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Companhia de Pesquisa de Recursos Minerais
Diretoria de Geologia e Recursos Minerais
Departamento de Recursos Minerais

**KAOLIN EXPLORATION IN THE CAPIM RIVER REGION
STATE OF PARÁ**

EXECUTIVE SUMMARY

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2000

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Presentation

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1 - Introduction

CPRM geologists during late July 1971 checked on the occurrence of a thick mass of white kaolin along the banks of Capim river at its confluence with "*igarapé*" (stream) Ciputeua in the Eastern region of the State of Pará.

This discovery led to the issuing of 10 applications for exploration, corresponding to 10 areas of 1,000 hectares each under DNPM's N. 812,869 to 812,878/71. The authorizations for exploration were given by Permits N. 868 to 877 dated July 13th 1972, published in the Official Gazette of July 20, 1972.

This Survey Report describes the works that took place in the areas (claims) conferred to CPRM, which enabled the delineation of a substantial reserve of good quality kaolin in that region.

This brochure is an Executive Summary of the Final Report of the Rio Capim Project, due em 1973, compiled, adapted and updated to the year 2000, to become a part of the Informe de Recursos Minerais nº 23 of the Mineral Opportunities – Up-Dated Review of Project Series.

2 - Geographical Aspects

2.1- Localization and Access Routes

The exploration areas, with a total surface of 10,000 hectares, comprise two groups of 5 areas located North and South of "igarapé" Ciputeua or Bacuri, right bank tributary to Capim river, at parallel 2°25' South and meridian 47°45' West of Greenwich, the municipal district of Ipixuna do Pará, State of Pará, (figure 1).

The exploration areas may be easily accessed from Belem, PA, by river, at any time of the year using small and medium tonnage vessels, travelling first about 120 km on Guamá river and then 120 km on Capim river.

There are other accesses alternatives by air and/or road.

2.2 - Morphology and Hydrography

The investigated area spreads throughout a region of low altitudes with maximum heights of around 90 meters, presenting a smooth and leveled relief, characterized by low "plateaus" with lowered platforms and scaled terraces.

The hydrographic system of the region of the exploration areas is commanded by Capim river whose origin lays in the SE of the State of Pará. It flows through an extension of about 450 km into Guamá river, receiving in the process a great number of effluents, among which Candiru-Açu river and "igarapés" (streams) Candiru-Mirim, Tauari and Ciputeua or Bacuri can be mentioned. The last one crosses the project area.

The presence of meanders with large curves and the absence of waterfalls and rapids characterize Capim river as mature to old, regarding stage of evolution.

Meandering through young, weakly consolidated sedimentary formations, and being composed of predominantly clayey and sandy material, the Capim river is in fact, regardless of its stage of evolution, the main erosive element to shape the relief of the investigated areas.

The geological framework picturing the river and the land it crosses is further enhanced by the good navigability of small and medium size vessels, offered by the river throughout its extension, in the area.

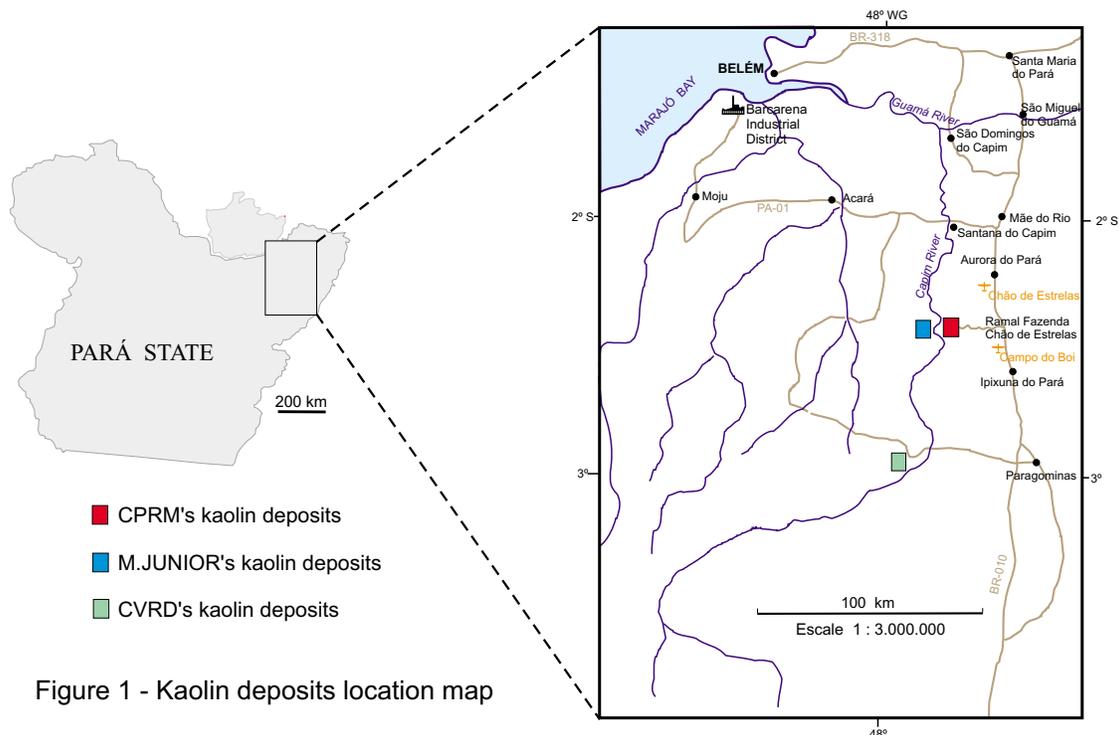


Figure 1 - Kaolin deposits location map

2.3 - Climate and Vegetation

The site of the investigated areas is affected by climate patterns of equatorial-tropical regions in which relatively well distributed rains predominate throughout the whole year presenting a period of high precipitation rates during the months of December through May, and of relative drought between June and November. The average annual rainfall is rather high, reaching 2,500 mm (figure 2).

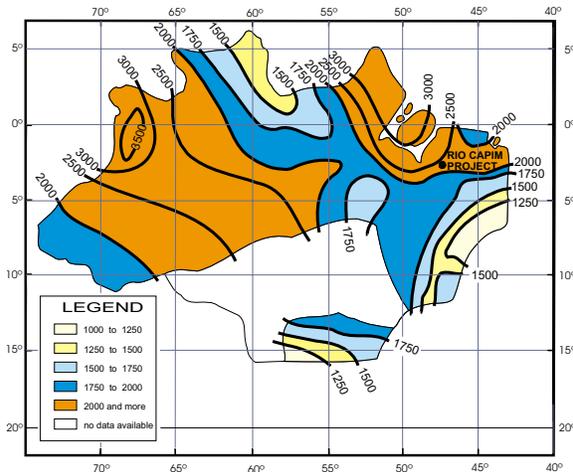


Figure 2 - Amazon region annual isohyetal lines

Steadily high temperatures prevail and their maximum and minimum annual limits are 33°C and 23°C, respectively (figure 3).

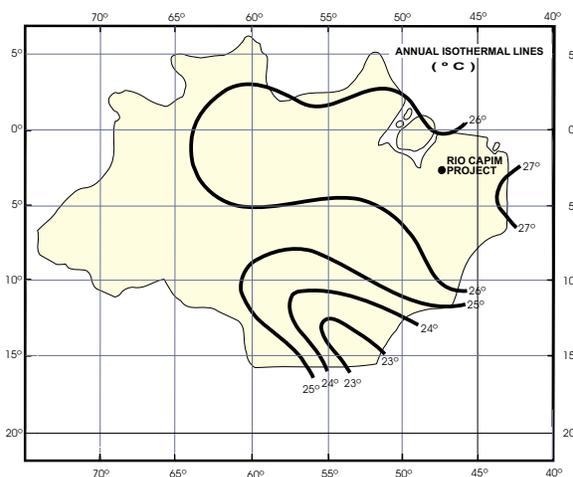


Figure 3 - Amazon region annual isothermal lines

Relative humidity of the air is also high, usually oscillating around 90%.

It is, therefore, possible to classify the climate of the region as to the Köppen Afi type (heavy and well distributed rainfall, high relative humidity) (figure 4).

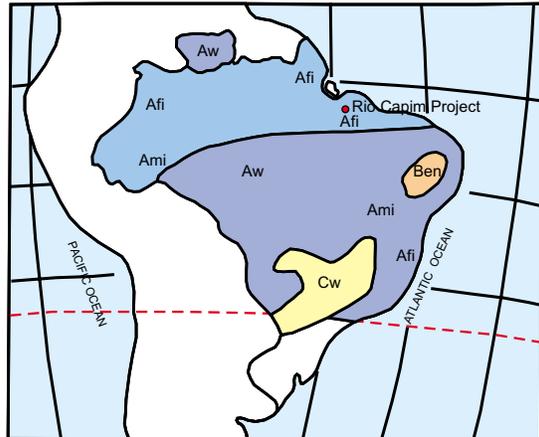


Figure 4 - Climate distribution according Köppen

The high rate of rainfall in the region is the main factor responsible for the existence of exuberantly green vegetation found in the Capim river region. It is comparable to the Latifoliated Equatorial Forest.

The woods of the plains, composed of trees of smaller size, herbs, shrubs and bushes, predominate in the lower and flooded parts, along the banks of rivers and streams of the region, gathering species such as Açazeiro (*Euterpe edulis*), Mamorana (*Bombaz aquaticum*), Maruré (*Brosimopsis acutifolia*), Taxi (*Triplaris surinamensis*), Sapucaia (*Lecythis apraensis*), Embaúba (*Cecropia palmata*), Jauari (*Astrocaryum Jauari*), Jarandeuia (*Phitecolobium latifolium*), etc.

2.4 - Social-economic Infrastructure

The area under exploration is part of the municipal district of Ipixuna do Pará, which holds in its 5,340 km² an officially verified population of around 9,100 inhabitants.

Although education standards of the inhabitants are not high, governmental action to improve their rates of literacy resulted in an increase in the number of elementary schools, trying to raise the culture level of the people.

Regarding education and health facilities, São Domingos do Capim and Paragominas are the best options in the region.

The region's availability in terms of fluvial transportation is enormous, especially if we bear in mind that both rivers Guamá and Capim offer complete navigability, during the whole year, if small to medium vessels are used.

The region's economy is based on extraction of good quality lumber widely spread throughout the region. Agriculture's diversity is very low and production is aimed at subsistence level, with no commercial of agricultural products being of rate mentioning. Of major importance is the production of manioc flours, the main component of the population's diet. Raising cattle, despite favorable conditions for their maintenance, is done at a primitive level, although more suitable brands are being introduced, in view of ecological factors and technical experimentation. Among those brands, zebu and buffalo predominate, but their numbers are not known.

At the municipal center, SAAE - the sanitation service carries out the distribution of water extracted from artesian wells, while electric power is supplied by CELPA - Centrais Elétricas do Pará. The biggest power station is a 138kV, 30mW, 60Hz capacity. Other minor stations have the following characteristics: 13,8kV, 15mW and 60Hz.

Sanitary facilities in the municipal district are deficient, medical attendance being effective only three times a week.

Belém stands out as the most fa-

vorable location for a support base for a mining project, due to the lack of infrastructure in the Capim river basin.

Considering the Government policy of reducing regional economic disproportions by granting incentives for developing backward regions, it becomes consequently natural to predict the success of working out a large industrial complex in the area.

Local people can presently provide for non qualified labor.

Considering, however, the healthy conditions prevailing in the region, the rise in local economic standards, with the introduction of working benefits from modern technology, reflecting upon increasing general living conditions, the local population will profit from his new experience in achieving better education, thus becoming an element of strong work force.

2.5 - Navigability

The Capim river is navigable throughout the year on the portion extending from the prospected areas to its mouth into Guamá river along a distance of approximately 120 km.

CPRM performed bathymetric works on Capim river, taking cross readings every 500 m, with smaller intervals when needed, using an echobathymeter. This task lends to detailed and more accurate knowledge on the navigability conditions of this river, for small and medium vessels (250 t barges), to flow in the future by this route. Presently, mean depth of Capim river inside the explored area is estimated at around 5m.

A special report on Capim river navigability is available at CPRM main office in Rio and at Belém Superintendency in the city of Belém (CPRM, 1973) - 1 vol., text in Portuguese.

2.6 - Port

The capital city (Belém) of the State of Pará is located on a higher land strip at the confluence of Guamá and Guajará rivers, approximately 70 miles from the mouth of Pará river, being an excellent port-city from where Southern of Brazil, Europe and North America may easily be reached. This port is linked by land to the southern and southwestern regions of the country, by the Belém-Brasília road, which lays some kilometers east of the investigated areas. The fluvial access from these areas to the port, includes Capim and Guamá rivers.

The port of Belém offers a mooring length of 2,297 m of which 1,260 m are appropriate for docking ships drawing up to 8 m (26 ft), 600 m for ships of small gauge and the remainder for very small ships. Barcarena port, situated at the left side of Guamá river, west of Belém, has a 12 m capacity.

There are 10 warehouses with 2,000 m² area each, close to the pier, northward from which Marechal Hermes Dock is located to moor small vessels, being composed of 2 warehouses with 4,800 m² area each.

On the pier, three electric cranes

with 3 to 5 ton capacity plus 8 steam cranes with 2 to 10 ton capacity moving on rails besides a parked 30 ton crane make up the facilities.

The entrance to the channel leading to the port is located between Chapéu Virado Point and Tatuoca Island, 5 miles SSW from the former. Existing obstacles reduce the width of the entrance to less than 2,5 km (1.5 miles) and further, from Val-de-Cans on where a dredged channel begins, it becomes 100 m in width, along the coast up to the Belém port

At this port the sea is always calm, even during the windy seasons in the months of September through November.

The excellent facilities offered by the port of Belém to transportation by large freighters, ensure the flow of the material assessed in the Capim river region, mine-port transport being done on barges of specific size. (Rio Capim Comercio S.A., an enterprise that is working for kaolin in the region, uses 1,000-tonne capacity barges in four-barge convoys to transport their products from the areas to the Barcarena Industrial District mineral dressing facilities. For another hand, CVRD and its associates use a 180-km pipeline for the same purposes).

3 - Regional Geology

3.1 - General Aspects

Studies to determine the stratigraphic column of the terrains in the Capim river region were impaired by the lack of specific information on the area. Oliveira and Gomes (1926) have referred to kaolinic plateaus on the Piracaua, as well as white sandstones which crop out along the lower course of the river. Sombroeck (1962) refers to the same sandstone giving it Eo-Paleozoic age, Molnar and Almaráz (1966) have presented a geologic outline of the river, covering its extension almost completely. During this Project's work (1972) at Itateua beach, in the upper Capim river, occurrences of Precambrian rocks of the basement complex were observed. The Regional Geologic Map, attached herein, was compiled from the Brazilian Geological Map, 1971, 1:1,000,000 scale (**figure 5**).

Generally speaking, the Cenozoic sequence (Lower Tertiary to Recent Quaternary) predominates in the region while Eo-Paleozoic and Pre-Cambrian rocks complete the geological framework.

The Recent sediments are composed of sands, silts and clays, covering the flood plains or filling ancient river channels.

Sediments of Miocene to Pleistocene in age form a rather complex stratigraphic composite, namely the Barreiras Formation. The predominant lithological units are clays, siltstones and sandstones with variable grain sizes. They generally present cross and channel stratifications, gradational deposits, small angular unconformities, disconformities, levels of heavy minerals and microfaults. Facies changes are widespread, both horizontal or vertical, making it difficult to study the formations one by one.

The Lower Miocene is represented by the Pirabas Formation, where lithology are mainly composed of fossiliferous limestone. Along Capim river, this unit does not occur whereas a few outcrops are observed along BR-010 road.

The Paleozoic sequence is composed of a white sandstone with variable grain size. At Tapiucaua waterfalls, in the upper Capim river, an orthoquartzitic conglomerate including pebbles with up to 20 cm in diameter crops out, the matrix of which is composed of a white sandstone. Such rock forms large blocks along the beds of the rivers, being friable and presenting various fracture directions.

In Capim river's upper course, a laminated rock, with sub-horizontal, silty clay layers intercalate with silica.

The Pre-Cambrian is composed of boulders which occur along the river bed as observed in Itateua beach.

The stratigraphic column presented as follows is based on studies by Petrobrás complemented with local observations made during field works of this survey (**figure 6**).

3.2 - Stratigraphy

3.2.1 - Pre-Cambrian

Pre-Cambrian rocks crop out along the upper Capim river, in Itateua beach, near the north of "igarapé" Lontra, right hand tributary to the Capim river. These outcrops are located along the river bed, forming small islands amid younger rocks.

Macroscopic observations identifies a medium to coarse grained biotite-gneiss with well developed and altered feldspar crystals, showing several fracture lines.

3.2.2 - Eo-Paleozoic

Oliveira and Gomes (1926) have referred to a quartzitic sandstone which crops out at Maroim and Fari, "igarapés" on the lower Capim river. Sombroeck (1962) has given it Eo-Paleozoic age, while Molnar and Almaráz (1966) consider it Paleozoic estimating its thickness to be 26 m in an occurrence strip of at least 15 km along the upper Capim river. It is a white rounded to subrounded sandstone with massive to conglomeratic granulation,

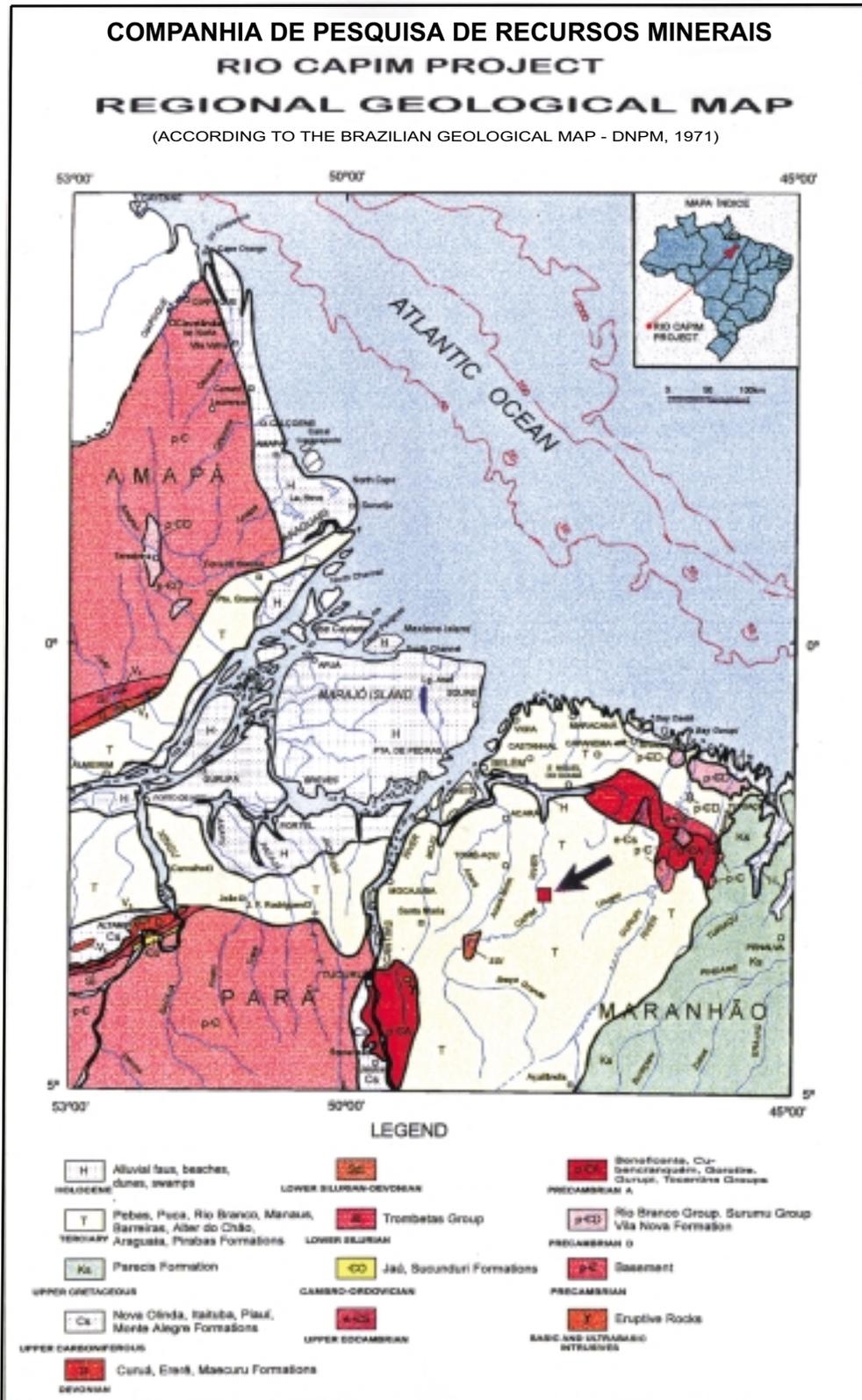


Figure 5 - Regional Geologic Map

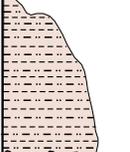
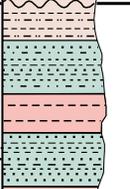
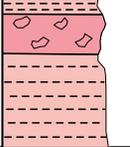
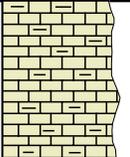
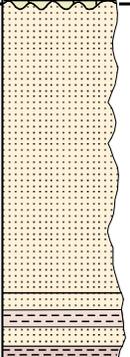
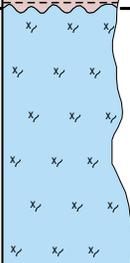
ERA	UNIT			LITHOTYPE	THICKNESS (m)	LITHOLOGICAL DESCRIPTION
	Chronostratigraphic		Lithostr.			
	System	Series	Formation			
CENOZOIC	QUATERNARY	HOLOCENE			± 4	Unconsolidated sediments, composed by clays, silts and sands.
		PLEISTOCENE	BARREIRAS		± 120	Kaolinic clays, sandy-clayey and clayey-sandy sediments of yellowish to reddish colours. Levels of ferruginous sandstones are common in irregular and single blocks ("grés do Pará") and sandy intercalations showing cross-bedding and local disconformities.
	PLIOCENE					
	TERCIARY	MIOCENE	PIRABAS		± 5	Very fossiliferous limestone lenses, intercalated with clay and calcitic sandstones.
EOPALEOZOIC					± 26	Light colored sandstones, partially silicified with medium to coarse granulometry. Intercalations of silty-clayey layers with worm tubes and prints with partially silicified sandstones showing cross-stratification.
PRECAMBRIAN	ARCHAEOZOIC					Gneissic Complex (with predominance of biotite-gneisses)

Figure 6 - Stratigraphic Column

partially silicified presenting several fracture directions.

White, fine to coarse grained sandstone alternate in layers, presenting coarse stratification, partial and irregular solidification, its age being considered the same as the previous sandstone as both occur in the same stratum. It is associated to very fine, well stratified, sub-horizontal (N 25° E; 5° SE) sandstones, bearing mica blades oriented along the planes and to a darker, pink to brown, lithology composed of clayey siltites, presenting tube remains and worm traces. In places, stratification planes display undulated forms due to differential compression. Along "igarapé" Itaqueua Grande, right tributary to Capim river, Eo-Paleozoic rocks occur on top of this sequence.

3.2.3- Tertiary

Miocene - Pirabas Formation

Geological references include this formation as topics of many works, first of which dates back to 1876, when Ferreira Pena studied the existence of fossiliferous limestone in the village of Ilha da Fazenda, district of São João de Pirabas.

The Pirabas Formation is well compacted, characterized by grey to yellow limestone beds, intercalated with sands and clays with successive layers of calciferous clays. Main fossils are foraminifera, brachiopods and cephalopods. Their origin is ascribed to long periods of alternate transgression and regression, with deposition of reworked calcium carbonate in marine environment. The age of this Formation is perfectly related to its fossil samples, but its contact surface remains undefined, and since they conform with continental sediments of the younger Barreiras Formation, some authors consider it as a marine facies of the latter. On the other hand, it also lies directly on ancient rocks, and displays little tectonic disturbance.

In the Capim river area, Pirabas Formation is absent, showing only a few

outcrops at km 21 of BR-010 road.

Miocene/Pleistocene - Barreiras Formation

Sediments of this unit lay on the larger part of the region under consideration. In the geological literature doubts still persist as to its characterization.

Matoso (1959) considers these sediments as "Cenozoic Formations", while Bigarella and Andrade (1964) adopt the designation of Barreiras Group. Francisco et al. (1971) based on the profiles of some pits and drillings made in Capanema, State of Pará, noticed that there is a clear transition of the Pirabas Limestone into the clays of the Barreiras Formation, fact that led to the supposing that deposition of the continental sediments of Barreiras Formation began in the Miocene, the final phase of deposition of the Pirabas Limestone.

The Barreiras Formation is a very complex stratigraphic sequence showing horizontal and vertical facies changes and gentle dips probably due to evening up of layers or to reopening of ancient fault lines. It is composed of a sedimentary sequence, varying from multicolor clays, observed in the lower portion, to unconsolidated clayey-sand or sandy-clay, generally composed of various colors displaying layers of coarse material, with quartz pebbles varying in size.

Cross and channel stratifications with gradational depositions, small angular unconformities, surface unconformities, levels of heavy minerals and microfaults and, still, discontinuous levels of a ferruginous sandstone ("Grés-do-Pará") in loose, irregular blocks of varied size, are present.

3.2.4- Quaternary

Holocene

In the region, recent alluvial sediments represent the Late Quaternary, composed of silt, sand and gravel, located mainly in the valleys that cut across the region.

3.3 - Tectonics

The geological structures are best evident where rocks of the crystalline basement occur, having been submitted to intense Proterozoic tectonism, suffered faultings with more or less patterned alignments.

Starting in the Mesozoic, ancient weak lines were reactivated, giving raise to the displacement of blocks of the crystalline basement promoting the formation of horst and graben structures of wide basins along the Marajó-Bragança-São Luiz coast, example of which is the Bragança marine Cretaceous basin, prospected by Petrobras,

through gravimetric and seismic works and confirmed by stratigraphic holes.

The Bragança basin is limited by faults in the general NW-SE directions. The same faulting system, which reached the region along the coastal area, is observed in the region of the medium and high courses of Guamá and Piriá rivers in areas of Pre-Cambrian rocks outcrops.

Faults of smaller amplitude involving more recent rocks, including those of the Tertiary, resulted from the arrangements existing along ancient fault lines.

4 - Geology of the Deposit

In the explored area, Miocene-Pleistocene rocks of the Barreiras Formation occur, examples of which are sandstones, clays and silts. The average thickness of this formation was determined by Petrobrás in 1967, being estimated at about 120 m.

In the explored area, the Barreiras Formation does not display a defined sequence, a fact observed when description works of the holes took place revealing notable facies changes, from conglomeratic sandstones to kaolinic clays.

Various lithologic patterns which occur from base-to-top can be described as follows (figure 7):

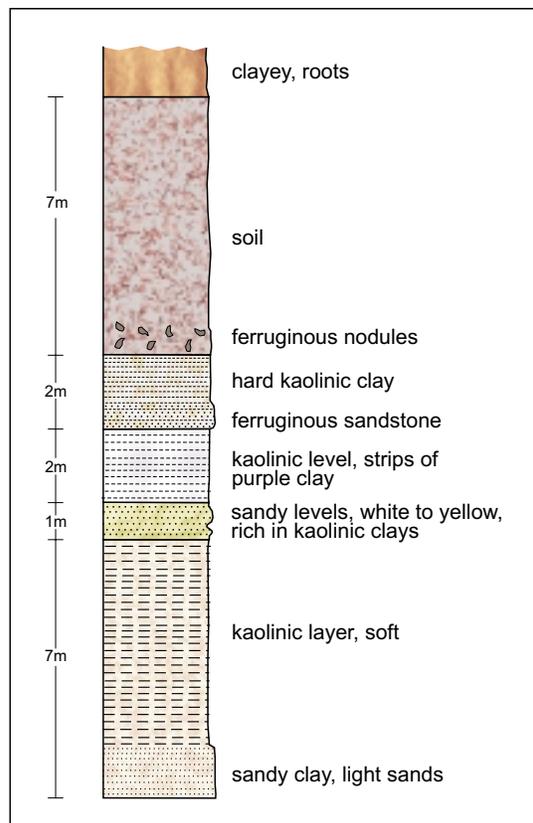


Figure 7 - Exploration Pits Composite Profile

At the base, a usually white, sandy clay sequence grades upwards into a strictly kaolinic layer, composed of very soft and extremely white material averaging 7 m thick.

Then sandy levels intercalate, showing well rounded, rather worked quartz grains, color of which may vary from white to yellow. These levels are also rich in kaolinic material and do not have more than 1 m in thickness.

A notably kaolinic level occurs on top with reduced strips of purple clay, being locally enriched in iron oxide showing thickness of about 2 m.

Approximately 2 m upward in the sequence, a very hard kaolinic material occurs with stained, friable, ferruginous sandstone showing millimetric granulometry, which suddenly tends towards the soil horizon, which in most cases bears a thickness of 7 m or more. At the base of this unit, abundant ferruginous nodules occur being a product of the laterization process. The upper stratum is clayey, filled with new or ancient roots which often contribute with humic acids, product of degradation, to contaminate the material where they are intercalated.

There are several economically interesting kaolin strata totaling around 9 m including the sandy kaolinic intercalation, since they present a relative ease of separation into two fractions. At the base, the mixture of kaolin with light sands constitutes the sequence, commonly having economical importance. In most cases, the real explorable width of kaolin is unknown. Conclusions hold that with the advance of exploration in depth, a substantially larger reserve may be attained.

All light kaolin horizons presently located between the upper contaminated level and the lower part where white sands begin to show up in greater amount may be profitably mined.

5 - Exploration Works

5.1 - Topography

Initial operations of the topographic survey were carried out with magnetic declination calculation at the mouth of "igarapé" Citupea, at the confluence of Capim river, the reference for all areas of the Project (see: 1:50,000 location map). This work was based on an isogonic chart issued in 1970 by RADAM Project. This declination is 17°27'W.

Closing polygons with minimum error were after constructed. A North-South base line was crossed by transverse trails opened at every 100 meters, covering the whole Project area. Opened trails totalled 100 km, being 50 km in the South area and 50 km in the North one.

Altimetry of each of these lines was determined for reserves measurements purposes and topographic profiles were constructed.

5.2 - Pits and Pipes

A quadrangle net of boreholes was drilled aiming at a preliminary visualization of the overburden and forming a square-like grid.

In similar grids controlled by the previously described topographic lines, pits with depths varying from 20 to 26 m, starting from sites with less overburden, were excavated. Details concerning the construction of such pits are available in the Project Report and are of a great importance for new exploration works.

The initial grid had a spacing of 2,000 m and served for selection of the most favorable areas, where an internal spacing was later on narrowed to 1,000 m and then to 500 m.

77 pits were opened, totalling 1,324 linear meters, and 842 cubic meters of excavated material was extracted.

5.3 - Drillings

In the initial phase of the survey, as previously mentioned, a mechanic STIHL

drill was used, to help obtain a notion of the geologic setting of the mineral body and its overburden. Eight boreholes along T03, T05, T09 and T13 trails were made, each of them 2 km apart, totaling 108.40 m, with an average of 13.55 m per hole. At the sites of the most promising holes, prospecting pits were excavated.

During part of the exploration works, a WINKIE drill machine model GW-15 was also used. A total of nine boreholes were drilled along T01-2, T01-3, T01-6, T03-3, T03-4, T03-5, T05-3 and T05-4, totaling 234.80 m, 219.22 m of which were sampled, and 128.79 m recovered.

Recoveries obtained from these pits were low, averaging 58.7%.

5.4 - Sampling

To properly evaluate the characteristics of kaolin from Capim river, careful sampling was carried out adopting as a rule, one meter spacing, for all the types of drilling and excavations performed, as well as for the outcrops, totaling approximately 600 samples.

In the pits, sampling was made in vertical channels 20 cm wide and 5 cm deep, gathering about 2 kg of sample per meter.

When drilling was executed, cores were taken to offer representative samples of the deposit, being processed in the same way as the rest of the samples.

5.5 - Kaolin Qualification

Although kaolin presents a large range of industrial uses, the study of the existing reserves in the vicinity of Capim river aimed only at high quality kaolin to compensate for the transport expenses and difficulties of the regional infrastructure.

The results encourage the utilization of the Capim river kaolin in the paper industry, in view of its suitable characteristic for application as coatings according to the

data herein presented.

The technological specifications, regarding the use of kaolin in the paper industry, are controlled through rigorous specifications. Thus, the present survey was concerned with details of characteristics which make kaolin adequate to this range of industrial uses.

Samples were sent to the following laboratories:

- English Clays Lovering Poching & Co. Ltd.
- Cornwall, England
- Erbsloh & Co. ,Germany
- NUTEC (CPRM) Rio de Janeiro
- Laboratory of CPRM's Belém Office - Pará

5.5.1 - Technological Assays

Kaolin adequacy for use in the paper industry, is attained with preliminary acceptance or rejection tests and other specific assays regarding its use as coating. Kaolin to be used as filler, needs not an evaluation through these specific tests, since requirements for its use as filler are less rigorous than those for the first case.

5.5.1. 1 - Preliminary Assays

In order to get a preliminary evaluation of Capim river deposits, the following preliminary assays were made (see table below).

TECHNOLOGICAL ASSAYS

ASSAY	QUALITATIVE RESULT	QUANTITATIVE RESULT
Chemical Composition	Below 1% of Fe ₂ O ₃	Al ₂ O ₃ 30 to 40%
Electronic and X Ray Microscopy	Good Crystalling Properties	Halloysite Absence
Sieving	Highly Satisfactory Results	75% Avg. at 325 Mesh screen
<2 μ Ponderal Distr. of Particles.	Excellent Results	<325 Mesh: > 50% of Particles
Reflectance	Satisfactory Results	Whiteness of 99.5 at "Elrepho" Phototer 457 Filter, 100 G.E.
pH	Satisfactory Results	pH 4.5 to 7

5.5.1.2 - Specific Assays

After preliminary assays showed positive results, specific ones were made, as follows:

Assays on the coating ink of the paper:

- a) Viscosity
- b) Total solids
- c) pH

Assays on paper:

- a) Reflectance
- b) Brilliance
- c) Smoothness
- d) Softness
- e) Opacity
- f) Absorbtion of the ink on the paper

From the above test list it is noted that specific assays were carried out in a level of adequacy for the paper manufacture. Preliminary tests revealed good results, being possible to foresee that kaolin from Capim river will have acceptance in both the national and international market of paper manufacture.

Núcleo de Tecnologia Mineral of CPRM (CPRM's NUTEC) and The Geology Department of the University of Georgia were selected to perform the viscosity tests, results of which although restricted in their scope, showed exceptional values, this kaolin deposit being composed of very good quality material for paper coating since test values for the samples were around 140 centipoise.

6 - Reserves

Taking into consideration the relation between the geographical location of the explored deposit and industrial centers of larger capacity, selection of the profitable reserves was made regarding material for noblest applications. Thus, only adequate material with proper technological characteristics for use in the paper industry, was computed for evaluation of the reserves.

Data from 77 survey pits and from 9 drillholes were considered to determine the volume of the deposit and as a general rule, the method of influence areas for each pit was used, extending to half the distance that mediates the neighboring pits.

The areas were graphically encircled on a 1:20,000 scale map and measured through with the aid of a planimeter. The total value of these measurements multiplied by the respective thickness of the workable layer, gives its volume.

The specific density of the material was determined in the field, in its natural

state, presenting a value of 2.1 t/m³. For safety purposes, the value of 2.0 t/m³ was adopted and this, times the volume, gave the tonnage of the material economically valuable.

For volume calculations some lenses of red clay included in the kaolin layers were not deducted from the thickness of this layer, considering their small volume in relation to the bulk of the exploitable material.

There was the concern in setting a cautious rule for calculations to widen the certainty margin with records to the measured reserve. Thus, although the method of influence areas was generally adopted, the pits near the borders of the plateaus or next to the limits of the prospected areas only helped in drawing the geometric figure inside which measurements were made.

The following Total Reserves Table summarizes the potential of Capim river kaolin deposits:

**CAPIM RIVER PROJECT
TOTAL RESERVES TABLE**

DNPM - SUB-AREA	RESERVE (TONS)			TOTAL BY SUB-AREA (TONS)
	MEASURED	INDICATED	INFERRED	
812.869/71 - CA	60,561,160	43,932,774	22,278,256	126,772,190
812.870/71 - CB	5,887,500	24,050,458	14,218,960	44,156,918
812.871/71 - CC	85,223,910	29,009,060	24,139,680	138,372,650
812.872/71 - CD	42,278,144	60,206,666	20,893,760	123,378,570
812.873/71 - CE	13,200,000	69,629,428	9,369,840	92,199,268
812.874/71 - AA	-	-	-	-
812.875/71 - AB	-	-	-	-
812.876/71 - AC	-	7,605,588	421,280	8,026,868
812.877/71 - AD	-	-	-	-
812.878/71 - AE	4,613,760	20,753,340	8,545,600	33,912,700
TOTAL	211,764,474	255,187,314	99,867,376	566,819,164

7 - Mineral Dressing Assays

In order to check the feasibility of refining kaolin for industrial application, representative samples of the deposit were submitted to mineral dressing assays.

Samples weighing 80 kg were collected from each pit T07-6 (10.0 to 14.0m) and T09-10 (7.0 to 10.3 m).

Assays were carried out in the

specialized laboratories of the Paulo Abib Andery. Results were very satisfactory as stated in a separate report. This is the "Anteprojeto para Beneficiamento de Caulim" (Kaolin's Dressing Assays Advance Project) by Paulo Abib Andery & Associados S.C. Ltda of October, 1973, Portuguese version, 1 vol., annexes, available at CPRM Rio's and Belém Offices.

8 - Conclusions

The results obtained in European and American laboratories with the Capim river kaolin, revealed that the material has very good characteristics for use as paper filler and coating.

Kaolin shows exceptional characteristics in regard to reflectance, to quantity of particles under 2 micra, to excellent viscosity and to low levels of content of free silica and further to the absence of hallo-site.

Deposits present sedimentary characteristics and more or less continuous structure with occasional lenticular layers.

Volume of reserves revealed expressive amounts: "measured" reserves, about 212,000,000 tons, and "indicated" reserves, around 255,000,000 tons. "Inferred" reserves may be estimated at 100,000,000 tons. With the continuing of the survey work at greater depths, during the exploitation phase, these numbers should increase, because kaolin presents a progressive improvement of its characteristics in the lower layers, and because drills made by Petrobras confirmed the presence of kaolinic sedimentary material up to the depth of 120 meters in the surrounding area.

The relation of average mining for the measured reserve is approximately 0.89 m³ /t, being easy to dispose mining waste and tailings in the large valleys that cross the area and where no kaolin occurs

Water supply for industrial and domestic use is no problem, due to the vicinity of Capim river and "igarapés" which cross the area. Water analyses grant the possibility of utilization of these waters.

In the vicinity of the area there are power plants with a major one at the locality of Paragominas and several other small ones near the areas of Rio Capim Project.

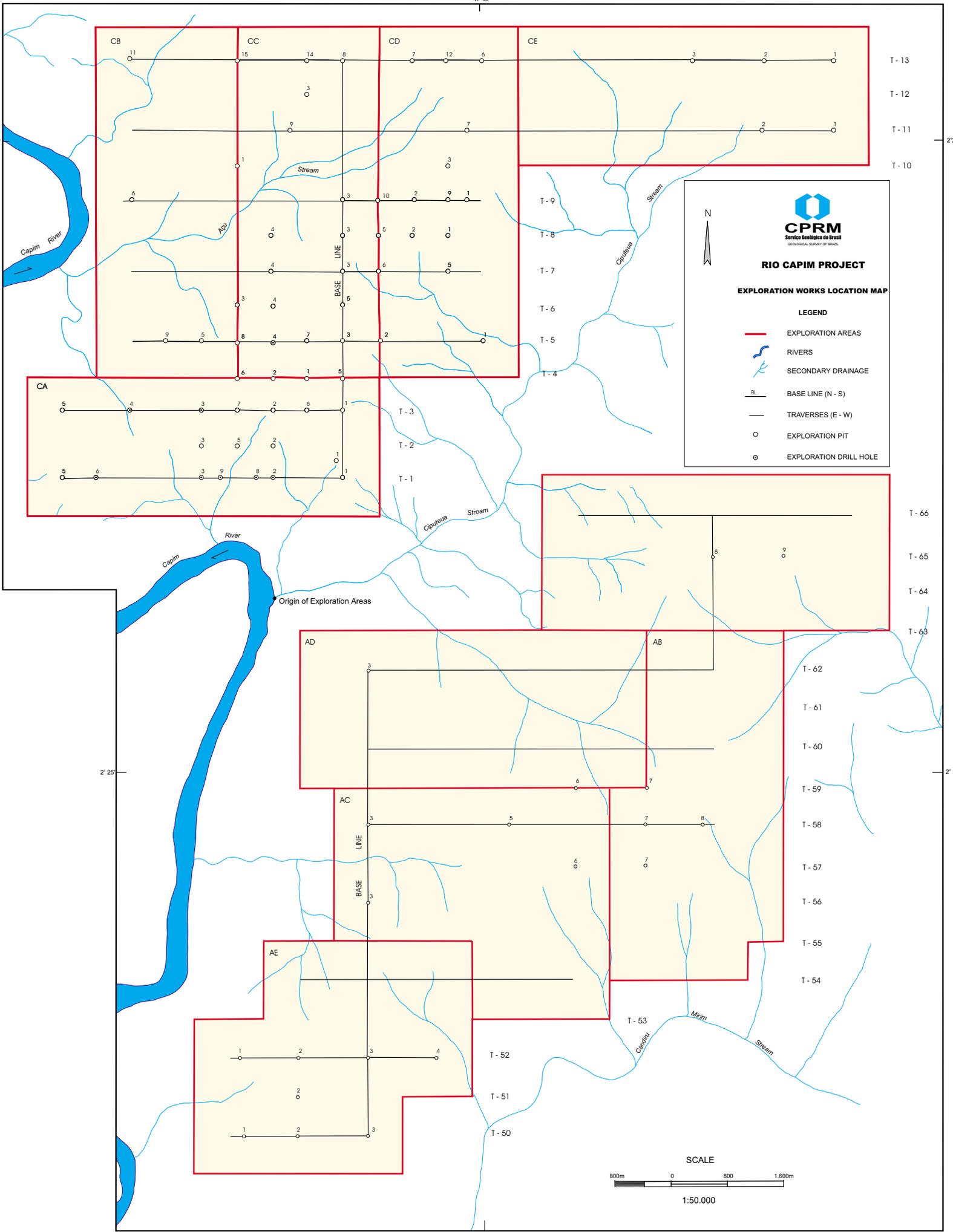
A survey on the navigational conditions of Capim river was carried out. It reveals the feasibility of the use of barges which is a favorable point as to the transportation of the material to the port of Belém. This in turn, according to elements stated in this report, builds up operation conditions for medium draft vessels (10,000 t). A report of this survey is available at CPRM's Rio and Belém Offices and is named "Navegação nos Rios Capim e Guamá" - Capim and Guamá Rivers Navigation - by CPRM - Operations Directory, 1973, 1 vol, annexes, Portuguese version.

The access to the area is commonly done by river, and a road junction BR-010, along a distance of approximately 25 km, linking the deposit to the national road system, was already built.

Lumber potential - according to a separate report - suggests the creation of a parallel industry for the exploitation of wood, part of the mining operations capable of being covered by it.

Potential markets for the studied material are national buyers as well as Latin American countries, Japan, part of Europe and even the United States, besides others, the privileged location of the deposit in relation to the large industrial centers of the world, having to be born in mind. More details are given in the report by Prof. Iran Machado as a CPRM Consultant, named CPRM's Rio Capim Bid (A Licitação do Caulim da CPRM - Relatório Final), 1 vol, June, 1966, Portuguese version.

With reference to other uses of kaolin, it should be pointed out that the present deposit will promote the appearance of a range of correlated industries in the Amazon, according to the Government plans for the development of the region.



RIO CAPIM PROJECT

EXPLORATION WORKS LOCATION MAP

- LEGEND**
- EXPLORATION AREAS
 - ~ RIVERS
 - ~ SECONDARY DRAINAGE
 - BASE LINE (N - S)
 - TRAVERSES (E - W)
 - EXPLORATION PIT
 - ⊙ EXPLORATION DRILL HOLE

