

TIJUCAS DO SUL SEDIMENTARY BASIN STRATIGRAPHY

ESTRATIGRAFIA DA BACIA SEDIMENTAR DE TIJUCAS DO SUL

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RESUMO - A Bacia Sedimentar de Curitiba e a Bacia Sedimentar de Tijucas do Sul estão posicionadas sobre terrenos graníticos gnáissicos da borda leste do Paraná e embora distante uma da outra são comumente correlacionadas. Esse artigo mostra a diferença entre elas em termos da origem, preenchimento e cronologia. Os resultados demonstram que a Bacia de Tijucas é mais jovem, justificado por três pulsos sedimentares, possivelmente ocasionados por eventos tectônicos locais. O primeiro pulso (D1) é caracterizado por um sistema deposicional de leques aluvionares, com características paleocorrentes indicando fluxo para sul. O segundo (D2) é caracterizado pela migração dos canais para nordeste e leste, mudando o gradiente hidráulico que favoreceu incisões de canais fluviais, gerando superfície erosiva que marca o início da sedimentação do sistema fluvial. O pulso final (D3) é evidenciado pela ocorrência de canais do pulso anterior abandonados, suspensos no topo dos taludes. A sedimentação da Bacia de Tijucas do Sul ocorreu em clima úmido, diferentemente do clima semiárido proposto para a Bacia de Curitiba. As diferenças geográficas, cronológicas, sedimentares, (paleoambientais), paleontológicas e estratigráficas entre a Formação Guabirota (Bacia de Curitiba) e a Bacia de Tijucas do Sul justificam nesse trabalho a individualização dessa bacia sobre o nome Formação Tabatinga.

Palavras-chave: Bacia Sedimentar de Curitiba, Bacia Sedimentar de Tijucas do Sul, Rift Continental do Sudeste do Brasil, tectônica ativa, neotectônica.

ABSTRACT - Curitiba Sedimentary Basin and Tijucas do Sul Sedimentary Basin are located on gneissic-granitic lands in the eastern state of Paraná, previously considered correlates, even distant ones. This article shows data that differ from each other in terms of origin and sedimentary content, and not chronologically correlated. Results showed that the sedimentation of the Tijucas do Sul Sedimentary Basin is younger and that was controlled by three sedimentological pulses settings, possibly linked to the local tectonic framework. The first pulse (D1) developed a depositional system of alluvial fans with the general paleo current to south. The second pulse (D2) shifted channels to east and northeast changing the hydraulic gradient which was favored incision of the fluvial channel, generating erosive surface that marks the fluvial system sedimentation. The final sedimentary pulse (D3) it is evidenced by occurrence of abandoned channels suspended on the top of the slope. Tijucas do Sul basin sedimentation would have occurred under humid settings, unlike the semi-arid settings proposed for the Curitiba Basin. Owing to geographic, chronological, sedimentary, paleoenvironmental, paleontological and stratigraphical differences between the Guabirota Formation (Curitiba Sedimentary Basin) and the Tijucas do Sul Sedimentary Basin, justify here been individualized under the name of Tabatinga Formation.

Keywords: Curitiba Sedimentary Basin, Tijucas do Sul Sedimentary Basin, Continental Rift of Southeastern Brazil, Active tectonics, Neotectonics.

INTRODUCTION

The sedimentary sites of the Tijucas do Sul municipality, more than 30 km south of Curitiba, have been considered part of the Curitiba Sedimentary Basin supported by the lack of stratigraphic studies (Moreira, 2018).

The Curitiba Basin sits in the southern portion of the Continental Rift of Southeastern Brazil which is formed by horsts and grabens from Rio de Janeiro to Paraná, as proposed by Riccomini et al. (1989). According to those authors, the opening and sedimentation of these structures would take place in the Eocene/Oligocene as a response to NNW-SSE extensional events that evolved into NE-SW compressional events, followed by WNW-ESE

compressional events in the Pleistocene.

Thirteen tectonic structures have been ascribed to the Continental Rift of Southeastern Brazil by Riccomini et al. (1989): Itaboraí Basin, Barra de São João Graben, Macacu Basin, Volta Redonda Basin, Resende Basin, Taubaté Basin, São Paulo Basin, Sete Barras Graben, Pariquera-Açu Formation, Alexandra Formation, Guaraqueçaba Graben, Cananéia Graben and Curitiba Basin.

The Curitiba Sedimentary Basin was first named by Bigarella & Salamuni (1962) when describing the Guabirota Formation. In the 1960s, the Geological Commission of Paraná suggested that the isolated sedimentary bodies that

of a homonymous district in the center of the basin as well as the existence of characteristic white and light-gray clays. In the Tupi-Guarani language, white clay, white mud or white house has an etymological meaning correlated to the name Tabatinga (Bueno, 2008).

This paper goal to rename the sedimentary unit of the “Tijucas do Sul Basin” to Tabatinga Formation, and definitely separate it from the Curitiba Basin. New and current research on the Tijucas do Sul Basin aims at showing that this basin is not part of the Curitiba Sedimentary Basin. The need to prove that their sedimentary evolution has taken place at both different geological environments and times is the scope of this work.

The Tabatinga Formation is located 30 km south of Curitiba, in the municipality of Tijucas do Sul, state of Paraná - southern Brazil. The best outcrop exposures surround the Tabatinga village, located beside the state highway PR-281, like figure 1.

In the central portion of the Curitiba plateau, there are two important Cenozoic sedimentary deposits. The first one refers to

the Curitiba Sedimentary Basin, which is located in a homonymous municipality and is surrounded by an NE-SW structural trending. The second refers to Tijucas do Sul Sedimentary Basin, which is located in a homonymous municipality, scope of this article (Figure 2), here is defined as an independent sedimentary basin filled by the Tabatinga Formation.

The Curitiba Sedimentary Basin overlies the lithotypes of the Atuba Complex as well as rocks of the Açungui Group. It is bounded on the north by the São João-Lamenha Grande Lineament (Fiori et al., 1984) - later named the Curitiba Shear Zone (Salamuni, 2010) - and on the south by the Mandirituba-Piraquara Lineament (Fiori et al., 1984, Siga Jr., 1995). The Tijucas do Sul Sedimentary Basin being bounded on the west by the Rio Pien Granite Suite (Fiori et al., 1984; Harara, 2001, Perrota et al., 2004) and on the east by volcanic rocks of the Guaratubinha Formation (Perrota et al., 2004) and on the south and north by the Santa Catarina Granulitic Complex (Perrota et al., 2004) (Figure 2).

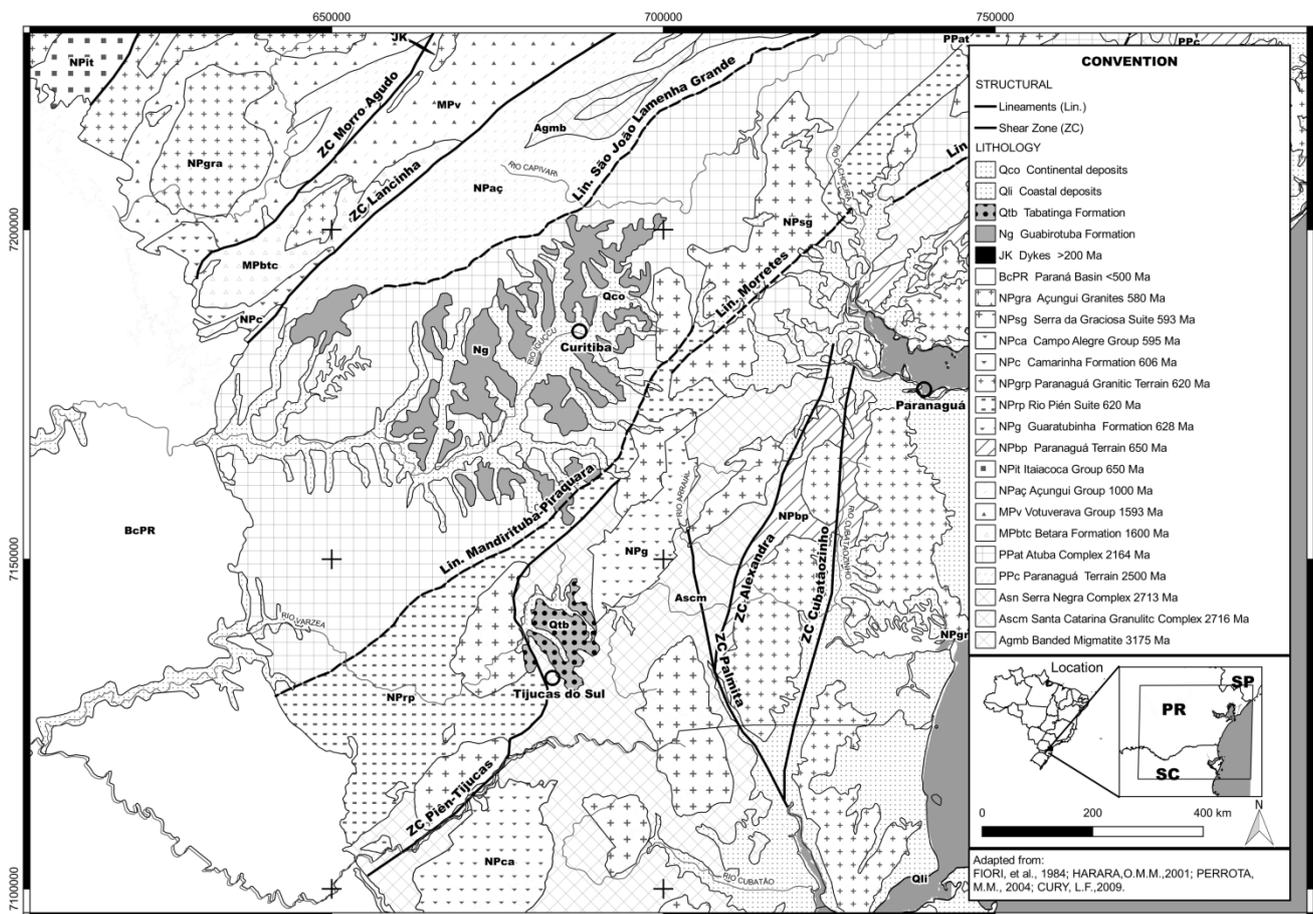


Figure 2 – Geological outline and location of the Tijucas do Sul and Curitiba basins. Adapted from Fiori et al. (1984); Harara (2001); Perrota et al. (2004) and Cury (2009).

MATERIALS AND METHODS

The limits of the Tabatinga Formation are those defined by Trein et al. (1969) at a 1:70,000 scale. The geological outline was obtained on the basis of data integration among SG-22 Sheet at a 1:1,000,000 (Perrota et al., 2004); Curitiba Sheet SG.22-X-D at a 1:250,000 (Mineropar, 2005); Harara (2001) and Cury (2009).

Paraná Mineração S/C LTD has provided data from auger and percussion drilling campaigns carried out at 12 sites of mineral research with an average depth of 7 m. The mining company recognized four materials, from top to bottom, based on their economic use: sand layer, organic sediment layer, kaolinitic clay layer and clay layer; the latter refers to weathered material at the basement. Two NE-SW longitudinal sections were elaborated with those data to support interpretation.

Planimetry and altimetry of the area were obtained on the basis of integration of topographic charts MI-2857-4 (NE, SE, SW and NW) at a 1:25,000 scale provided by the Military Geographical Service Division (Brasil, 2002a, b, c, d; 2008). This material was used as the basis for the construction of longitudinal and columnar sections and construction of two cross sections matching auger data and altimetric data.

Twelve sedimentary facies were recognized out of the description of twenty-one outcrops and grouped into five facies associations. Nine

columnar sections were created to sustain the elucidation of basin evolution. A general columnar section was constructed as shown by integrating information obtained from individual columnar sections and cross sections.

The plant fossils presented in this work are part of the Paleobotany Collection of the Laboratory of Paleontology of the Department of Geology of UFPR.

Field work has shown that the Tijucas do Sul Sedimentary Basin is filled by 8 sedimentary facies (table 1) organized in 5 facies associations A, B, C, D and E (table 2), arranged in the few outcrops found in the basin, as shown in figure 3.

The auger data suggest that the upper contact of the basement is an erosional surface covered by poorly sorted gravels represented by lithic fragments and quartz sands. On the field analysis has been observed Tabatinga Formation's basis controlled by conglomerates, arcoses and mud lenses, interpreted as alluvial fans, with over 10 m thickness, denominated E association, limited on top and base by erosive surface. The conglomerates are polymitic, immature arkoses matrix, interpreted as the lobe of alluvial fans (figure 4).

This association has the best outcrop settled on the road side of the BR-376 federal highway, Km 648 South, on Tijucas do Sul city.

Table 1 – Facies defined in the field mapping.

FACIES	FACIES DESCRIPTION
Mud	Lenses characterized by intercalation of clay and very fine sand laminae showing parallel lamination. Mud cracks are commonly observed. Fossiliferous.
Gravel	Stone line of subrounded and imbricated quartz pebbles, and intraclasts of organic silt or kaolin.
Kaolinitic clay	White, light green, gray or brown, massive kaolin. Angular quartz granules (<10%). There is an increase in nodule concentration (mm-cm) of gibbsite from bottom towards the top. They are commonly in the upper portion.
Diamictite	Clayey conglomerate with gray kaolinite matrix (crevasse), framework composed of pebbles and angular quartz and plagioclase granules. Very bioturbed and with vegetable remains. Grades upward into kaolinite clay.
Trough cross-bedding	The facies associations D and E are formed by arcosean sandstones while facies association B is essentially composed of quartz sand.
Low-angle cross-bedding	Medium to thick-grained, poorly sorted arcosean sandstones, with angular quartz intraclasts and lithic fragments. In Association E, it grades upwards into poorly sorted medium sand.
Orthoconglomerate	10-50 cm thick lenses, poorly sorted arcosean matrix with subrounded pebbles of granites, gneisses, schists, volcanic rocks, among others. Subtle imbrication. At the eastern edge of the basin, the imbrication is thicker and more frequent, however it exhibits gradual decrease towards the western edge.
Paraconglomerate	Polymitic conglomerate whose matrix vary from coarse sand to angular granules. Massive structure. The fabric is made of subrounded pebbles of granites, gneisses, schists, and volcanic rocks, among others.

Table 2 – Description and Interpretation of Facies Association.

INTERPRETATION OF FACIES ASSOCIATION	
A	Floodplain.
B	Shallow and narrow channels.
C	Floodplain formed by very-fine sand intercalated with kaolinitic clays. Common occurrence of centimeter and millimeter-sized laminae characteristic of channel breach (crevasse). Fossil roots of arbustive vegetation and bioturbation.
D	Channels showing lateral-accretion surfaces. Commonly bioturbated and fossiliferous.
E	Coalescent alluvial fans, with perennial distributary channels and limited floodplain.

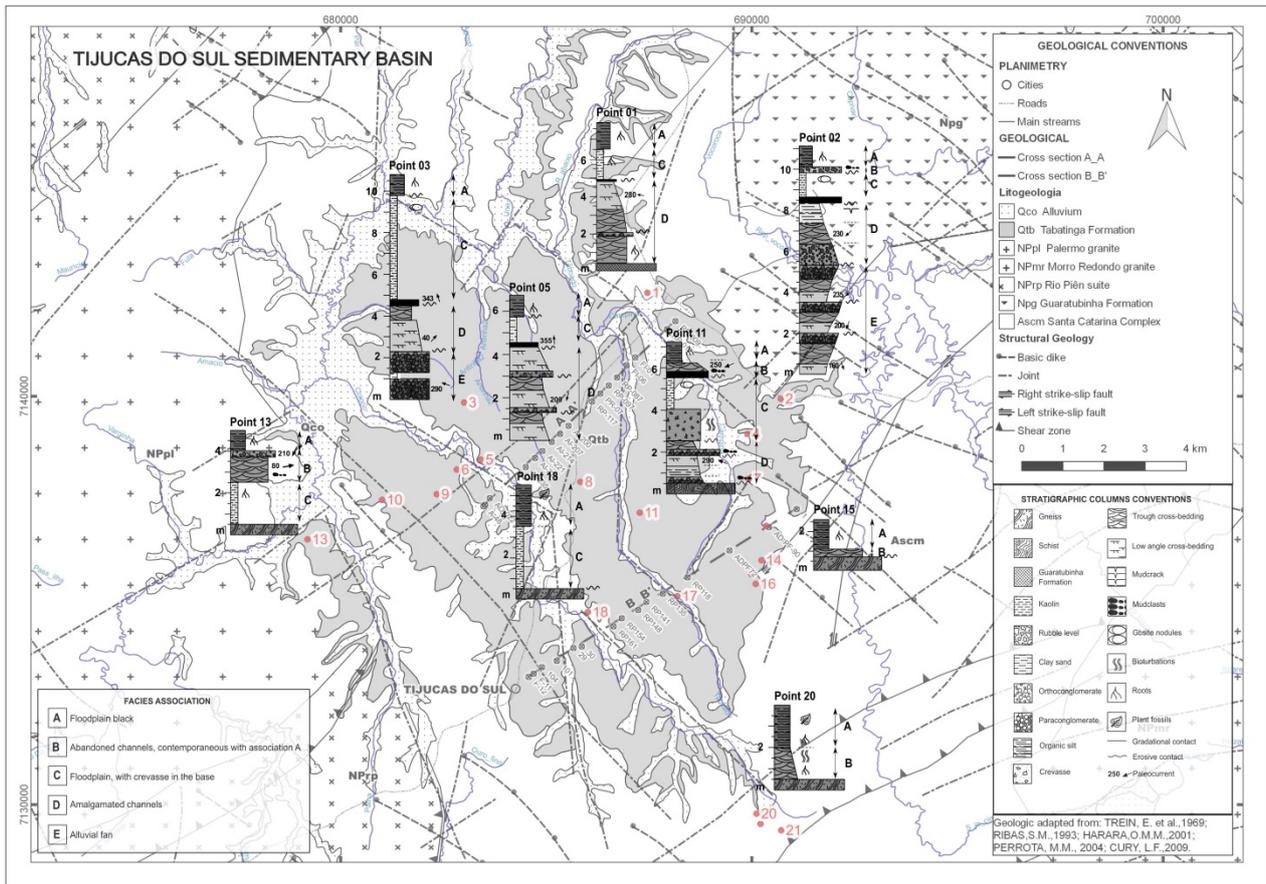


Figure 3 – TSSB outline as shown by the stratigraphic columns as well as integrated facies association data.

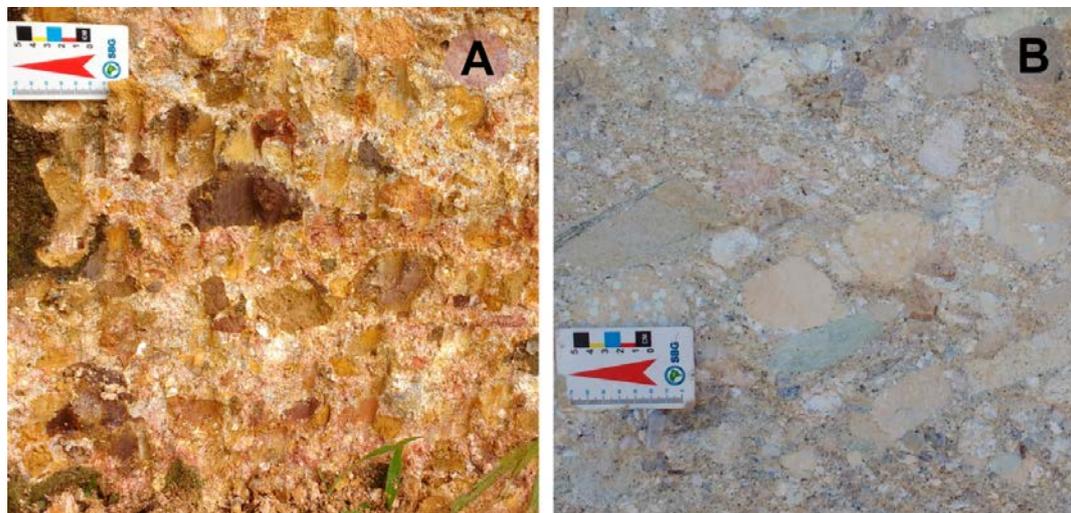


Figure 4 – Clast-supported conglomerates with arcosean matrix, municipality of Tijucas do Sul. (A) occurrence in the southeastern portion of the basin, Campo Alto surroundings; (B) occurrence in the mid-northwestern portion of the basin, Fazendinha mine site, Contenda surroundings. Outcrops 2 and 3 in figure 3.

On the E association several channels have been identified excavating the conglomerates. Those channels are characterized as immature arkosean sandstones, developing cross stratification to massive structure. The channels are 1-2 m wide and up to 1 m thick, commonly abandoned and filled by mud. The alluvial fans of facies association E have their upper portion truncated by an erosional surface that marks an abrupt change into facies association D (Figure 5).

The facies association D is composed of arkose and commonly exhibits channel facies, lateral-accreted gravel bars, migrating to the first and fourth quadrants, occasionally conglomerate lenses and thin massive siltstone lenses. The best exposures of the association D occur on the eastern border, overlapping the association E, and in the center of the basin, on

the Taboado River and on the Colono River (Figure 6).

On the eastern border of the Tijucas South Sedimentary Basin (point 01, figure 3) were found in a lateritic crust of 5 cm thick by approximately 5 m wide, fossils of dozens of woody tissues and stems with sizes smaller than 1 cm and at least three hundred of whole or fragmented leaves.

Those fossils has distinct morphological kind shown small size (ranging from 3 cm to 0.5 cm, nanofitas e microfilas), pinnate primary vein, convex apex and base and with entire margin, as seen in figure 7. Most of the leaves have been found distended and accordant of the bedding, showing imprint fossil and mineralization of the wall replaced by oxides, especially in woody tissues.

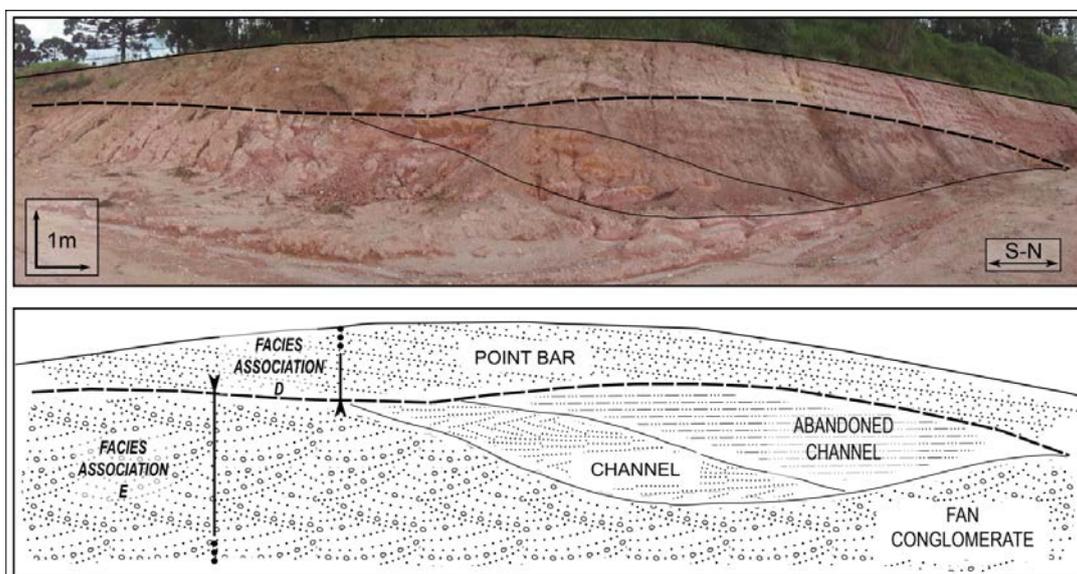


Figure 5 – Contact between facies associations D/E. Curitiba-Joinville Federal Highway, BR-376 km 648. Outcrop 2, figure 3.

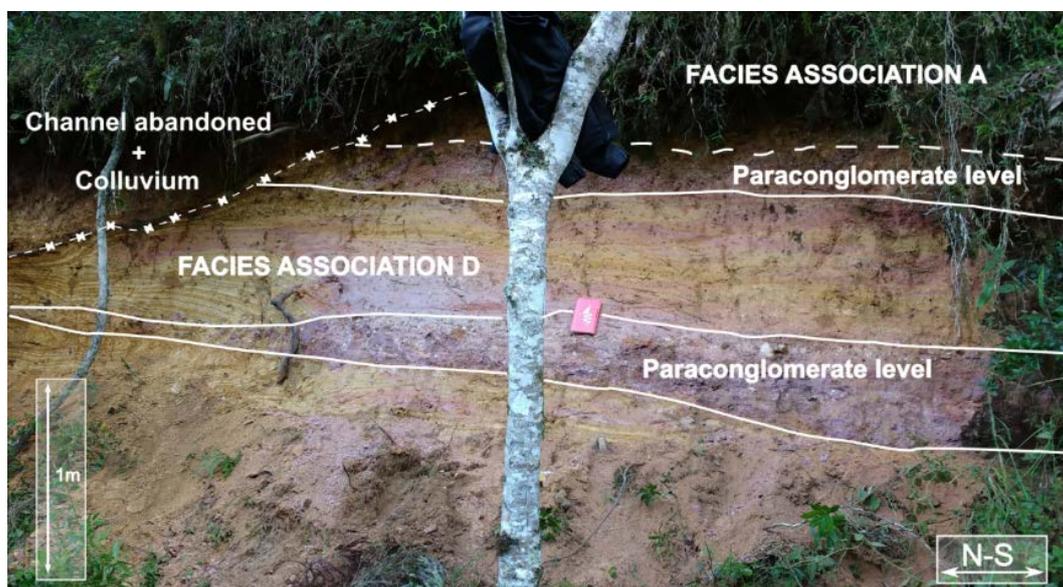


Figure 6 – Typical D Association, outcrop 5 on figure 3. Located on right margin of Colono river.

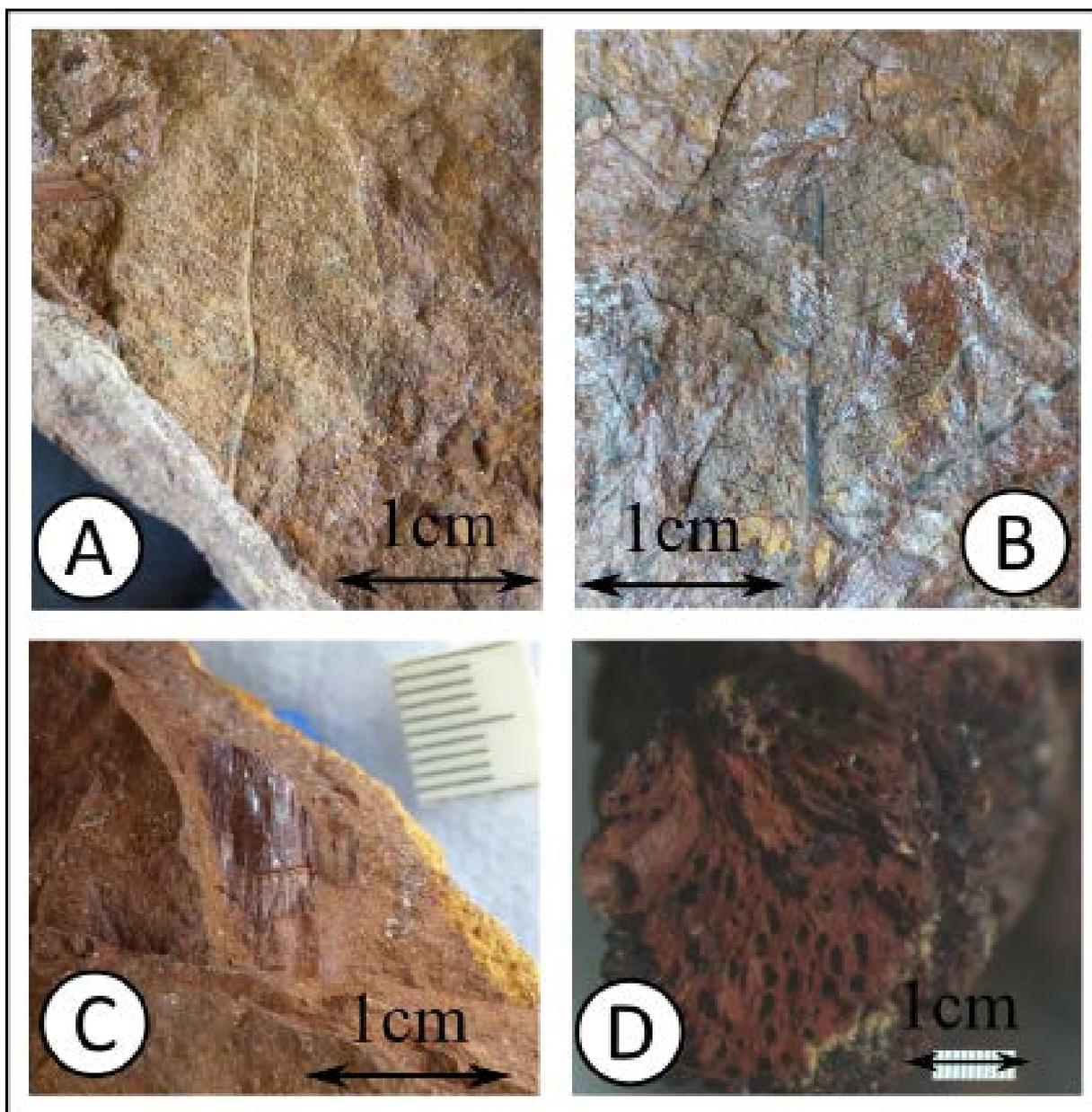


Figure 7 - D association fossils. A) Small leaf print with pinnate vein, convex apex and whole margin; B) Leaf with preserved veins; C) stem fragment; D) Lignous tissue fragment showing the vessels in transverse view. Outcrop 1, figure 3.

The crust was developed preserving a channel's feature, at the interface between the D and C associations, corroborated by the orientation of the leaves indicating paleocurrent direction to north. In an area adjacent to the occurrence of fossils, the lateritic crust preserved a mudcracks-like structure, suggesting that the transport of leaves and plant fragments in a flood and deposited in the floodplain. The lateritic crust is superimposed by a layer of up to 5 m thick formed by colluvium, interpreted that the burial site was relatively fast, although there is no evidence that the colluvium has deposited in a single event.

Association D is commonly found in lateral or vertical contact with facies association C,

which is characterized by kaolinitic layers, with diamictite deposits in the bottom that grade upward into massive kaolinitic clay with a progressive increase of gibbsite nodules upward, correlate with very fine sand lenses, developing parallel stratification. The kaolinitic clay massive layers of the C association are ordinary on all basin. On the eastern border kaolin occurs as lenses to meter-sized layers and the western occurs as lenses, as seen in figure 8.

The diamictite fabric is regular in the center of basin and is formed by millimetre - to centimeter-sized clasts of quartz, feldspar, lithic fragments, and vegetal fragments arranged into a clayey-silty matrix showing massive structure and incipient planar-parallel stratification. It is

widespread found in C association fossils of woody tissues, stems and bioturbations, as shown in figure 9.

Those fossils has 0.5 – 2 cm wide and and bioturbation 1 cm wide, usually fill in vertical tubes.

The top of associations C/D is abruptly

truncated by erosional surface marked by the contact with facies association A/B, as shown in figure 8 e 10. The associations A and B are distinct from the other facies associations (C, D and E) because of the characteristic black color of facies associations, rich organic matter composition.

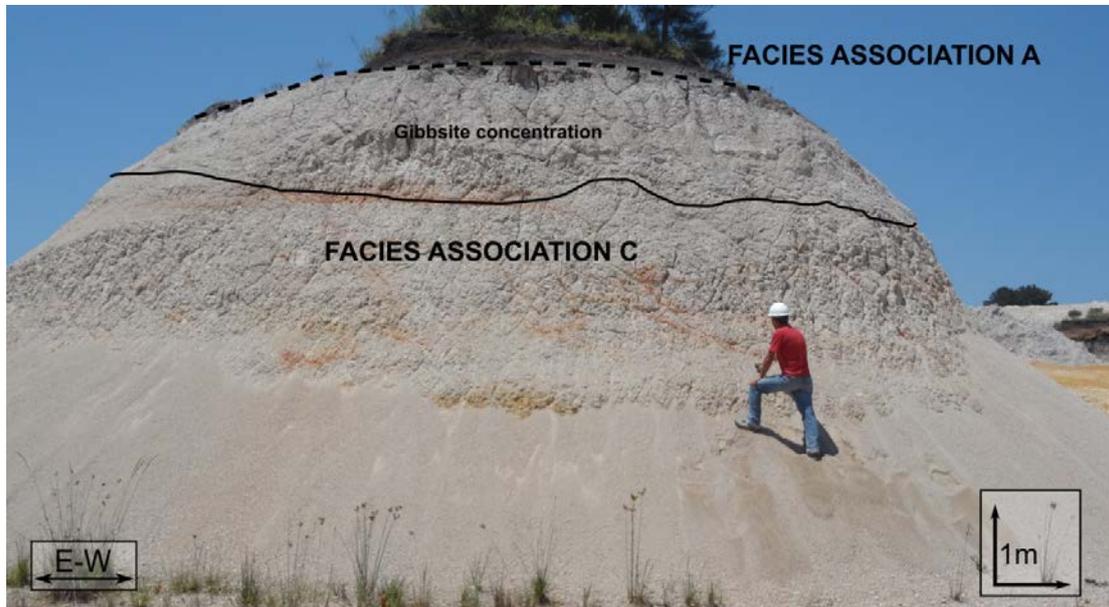


Figure 8 – Contact A and C associations. Typical C association. Outcrop 3, figure 3.

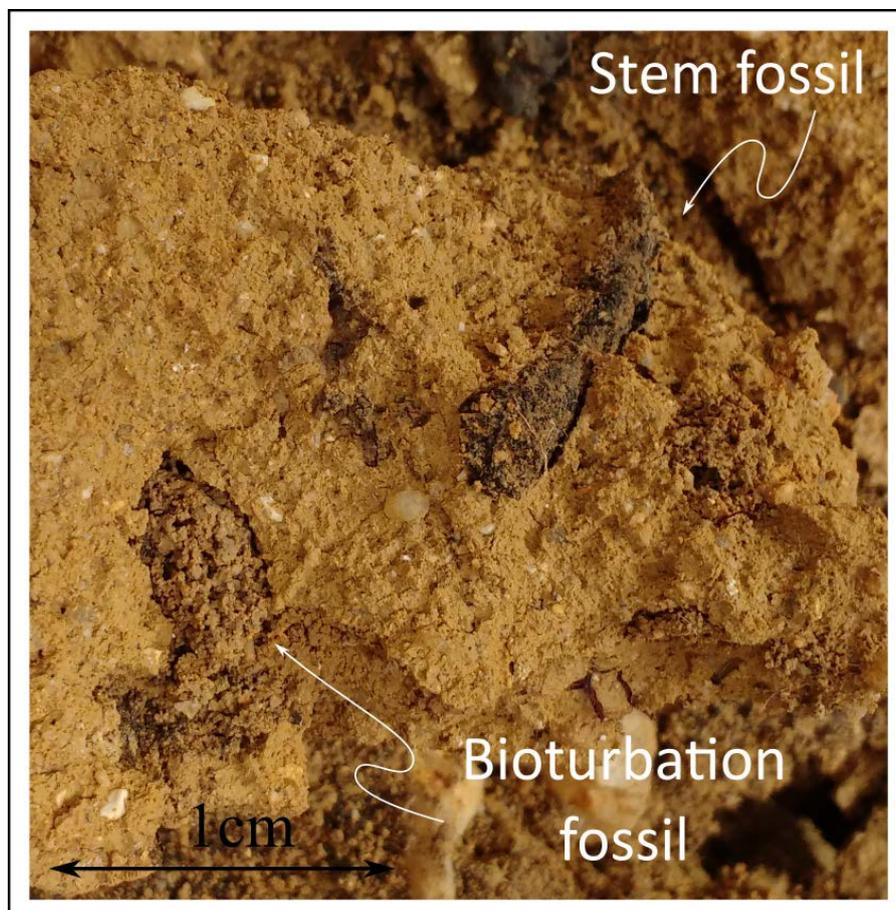


Figure 9 – Diamictite in the base of C association. Bioturbation and remains of wood tissue (stem or root). Outcrop 11, figure 3.

Association B corresponds to essentially fine- to coarse-grained quartz sand lenses that characterize bars and channels displaying trough cross-bedding and low-angle cross-bedding, commonly bioturbated. Are regular to this

association subrounded thin gravel lenses fundamentally composed of quartz with intraclasts of organic soil, interpreted as a product of reworking of facies C, D and E (Figure 10).



Figure 10 – Contact among facies associations C, D and E. Outcrop 11, figure 3.

Association A is identified by black color, composed by silt and very fine sand laminae developing incipient trough cross-bedding and abundant fossils of leaf fragments from arboreal vegetation with root marks.

Contemporaneousness of associations A and B is explaining a fluvial system possibly meandering, justifying the interdigitation between them. The occurrence of associations A and B is generalized throughout the basin, however, in the center is more evident, and can reach thicknesses of up to 5 m.

In the southeast of the basin, in a sand mine (point 04, figure 3), were found dozens of woody fragments with sizes that can vary from millimeters to centimeters. Among the fossils were identified fragments of stems of the Coniferophyta division in relation to *Araucaria angustifolia* (Bertol.), with 10 cm and 15 cm, probably a colon region that is a transition region between the stem and the roots, characteristic of the Dicotyledon Class (Figure 11). This material was deposited at the interface between the A/B/E associations, interpreted as fluvial reworking of the southeastern border of the Tijucas do Sul Sedimentary Basin.

The Tijucas do Sul Sedimentary Basin is characterized by a relatively flat relief formed by cuestas with front turned to west and reverse

to east. Cuestas show a typical drainage pattern composed of subsequent rivers flowing from SE to NW, consequent and resequent rivers flowing from SW to NE, and consequent rivers flowing from NE to SW. In sections A-A' (Figure 12) and B-B' (Figure 13), cuestas are marked by high and low blocks, which are indicative of normal faulting. Those scarps are smoothed by erosion which causes the retreat of sedimentary layers in the cornice, which the sedimentary layers have been completely eroded away leaving exposed the basement remnants.

Along the cross sections A-A' and B-B' (Figure 12 and 13) interpret predominance of continuous kaolinitic layer surrounding sand lenses which are abruptly overlaid by a layer of organic soil material.

There are places where the colluvium overlies the kaolinitic material and, eventually, the basement as well. Colluvium is reddish or yellowish, sandy-silty, with millimeter-to centimeter-sized angular quartz clasts. The sand fraction is poorly sorted and formed by angular quartz. The basement is weathered and composed of red sandy-clay soils, pink, and yellow and, in some places, white to light gray, which represents Gneiss soproilite, showed as a result of the alteration of feldspars and phyllosilicates into clay minerals.

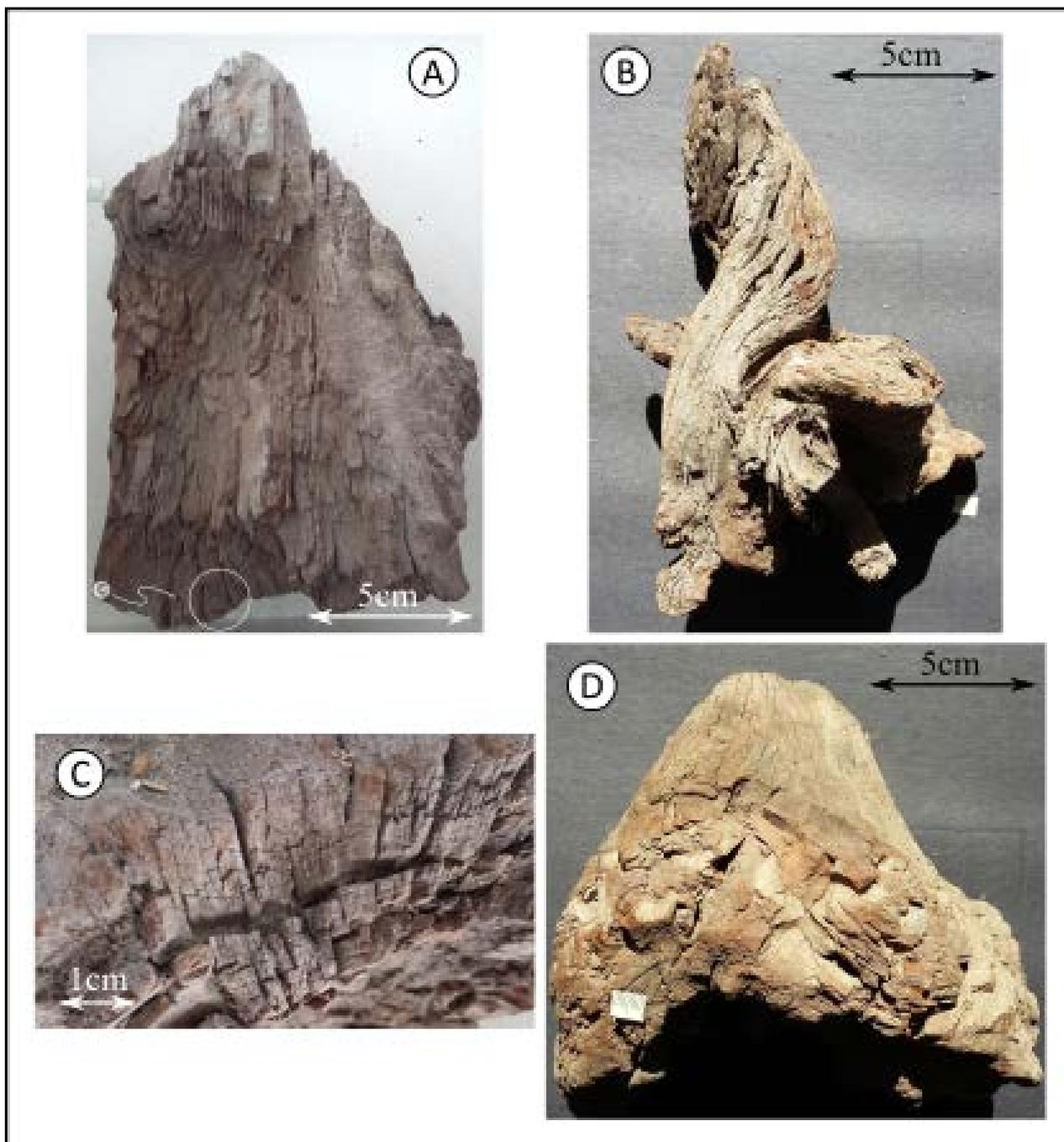


Figure 11 – Campo Alto Fossils, found at the interface between B / E facies associations. A) *Araucaria angustifolia* stem fragment (longitudinal view); B) Probable colon region of a Dicotyledon with part of the stem and roots; C) Detail of A, showing the growth rings in transverse view; D) Part of the same stem fragment of *Araucaria angustifolia* shown in A. Outcrop 4, figure 3.

DISCUSSION

The development of the Tijucas Sedimentary Basin takes place by three sedimentary period or pulses. The first one, here denominated D1, is characterized by alluvial fans deposits, represented by E association.

The alluvial fans of association E are positioned in the center of the basin and the general directions of paleocurrent indicate flow to the south, on the east border of the basin the flow was east to west and the west border from west to east.

The second pulse or D2 redirected the drainage to the first and fourth quadrants indicate by the change of direction of the paleocurrent. In this pulse the sedimentary load was switched to arkose and kaolinitic clay, with subordinated orthoconglomerate lenses. The change in flow direction corroborates the erosion of the association E, observed at the base of the association D, in the southeast and northwest section of the sedimentary basin, as seen in figure 5.

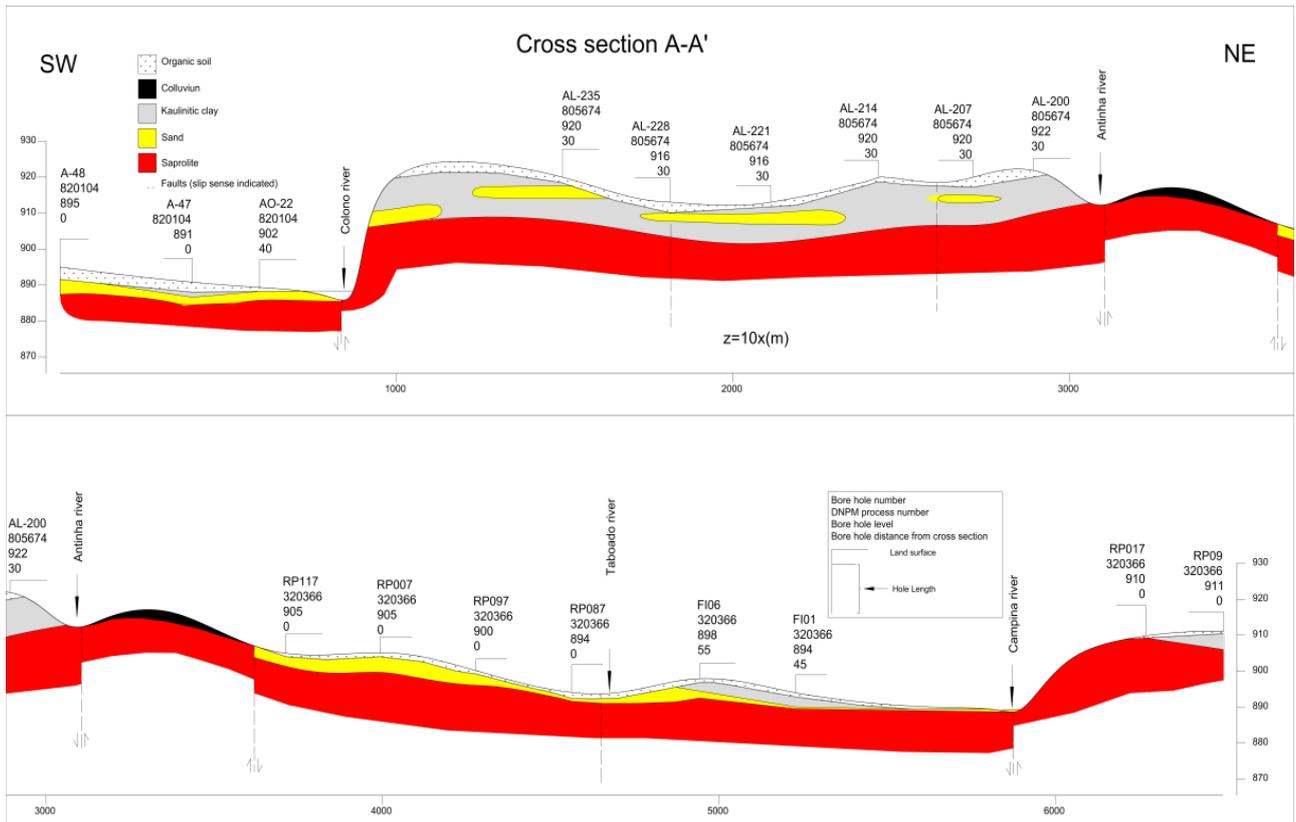


Figure 12 – Section A-A' from integrated drill core and outcrop data. The lower section complements the upper section. This section is presented in figure 3.

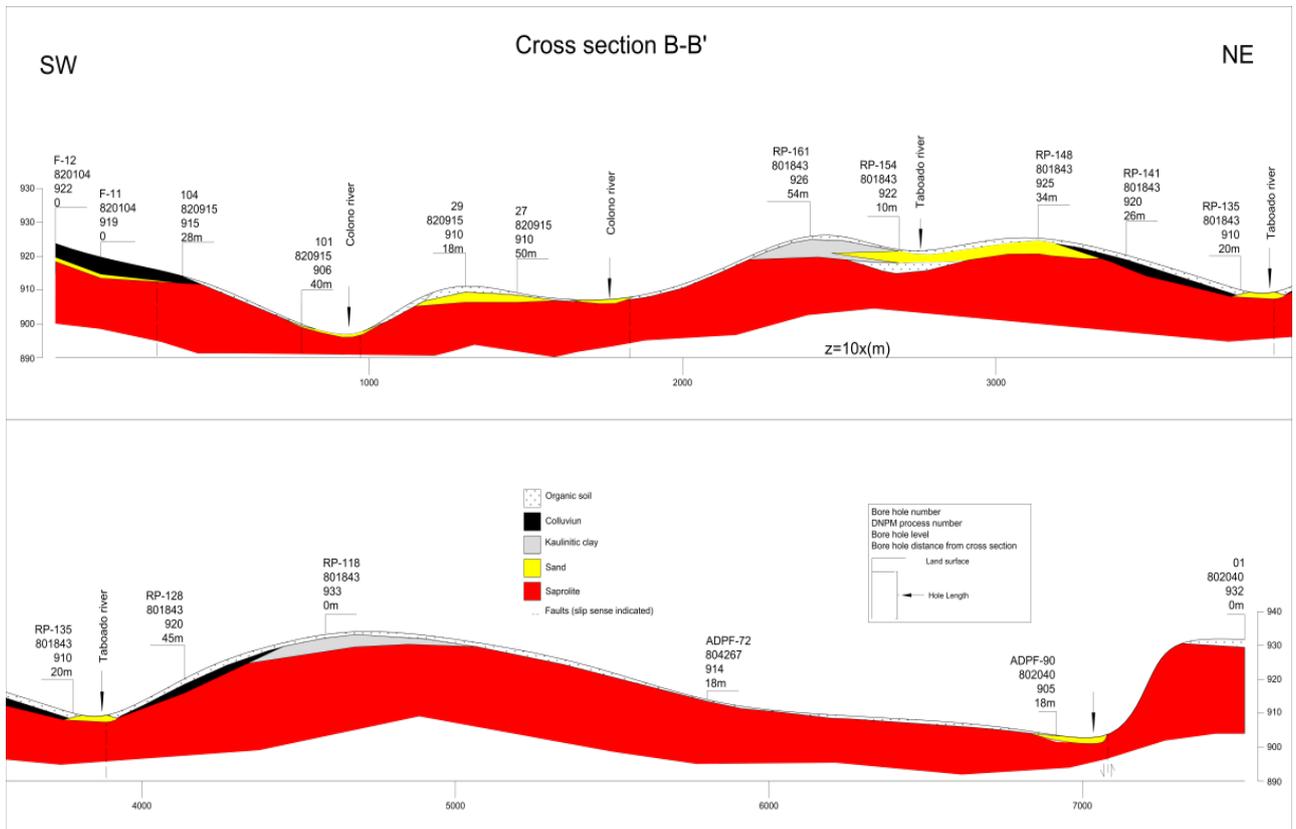


Figure 13 – Section B-B' from integrated drill core and outcrop data. The lower section complements the upper section. This section is presented in figure 3.

In D2 pulse the accommodation space of the basin would have been quickly filled, the channels began to transport less and less thick sediments and began to transport thinner sediments, testify to granulometry decrease toward the top. The gradual passage of the

diamictites to massive clays suggests the decrease of the hydraulic gradient and the development of the floodplain in a flooded area.

The third pulse or D3 it is recognized by the changing of the channels direction towards southwest. This change affected the D1 and D2 sedimentary source site, stopping the transport and sedimentation of the arkose, beginnings rework the previous association's facies, developed in D1 and D2 pulses.

During the development of association A, generalized pedogenesis took place as demonstrated by thick layers of red to brown clayey-silty soil bounding the basin, as well as by fixation of aluminum by gibbsite in C association with the formation of primary kaolin and ferruginous crusts at the contact between associations C and D. The facies of D and C associations suggest that the deposition would have arise in a fluvial valley, whereas the

association D developing the main channel and C deposited in a floodplain, with recurrent overflows of the main channel, explaining the deposition of the diamictites. The circumstance of the D association developing lenses and in an interdigitated contact with C association propose migration of the main channel in a floodplain, suggesting a meandering fluvial system.

The study carried out on the Tijucas dos Sul Sedimentary Basin allowed to distinguish features that support the non-contemporaneity with the Curitiba Sedimentary Basin. The first feature is the depositional system which, is represented by coalescing alluvial fans in the Curitiba Basin whereas the stratigraphy in Tijucas do Sul Basin varied in at least two depositional systems, alluvial fans and meandering fluvial system, which have evolved continuously, as is demonstrate in table 3.

Table 3 – Comparison between Tabatinga and Guabirotuba Formations, interpreted from several authors

Stratigraphic unit		Period / Epoch					
		Neogene	Pleistocene			Holocene	
			Early	Middle	Late		
TABATINGA FORMATION	Aumond (1993)	Unit		Base	Middle	Upper	
	Facies		Conglomerates polymitic, arkoses matrix and kaolin	kaolin massive layers, Gibbsite layer on the top		Black clay organic matter rich	
	System		Semi-arid	Swamp or marsh (floodplain)		Swamp or marsh (floodplain)	
	Climate		Semi-arid	semi-arid to humid		Humid	
	In this work	Unit			Campo Alto	Colono Taboado	
	Facies				Paraconglomerates, arkoses, sand and mud channels	Floodplain, crevasse, Floodplain, sandy and kaolin, Gibbsite layer gravelly channels	
	System				Alluvial fans	Meandering alluvial Meandering alluvial	
	Climate				Humid	Humid	
	Bigarella and Salamuni (1962)	Unit		Guabirotuba			Aluviun
	Facies			Mud, drebri flows			Sands, mud
System			Alluvial fan coalescent, <i>playa lacustre</i>			Alluvial meandering	
Climate			Semi-arid			Humid	
Becker (1982)	Unit		Guabi	Tinguis	Boqueirão	Aluviun	
Facies			Sands, mud, arkoses	Sands, mud, arkoses	Sands	Sands, mud	
System			Alluvial fans	Alluvial rivers	Alluvial braided	Alluvial meandering	
Climate			Semi-arid	Humid	Humid	Humid	
GUABIROTUBA FORMATION	Salamuni (1998)	Unit	Guabirotuba	Tinguis		Aluviun	
	Facies		Massive clay, arkoses, carbonate	Massive kaolin matrix. Conglomerate layers		Sand bad sorted, clay matrix	
	System		Alluvial fans coalescent	Debris flow		Alluvial	
	Climate		Semi-arid	Humid		Humid	
	Lima (2010)	Unit		A to F association			
	Facies			Meandering rivers, sandy and gravelly bars, floodplain,			
	System			Alluvial fans			
	Climate			Humid			

The second feature is the sedimentary content, which is composed of clays that vary in composition amongst kaolin, montmorillonite and illite in the Curitiba Sedimentary Basin, while the dominant phase in Tijucas dos Sul Sedimentary Basin is represented by kaolinitic clays (Santos, 2000 and Aumond, 1992).

Third feature it is determined by the climate or paleoenvironmental thus the morphology of the

fossils leaves in Colono member is outstanding environmental conditions index concerning rains precipitations and site temperature. The leaf architecture would be summarized in morphotypes, formally described and used in analyzes (Wing et al., 1999). The morphotype of the small leaves, pinned veins, base and apex convex indicates humid altitude forest (Wolf, 1995) and the entire-margined of the species it

is most significant character of the high temperatures (Wilf, 1997). According to Bolzon et al. (2017), about the fossils discovered in the Tabatinga Formation: "the leaf morphology indicates an association of moist forests with high latitude and high temperatures of the tree type with field elements equal what is currently occurring". Corroborates with that of the most classic vegetal specimen of the mixed ombrophilous forest is the *Araucaria angustifolia* which is considered sensible of the climate variation and its presence would be related to specific paleoenvironment (Bertoldo et al., 2014). That specimen it is steady on temperate climate e humid, without long term wet period, with precipitation annual average

between 1400 and 2200 mm (Behling, 2002).

The three sedimentary pulses distinguish each other from physical and sedimentary characteristics such as texture, structure, mineralogy and fossils. This division is corroborated by notable discontinuities throughout the basin. Therefore, in order to visualize the sedimentary processes and to facilitate the understanding of the evolution of the basin, it was suggested to separate the Tabatinga Formation in three members, Campo Alto at the base, correlated to the alluvial fans; Colono Member, in the center, related to the arkoses and the kaolinite clay; and the Taboado Member, at the top, allied to sediments rich in organic matter, as shown in figure 14.

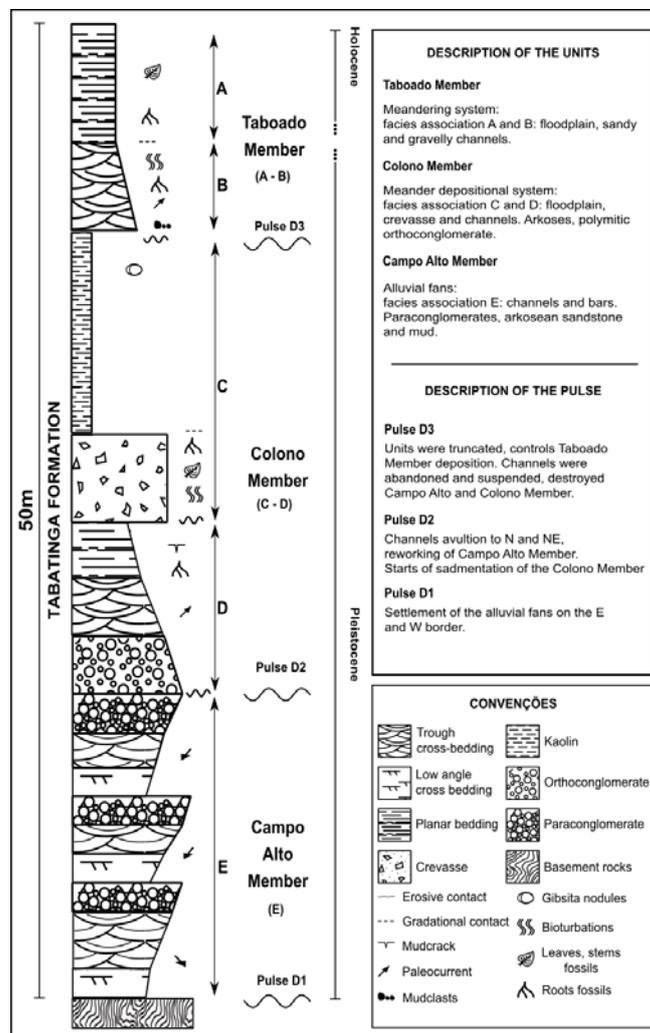


Figure 14 – Stratigraphic column of the Tabatinga Formation.

Therefore, the division of the Tabatinga Formation into three members is here suggested as follows: Campo Alto Member, at the bottom, which corresponds to the alluvial fans of facies association E exposed at road slope along the Curitiba-Joinville BR-376 federal highway, more specifically located in the surroundings of

Campo Alto, Km 648 South. The outcrops are identified on geological map in Figure 3 as outcrops 02 (UTM coordinates 690703E, 7139937N, zone 22S) and 04 (UTM coordinates 689899E, 7139075N, zone 22S).

Colono Member is the meandering alluvial system of facies associations C and D (Figure

3), with a stratotype at the Fazendinha mine site, outcrop 03 (UTM coordinates 683003E, 7139845N, zone 22S) and outcrop 05 (UTM coordinates 683412E, 7138446N, zone 22S) located on the right margin of the Colono river, a road cut along the secondary road between Tabatinga – Contenda in the municipality of Tijucas do Sul. The Taboado Member refers to facies associations A and B (best represented at outcrop 11 (UTM coordinates 687275W, 7137148S, zone 22S), located along the secondary road between Tabatinga - Postinho, after the Taboado river bridge (Figure 3).

Some differences discussed in the text

about Guabirotuba and Tabatinga concerning around physical characteristics of sedimentation, which suggests the climate was predominantly humid in Tabatinga period. In Tinguis Unit for instance as shown in table 3, Becker (1982) and Salamuni (1998), agree about the humid period in Pleistocene, but Becker (1982) believe that this climate condition persisted a short time, most specific in middle Pleistocene.

All those authors cited on table 3 agree that the climate has been changed after middle Pleistocene, but Salamuni (1998) precise the Guabirotuba Formation should be formed in a different climate, justifying Neogene period to these formation.

CONCLUSIONS

Filling of Tijucas do Sul Sedimentary Basin happens into three pulses: The first pulse or D1 develops Campo Alto Member. Pulse D2 is characterized by an erosional surface on top of alluvial fans, channel shifting to N and NE, which favored sedimentation of the Colono Member. The D3 pulse stands for a sudden event that reorganized the drainage by shifting the main river's course (Varzea river) from N to W or N to SW, as well as favored sedimentation Taboado Member.

The evolution of the Tijucas do Sul Sedimentary Basin still affects the features of the landscape nowadays: the structures that once controlled the development of the basin are now observed in the field leading to erosion, transport, and deposition.

Finally, we conclude that the Tijucas do Sul Basin is not part of the depositional tectonic

cycle of the continental rift of southeastern Brazil and is distinct from the sedimentation of the Curitiba Basin. It represents a new continental sedimentary cycle, probably caused by recent tectonic events. Curitiba Basin and Tijucas do Sul Basin were developed in different ages, in which the former is Eocene-Oligocene age (Salamuni, 1998) and the latter has been younger, likely with onset in the Upper Pleistocene or Holocene (table 3), further studies should answer this matter. The sedimentary unit filling the basin is here named as Tabatinga Formation, which composed from bottom to top by the Campo Alto, Colono and Taboado Members, and has a very distinct fossiliferous content and geological history from Guabirotuba Formation (unit that fills the Curitiba Basin).

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