Rede Guarani Serra Geral SC

EVIDENCE OF LINK BETWEEN CANOAS RIVER, GUARANI AQUIFER AND SOURCES OF POLLUTION (1)

Meta 2 Componente 2 - Carlos Henrique L emos Soares; Ivana E. Baptista

The Botucatu Formation is a Cretaceous continental red bed that occurs in the Parana Basin, central South America, covering the south and central regions of Brazil, the east of Paraguay and the northeast of Argentina. These sedimentary rocks were deposited in an eolian environment where crescentic and complex linear sand dune morphologies were predominant. These sediments were covered by the huge extrusion of basaltic lavas of the Serra Geral Formation, which helped to preserve this vast dune field all over the Paraná Basin. Of the total area of the Guarani Aquifer (1,195,500 km^2), approximately 12.8% is represented by the zones of outcrop, i.e. 153,000 km^2, with 67.8% (104,000 km^2) located in Brazil, 30.1% in Paraguay and 2.1% in Uruguay (ANA, 2001). Throughout the rest of its range, i.e. about 1,000,000 km^2, the aquifer overlies the volcanic rocks of the Serra Geral Formation.

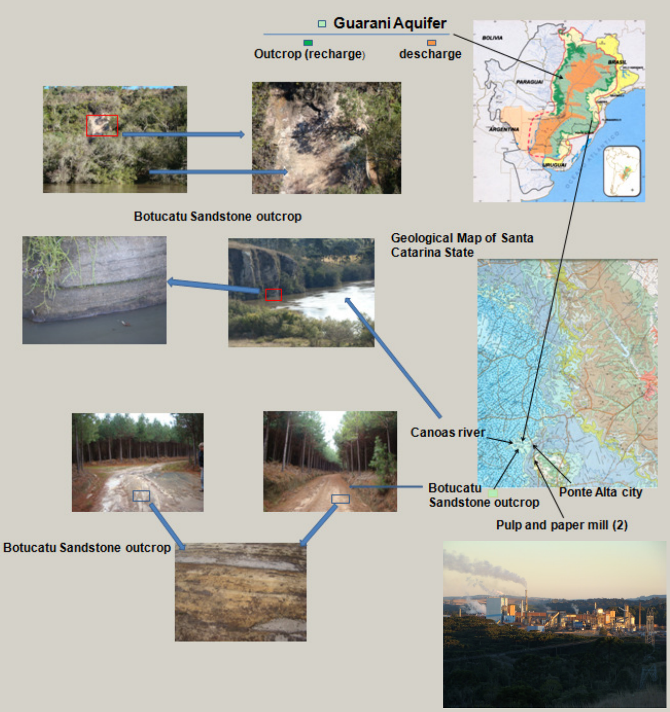
The Botucatu sandstone outcrops in a slim stripe along the margins of the volcanic rocks, locally modified by the the alkaline volcanism of the Cretaceous age that formed the Lages Dome.

The Guarani Aquifer, which consists of porous eolian sandstones, is more vulnerable to contamination in its area of outcrop, that consistes of the major direct recharge zone of the aquifer.

In the Canoas river basin, possible changes in the degree of surface and groundwater pollution of the Guarani Aquifer have been regularly monitored by analysis of the physicochemical and biological parameters, especially in the critical areas outlined in the vulnerability study. The main tool used for this assessment of water quality is the measurement of chronic toxicity using biomarkers. Our studies have demonstrated a **high degree of pollution** caused by discharge of effluents from pulp and paper mills in the Canoas river.

The figures below show the area of occurrence of this system throughout the western region of Santa Catarina, highlighting the range of the Guarani Aquifer outcrop, where it is most vulnerable to contamination. In Ponte Alta and Correa Pinto the Canoas riverbed overlaps areas of outcrop of the Guarani Aquifer.

For this whole area the waters of the Guarani Aquifer represent a reserve of strategic importance due to its use in public supply, for the watering of livestock, industry, agriculture, and tourism as a result of its geothermal features.



Previous studies have shown that the River Canoas in this area shows altered physicochemical characteristics, particularly with respect to total phenols concentration (0.3 ppm), sulfides (1.4 ppm) and nitrate (0.5 ppm). Toxic effects were found in algae, daphnia and fish as follows:

Algae: reduction of algal growth, reduced efficiency of photosynthesis, reduction of chlorophyll and carotenoids concentrations.

Daphnia: No acute toxicity was found. Reduced production of offspring in 21-day tests. Morphological changes.

Fish: Changes in plasma enzymes indicating cell damage in liver, gonads and gills. Histopathological changes in liver and gills. Plasma concentration of glucose and altered Cholesterol.

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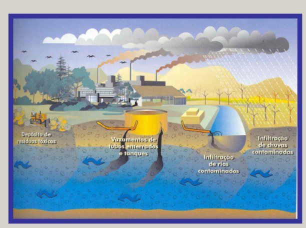
SOURCES OF POLLUTION



Canoas river X Pine reforestation

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EVIDENCE OF LINK BETWEEN CANOAS RIVER, GUARANI AQUIFER AND SOURCES OF POLLUTION (2)

Meta 2 Componente 2 - Carlos Henrique Lemos Soares; Ivana E. Baptista

Figure 1 – Skyscan 1072 μ-CT system used to study the sandstone samples. The equipment is simple to operate and the resolution depends on sample size and composition. PETROBRÁS Research and Development Center (CENPES), Rio de Janeiro, RJ, Brazil.

Acquisition of μ-CT Images

The μ-CT images were obtained in a Skyscan 1072 μ-CT scanner (Fig. 1) with an air cooled sealed microfocus X-ray tube, using a tungsten anode and operated at 60kV and 165μA (spot size <5μm). This sample was analyzed using a 1mm Al filter and an 8-bit CCD camera (1K x 1K resolution) with on-chip integration mode and lenses coupled to a scintillator (28 to 65 mm field of view). The equipment detectability varies from 2 to 5 μm depending on sample size and composition (contrast resolution). Total rotation angle of the sample was 180.0o, with rotation step size angle of 0.45o. The images were generated using a cone-beam (Feldkamp) reconstruction algorithm.

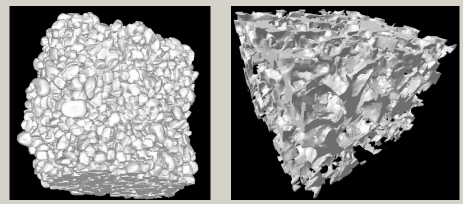

Figure 2 – Left: 3-D μ-CT image showing part of the sample grains in light gray. Right: a cubic section of the same μ-CT volume showing the pore space in light gray. The pixel resolution in both images is 3.8 μm. Average grain size fraction is fine to medium sand.

The measurement in groups of 50 slices, representative of about 190 μm, allowed tracing a porosity profile for the sample. The porosity values range from 28.7 to 33.6% were found and the global average porosity was 30.2% while the experimental porosity measured by the gas expansion method (Boyles Law) was 30.0%.

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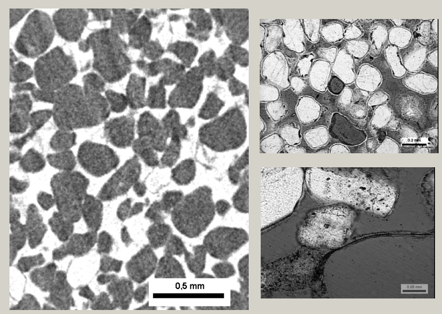


Figure 3 – Left: μ-CT cross section of the Botucatu sandstone showing grains (G-dark gray), moldic pores (M) delineated by micro quartz cement (lighter gray) and pores (Pwhite).Top right: petrographic thin section of the same sample (solid in light gray) showing the ubiquitous occurrence of fringing micro quartz cement moldic pores (arrows) and enhanced (secondary) pores (dark gray due to low density resin impregnation). Bottom right: detail of the micro quartz cement that fringes grains and delineate moldic pores (arrows). Note that all images present the same quality of porous media characterization.

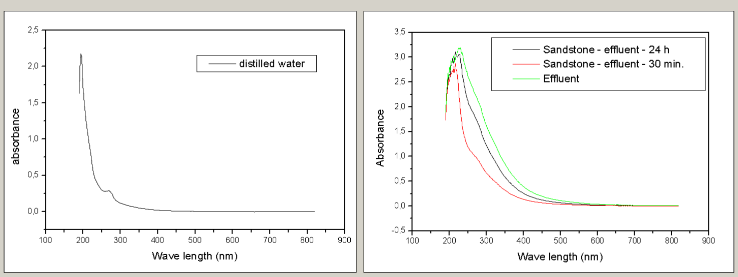
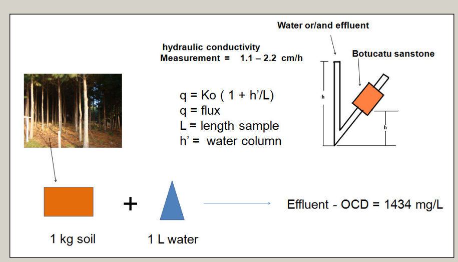


Figure 4. UV – Visible spectral characteristics of water passed across Botucatu sandstone
Left – distilled water right – diluted pulp and paper mill effluent.
Sandstone does not retain the effluent compounds.



The thickness of the aquifer is quite variable. Thicknesses exceeding 600 m have been reported, however, mean thicknesses from 100 to 200 m are most common in this area.

There are tectonic structures that are able to partition the aquifer into large blocks with different geological, hydraulic, hydrochemical and hydrodynamic features.

Table 1. Physicochemical parameters of water samples of Guarani Aquifer

Sample	Conductivity (mS/cm)	Chloride (mg/L)	Bicarbonate (mg/L)	total nitrogen (mg/L)	dissolved organic carbon	Fluoride (mg/L)	Magnesium (mg/L)	Nitrate (mg/L)	Sodium (mg/L)	Potassium (mg/L)
Guarani	0.125	1.2	48	0.15	1.31	0.1	1.6	0.2	2.8	2.59