MINERALOGICAL AND TEXTURAL CHARACTERISTICS OF THE RAW MATERIAL USED IN DRY MILLING IN THE CERAMIC POLE OF SANTA GERTRUDES-BRAZIL

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The Santa Gertrudes ceramic pole, located in the interior of the State of São Paulo, Southeast Brazil, has 43 ceramic floor and wall tiles companies, making up the largest production complex of the branch in the Americas. Most of the companies work with the dry milling process, using hammer and pendulum mills, and just two use the wet production process.

All the raw material used in the preparation of the base mass by dry milling is extracted within a 20 kilometre radius of the seat of the pole, and all come from the Corumbataí Formation, a stratigraphic unit of the Permian age of the Paraná Basin, consisting of layers of clayey silts, argillites, ritmites and siltites, with subordinated interleaving of limestones, marls, bone bed and diatomites. The rocks of finer granulations exhibit colours varying from red to chestnut purple, while the levels and layers of siltites (sometimes sandy) and limestones exhibit a lighter coloration, frequently of a cream colour. Completing the petrographic picture are the more rarely appearing venous forms or venules of quartz and/or carbonates and nodules of iron oxides and phosphates.

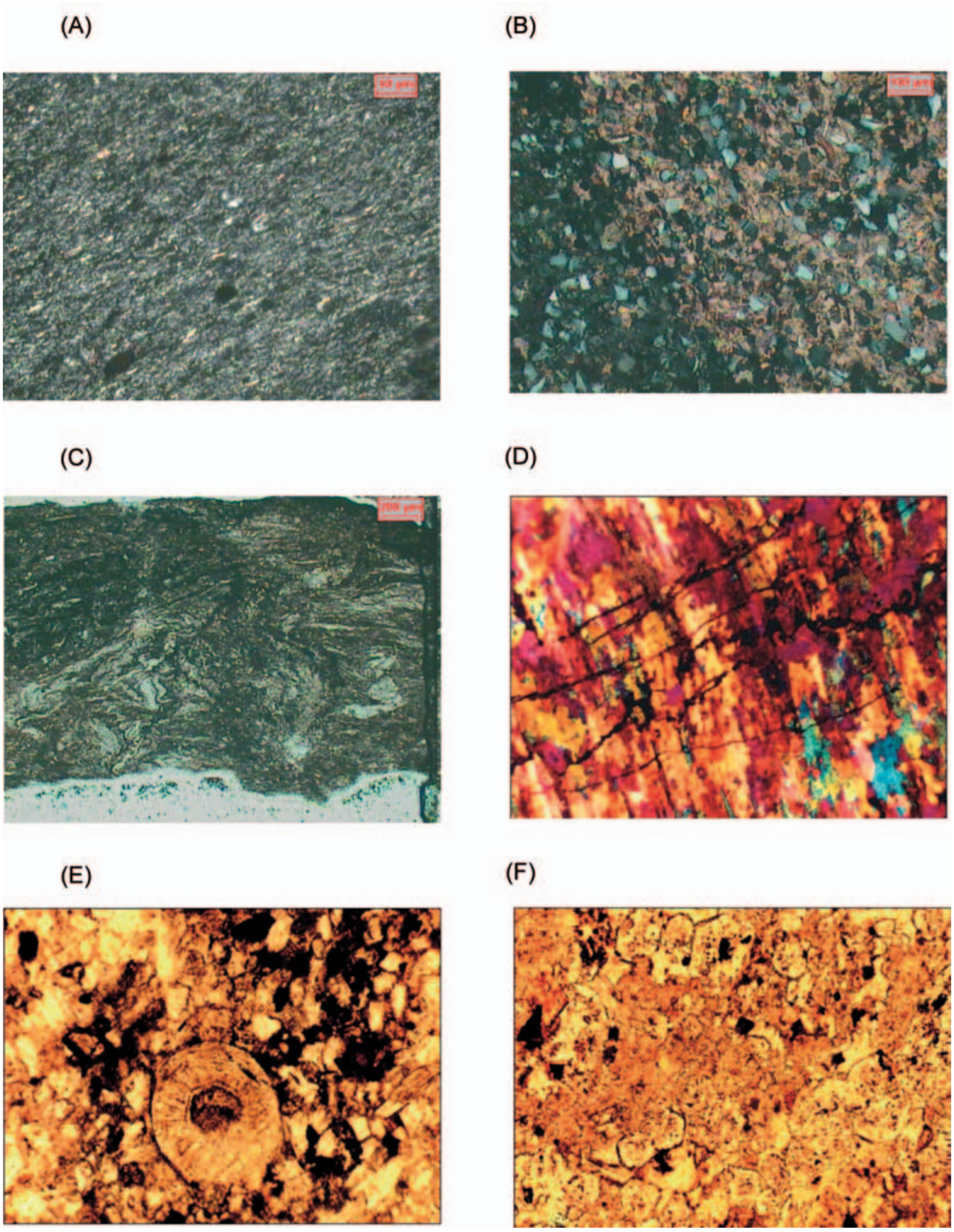

Image 1. Micrographs of sheets of the Corumbataí Formation, showing, in decreasing order of occurrence, the mineralogical composition: (a) Illitic matrix; (b) Arcabuz consisting of quartz and feldspars with carbonate cement; (c) Neo-formed feldspar occurrence; (d) Quartz vein; (e) Fossil fragment; (f) Analcime.

The data and considerations are based on field and laboratory work. The field work includes analysis of mine working fronts and deposits scattered though the region, with the collection of representative samples of the different extraction constituents from the Corumbataí Formation, in order to obtain laboratory data. The laboratory work has consisted of: microscopy analyses to estimate the particle size distribution, texture, mineralogy and the occurrence of the components; X-ray diffraction of the total sample and of the silty fraction in its natural form, treated with ethylene glycol and fired at 500°C; Chemical analysis of the main elements by X-ray fluorescence.

The sedimentary rocks comprise illites, quartz (detritic and native), alkaline feldspars (native and detritic), hematite, carbonates (calcite and dolomite), chlorites, interbedded phyllosilicates, montmorillonites, fossil remains, biotite, muscovite, iron hydroxides, analcime and kaolinite, this last mineral restricted to the material altered under strong leaching conditions, an appearance that is observed in few mines. The mineralogical distribution is quite heterogeneous, showing abrupt variations in the vertical arrangement, marking the lamination and millimetric to decametric banding laterally in quite a subtle way. Microscope and X-ray diffraction analysis evidence variations in the composition of the illite, which shows good crystallinity [2] displaying mean lengths greater than 10 μm. The detritic quartz normally displays dimensions smaller than 120 μm totalling less than 25% of the volume, also in the sandiest extracts. The terrigenous feldspar clasts (microcline and orthoclase) are always present in a smaller or equivalent proportion to that of detritic quartz. The native minerals are represented mainly by albite, as a cement and become the dominant phase in some beds. Carbonates occur as cement, beds and venules; hematite occurs in the form of very small dispersed crystals, forming small concentrations in form of powder and as fillets; the interbedded chlorites are found intergrown with illite and the minerals of the montmorillonite group are native of the supergenic alteration, and are concentrated in the upper portions of the diggings [3].

Mineral	Sample					
	1	2	3	4	5	6
Illite	xx	xx	xx	xx	xx	xx
Montmorillonite	--	x	x	x	x	x
Chlorite	x	xx	--	--	--	--
Quartz	xx	xx	xx	xx	xx	xx
Albite	x	x	x	x	x	xx
Hematite	x	x	x	x	x	x
Calcite	--	--	--	--	--	x

-- = absent; x = present; xx = relatively high content.

Table 1. Minerals found by X-ray diffraction analysis in some samples of argillites of the Formation.

X-ray diffraction only detects the minerals whose content is, generally, greater than 5%, which is why minerals like analcime and ironstone were only observed by optical microscopy; however, due to its fine particle size, for study the clay minerals this tool is fundamental.

Sample	LOI	SiO_2	Al_2O_3	Fe_2O_3	TiO_2	MnO	CaO	MgO	Na_2O	K_2O	P_2O_5
1	2,69	68,18	14,20	5,31	0,61	0,06	0,72	1,88	2,66	3,59	0,20
2	3,04	67,47	14,40	5,04	0,65	0,10	1,15	1,90	2,69	3,33	0,24
3	2,27	69,28	13,97	5,45	0,54	0,02	0,45	1,64	3,11	3,22	0,11
4	2.90	67.86	14.39	5.21	0.63	0.03	0.62	1.97	2.63	3.55	0.19
5	3,58	68,18	14,08	4,81	0,65	0,03	0,64	1,88	2,29	3,71	0,20
6	9,50	60,05	10,82	3,01	0,39	0,09	8,81	2,66	2,52	2,00	0,17

Table 2. Major chemical elements, expressed as an oxide percentage, of the same samples analysed by X-ray fluorescence spectrometry.

The average chemical composition of the raw materials of the Corumbataí Formation is of the order of: SiO_2 (64-67%), Al_2O_3 (13-17%), Fe_2O_3 (4,5-6%), Na_2O (1-2%); K_2O (1,5-2,5%), CaO (0,5-2%), MgO (1,5-2,5%), P_2O_5 (0,1-0,2%), TiO_2 (0,5-0,8%), MnO (0,1-0,2%) e PPC (4-6%) [1].

These mineralogical, textural and chemical characteristics make it possible to obtain ceramic tiles of excellent quality by dry milling and fast firing cycles (25 to 30 minutes).

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