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Groundwater favorability map using GIS multicriteria data analysis on crystalline terrain, São Paulo State, Brazil

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Summary This paper presents the groundwater favorability mapping on a fractured terrain in the eastern portion of São Paulo State, Brazil. Remote sensing, airborne geophysical data, photogeologic interpretation, geologic and geomorphologic maps and geographic information system (GIS) techniques have been used. The results of cross-tabulation between these maps and well yield data allowed groundwater prospective parameters in a fractured-bedrock aquifer. These prospective parameters are the base for the favorability analysis whose principle is based on the knowledge-driven method.

The multicriteria analysis (weighted linear combination) was carried out to give a groundwater favorability map, because the prospective parameters have different weights of importance and different classes of each parameter. The groundwater favorability map was tested by cross-tabulation with new well yield data and spring occurrence. The wells with the highest values of productivity, as well as all the springs occurrence are situated in the excellent and good favorability mapped areas. It shows good coherence between the prospective parameters and the well yield and the importance of GIS techniques for definition of target areas for detail study and wells location.

Introduction

The geoprocessing techniques to evaluate the favorability to mineral and petroleum occurrence have been applied with success in the last few or two decades (Bonham-Carter, 1994; Rostirolla et al., 1998; Raines, 1999; Harris et al., 2001; Araújo and Macedo, 2002). However, few researches

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apply the favorability analysis techniques to groundwater study (Langevin et al., 1991; Sander, 1997; Moore et al., 2002).

The first step to mineral favorability analysis is the mineralization model definition (Bonham-Carter, 1994; Rostirolla et al., 1998). Based on the inherent complexity of the fractured aquifer, a hydrogeologic prospective model has to be made, based on a conceptual model and elaborated by using geoprocessing of hydrogeologic variables.

Based on the hydrogeologic prospective model the groundwater favorability map was carried out using multicriteria data analysis (knowledge-driven). This methodology considers the opinions of experts for quantification of the hydrogeologic prospective parameters (geologic and geomorphologic variables).

Study area

Geological setting

The area is located in the eastern part of Sao Paulo State, Brazil. It is in a region named ''Water Circuit of Sao Paulo State'' due to the existence of many mineral springs. The area has approximately 2000 km^2 comprising Lindoia, Aguas de Lindoia, Serra Negra, Socorro and Itapira cities.

The main lithological units of the study area are of Paleo to Neoproterozoic age and comprises high-grade metamorphic infracrustal sequences (banded migmatites, granulites and tonalitic-trondhjemitic-granite orthogneisses), supracrustal sequences (paragneisses and anphibolites) and igneous intrusions. These rocks are associated with NE—SW trending, ductile low-angle shear zones (Ibitinga shear zone) and ductile-brittle strike-slip shear zones (dextral strike-slip Monte Sião and Jacutinga shear zones). Brittle structures such as normal and strike-slip faults and joint zones, which overprint the Precambrian structures, record the extensional tectonics that occurred during the Mesozoic and Tertiary period (Fig. 1).

Hydrogeological setting

The fractured crystalline aquifer develops on discontinuities generated by rock fracturing. In the study area, the climate is subtropical wet, C_{wf} (Köppen classification) and the average annual rainfall is 1400 mm. The relief is moderate to high with elevations ranging from 700 to 1100 m and a thick weathering cover varying from 10 to 70 m.

The depth of productive zones extend to approximately 165 m (DAEE, 1981). Fig. 2 presents the groundwater potential based on well data.

The results of isotopic data analysis (Yoshinaga, 1990) denote that the water of the springs is a mixture of superficial water and groundwater.

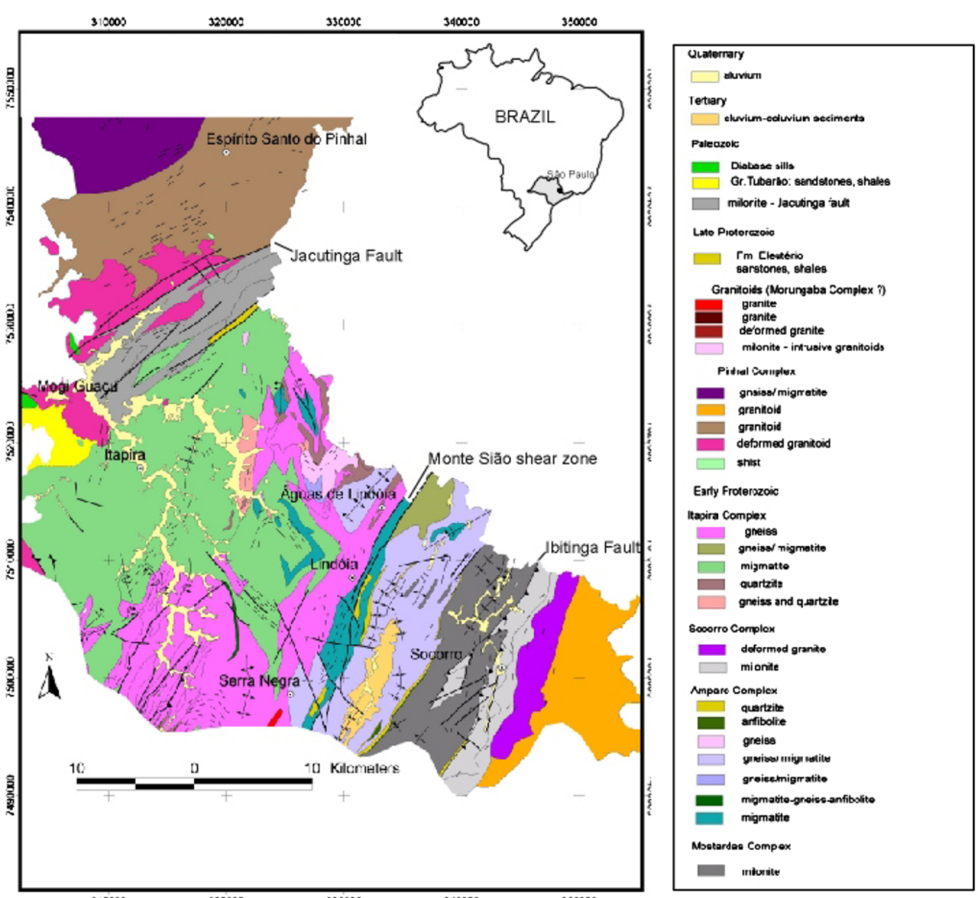

Figure 1 Location of study area and geological map.