BOOLEAN, INDEX AND FUZZY METHODS APPLIED TO SPATIAL METALLOGENIC ANALYSIS: CERRO AZUL AND APIAÍ QUADRANGLES (SB.22-X-B-IV/V)

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Metallogenic analysis is a crucial step in establishing the future use of of land, for mining, agriculture or environmental conservation. It was applied to an area of 1° by 30', comprising occupied and forested areas of the Ribeira River Valley, at the border of Paraná and São Paulo States, Brazil. Geologic data, separated in lithologic, stratigraphic and age maps, geochemical and topographic maps were digitized from DNPM/CPRM, Pró-Minério/IPT and IBGE reports, rasterized and combined with digital geochemical files from CPRM and Mineropar. The maps were preprocessed to make lithologic, stratigraphic, structural and geochemical factor maps.

These maps were analyzed using a knowledge-based approach. In this part of the research, the logic of analysis was of the multi-criteria, single-objective type[1], aiming at areas favorable to mineralization, combining factors of mineralization. In a subsequent part of the project these areas will be analized according to constraints associated to environmental impacts of mining and environmental values that preclude mining, such as old-growth forests.

Two mineral deposit models were used:

- **exhalative massive sulphides** (Perau type): factors: favorable lithologies: calc-schists, limestones, proximity to micaschists and amphibolites; favorable stratigraphic units: Perau formation; geochemical factor: Pb, Cu, Zn anomalies.

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- **polymetallic veins** (Rocha type): factors: favorable lithologies: marbles, limestones, calc-schists; proximity to granites; estructural factor: proximity to lineaments; favorable stratigraphic units: Lajeado subgroup; geochemical factor: Pb, Cu and Zn anomalies.

Proximity maps were made with 1000 m buffers around favorable geological features.

Unique condition maps were made by three methods[2]: **boolean** method, assigning a value of one to an area with a favorable condition, zero to the absence of the condition; **index** method, assigning scores of favorability, fixed by experts; **fuzzy** method, with favorability expressed by fuzzy set membership values, calculated from indexes attributed by experts. The maps were combined using operators adequate to an absence of constraints (boolean **or**, summative indexes, fuzzy **or** and fuzzy sum).

The results were checked against the number of known mineral deposits located in areas recognized as highly favorable by each method. The three methods resulted in similar numbers of deposits by surface area recognized as favorable to mineralization. The boolean method resulted in the smaller area, the index method produced the larger one; the fuzzy method gave different areas, according to the operators used to combine the unique condition maps.

References:

1 - EASTMAN, J.R., JIN, W., KYEM, P.A.K. & TOLEDANO, J., 1995 - *Raster procedures for Multi-Criteria/Multi-Objective Decisions*. **Photogrammetric Engineering & Remote Sensing**, 61(5):539-547.

2 - BONHAM-CARTER, G.F., 1994 - **Geographic Information Systems for Geoscientists: Modelling with GIS**. Ottawa, Pergamon, 398 p.