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MORPHOSCOPIC EVALUATION OF SANTO ANTÔNIO RIVER SEDIMENTS IN SERRA DA CANASTRA NATIONAL PARK - MG AND SURROUNDINGS

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ABSTRACT
The sedimentary morphoscopy studies is an important tool to characterize grains of a given channel with studies of sphericity, roundness and parental material, from their results, which can influence the relief sculpture. The purpose of this research is to understand the distribution and characterization of sediments collected in the Santo Antônio River Basin, located in the Serra da Canastra National Park – MG and surroundings, in order to evaluate the dynamics of sediment transport that occur in this space. Through textural analysis and the study of the genetics of the samples collected in the river channels, they are the result of dynamic processes that collaborate for the sculpting of the regional relief. These channels carry sediments, which were collected in a total of 51 points and, for each sampling point, 50 discontinuous grains with three different diameters were evaluated: 0.600mm; 0.850mm; 1.70mm. In all, approximately 7,650 grains were evaluated. Enabling the quali-quantification of the grains on their sphericity, roundness and the lithological aspect of the material. From the analyzes carried out with the granulometry method by sieving and observation by a precision portable digital type magnifier, monocular, 1000x magnification with a 2.0 megapixel camera. The results point to a greater number of sediments with low sphericity, roundness of the very angular to angular type, with predominance of material of geological aspect such as quartz, laterite and mica.
Keyword: Serra da Canastra. Sediment morphoscopy. Sphericity. Rounding. Source material. Geomorphology.

AVALIAÇÃO MORFOSCÓPICA DE SEDIMENTOS DO RIO SANTO ANTÔNIO NO PARQUE NACIONAL DA SERRA DA CANASTRA – MG E ENTORNO

RESUMO
Os estudos de morfoscopia sedimentar é um importante instrumento para caracterizar grãos de um determinado canal com estudos da esfericidade, arredondamento e material de origem litológica, a partir de seus resultados podendo influenciar na esculturação do relevo. A proposta desta pesquisa é entender a distribuição e a caracterização dos sedimentos, selecionados na Bacia Hidrográfica do Rio Santo Antônio, localizada no Parque Nacional da Serra da Canastra – MG e entorno, com intuito de avaliar a dinâmica do transporte dos sedimentos que ocorrem nesse espaço. Através da análise textural e do estudo da genética das amostras coletadas nos canais fluviais, sendo eles o resultado de processos dinâmicos que colaboram para a esculturação do relevo regional. Estes canais carregam sedimentos, os quais foram coletados em um total de 51 pontos e, para cada ponto amostral foram avaliados 50 grãos descontínuos com três diâmetros distintos: 0,600 mm; 0,850 mm; 1,70 mm. No todo, foram avaliados aproximadamente 7.650 grãos. Possibilitando a quali-quantificação dos grãos sobre sua esfericidade, arredondamento e o aspecto litológico do material. A partir das análises realizadas com o método de granulometria

por peneiramento e observação por lupa de precisão portátil do tipo digital, monocular, ampliação de 1000x com câmera de 2.0 megapixels. Os resultados apontam para um maior número de sedimentos com esfericidade baixa, arredondamento do tipo muito angular a angular, com prevalência material de aspecto geológico do tipo quartzo, laterita e mica.
Palavra-chave: Morfoscopia de sedimentos. Esfericidade. Arredondamento. Material de origem. Geomorfologia.

INTRODUCTION

It is understood that geomorphology is the science responsible for the study of terrestrial relief with its wide diversity to be explored and understood (CHRISTOFOLETTI, 1980).

Sedimentary morphoscopy is a technique that studies the shapes of sphericity and roundness of a given sedimentary particle. Consequently, this technique becomes an auxiliary attribute, widely used to clarify sedimentation environments. The particularities of an environment determine general aspects of the sediments accumulated in a geomorphic unit. Thus, such general aspects suggest genetic acquisition, relating the sediment to the environment of origin (MENDES, 1984).

Therefore, this present research is related to fluvial geomorphology with emphasis on parameters of sediment morphoscopy through granulometric analysis in order to characterize and understand the distribution of grains collected in the Santo Antônio River Basin present in and around PARNA Canastra.

There are some plausible arguments about the importance of granulometric analysis where it is possible to find in the granulometry pertinent information for an accurate description of the sediment; the granulometric distribution can be an attribute of a sediment which was deposited in an established place; there is the possibility of recognizing the erosive processes acting during sedimentation and obtaining parameters such as permeability and sediment modifications (SUGUIO, 1980).

The study region has a tropical climate with a prevalence of two seasons, from December to February the season is humid, in the driest seasons that occur from June to August are the coldest months, with an average temperature the place varies between 18º C, in the warmest months with 22º C. In the case of rainfall, there are variations between 1000 mm and 1500 mm (BARCELOS, 2020).

PARNA Canastra is represented in five units with distinct topographical, morphological, climatic and pedological characteristics: plateaus, intermontane depressions, elongated and elevated hills, elongated hills and convex hills and gently undulating hills (ICMBIO, 2005).

The drainage basin is defined by a set of channels or a river which carry out the drainage process through the flow, therefore, the size of the area occupied by the hydrographic basin delimits the amount of water traveled in the river channels. The watershed basically consists of the classification of its channels, according to the classification of Strahler (1952), the index is categorized into up to six classes the study area contributes a lot to the relief sculpture from its sinuous channels. (NAZAR & RODRIGUES, 2019).

For a better administration of the Park, it is important to emphasize the importance of the springs, in view of this, the study area configures as a “drainage disperser” as it is an interfluve of the hydrographic basins of the São Francisco and Paraná rivers (SILVA. 2019).

The drainage density is equivalent to the harmonically discordant interfluvial distance, that is, the greater the drainage density, the smaller the interfluvial distance. Furthermore, the Drainage Density (DD) reproduces the degree of topographic dissection of the areas where the channels act, quantifying them for flow. (NAZAR & RODRIGUES, 2019).

The basin object of study is located in the folding belt, called Brasília Belt, with an extension of approximately 1200 km, located on the western edge of the São Francisco Craton that covers part of the states of Tocantins, Goiás and Minas Gerais dating from the Neoproterozoic. (ARAÚJO, 2017).

The study area of the region is located on the geological Units of the Canastra Group and the São Francisco Supergroup, structures that present lithological and tectonic differences. The São Francisco Craton is composed of quartzic rocks, while the Brasília Belt is composed of sediments of volcanic rocks that have undergone metamorphism, originating rocks of the schist and phyllite type predominant in the folding belts" (SOUZA, 2014).

The structures of the São Francisco Craton and Brasília Belt, support smaller geological units, classified in the geological distribution scheme, therefore the interference of exogenous agents obtaining a topography that varies from 630 meters to 1500 meters of altitude. Originating a complex relief of tabular surfaces, scarps, ridges, depressions, dissected plateaus, erosive and flattened surfaces, (SOUZA, 2014).

The transport mode of sediments produces as a result, distinct deposits, therefore in several parameters the transport affects the sedimentation. In view of this, well classified sediments were subjected to prolonged action of water, poorly selected sediments suffered little transport, that is, they were close to their source of origin (SUGUIO, 1980).

The term rounding was created by Wentworth (1919), as he calculated the shape of the radius of curvature of the sharpest edge and the particle diameter, referring to the shape of the curvatures of a grain (SUGUIO, 1980).

This sediment modeling process ends up generating some physical changes, which allows its classification in roundness (from the most angular to the most rounded). According to Russell and Tayllor (1937a, b) apud Suguio (1980) there are five classifications that determine the roundness of a sedimentary particle: Very angular, angular, sub-angular, sub-rounded, rounded and well-rounded (SUGUIO, 1980).

The classificatory part of sphericity (how circular a particle is) that increases through the continuous action of transport, is analyzed from three classes: high sphericity, medium sphericity and low sphericity (POWERS, 1953).

The degree of roundness of a sediment corresponds to a physical property, therefore, it must be described. To measure the circularity of a particle depends on the analysis of edges and corners regardless of shape. The authors superimposed particles in five classes comparing with photographs, a method created by Wadel, (POWERS, 1953).

The boundaries of the sedimentary particles were not meticulously classified, the arithmetic means of the intervals were used as the midpoint, not providing minor subdivisions that are important in the lower values. Therefore, the difference in sphericity is visible when the roundness values of a grain are lower.

The comparison of angles from the characteristics of a three-dimensional particle is easy to observe under a microscope, focusing through the thickness of the sediment, (POWERS, 1953)

To determine the degree of roundness of a particle and classify it, it is necessary to compare the grain with the classes of photography, this method is commonly used in laboratory work, that is, it is considered as accurate as other methods, (POWERS, 1953).

The main objective of this work is to carry out a morphoscopic analysis of sediments from the Santo Antônio River basin found in the fluvial channels of this basin, which is located on the northern edge of Serra da Canastra. And the secondary objectives, based on this: to evaluate the hydro-geomorphological evolution resulting in the modeling of the grains; perform granulometric analysis of sediments; evaluate sphericity, roundness and origin matrix of the sediments; establish a correlation between the results of morphoscopic analysis with thematic maps of slope, relief shape pattern, lithology; and understand how the procedures of the channels behave from the interaction of the granulometric morphometry of the materials carried by the bed of the fluvial channels.

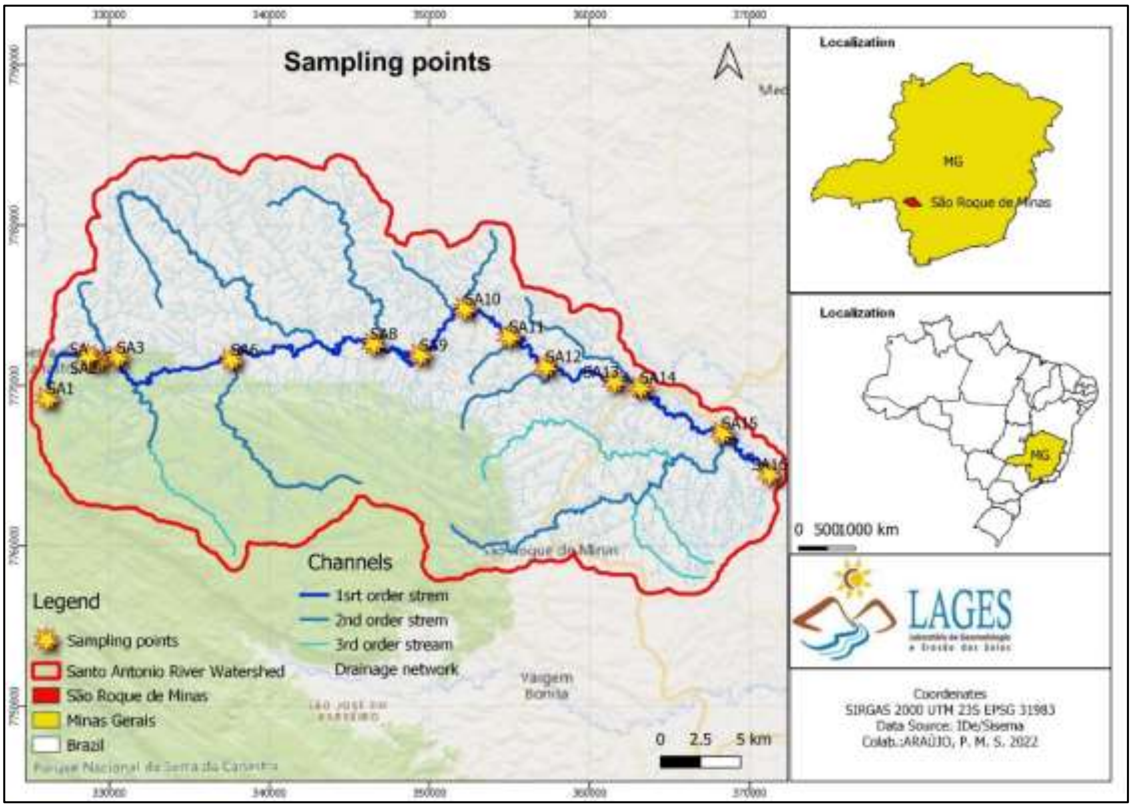
MATERIAL AND METHODS

To carry out this research, three stages were necessary: Pre-field (desktop work with bibliographic research and interpretation of satellite images to help with the elaboration of maps); Field (data acquisition as recognition of the study area); Post-field (data analysis and correlation, sediment washing processes, granulometric analysis, choice of grains for morphoscopic analysis, creation of tables, graphs and maps of the study area), then in Figure 1, the locations of the sample collections used to exemplify this research.

The research area is located between latitude 20°12'9.60"S and longitude 46°32'28.87"W, the Santo Antônio River Watershed is located in the upper course of the São Francisco River, comprising 15 main channels counting the secondary and tertiary channels which are responsible for the water dynamics of the place, (ARAÚJO, 2016)

The sediments analyzed were collected in the main existing channels of the Santo Antônio River Basin (primary river), secondary channels (Córrego Esmeril, Ribeirão do Pinheiro, Córrego da Buraca, Córrego Palmital, Córrego 3 Barras, Córrego da Taquara, and Rio do Peixe), those of third order that correspond to the rivers Rio Grande, Córrego da Ema, and Córrego das Batatas, Figure 1.

Figure 1: Location of sampling points.



Data source: IBGE. (2021). Org.: The authors. (2022)

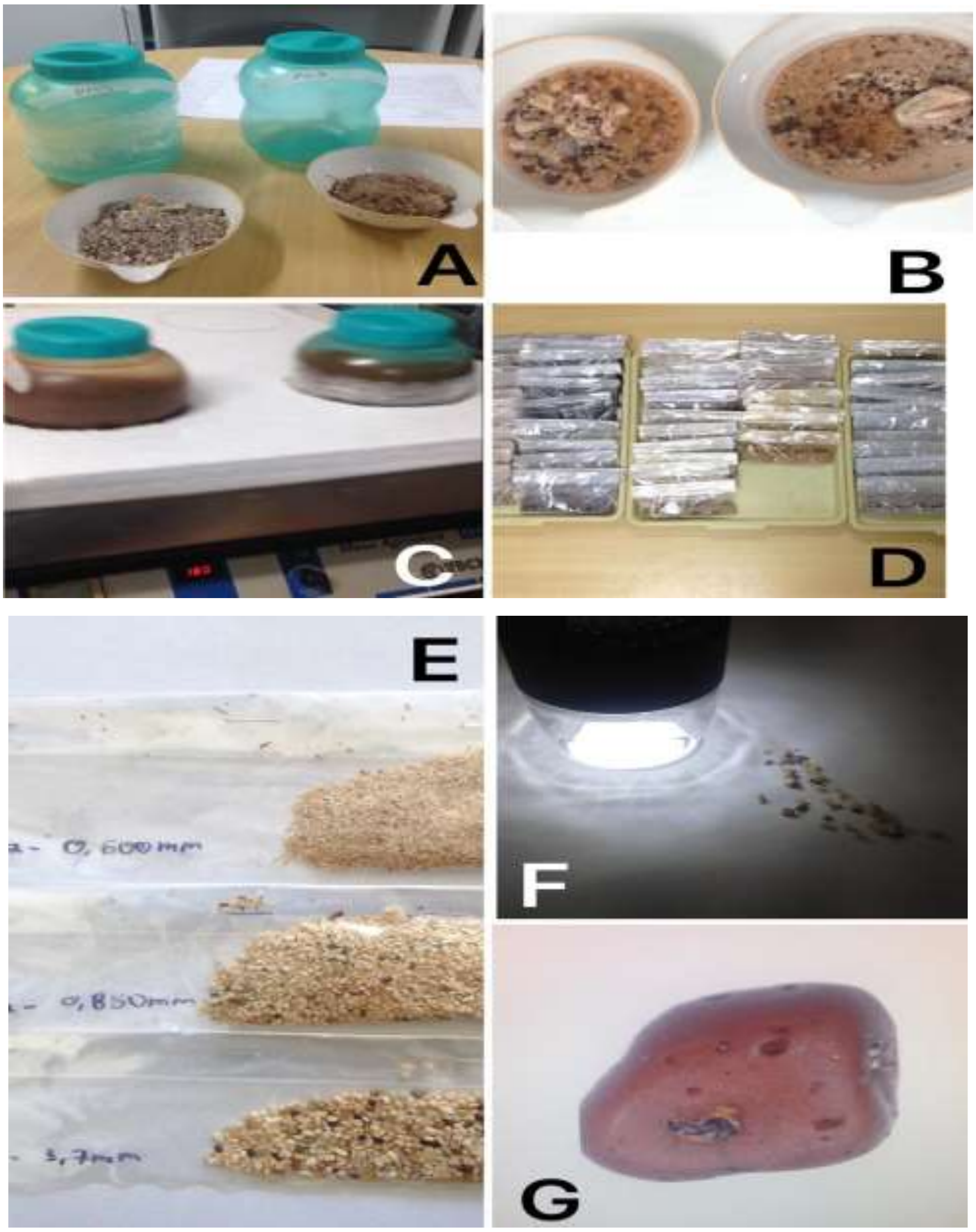
The laboratory analysis processes allow us to interpret the data from the chemical and physical compositions of the materials, although it is a detailed work, it is still fundamental in helping the research. Previously, studies were carried out on the research area in Google Earth, to collect material, where later a visit to the study site was carried out and manually collected the samples of the channels with continuous flow using a shovel, from the sample collections in the Rio Santo Antônio with their respective identifications, markings of the coordinates of each point collected were made, using the GPS.

In the laboratory, the sieving granulometry method was carried out, where the material was washed and dried at 105º Celsius in an oven for 16 hours, to remove all moisture from the material and disposal of clays and silts, procedures carried out 3 (three) times in a row. , standard process according to the authors Santos and Rodrigues, (2019), corresponding to (Figure 1) and (Image A and B). Subsequently, 300 grams of material were removed for washing in a solution of 225 ml of NaOH and 1 liter of distilled water, placed for agitation on an orbital shaking table for 16 hours at 180 rotations per minute, as shown in Figure 2 and (Image C).

Last wash in running water for silt and clay to be discarded. Again in an oven at 105º Celsius, the samples will be placed for final drying and then the granulometries will be separated using a dry shaker, passing through a set of sieves whose meshes are: 4.75 mm;

2 mm; 1.70 mm; 0.850 mm; 0.600 mm; 0.425 mm; 0.300 mm; 0.212 mm; 0.150 mm; 0.075 mm; 0.053 mm, a procedure which separates the grains into gravel, coarse sand, medium sand, fine sand, silt and clay. After the granulometric separation process, the materials are bagged with proper identification, as shown in (image D).

Figure 2 - Sequence of the sieving granulometry method. A) weighing the material 300g; B) washing the sediment; C) sediments with soda water solution on the orbital shaker table and D) washed, packaged and identified sediments, E) bagged sediments; F) Morphoscopy technique using a digital magnifying glass; G) Grain of lateritic conglomerate.



Source: The authors, 2022.

The choice of grains in the measurements of 0.600mm; 0.850mm; 1.70mm, it was given for being easier to see, and to handle. The three size classes make it easy to observe the variability of materials from the thickest to the thinnest. From the random separation of 50 grains, samples were taken to the sedimentary morphoscopy process, according to (Figure 2 and image E).

With 1000x Portable USB Zoom Professional Digital Precision Magnifier Counting

with a 2.0 Megapixel camera, light source composed of 8 white light LEDs, white A4 sheet base, enabling the use of the sedimentary morphoscopy technique, in order to analyze the sphericity, roundness and source material collected in the channels rivers, as shown in (Figure 2) and (Image F). For a possible conclusion of the analysis of grain shapes, (Figure 2) and (image G).

RESULTS AND DISCUSSION

From the previously mentioned procedures, it was necessary to create an Excel spreadsheet to record the amount of sediments with their singularities and measurements. In all, 51 samples were collected and analyzed, but only samples SA, SA1, SA3, SA9, SA10, SA13, SA14 and SA15 will be exemplified in this work.

The 50 grains selected and analyzed by precision magnifying glass were quantified and qualified as shown in (Table 1), below. From the characteristics of rounding, it was possible to diagnose the following six classifications: Very angular, Angular, Subangular, Subrounded, Rounded and well rounded, (corresponding to the letters A, B, C, D, E, F) respectively in the table, the The sphericity of the material was classified as High, Medium and Low, the rocky material of origin is classified into Quartz, Mica, Laterite, lateritic conglomerate and others (rocks whose origin could not be recognized.

Table 1: Results of analysis using a professional handheld digital precision magnifier USB Zoom 1000x with a 2.0 Megapixel camera.

SA	Roundness						Sphericity			Fabric material				
	A	B	C	D	E	F	Alta	Média	Baixa	Quartzo	Laterita	Mica	C.Laterítico	Outras
0,600mm	23	9	5	5	8	0	0	0	50	37	2	10	1	0
0,850mm	20	15	6	1	6	2	0	0	50	41	1	6	0	2
1,70mm	30	15	2	0	3	0	0	0	50	45	2	3	0	0
SA1	Roundness						Sphericity			Fabric material				
	A	B	C	D	E	F	Alta	Média	Baixa	Quartzo	Laterita	Mica	C.Laterítico	Outras
0,600mm	11	9	2	5	15	8	2	14	34	48	2	0	0	0
0,850mm	7	13	8	7	12	3	4	6	40	43	5	0	1	1
1,70mm	18	16	4	4	4	4	2	4	44	36	6	0	2	6
SA3	Roundness						Sphericity			Fabric material				
	A	B	C	D	E	F	Alta	Média	Baixa	Quartzo	Laterita	Mica	C.Laterítico	Outras
0,600mm	15	23	4	4	4	0	0	1	49	45	1	2	1	1
0,850mm	20	16	7	5	1	1	2	2	46	42	3	2	1	2

1,70mm	29	14	0	4	1	2	0	1	49	43	1	2	2	2
SA9	**Roundness**						**Sphericity**			**Fabric material**				
	A	B	C	D	E	F	Alta	Média	Baixa	Quartzo	Laterita	Mica	C.Laterítico	Outras
0,600mm	11	30	2	2	4	1	0	0	50	43	2	5	0	0
0,850mm	15	22	2	5	6	0	0	0	50	39	1	9	0	1
1,70mm	13	23	5	2	7	0	0	0	50	41	0	6	1	2
SA10	**Roundness**						**Sphericity**			**Fabric material**				
	A	B	C	D	E	F	Alta	Média	Baixa	Quartzo	Laterita	Mica	C.Laterítico	Outras
0,600mm	21	12	8	5	3	1	1	0	49	39	4	7	0	0
0,850mm	12	12	9	13	1	0	0	0	50	32	3	13	0	2
1,70mm	16	13	9	7	4	1	0	1	49	38	4	8	0	0
SA13	**Roundness**						**Sphericity**			**Fabric material**				
	A	B	C	D	E	F	Alta	Média	Baixa	Quartzo	Laterita	Mica	C.Laterítico	Outras
0,600mm	30	11	7	2	0	0	0	0	50	43	5	2	0	0
0,850mm	14	16	11	7	1	1	0	1	49	34	6	8	0	2
1,70mm	24	18	2	4	0	2	1	0	49	42	2	3	1	0
SA14	**Roundness**						**Sphericity**			**Fabric material**				
	A	B	C	D	E	F	Alta	Média	Baixa	Quartzo	Laterita	Mica	C.Laterítico	Outras
0,600mm	30	7	6	0	0	0	0	0	50	43	0	6	0	1
0,850mm	36	2	3	8	1	0	0	0	50	36	1	8	0	5
1,70mm	22	19	2	5	1	1	0	0	50	41	2	6	0	1
SA15	**Roundness**						**Sphericity**			**Fabric material**				
	A	B	C	D	E	F	Alta	Média	Baixa	Quartzo	Laterita	Mica	C.Laterítico	Outras
0,600mm	23	12	6	8	0	1	0	0	50	44	2	7	1	0
0,850mm	18	16	5	6	5	0	0	0	50	39	6	4	0	1
1,70mm	36	7	4	1	2	0	0	0	50	44	5	1	0	0

Source: The authors, 2022.

The altimetry of the Santo Antônio River Basin varies from 700 to 1500 meters. In the higher areas there are the springs of the secondary and tertiary channels, channels that carry lithology of the band and folds of the São Francisco Craton, therefore, the channels travel, bringing with them rocks composed mostly of quartz.

Based on the analyzes corresponding to each measurement of the samples, it was possible to elucidate through graphs that the 0.600mm grains have average roundness, compared to the 0.850mm and 1.70mm grains. According to the author (SUGUIO, 1980), the sandy sediment mixed with silt and clay will have variable transport with the granulometry. Therefore, sand is more susceptible to transport, suffering from the action of deterioration by friction with other sediments.

Samples SA, SA1, SA3, SA9, SA10, SA13, SA14 and SA15 were collected in their original environment in the fluvial channels of the Santo Antônio River Basin. The angularity of the sediments represented by the samples SA, SA1, SA3, SA9, SA10, SA13, SA14 and SA15, indicate that the roundness of the samples is mainly composed of very angular to subangular sediments.

The grains of the SA sample correspond in greater proportion to sediments with very angular roundness. Sample SA1, due to the short path performed and its compositions results in a low sphericity, in most of the analyzed sediments of this sample, it is consistent with angular type rounding material.

Samples SA3 and SA9 were categorized with angular rounding, whereas sample SA10 points to a greater amount of sediments with very angular curvature. Samples SA13, SA14 and SA15 are classified as angular and very angular, respectively. (Suguio et al, 1974) stated that for reasons of chemical compounds, quartzes inherit the roundness from previous cycles of sedimentation.

Highlighting another very important factor, the composition of the sediment, for example, sedimentary rocks or schist rocks such as quartzite are more likely to produce more tabular fragments compared to homogeneous rocks which tend to generate spherical sediments. (SUGUIO, 1980).

Due to the short course carried out and its chemical compositions, the sphericity in most of the sediments analyzed from the samples SA, SA1, SA3, SA9, SA10, SA13, SA14 and SA15 are from low to medium sphericity and 4 (four) samples with high sphericity . There are grains with high sphericity measuring 0.600mm and grains with medium sphericity measuring 1.70mm.

The source material of the SA samples; SA1; SA3; SA9; SA10; SA13; SA14; The vast majority of SA15 are of geological origin such as quartz, as the lithology of the point collected in front of the Serra da Canastra relief is micaceous quartzite, in the background, the rocks of the laterite, mica, lateritic conglomerate, and others that are the unidentified rocks.

CONCLUSION

The research area is located between latitude 20°12'9.60"S and longitude 46°32'28.87"W, the Santo Antônio River Watershed is located in the upper course of the São Francisco River, comprising 15 main channels counting the secondary and tertiary channels which are responsible for the water dynamics of the site.

The composition of the rocks present in the research area derives from shelf or marine sedimentation such as fluvial deposits from a remote period estimated at 1,040 Ma. The morphostructural units of the São Francisco Craton have rocks from the Neoproterozoic period, predominantly siltstone and sandstone, shales and carbonate lenses.

The morphoscopic analysis performed on the 7,650 grains with a precision portable digital, monocular magnifying glass, 1000x magnification with a 2.0 megapixel camera, from the analyzes carried out with the sieving granulometry method, the results point to a greater number of sediments with low sphericity, rounding of the very angular to angular type, with a predominance of material with a geological aspect such as quartz, laterite and mica.

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