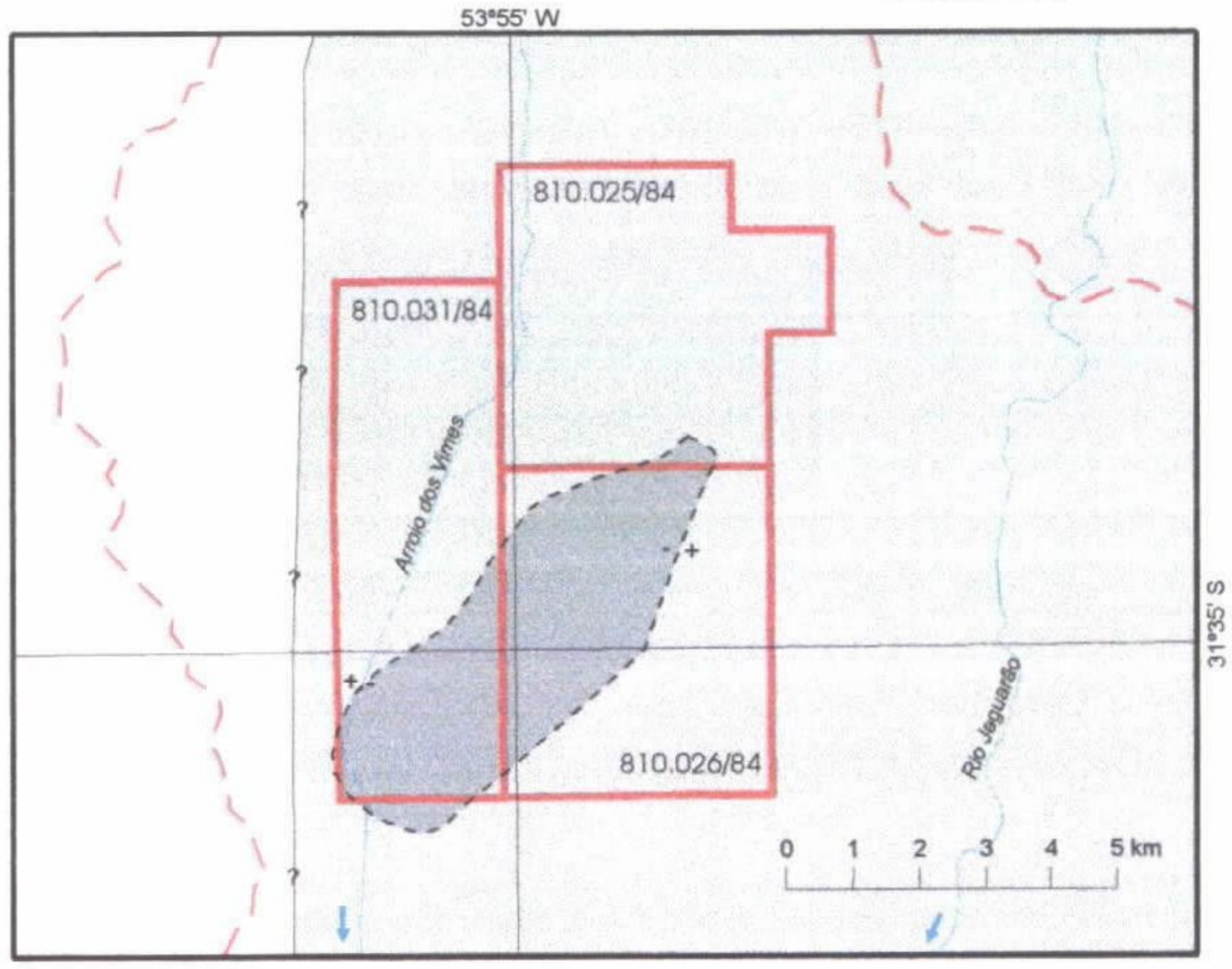
Table VII - Reserves in the Arroio dos Vimes Block calculated in the Final Exploration Report

DNPM Process Nº	Overburden	Reserves in 10^6 tons			
		Measured	Indicated	Inferred	Total
810.025/84	< 50 m	0,402	1,677	0,000	2,079
	> 50 m	8,978	83,072	67,244	159,294
	Sub-Total	9,380	84,749	67,244	161,373
810.026/84	< 50 m	14,848	63,142	0,000	77,990
	> 50 m	8,731	76,324	42,238	127,293
	Sub-Total	23,579	139,466	42,238	205,283
810.031/84	< 50 m	15,329	35,013	0,000	50,342
	> 50 m	7,732	52,264	13,652	73,648
	Sub-Total	23,061	87,277	13,652	123,990
Total	< 50 m	30,579	99,832	0,000	130,411
	> 50 m	25,441	211,660	123,134	360,235
	Sub-Total	56,020	311,492	123,134	490,646

Index Map



Location Map



Simplified Map of the Deposit

Figure 5 – Candiota Deposit. Arroio dos Vimes Block

Of these 130.411 Mt below less than 50 m-thick overburden, 120.282 Mt correspond to the Candiota coal seam and the remaining to the Cl_2, Cl_3 and Cl_4 seams.

Based on drilling information and on topographic contour lines of the Tupi Silveira topographic sheet, in a 1:50,000 scale, the reserves parcels of the Candiota Seam have been estimated by overburden thickness, as indicated below:

- 15% (18 Mt) with overburden less than 20m;
- 40% (48 Mt) with overburden between 20 and 30m;
- 25% (30 Mt) with overburden between 30 and 40m;
- 20% (24 Mt) with overburden between 40 and 50m.

DNPM approved the reserves shown in Table V, as published in the Federal Official Gazette:

Table VIII - Reserves in the Arroio dos Vimes Block
Approved by DNPM)

DNPM Process Nº	Reserves in 10^6 tons			
	Measured	Indicated	Inferred	Total
810.025/84	9,380	84,749	67,244	161.373
810.026/84	13,579	139,466		153.045
810.031/84	23,061	87,277	13,652	123.990
Total	46.020	311.492	80.896	438.408

When comparing Table VIII with the previous table, it can be seen that the measured reserves for the area No. 810.026/84 have been reduced by exactly 10,000,000 tons and the inferred reserves have been cancelled, possibly due to transcription errors.

The coal quality of the Arroio dos Vimes Block is similar to that found in other blocks of the same deposit.

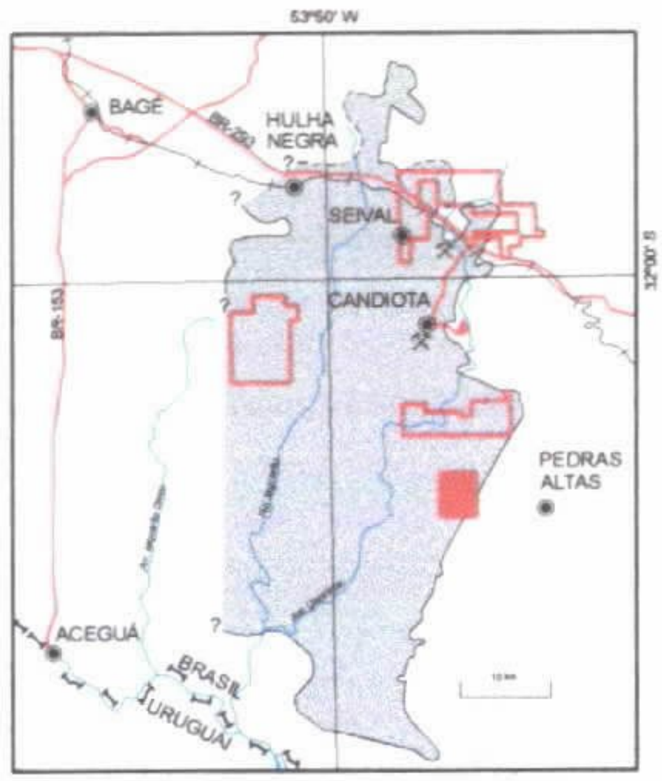
3.4 Estância da Glória Area

3.4.1 Location

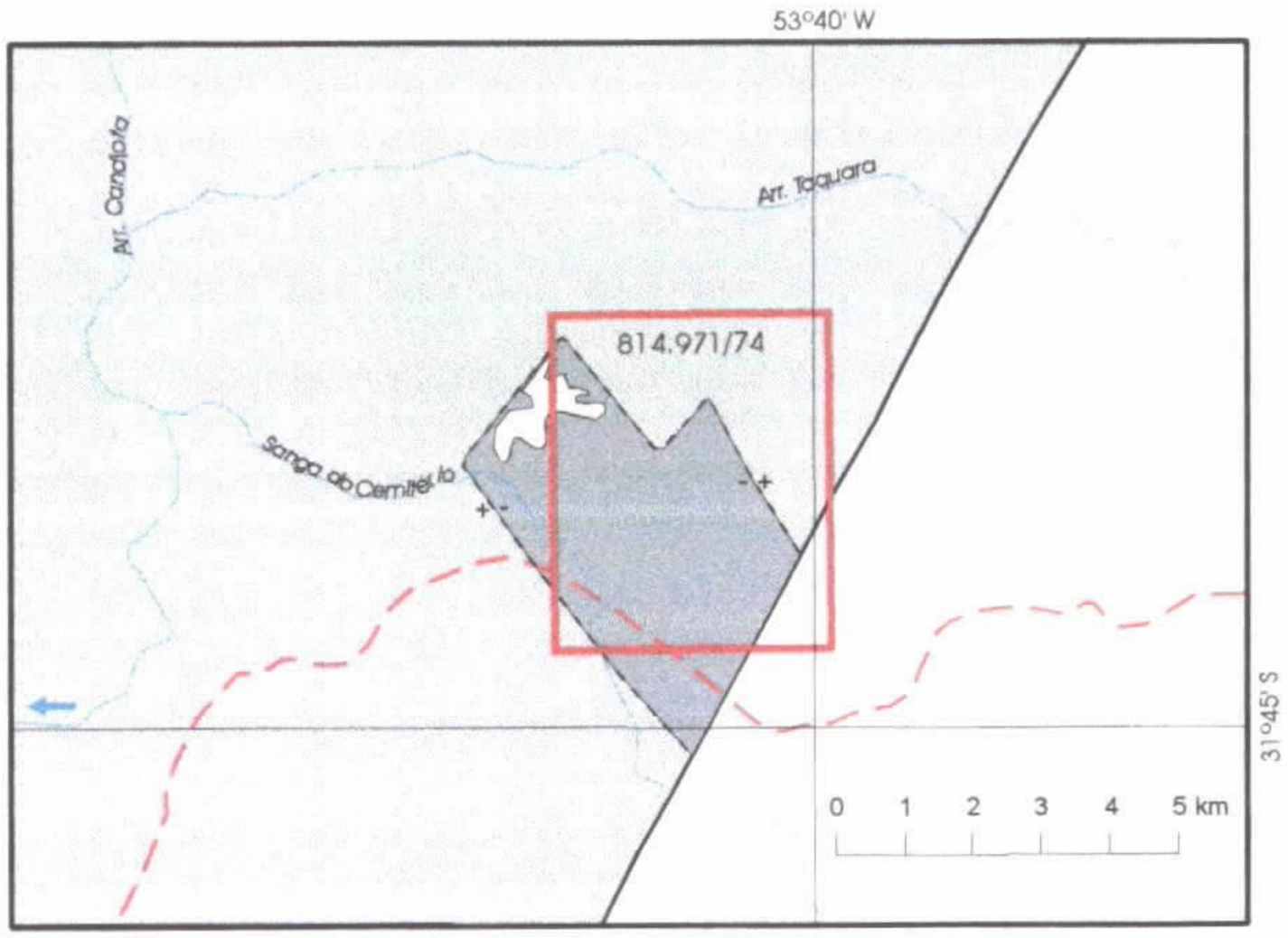
As shown in Figure 6, this area is located at the southeastern border of the Candiota deposit, in the municipalities of Erval and Pinheiro Machado, but the nearest urban center is the recently emancipated town of Candiota,18 km to the north. This town is accessed by paved roads and by railroads from Bagé and Pelotas; local access is by unpaved municipal roads.

The area under study corresponds to DNPM Process No. 814.971/74, whose Exploration Report has already been approved by the Ministry of Mines and Energy.

Index Map



Location Map



Simplified Map of the Deposit

Town

Paved road

Unpaved road

Railroad

Drilling

Area available for negotiation

Coal deposit

50 m isopach overburden over the Candiota Seam

Coal mine

Thermo-eletric power plant

Figure 6 – Candiota. Estância da Glória Area

3.4.2 Level of Knowledge

The Exploration Report, prepared in 1982 for this and other five adjacent areas, includes information obtained from only two drillings carried out at the time in addition to four other drillings, carried out in adjacent Prospect Permits areas. Later on, another eight drill holes were made, all positive for coal, whose data have been consolidated in the Eastern Border of the Paraná Basin Project. It should be pointed out that there is not precise information concerning the W and SW limits of the section exploitable by open pit methods. The geological information have been complemented by geological mapping in the scale 1:50,000.

3.4.3 Deposit Features

In the Estância da Glória Area features have been found from seam CBS to Cl_4, in an average usual vertical interval of 18m. In the Project Report, reserves have been calculated for the seams CBS + CBI and Cl_2. Data consolidation of the most recent drillings may add several million tons from Cl_3 and Cl_4 seams.

The great Açotéia Fault, striking N30°E, which crosses the SE limit of the studied area, limits the Gondwana Basin to SE, closing the deposit in this direction.

The ten drill holes made cover the central part of the area, with an average spacing of 1 km. In a preliminary analysis, based on drillling results in this area and in other drill holes nearby and in the geological mapping, a 50 m isopach line has been drawn over the CBS seam. The sections under low overburden cover, corresponding to a little more than 50% of the calculated reserves, may be considered exploitable for open pit mining. Naturally, it would be necessary to complete the 1 km x 1 km drilling grid to better define the overburden volumes to be removed and evaluate precisely the quantity and quality of the reserves of each one of the coal seams.

In the Sanga do Cemitério thalweg, next to the western border of the Estância da Glória Area, an outcrop line and a small erosion window of the Candiota Seam were found.

3.4.4 Reserves "in situ"

A résumé of the reserves by seam and category presented in the Exploration Report and approved by DNPM is shown in Table IX.

Table IX - Reserves in the Estância da Glória Area

Coal Seam	Reserves tn 10^6 tons			
	Measured	Indicated	Inferred	Total
Cbs + Cbi	10,771	77,207	107,279	195,257
Ci_2	2,182	14,671	19,353	36,206
Total	12,953	91,878	126,632	231,463

In the Final Exploration Report, based on the two drill holes mentioned in the Prospection Permit area, and in four drillings nearby, it has been estimated that the area with less than 50m-thick overburden would comprehend about 600 hectares, containing 33% of the total reserves (64.793 Mt in the Candiota seams and 12.206 Mt in the Cl_2). After the eight drillings carried out subsequently, it was verified that the limits of the section with lower overburden had increased to about 1,050 ha. A new calculation of the reserves would certainly increase the parcel exploitable by open pit methods to a little more than 50% of the total, also quantifying the presence of considerable reserves in the seams Cl_3 and Cl_4.

3.4.5 Quality

Similarly, in the rest of the Candiota deposit, in the Estância da Glória Area, the coal is in the category of "Non-Coking High-Volatile C Bituminous Coal" of the ASTM classification. Theoretical yields vary from seam to seam and from section to section. The review of the assays carried out on the ten drillings indicate a quality similar or a little better than that found in the Arroio da Pitangueira Block.

In summary, the average values below can be expected:

- The ROM ash contents may be close to 48% for the Candiota seam, as well as for Cl_3 and Cl_4 and theoretical yields of C_{35} may be close to 40%.
- The Cl_2 seam may be a little inferior as far as quality is concerned, with a ROM ash content close to 54%.
- Sulphur contents of the total seams are below 2% and those of the C_{35} fraction are below 1%.

3.4.6 Utilization

The coal of Estância da Glória Area may have the same use of that of the remaining blocks, with variable yields, depending on the selected seams and sections.

3.4.7 Division

Reserves are more than sufficient to carry out large open pit exploitation or several medium ones. However, as they are included in one Prospection Permit, they cannot be divided.

4
Capané Deposit

4.1 Arroio Capané Block

4.1.1 Location

As shown in Figure 7, in the southern border of the Capané deposit there is an area with 4,398 ha which contains a coal deposit with low overburden. It is located in the Municipality of Cachoeira do Sul, about 30 km SW of the town of Cachoeira do Sul. It comprehends four Prospection Permits related to DNPM Processes Nos. 810.006/80, 810.007/80, 810.013/80 and 810.014/80. The Exploration Report has been approved by the Ministry of Mines.

4.1.2 Level of Knowledge

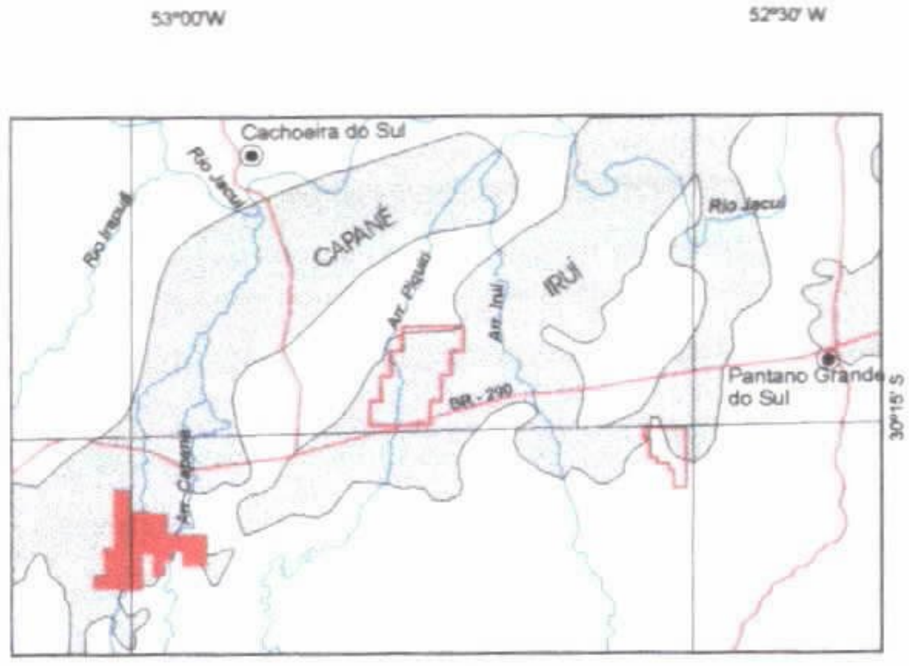
Fifty nine diamond drillings have been made, with an average spacing of 0.7 km, as well as six trenches, delimitation of outcrop lines and numerous technological tests. Subsequently to the preparation of the Exploration Report, the Pre-Feasibility Study was prepared, with detailed quantitative and qualitative study of the Capanezinho Seam, of the overburden conditions, selection of exploitation methods, treatment and environmental control, as well as estimates of their respective costs.

4.1.3 Deposit Features

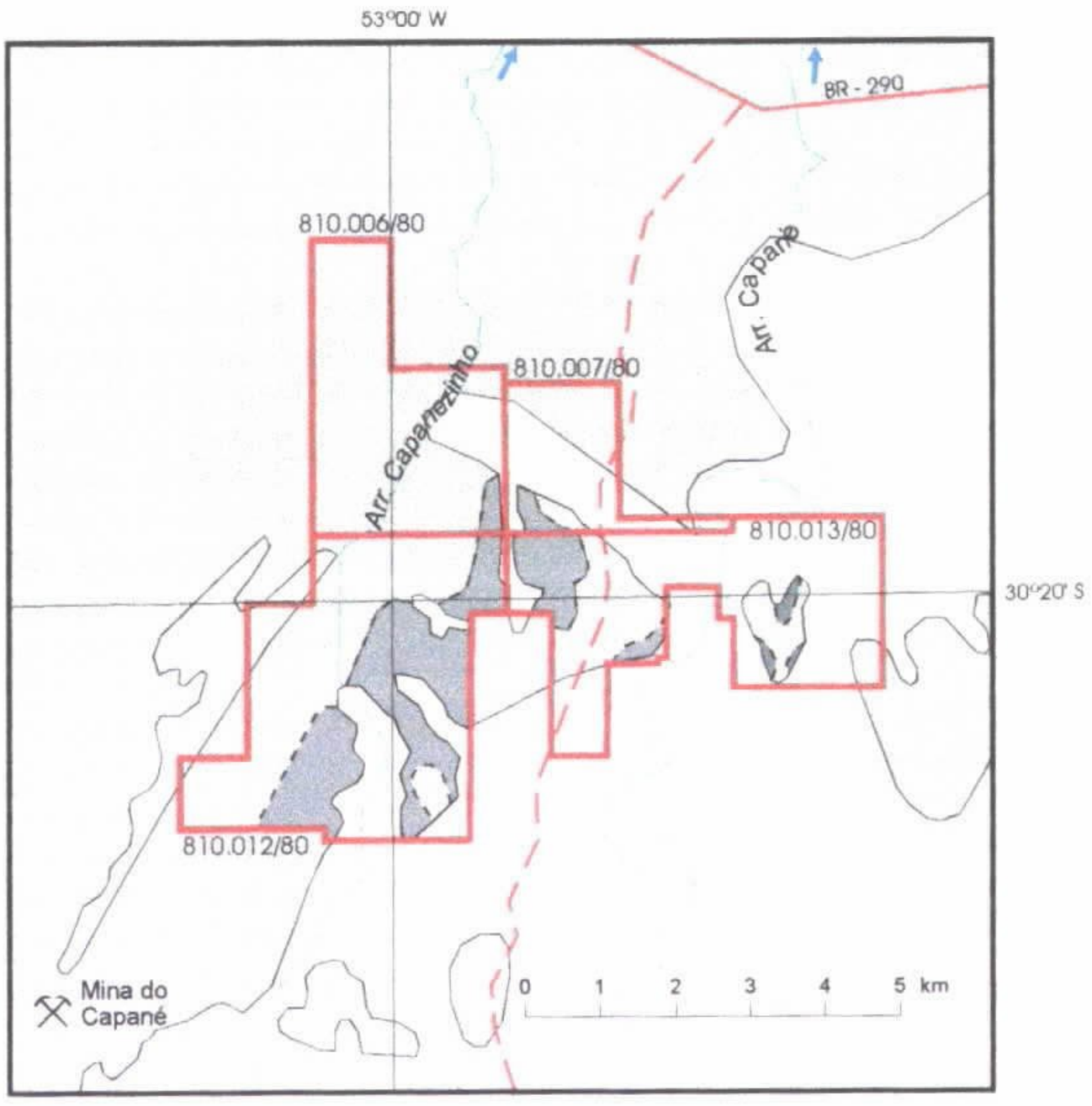
There are seven coal seams, three of which of economic importance:

- The Capanezinho seam, with greater continuity, extensive and irregular outcrops lines, exploitable by open pit methods on 10 discontinued sections.

Index Map



Location Map



Simplified Map of the Deposit

Town

Paved road

Unpaved road

Drilling

Area available for negotiation

Coal deposit

Section of open pit mining reserves included in CPRM's Permits

Coal mine

Figure 7 – Capané Deposit. Arroio Capané Block

The Triângulo seam, about 10m below the Capanezinho seam, with small discontinuous sections.

- The Jeribá seam, about 15 m below the Triângulo seam, is thick and continuous on the deeper border of the selected areas, not exploitable by open pit methods. Its calculated total reserves are of 24.615 Mt, as presented in the Final Exploration Report.

The structure is uniform, with an average down slope of 6% from SE to NW. There is a large fault, with a displacement of 150 m.

4.1.4 Reserves "in situ"

The DNPM only approved the reserves presented in the Final Exploration Report for the Capanezinho and Triângulo seams, in a total of 42.192 Mt for the four areas, listed in Table X.

Table X - Reserves in the Arroio Capané Block Approved by the DNPM

DNPM Process Nº	Coal Seam	Reserves in 10^6 tons t			
		Measured	Indicated	Inferred	Total
810.006/80	Capanezinho	3,144	0,831	0,000	3,975
	Triângulo	0,381	0,085	0,000	0,466
	Sub-Total	3,525	0,916	0,000	4,441
810.007/80	Capanezinho	1,105	0,405	0,000	1,510
	Triângulo	0,340	0,102	0,000	0,442
	Sub-Total	1,445	0,507	0,000	1,952
810.012/80	Capanezinho	12,751	6,273	0,118	19,142
	Triângulo	5,416	2,887	0,071	8,374
	Sub-Total	18,167	9,160	0,189	27,516
810.013/80	Capanezinho	3,493	1,841	0,000	5,334
	Triângulo	1,282	1,596	0,071	2,949
	Sub-Total	4,775	3,437	0,071	8,283
Total	Capanezinho	20,493	9,350	0,118	29,961
	Triângulo	7,419	4,670	0,142	12,231
	Sub-Total	27,912	14,020	0,260	42,192

It is presumed that the DNPM did not accept the reserves attributed to the Jeribá seam (24.615 Mt, from which 8.032 Mt measured, 11.964 Mt indicated and 4.619 inferred) due to the fact that the great depths of the reserves and the relatively unfavorable average quality of them do not economically justify their exploitation.

In the Pre-Feasibility Study, which includes information on some supplementary drillings, the totals for the Capanezinho seam were re-calculated, as follows:

Measured:	21.793 Mt
Indicated:	8.499 Mt
Inferred:	0.133 Mt
Total:	30.425 Mt

Of this total, 11.811 Mt of coal (corresponding to 19.133 Mt of the total seam) are in sections selected according to the following criteria:

- Average overburden of 18.3m and maximum of 40m.
- Overburden/ore average ratio of 10.3m^3/t of coal seam and maximum of 16m^3/t of coal seam.
- Low elevations near Arroio Capanezinho, where the elevations of the coal seams are way below the level of the creek would lead to high flooding risks.

4.1.5 Exploitation and Treatment

The Pre-Feasibility Study shows that it is possible to have an open pit mine, by using a 35 cu.y. bucket 260 ft dragline. This equipment would permit a 25m-wide strip mining with a re-handling, i.e. a second pass for only 5% of the total area.

Monthly averages of 717,000 m^3 of overburden stripping and 112,000 tons of ROM during 15 years are foreseen. Jigging treatment with a 330 tph feeding capacity may produce 81,000 tons monthly of C_{3700}, with Calorific Power of 3,700 cal/g, 44,1% ash and 0,4% sulphur.

4.1.6 Quality

The coal fits in the category of "Non-Coking High-Volatile C Bituminous Coal" of the ASTM classification.

The Feasibility Study compares the possible yields for various types of treated coal, considering the industrial treatment losses. It is concluded that the proportion of the parcel with low ash content and high Calorific Value is small; yield losses are higher than the unit value gains of the products. Consequently, if there is a market available, it would be preferable to have a sole product with Calorific Value not higher than 3,700 cal/g than a high product with 4,700 cal/g plus a middling of 3,300 cal/g. The best hypothesis has already been mentioned in the previous item.

4.1.7 Utilization

Due to its characteristics, the main use of Arroio Capané's coal is for thermo-electric power plants, cement and other industry located at a distance not farther than 300 km, i.e., only in the central region of the State of Rio Grande do Sul or in the industrial poles around Porto Alegre and Caxias do Sul.

5
Iruí Deposit

5.1 Cordilheira Block

As shown in Figure 8, this block is located at the southern border of the Iruí Deposit, and refers to two prospection permits, corresponding to DNPM Processes Nos. 810.416/79 and 810.417/79. The Exploration Report has already been approved by the Ministry of Mines and Energy. There are two seams, with total reserves of 113.661 Mt of coal in the lying seam, at depths between 50m and 200m, as shown in Table XI.

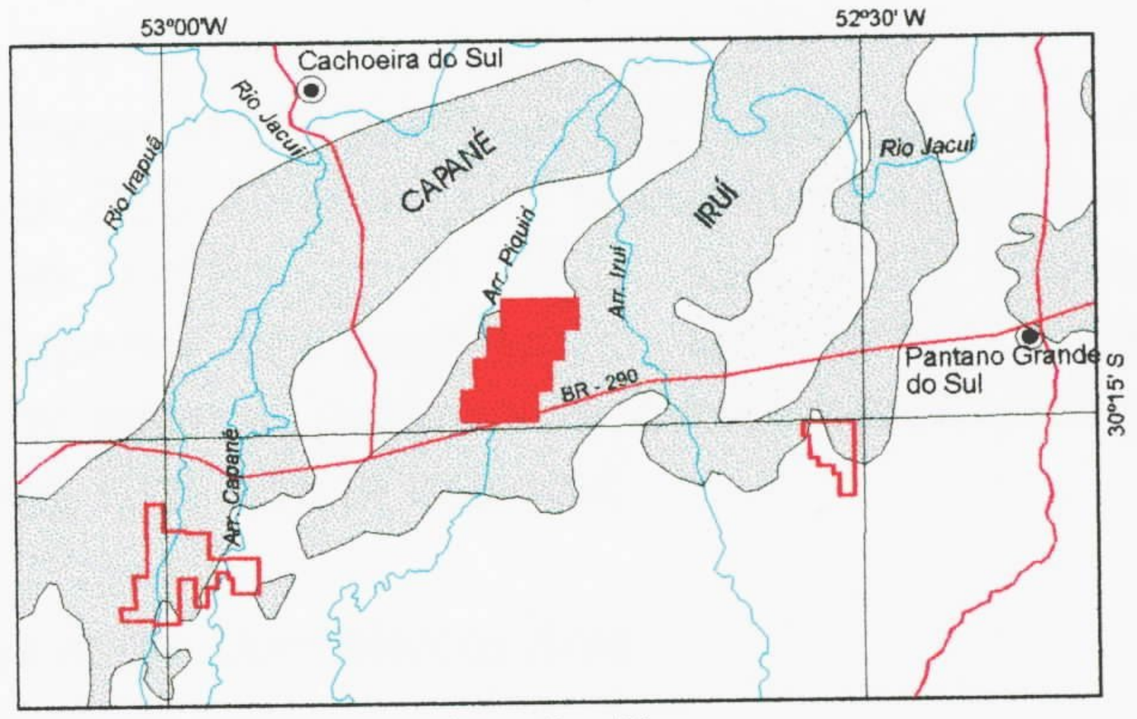
Table XI - Reserves in the Cordilheira Block

DNPM Process Nº	Reserves in 10^6 tons t			
	Measured	Indicated	Inferred	Total
810.416/79	10,737	58,566	1,707	71,010
810.417/79	4,918	31,733	6,001	42,652
Total	15,655	90,299	7,708	113,662

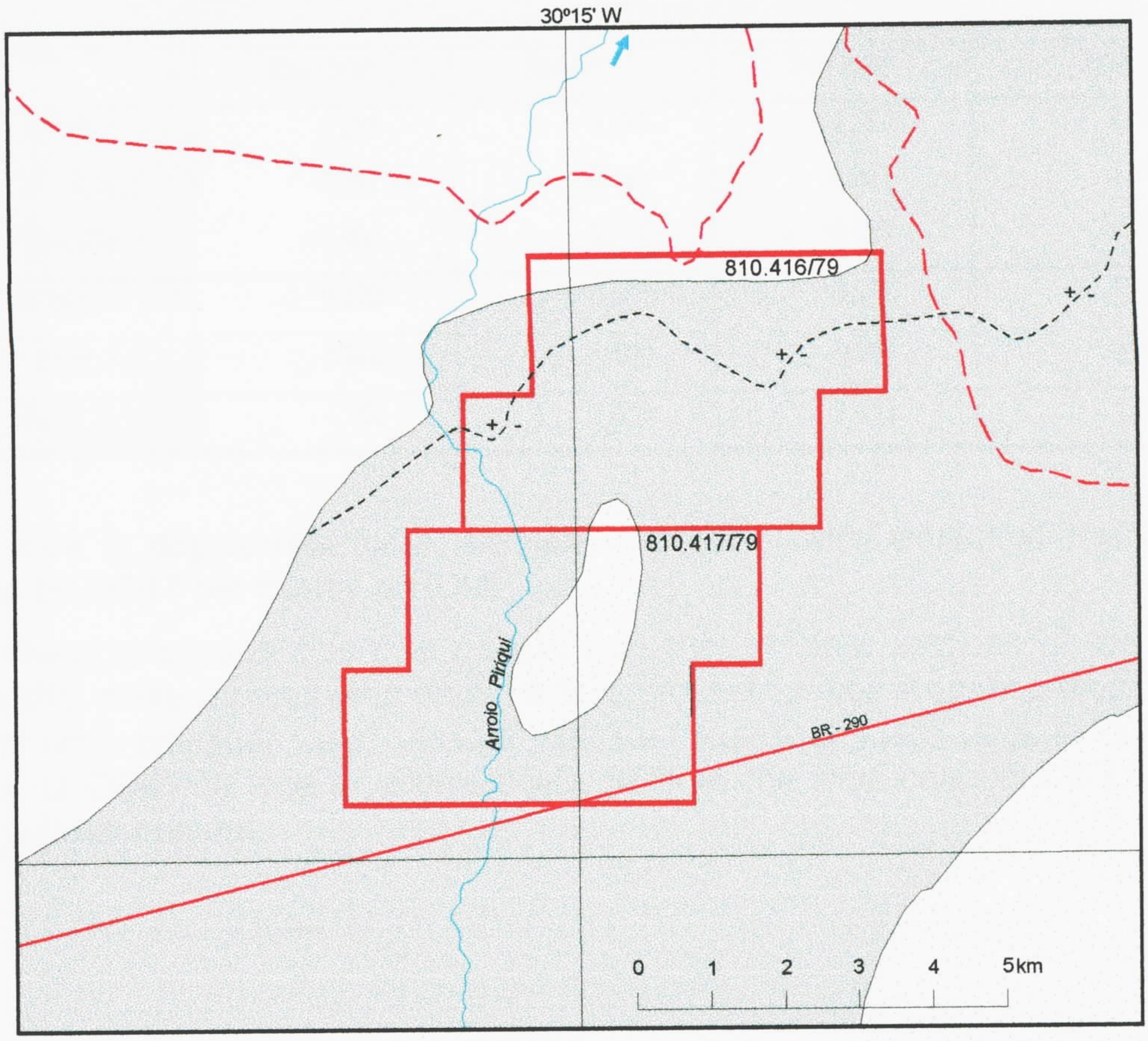
The presence of thick coal seams at moderate depths lead to the perspective that exploitation cost would be relatively low in relation to other Brazilian underground mines.

The similar features of this type of coal to those of the Iruí and Leão deposits make it possible to obtain a final product to be used in thermo-electric power plants and other energetic uses. Assays indicate theoretical yields close to 49% and 56% in the production of the CE-4700 type, respectively for the Upper Iruí seam and Cordilheira seam; sulphur content for both is below 0,5%.

Index Map



Location Map



Simplified Map of the Deposit

- Town
- Paved road
- Unpaved road
- Drilling
- Area available for negotiation
- Coal deposit
- 150 m isopach overburden

Figure 8 – Iruí Deposit. Cordilheira Block

5.2 Dom Marcos Area

As shown in Figure 9, this Area is located at the southeastern border of the Iruí deposit, corresponding to DNPM Process No. 810.374/84. The respective Exploration Report was presented to the Ministry of Mines and Energy on 12 January, 1989 and is still awaiting approval. The coal seam Iruí Superior has been found, with total reserves of 4.252 Mt of coal in the layer. Part of the reserves present low overburden covering, as shown in Table XII, making open pit mining easy and of low cost.

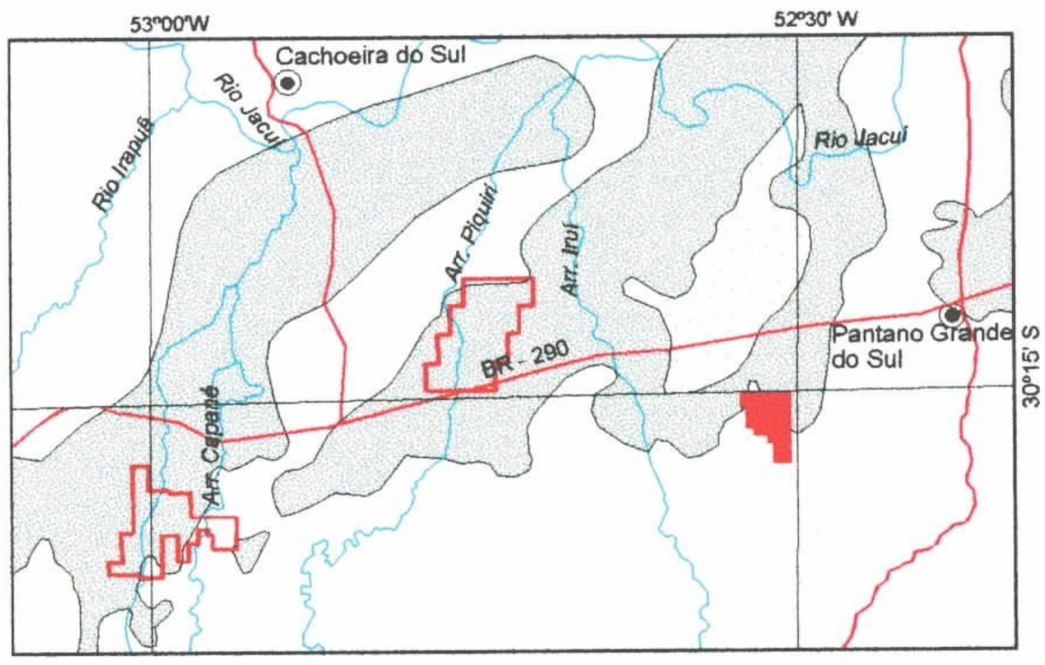
Table XII - Reserves in the Dom Marcos Area

Overburden	Reserves in 10^6 tons			
	Measured	Indicated	Inferred	Total
0 - 10 m	0,028	0,196	0,081	0,305
10 - 20 m	0,292	0,491	0,057	0,840
20 - 30m	0,000	0,072	0,033	0,105
Sub-total	0,320	0,759	0,171	1,250
> 30 m	0,960	1,800	0,242	3,002
Total	1,280	2,559	0,413	4,252

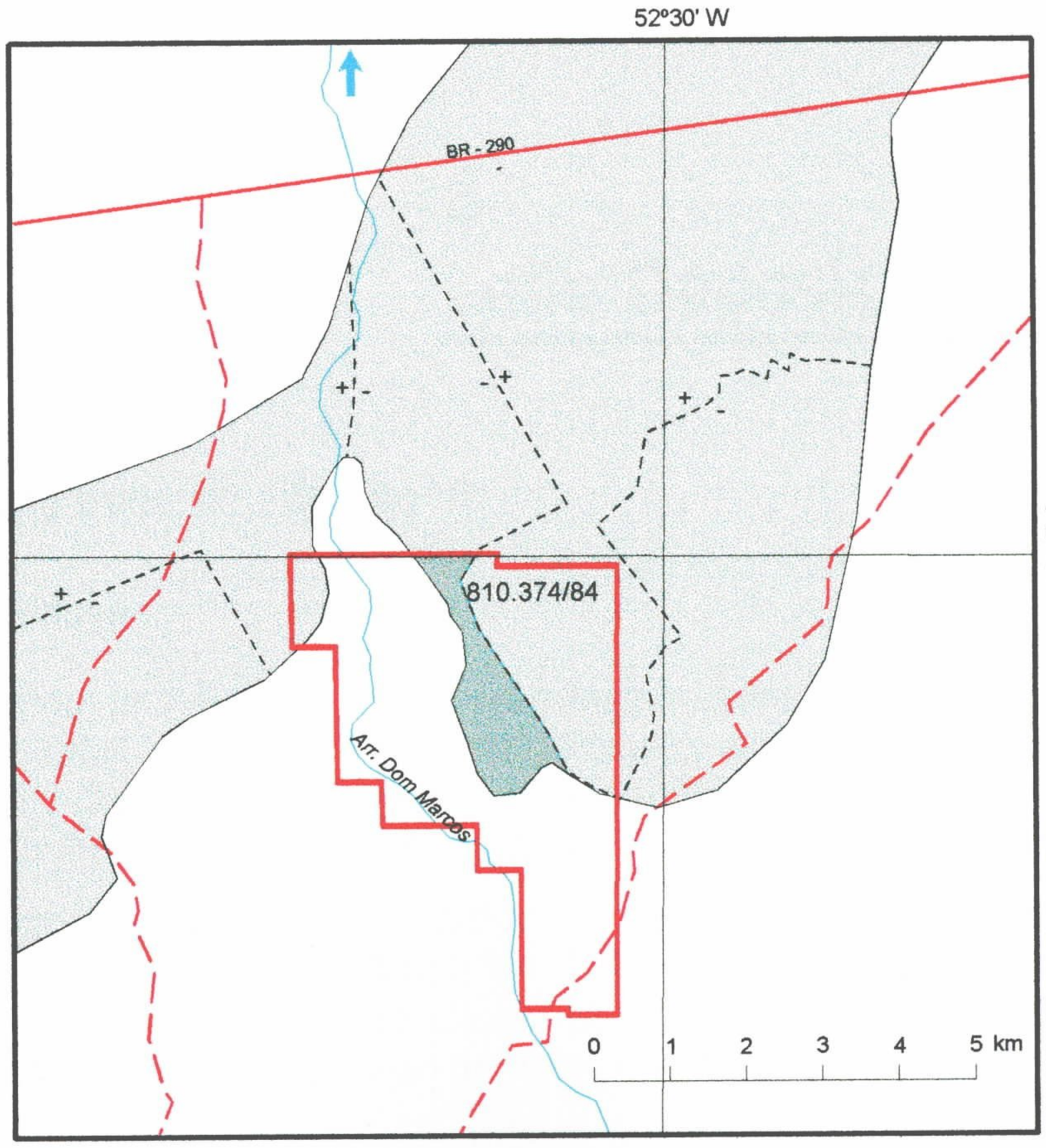
This area is appropriate for a medium size mine, with extraction running from 15,000 to 50,000 t per month of ROM.

The characteristics of this coal, similarly to that of other sections of the Iruí and Leão deposits, make it possible to obtain a final product for use in thermo-electric power plants and other energetic uses. Assays indicate theoretical yields close to 50% in the production of CE-4700 type or, alternatively, 86% in the production of CE-3700, both with low sulphur content.

Index Map



Location Map



Simplified Map of the Deposit

Town

Paved road

Unpaved road

Drilling

Area available for negotiation

Limit of the deposit

50 m isopach overburden

Section of open pit mining reserves included in CPRM'S Permit

Figure 9 – Iruí Deposit. Dom Marcos Area

6
Leão Deposit

6.1 Mining Units "C", "D" and "E"

6.1.1 Location

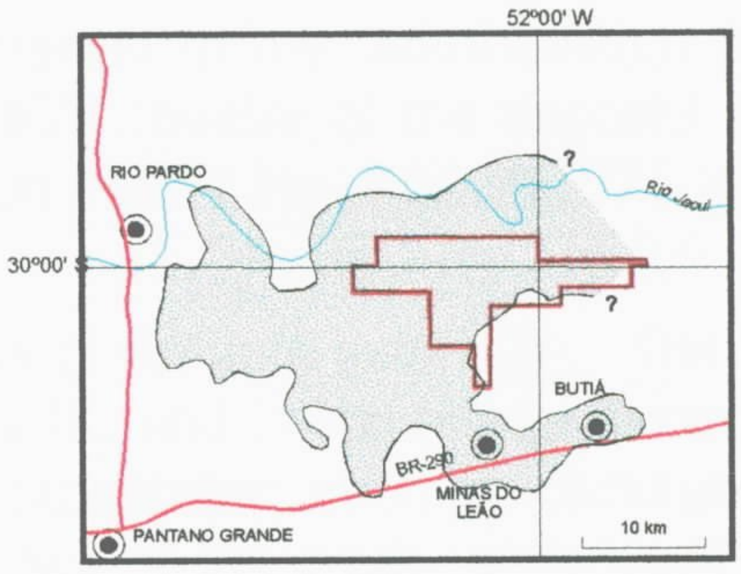
As shown in Figure 10, at the northeastern-center of the Leão deposit there is a large section included in CPRM's Prospection Permits, where several mines of large size can be established. This section is located in the Municipality of Minas do Leão, reaching the Municipality of Rio Pardo at west. Its center is 14 km to north of the Minas do Leão town.

It comprehends 7 prospection areas, included in DNPM Processes Nos. 802.363/75, 802.363/75, 802.364/75, 802/368/75, 802.369/75, 801.481/76 and 801.482/76, corresponding to Mining Units "C", "D" and "E" of previous studies, reports of which have already been approved by the DNPM.

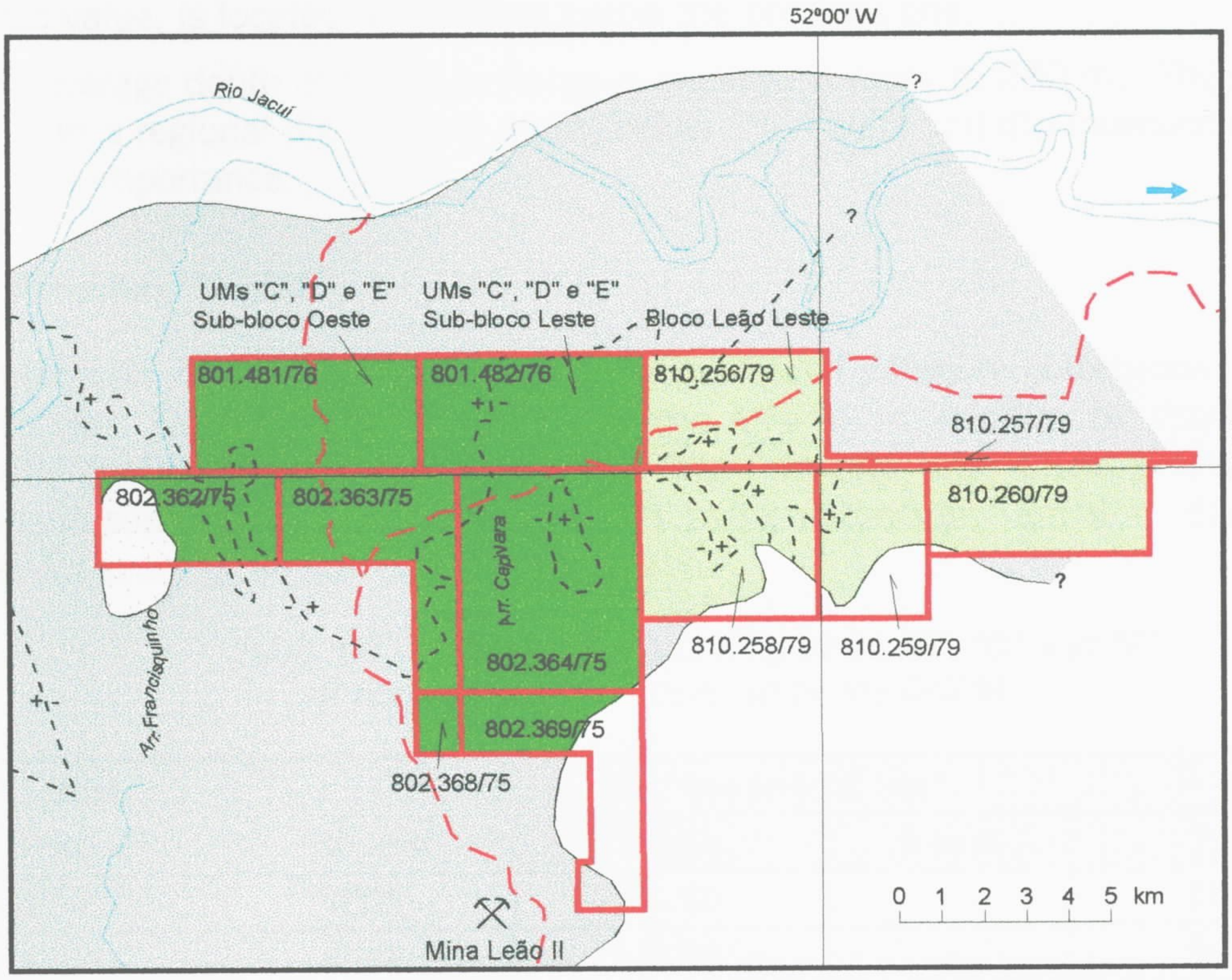
6.1.2 - Level of Knowledge

Based on about 65 drillings (1 km x 1 km spacing) carried out in two stages, Exploration Reports have been prepared, followed by Complementary Information Reports, all already approved by the Ministry of Mines and Energy. Afterwards, about fifty drill holes, in addition to seismic profiles of high resolution confirmed the continuity and the gentle tectonic of the seams.

Index Map



Location Map



Simplified Map of the Deposit

Town

Paved road

Unpaved road

Drilling

Area available for negotiation

Coal deposit

300 m isopach overburden

Coal mine

Figure 10 – Leão Deposit. Mining Units "C" "D" and "E"

6.1.3 Deposit Features

The extension of the carbonaceous pack covers about 90% of the 7,836 ha surface of the seven areas. Negative sections are only present in the southeastern part of the area included in Prospection Permit Nº. 802.369/75 (border of the deposit) and in the western section of the area included in Prospection Permit No. 802.362/75 (where diabase sills destroyed the coal).

Dozens of coal beds are grouped in six seams of variable extension. The barren intervals between the beds of the two upper seams (S_2 and I) sometimes become thicker and sometimes become thinner, allowing joint exploitation of thick packages in some sections. About 2 m below, seam I_2 is found in two of the areas, of reduced thickness but exceptional quality. After another interval of 6 m to 12 m of siltstone, the seam I_3 extends itself; it is thicker but of inferior quality. The last seam, I_4, with practically no economic value, is located 4 m to 5 m below the previous one.

The average depth of the carbonaceous package is close to 280 m. The structure is gentle, with a regional dip towards north, below 1°. Faults and dip inversions are generally of little importance.

6.1.4 Reserves "in situ"

As a result of the close drilling grid the measured category correspond to 56% of the reserves. The reserves approved by the DNPM in relation to Processes Nos. 802.363/75, 802.364/75 and 801/481/76 are smaller than those presented in the Final Exploration Reports, these differences being numerically equal to the estimated reserves for seam I_4, as per Tables XIII and XIV.

Table XIII - Reserves in the Mining Units "C", "D" and "E" of the Leão Deposit approved by the DNPM

DNPM Process Nº	Reserves in 10^6 tons			
	Measured	Indicated	Inferred	Total
802.362/75	17,010	11,600	-	28,610
802.363/75	51,750	40,080	-	91,830
802.364/75	84,090	70,590	-	154,680
802.368/75	5,920	3,740	-	9,660
802.369/75	7,230	13,430	-	20,660
801.481/76	53,370	32,300	-	85,670
801.482/76	45,900	33,410	-	79,310
Total	265,270	205,150	-	470,420

Table XIV - Reserves in the Mining Units "C", "D" and "E" of the Leão Deposit for the Seam I_4 calculated in the Final Exploration Report

DNPM Process Nº	Reserves in 10^6 tons			
	Measured	Indicated	Inferred	Total
802.363/75	2,630	1,360	-	3,990
802.364/75	4,310	3,710	-	8,020
801.481/76	1,050	0,530	-	1,580
Total	7,990	5,600	-	13,590

DNPM's appraisal excluded Seam I_4 from the reserves due to the fact that it was not considered as having sufficient quality to economically justify its exploitation. This decision is of little importance "vis-à-vis" the global evaluation, as these calculated reserves for seam I_4 represent less than 3% of the total reserves.

The reserves approved by the DNPM for the four remaining areas coincide with those given by CPRM in the Final Exploration Reports.

The above value represent the addition of the cubed quantities of Coal in the Seam, the barren intercalations being deducted. The Exploration Reports evaluate the average proportions in weight of the Coal in Seam in relation to the Total Seams (Camadas Totais CTS) of each seam. A summary of the values are in Table XV.

Table XV - Reserves of Coal in Seam (CC) and of Total Seam (CT) in Mining Units "C", "D" and "E" in the Leão Deposit)

Coal Seam	Cubed Reserves of CC (Mt)		Proportion (%)		Average Proportion CC/CT (%)		Reserves of CT (Mt)	
S_2		174,14		36,0		42,1		414
I		132,62		27,4		41,8		317
I_2		20,29		4,2		100,0		20
I_3		143,37		29,6		56,5		254
I_4		13,59		2,9		62,4		22
Total		484,01		100,0				1.027

6.1.5 Size of Exploitation and Division

For exploitation planning purposes, it can be estimated that from the 1,005 Mt of ROM in seams S_2, I, I_2 and I_3, about 70% can be selected as exploitable blocks (thicker

section, from which are excluded the structurally more irregular parts, safety pillars, etc.). Considering an exploitation ratio of 50%, a very pessimist hypothesis, and a diluting factor of 10%, we arrive at a total of extractable ROM of:

$$1{,}005\ Mt \times 0.7 \times 0.5 \times 1.1 = 387\ Mt$$

It can be seen that the block allows for up to five large size Mining Units, each one being able to supply 2.5 Mt/year of ROM during 30 years. However, the present Brazilian law does not foresee division of areas. Consequently, it is believed that the most rational division is that into two blocks: to the west, areas Nos. 802.362/75, 802.363/75 and 801.481/76, with 211.68 Mt of lying Coal in the Seam and to the east, the four remaining areas, with 272.33 Mt of lying Coal in the Seam.

6.1.6 Quality

Coal fits into the category "Non-Coking High-Volatile C Bituminous Coal" of the ASTM classification. Some of the assays of the lighter fractions of the density tests of the core drills showed very low agglomerating properties.

Seams S_2 I and I_2 have high proportions of the lighter fraction, of good quality, averaging from 5,000 cal/g to 6,000 cal/g, remaining as a secondary product a proportion approximately equivalent to middling, averaging from 3,000 cal/g to 3,700 cla/g. In the seams I_3 and, mainly, I_4, the light fraction is proportionally very small.

As an example, Table XVI show the average theoretical yields, not taking into account treatment losses, as from CS and TS (2nd and 3rd columns of the above table, respectively). As examples of products, C_{20} (20% ash content and 5,880 cal/g) and C_{52} (52% ash content and 3,250 cal/g) have been selected.

Table XVI - Theoretical Average Yields in the Coal Treatment in Mining Units "C", "D" and "E" of the Leão Deposit.

Coal Seam	Yields		Sulphur
	Of the Cubed Coal (CC)	Of the Total Seam (CT)	Contents (*)
S_2	50% C_{20} + 44% C_{52}	21,0% C_{20} + 18,5% C_{52}	0,55%
I	55% C_{20} + 30% C_{52}	23,0% C_{20} + 12,5% C_{52}	0,43%
I_2	53% C_{20} + 47% C_{52}	53,0% C_{20} + 47,0% C_{52}	0,60%
I_3	19% C_{20} + 81% C_{52}	10,7% C_{20} + 45,8% C_{52}	0,29%
I_4	6% C_{20} + 94% C_{52}	3,7% C_{20} + 58,7% C_{52}	0,24%
Obs: (*) Estimated averages for the treated fractions			

6.1.7 Utilization

The fraction with 15% to 25% ash content and high Calorific Value (averaging from 5,400 cal/g to 6,300 cal/g) has an unit value relatively high, justifying its transportation, if necessary, to the industrial center of the country for burning in seethers or gasifiers. Middling, averaging from 3,100 cal/g to 3,700 cal/g, shall be consumed in seethers and thermo-electric power plants close to the deposit, in a distance not exceeding 100 km.

6.2 Mining Unit "G"

As shown in Figure 11, this Unit is located in the center-west of the deposit; it comprehends four prospection permits, corresponding to DNPM Processes Nos. 802.360/75, 802.361/75, 802.366/75 and 806/637/75. The Exploration Reports have already been approved by the Ministry of Mines and Energy.

The amounts of reserves approved by DNPM are shown in Table XVII, totalling 144.540 Mt:

Table XVII - Reserves in the Mining Unit "G" of the Leão Deposit approved by DNPM)

DNPM Process Nº	Reserves tn 10^6 tons			
	Measured	Indicated	Inferred	Total
802.360/75	34,820	27,790	-	62,610
802.361/75	20,290	16,020	0,190	36,500
802.366/75	4,520	4,040	-	8,560
806.637/75	17,710	18,650	0,510	36,870
Total	77,340	66,500	0,700	144,540

The values approved by DNPM in the Exploration Report with regard to process No. 802.361/75 differ from those presented in the Final Exploration Report, these differences being numerically equal to the reserves calculated for seam I_4, as per Table XVIII.

Table XVIII - Reserves of Mining Unit "G" of the Leão Deposit for Seam I_4, calculated in the Final Exploration Report.)

DNPM Process Nº	Reserves in 10^6 tons			
	Measured	Indicated	Inferred	Total
802.361/75	2,070	1,440	-	3,510

DNPM appraisal excluded seam I_4 from the reserves, considering it of insufficient quality to justify its economic use.

The quality is similar to that found in Mining Units "C", "D" and "E" reported in item 6.1.6. The average depth is a little above 300 m and the structure of the carbonaceous pack is quite irregular.

6.3 Eastern Leão Block

As shown in Figure 10, CPRM is the holder of five prospection permits referring to DNPM Processes Nos. 810.256/79, 810.257/79, 810.258/79, 8109.259/79 and 810.260/70. The Exploration Report has already been approved by the DNPM. This Block represents the continuity towards east of the Mining Units "C", "D" and "E".

This group is known as "Eastern Leão Block". A considerable thickening of seam I_2, of exceptional quality, occurs therein. There is also a gradual closing towards SE and E of the seams I and I_3, and seam S_2 can no longer be identified. The reserves values approved by the DNPM are shown in Table XIX, amounting to 100.894 Mt.

For three of these areas, the reserves approved by the DNPM of one of the reserve categories have, quantitatively, small differences from those calculated in the Final Exploration Report. Theses differences, probably resulting from errors in the data transcription, are listed in Table XX.

These five areas can be utilized, if convenient, to increase the reserves of the block "Mining Units "C", "D" and "E".

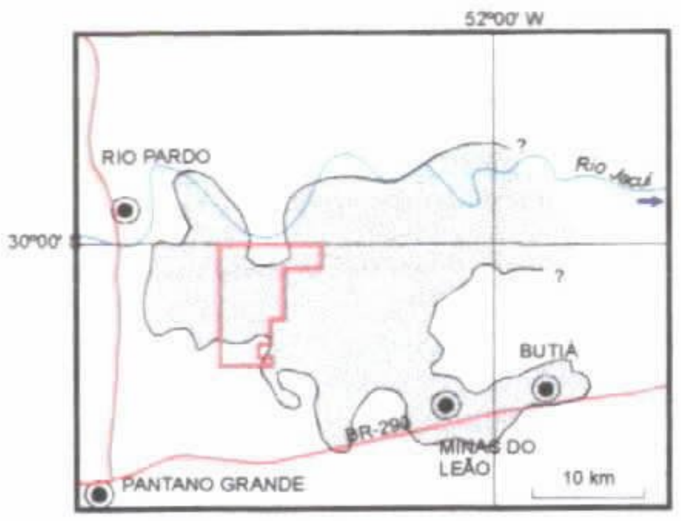
Table XIX - Reserves in Leão Leste Block approved by the DNPM

DNPM Process Nº	Reserves in 10^6 tons			
	Measured	Indicated	Inferred	Total
810.256/79	5,974	11,857	6,740	24,571
810.257/79	0,262	1,045	0,858	2,165
810.258/79	10,226	23,186	2,201	35,613
810.259/79	4,065	7,238	1,596	12,899
810.260/79	3,808	11,526	10,312	25,646
Total	24,335	54,852	21,707	100,894

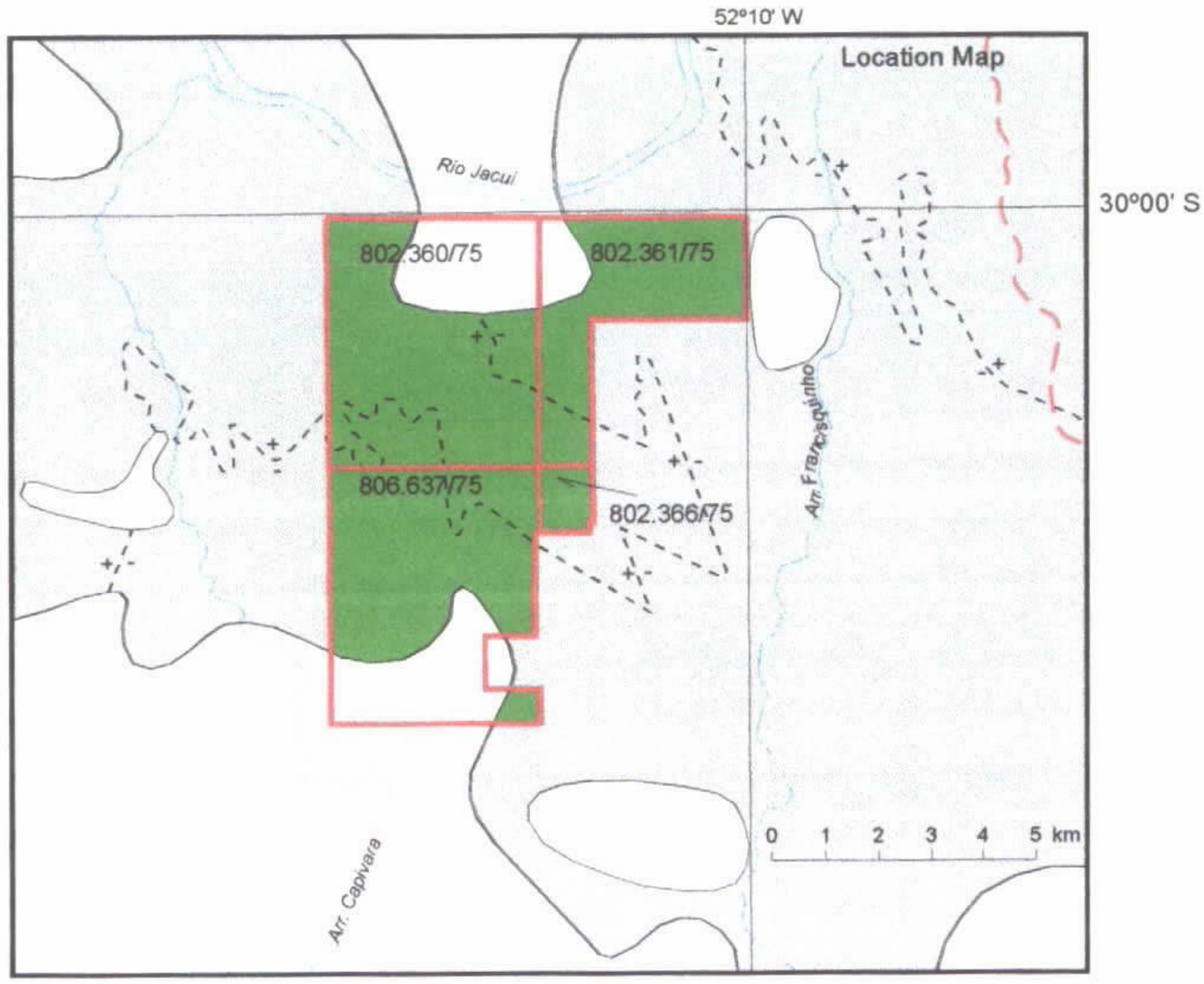
Table XX - Differences between CPRM's and DNPM's Reserves Calculations for Leão Leste Block

DNPM Process Nº		Reserves in 10^6 tons		
	Category	Exploration Report	Aproval Recommendation	Difference
810.256/79	Indicated	11,839	11,857	+ 0,018
810.259/79	Inferred	1,566	1,596	+ 0,030
810.260/79	Inferred	10,313	10,312	- 0,001

Index Map



Location Map



Simplified Map of the Deposit

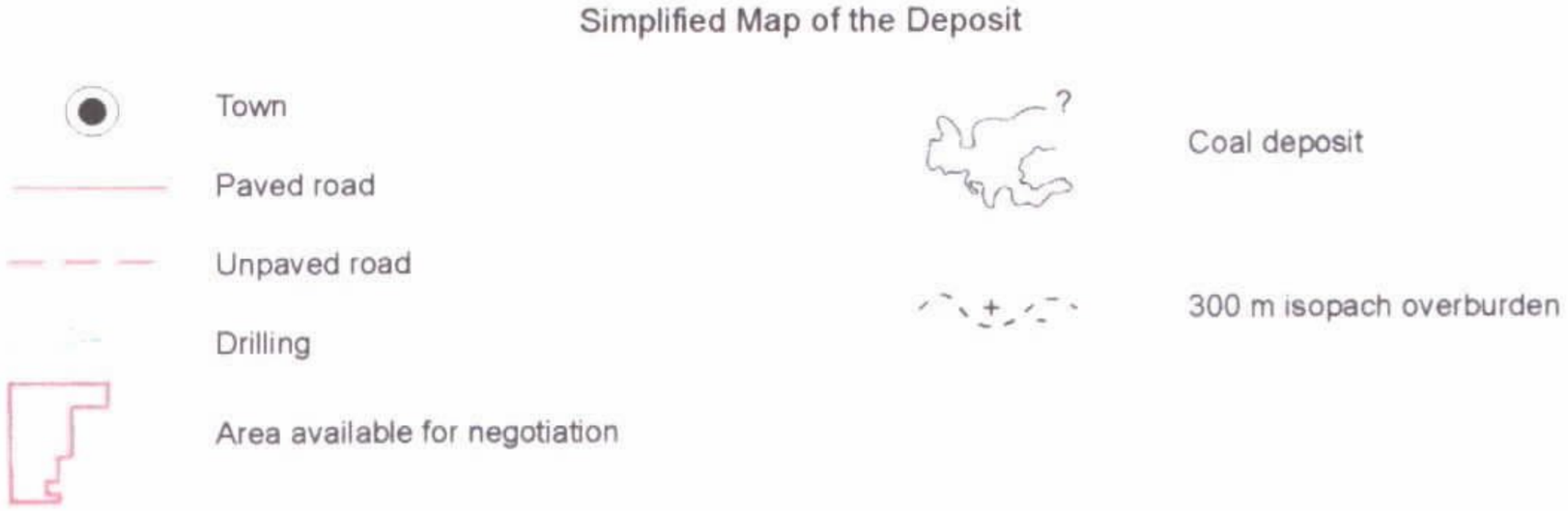


Figure 11 – Leão Deposit. Mining Unit "G"

7
Chico Lomã Deposit

7.1 Mining Unit "D"

7.1.1- Location

As shown in Figure 12, the eastern one third of this deposit, totally covered by CPRM's Prospection Permits, has promising geological and physical characteristics. Its center lies 10km south of the city of Santo Antonio da Patrulha, State of Rio Grande do Sul (RS), spread out under the territory of this and of three other neighboring municipalities.

It encompasses eight prospection areas, referred to as DNPM processes Nos. 812.597/76, 812.598/76, 812.599/76, 812.622/76, 812.624/76, 812.625/76, 812.628/76 and 812.629/76.

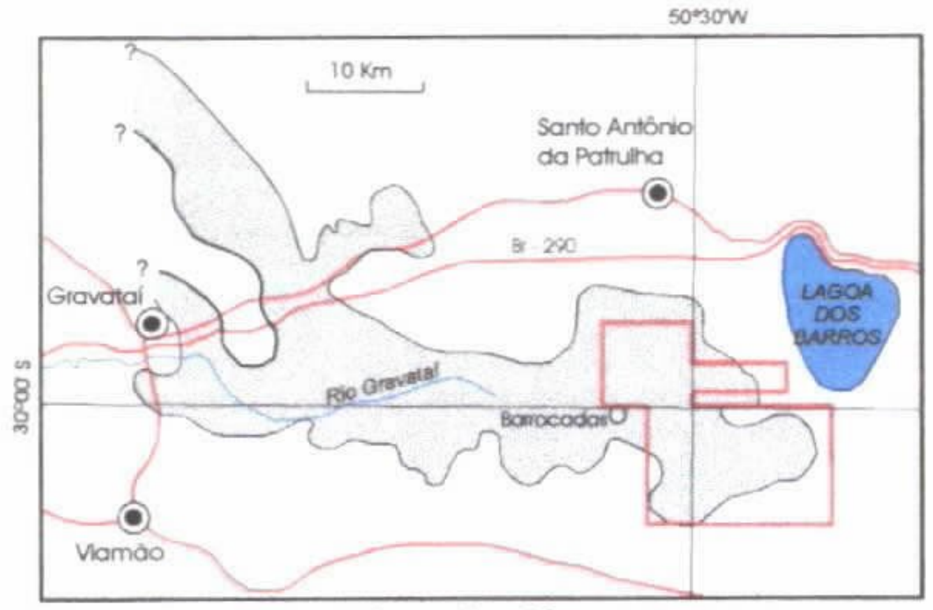
7.1.2 Level of Knowledge

The exploration was carried out through about 25 diamond drill holes, with an average spacing below 3 km and complemented by electro-resistivity and refraction seismic geophysical profiles. The Exploration Reports have already been approved by the DNPM.

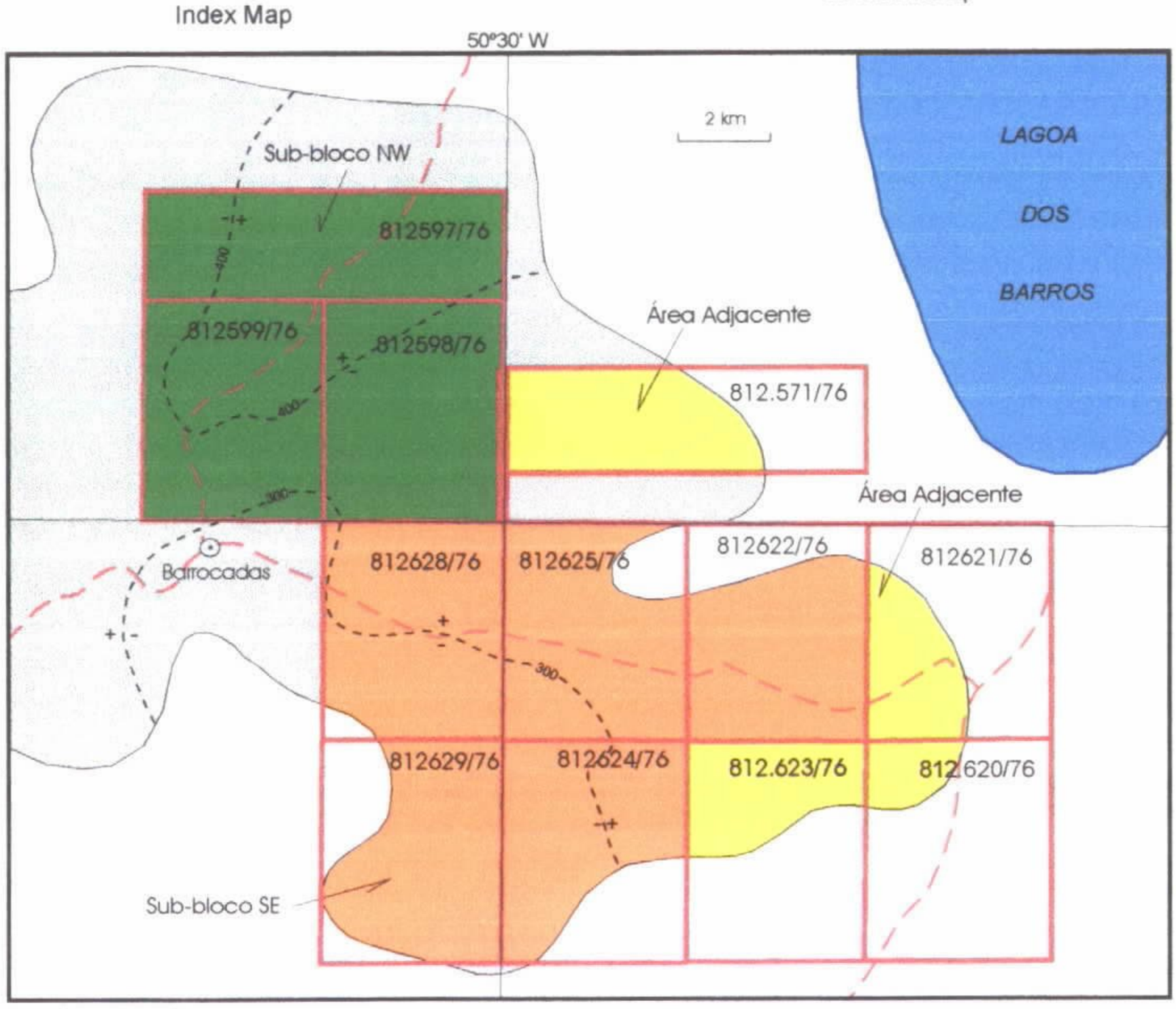
7.1.3 Deposit Features

There are six overlaid coal seams of economic importance, separated by barren intervals 1,5m to 6m thick. The Chico Lomã 4 seam (CL_4) is the most extensive and important one, with more than 3/5 of the reserves. One fifth of the reserves is situated in seam CL_6 and the remaining one fifth is in discontinuous seams CL_2, CL_3, $CL_{6.1}$ and $CL_{6.2}$.

Index Map



Location Map



Simplified Map of the Deposit

- Town
- Village
- Paved road
- Unpaved road
- Limit of the deposit (approximately)
- Isopach limit (in meters)
- Drilling
- Areas available for negotiation
- Sub-block NW
- Sub-block SE
- Adjacent areas

Figure 12 – Chico Lomã. Mining Unit "D"

The average depth, about 330m, is comparable to the existing Charqueadas mine. The greater depths, a little above 400m, are more a result of the topographical elevation of the Coxilha das Lombas ridge than due to the deepening of the seams.

Access to coal seams is hampered by the thick not well consolidated cenozoic sediments, demanding special techniques for the opening of shafts and/or inclined galleries. Except for the northeastern corner of area No. 812.597/76, where gondwanic rocks come to the surface, the drillings cut 100m to 270m of post-gondwanic covering.

7.1.4 Reserves "in situ"

The coal reserves of the eight areas are in Table XXI

Table XXI - Reserves of Mining Unit "D" of the Chico Lomã Deposit

DNPM Process Nº	Reserves in 10^6 tons			
	Measured	Indicated	Inferred	Total
812.597/76	8,926	65,478	24,713	99,117
812.598/76	8,780	17,080	24,080	49,940
812.599/76	8,890	22,270	26,550	57,710
812.622/76	2,440	15,390	20,760	38,590
812.624/76	0,520	4,380	21,600	26,500
812.625/76	1,950	14,770	13,860	30,580
812.628/76	0,670	10,410	4,970	16,050
812.629/76	1,920	11,260	7,520	20,700
Total	34,096	161,038	144,053	339,187

For processes Nos. 812.599/76, 812.622/76, 812.624/76, 812.625/76, 812.628/76 and 812.629/76 approved reserves coincide with those presented by CPRM in the Final Reports.

For process No. 812.597/76, the reserves shown on the above table, transcribed from the 1st DS/DNPM "Approval Recommendation", were recalculated in a consolidated report, carried out to comply with DNPM's requirement; they differ from those of the Final Exploration Report submitted (20,39 Mt measured, 52,51 Mt indicated, 13,87 Mt inferred and 86,77 Mt total).

For process No. 812.598/76 the indicated reserve of 17.080 Mt in the "Approval Recommendation" differ from the 17.850 of the Final Exploration Report, possibly due to an error in the data transcription.

From these reserves, a little over 3/5 are in seam CL4, about 1/5 in the CL6 and the remaining 1/5 corresponds to seams CL3, CL6.1 and CL6.2.

The above mentioned values represent the sum of the quantities of the cubed coal in the seam (CS), excluding the barren intercalations. The Prospection Reports estimate that these represent from 54% to 56% (in the case of CL_4), or from 61% to 63% (in the case of CL_6), of the tonnage of total seam (CT) or "in situ" ROM. Thus, the total reserves of ROM of the 8 areas are estimated to be about 360 Mt for seam CL_4 and 115 Mt for seam CL_6.

7.1.5 Mining Dimensions and Division

In order to plan the mining production one can estimate that out of the 475 Mt of ROM in seams CL_4 and CL_6, after a closer drilling program, about 60% could be selected for mining (thicker sections, excluding structurally irregular zones, safety pillars, etc.) Considering an extraction factor of 50%, a very pessimistic hypothesis, and a diluting factor of 10%, one arrives at a total of extractable ROM from the mines of:

$$475\ Mt \times 0.6 \times 0.5 \times 1.1 = 157\ Mt$$

This amount corresponds to two mining units of 2.5 Mt of ROM/year, during 31 years. Thus, the block of 8 areas might encompass an industrial undertaking of considerable size (an annual production almost equal to the total of the present production of the State of Rio Grande do Sul) or be divided into two sub-blocks:

- At NW, the areas 812.597/76, 812.598/76, and 812.599/76, with 206.767 Mt, where the larger average depth is compensated by larger averages thickness of the seams.
- At SE, areas 812.622/76, 812.642/76, 812.625/76, 812.628/76 and 812.629/76, with 132.420 Mt, where smaller average thickness of the seams are compensated by the smaller average depth.

7.1.6 Quality

The coal of Chico Lomã is within an evolutive scale higher than that of the deposits of Baixo Jacuí (Capané, Iruí, Leão Butiá and Charqueadas), fitting into the category of "High-Volatile Bituminous Coal" in the ASTM classification, with a vitrinite reflecting power between 0.6% and 0.7%. Due to this fact, its final products, for identical values in ash, have calorific values of about 200 cal/g above the values usually found in Leão-Butiá.

The treatment mat yield, according to market demands, two products:

- One with 12% to 22% ash content. Dry basis High Calorific Value (DBHCV) of 6.800 to 6.000 cal/g and FSI of 1 to 3, whose higher value permits competition in more distant markets, and
- A middling with 40% to 49% ash and 4.500 to 3.700 cal/g, for regional usage.

- The assays carried out foresee yields, as in the examples below, for the average ROM without taking into consideration neither enclosing rock dilution nor treatment losses:
- In seam CL_4 about 14% of C_{15} with 6.600 cal/g DBHCV plus 14% of C_{49} with 3.700 cal/g or, alternatively, 20% of C_{12} with 6.800 cal/g plus 38% of C_{49}.
- In seam CL_6 about 14% of C_{15} plus 44% of C_{49}.
- Final products from seam CL_4 present sulphur contents close to 0.7% and those from CL_6 close to 0.6%.

7.1.7 Utilization

The fraction with 6.600/6.800 cal/g has a smaller ash content and higher calorific value than any other commercialized Brazilian coal. It can be used in high output furnace, as carbonchemistry raw material or as soft coal in the coking coal mixture for the high furnace coke production.

According to market demands, middlings of 3.000 to 5.200 cal/g may be produced to be used both in thermo-electric power plants and in the cement industry as well as in the production of gas, steam or other industrial usage.

7.2 Adjacent Areas

Also shown in Figure 12, there are four CPRM areas (Processes DNPM 812.571/76, 812.620/76, 812.621/76 and 812.623/76), in the continuity of the above studied block, which represent portions of the borders of the Chico Lomã Deposit. The reserves of this section total 45.768 Mt, distributed between seams Cl_4 (about 4/5) and CL_6 (the remainder), as shown in Table XXII.

Table XXII - Reserves in the Adjacent Areas to Mining Unit "D" of the Chico Lomã's Deposit

DNPM	Reserves in 10^6 tons			
Process Nº	Measured	Indicated	Inferred	Total
812.571/76	1,762	7,931	7,315	17,008
812.620/76	0,080	0,880	3,080	4,040
812.621/76	0,660	4,450	6,630	11,740
812.623/76	0,920	3,990	8,060	12,970
Total	3,422	17,251	25,085	45,758

For Processes 812.620/76, 812.621/76 and 812.623/76, the values presented in the "Approval Recommendation" of the Exploration Reports are the same which those presented by CPRM in the Final Reports.

For Process 812.571/76, the results shown in the tables, based on the "Approval Recommendation", correspond to the calculations made in a consolidated report, prepared to comply with DNPM's requirement and differ from the first Exploration Report (0.16 Mt Measured, 0.62 Mt Indicated, 2.34 Mt Inferred and 3.12 Mt Total).

8
Sul-Catarinense Deposit

8.1 Morro dos Conventos Mining Unit

8.1.1 Location

As shown in Figure 13, this Unit is covered by two Prospection Permits, which areas are close to each other but not contiguous. These areas are located in the Municipality of Araranguá, southeast of the State of Santa Catarina, 5 to 10 km from the town of Araranguá, and are linked to this town and to BR-101 by paved roads.

They correspond to DNPM Processes Nos. 806.363/73 and 806.365/73, totaling 1,228.36 ha.

8.1.2 Level of Knowledge

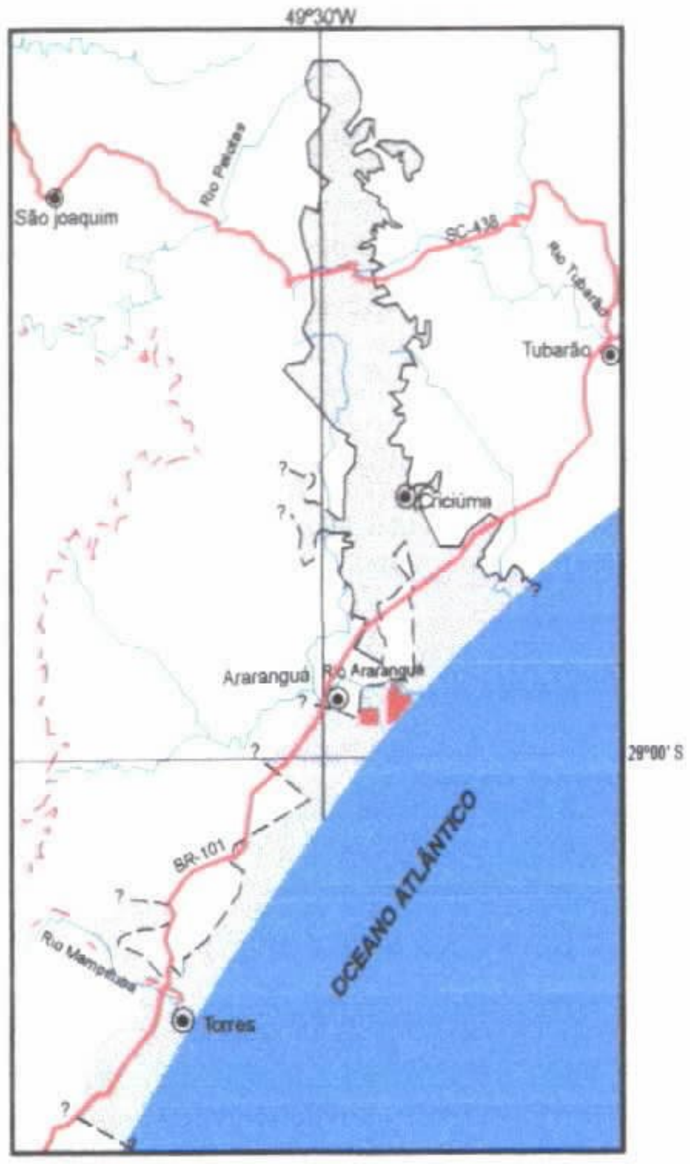
Results of six drill holes carried out in the prospected areas and in about a dozen of other areas nearby are available. The grid is irregular, with an average distance from 2.0 km to 2.5 km between drillings. The Exploration Report for both areas has already been approved by the Ministry of Mines and Energy.

8.1.3 Deposit Features

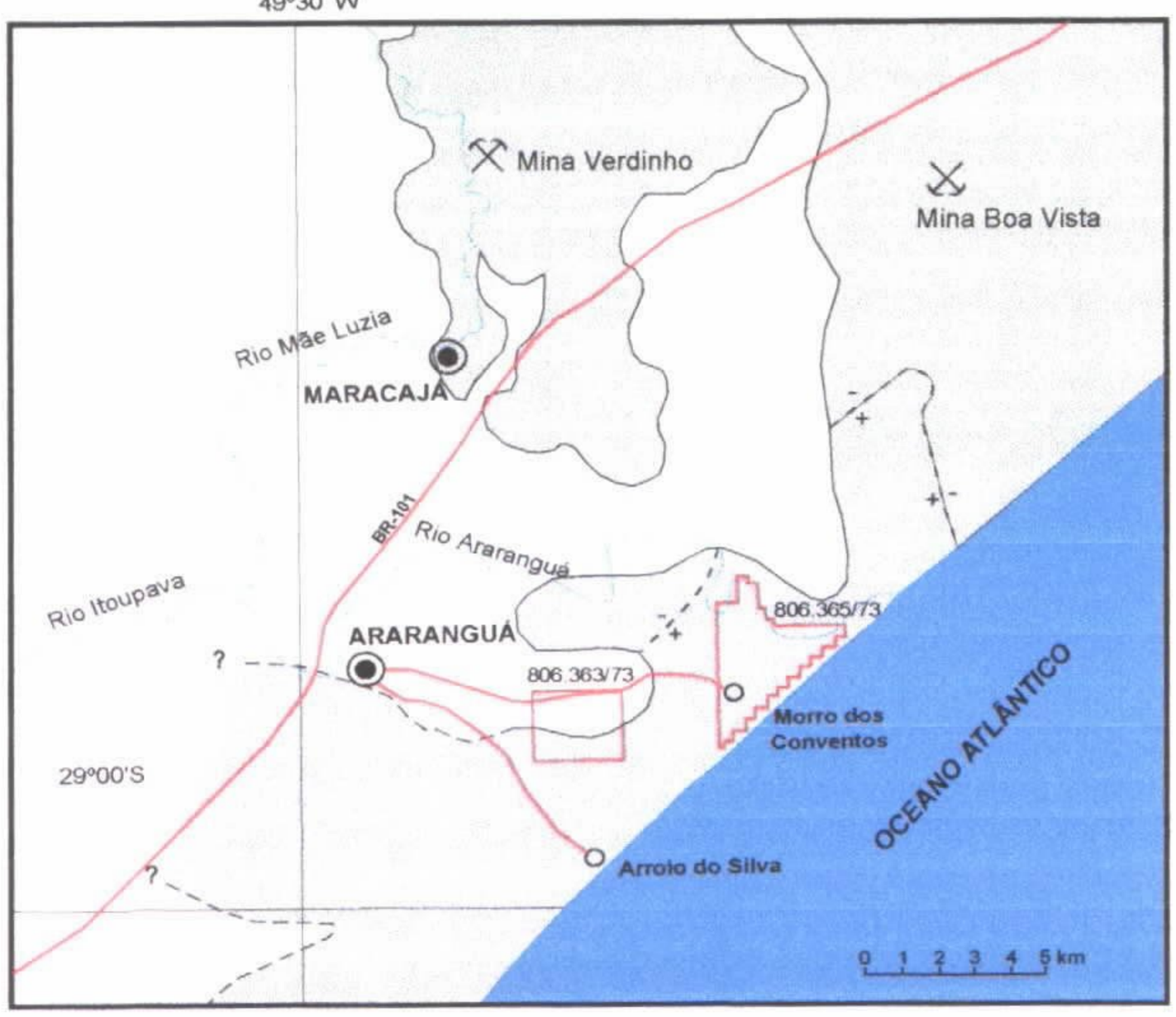
The areas are located in the southern extension of the Sul-Catarinense Deposit, which is under continuous exploitation since the last century. The nearest mines of Verdinho and Boa Vista, marked in the map, are less than 15 km away.

Index Map

Town
Village
Paved road
Area available for negotiation
Limit of the deposit
Probable limit of the deposit
300 m isopach overburden
State boundary
Drilling



Location Map



Simplified Map of the Deposit

Figure 13 – Sul-Catarinense Deposit. Morro dos Conventos Mining Unit

In the area included in DNPM Process No. 806.365/73, Permian sedimentary rocks of the Rio Bonito Formation contain three important coal seams, in a descending order: Barro Branco, Bonito Superior and Pré-Bonito Superior. Coal thicknesses in the seam (addition of the thicknesses of the coal beds), intersected by three drillings are far larger than the average thickness found in the Lauro Müller, Criciúma and Içara regions, shown in Table XXIII.

Table XXIII - Coal Thicknesses in Seam (CC) of the Morro dos Conventos Mining Unit

Coal Seam	Coal Thickness In the Seam	
	Máximum	Mínimum
Barro Branco	1,65 m	1,53 m
Bonito Superior	2,05 m	1,02 m
Pré-Bonito Superior	1,85 m	0,36 m

In the area of the DNPM Process No. 806.363/73, only the Barro Branco seam was found, which occurs in the southeastern half of the Prospection Permit, with thicknesses a little over the minimum considered as economic feasible for exploitation.

The deposit features show the continuity in the Sul-Catarinense Basin. There is a gradual deepening of the seams from NNE to SSW, with average dips close to 1 degree. Gravity faults cause sectioning , difficult to be detailed due to the overlying of Holocene sediments; the largest faults in extension and displacement are those striking from NE to SW. The diabase intrusions with variable extensions and irregular shapes are present, which, where occurring, may locally affect the seams.

The Barro Branco coal seam lies at an average depth close to 300 m; the Bonito Superior is under the previous one, separated by a predominantly arenaceous interval with an estimated average thickness of 43 m. The Pré-Bonito Superior coal seam is under the previous one, separated by about 3 m of siltstone.

The group of Gondwana rocks outcrops in a section with about 2 sq.km in the center of the area included in DNPM Process No. 806.365/73, at the site named "Morro dos Conventos". The remaining part of this area and the totality of the area corresponding to the DNPM Process No. 806.363/73 are covered by non-consolidated Cenozoic sediments with an average thickness close to 40 m.

8.1.4 Reserves "in situ"

Table XXIV show the reserves in these two areas, classified by category and coal seam.

Table XXIV - Reserves in Morro dos Conventos Mining Unit

DNPM Process Nº	Coal Seam	Reserves (tons)			
		Measured	Indicated	Inferred	Total
806.363/76	Barro Branco	372.000	1.398.400	184.800	1.955.200
	Sub-Total	372.000	1.398.400	184.800	1.955.200
806.365/76	Barro Branco	3.512.000	12.835.200	2.932.800	19.280.000
	Bonito Superior	3.360.000	13.256.250	2.537.500	19.153.750
	Pré-Bonito Superior	2.359.000	10.181.500	2.306.500	14.847.000
	Sub-Total	9.231.000	36.272.950	7.776.800	53.280.750
Total		9.603.000	37.671.350	7.961.600	55.235.950

8.1.5 Quality and Utilization

The coal fits in the category of "High-Volatile A Bituminous Coal" of the ASTM classification. The small amount of drill holes and assays only allows an initial appraisal of the average quality of the various coal seams.

In the Barro Branco seam, it will be possible, by means of gravimetric treatment, either to separate two saleable products (one fraction averaging from 15% to 18% ash content, usable for production of metallurgical coke or foundry and another fraction averaging from 40% to 45% ash content for thermo-electric power plant or industrial use) or have a sole product, with intermediary quality. Sulfur contents (averaging from 1.13% to 1.69% in the four assays of the float fraction of 1.5 density heavy media will be inferior to the average of the Sul-Catarinense deposit. The averages of the assays indicate, in a preliminary way, that the recover percentages of the useful fractions in ROM will probably be a little inferior to those of the mines near to Criciúma, maybe due to the sections with partial reduction of the volatile components, caused by intrusion thermal effects.

In the Bonito coal seam, assays indicated a medium quality similar to that found in the same coal seam of the region located between Lauro Müller and Içara in the prospection works carried out in 1976/77. A ROM averaging from 30% to 40% is estimated for the saleable coal with up to 40% ash content or, alternatively, a recovery a little above 50% for the saleable coal with 47% to 50% ash content.

The available assays for the Pré-Bonito Superior coal seam indicate a lower quality, containing reduced percentages of usable fractions. This makes this coal seam of secondary economic interest, only permitting exploitation if closer drilling identifies sections with better quality.

8.1.6 Exploitation Peculiarities

Some specific aspects related to the potential mining of these areas should be pointed out:

- In Area 806.365/76, coal thickness in the Barro Branco seam is larger than the average thickness in areas presently under mining in Santa Catarina, meaning a favorable economic aspect.
- The average depths close to 300 m in both areas will result in high pressures in the mines, making exploitation difficult by the methods presently being used in the State of Santa Catarina: room-and-pillar or blocks. With an overburden of 300 m, the usual option in other countries is the longwall mining, which demands uniform sections with minimum sizes of 80 m x 600 m and normally of even 150 m x 2,000 m.
- The prospections in the region between Criciúma and the Atlantic Ocean show a tendency to increase the tectonic movement and the presence of irregular diabase intrusions towards the continental margin. Detailing of such aspects by drilling and or geophysics is very expensive and imprecise.
- Digging and impermeabilization of mine shafts through dozens of meters of unconsolidated sediments is a task already dominated by current techniques, but very expensive.
- The regional coastal environment is ecologically fragile, increasing the costs of environmental preservation tasks. The touristic appeal of Morro dos Conventos and Arroio da Silva tends to favor arguments from groups contrary to any potentially harmful activity in the region.

AREAS AVAILABLE FOR NEGOTIATION

Areas Available For Negotiation

DNPM Nº	PERMIT Nº	PROJECT	DEPOSIT	UNIT
806.363/73	2.697/76	Morro dos Conventos	Sul-Catarinense	Morro dos Conventos
806.365/73	7.558/76			
814.965/74	1.867/79			
814.966/74	3.011/79	Grande Candiota	Candiota	Arroio da Pitangueira
814.967/74	1.962/79			
814.971/74	1.166/81	Grande Candiota	Candiota	Estância da Glória
802.360/75	4.030/80			
802.361/75	829/77	Iruí-Butiá	Leão	"G"
802.362/75	830/77			
802.363/75	831/77	Iruí-Butiá	Leão	"C", "D", "E"
802.364/75	3.567/80			
802.366/75	246/77	Iruí-Butiá	Leão	"G"
802.368/75	1.500/78	Iruí-Butiá	Leão	"C", "D", "E"
802.369/75	4.034/80			
806.637/75	5.231/77	Iruí-Butiá	Leão	"G"
801.481/76	1.494/78	Iruí-Butiá	Leão	"C", "D", "E"
801.482/76	1.495/78			
812.571/76	4.841/80			
812.597/76	6.929/77			
812.598/76	6.930/77			
812.599/76	6.931/77			
812.620/76	3.181/81			
812.621/76	3.182/81			
812.622/76	3.525/81	Torres-Gravataí	Chico Lomã	"D"
812.623/76	3.183/81			
812.624/76	3.184/81			
812.625/76	3.185/81			
812.628/76	3.187/81			
812.629/76	3.188/81			
810.256/79	4.613/80			
810.257/79	4.614/80			
810.258/79	2397/80	Iruí-Butiá	Leão	Leão Leste
810.259/79	3.429/80			
810.260/79	5.824/80			
810.416/79	2573/80	Iruí-Butiá	Iruí	Cordilheira
810.417/79	4616/80			
810.454/79	5.589/80			
810.455/79	5.590/80	Grande Candiota	Candiota	Seival II
810.456/79	3.438/80			
810.458/79	3.596/80			
810.006/80	2.092/81			
810.007/80	2.148/81	São Sepé	Capané	Arroio Capané
810.012/80	2.176/81			
810.013/80	3.467/82			
810.025/84	1.819/85			
810.026/84	1.820/85	Grande Candiota	Candiota	Arroio dos Vimes
810.031/84	8.637/85			
810.374/84	515/86	Iruí-Butiá	Iruí	Dom Marcos

Areas Available For Negotiation

DNPM Nº	PERMIT Nº	PROJECT	DEPOSIT	UNIT
806.363/73	2.697/76	Morro dos Conventos	Sul-Catarinense	Morro dos Conventos
806.365/73	7.558/76			
814.965/74	1.867/79			
814.966/74	3.011/79	Grande Candiota	Candiota	Arroio da Pitangueira
814.967/74	1.962/79			
814.971/74	1.166/81	Grande Candiota	Candiota	Estância da Glória
802.360/75	4.030/80			
802.361/75	829/77	Iruí-Butiá	Leão	"G"
802.362/75	830/77			
802.363/75	831/77	Iruí-Butiá	Leão	"C", "D", "E"
802.364/75	3.567/80			
802.366/75	246/77	Iruí-Butiá	Leão	"G"
802.368/75	1.500/78	Iruí-Butiá	Leão	"C", "D", "E"
802.369/75	4.034/80			
806.637/75	5.231/77	Iruí-Butiá	Leão	"G"
801.481/76	1.494/78	Iruí-Butiá	Leão	"C", "D", "E"
801.482/76	1.495/78			
812.571/76	4.841/80			
812.597/76	6.929/77			
812.598/76	6.930/77			
812.599/76	6.931/77			
812.620/76	3.181/81			
812.621/76	3.182/81			
812.622/76	3.525/81	Torres-Gravataí	Chico Lomã	"D"
812.623/76	3.183/81			
812.624/76	3.184/81			
812.625/76	3.185/81			
812.628/76	3.187/81			
812.629/76	3.188/81			
810.256/79	4.613/80			
810.257/79	4.614/80			
810.258/79	2397/80	Iruí-Butiá	Leão	Leão Leste
810.259/79	3.429/80			
810.260/79	5.824/80			
810.416/79	2573/80	Iruí-Butiá	Iruí	Cordilheira
810.417/79	4616/80			
810.454/79	5.589/80			
810.455/79	5.590/80	Grande Candiota	Candiota	Seival II
810.456/79	3.438/80			
810.458/79	3.596/80			
810.006/80	2.092/81			
810.007/80	2.148/81	São Sepé	Capané	Arroio Capané
810.012/80	2.176/81			
810.013/80	3.467/82			
810.025/84	1.819/85			
810.026/84	1.820/85	Grande Candiota	Candiota	Arroio dos Vimes
810.031/84	8.637/85			
810.374/84	515/86	Iruí-Butiá	Iruí	Dom Marcos