Possible use of Si-Phytoliths in metal anomaly prospection. Example from Riacho dos Machado region, Cerrado, Minas Gerais, Brazil.

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POSSIBLE USE OF Si-PHYTOLITHS IN METAL ANOMALY PROSPECTION. EXAMPLE FROM RIACHO DOS MACHADO REGION, CERRADO, MINAS GERAIS, BRAZIL.

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Abstract: This work investigates the distribution of selected heavy elements in soil samples and Si-Phytoliths from plants. The aim is to verify if metal contents are indicative for metal anomalies in the soil. Samples were collected in profiles near the Riacho dos Machados Goldmine. Granitic-gneissic rocks, in tectonized contact with the overlaying rocks, form the basis of the investigated region, which belongs to the Rio dos Machados Group of the Espinhaço Super Group. The whole rock substrate is covered by lateritic to arenitic soils with different exposure depths. Metal-rich fluid invaded this unit, forming metal anomalies, forming Zn-Pb-Au deposits, like that of Salobre-Porteirinha. After appropriate preparation, the samples were analyzed by ICP-OES (Si-Phytoliths) and XRF (soil). Anomalies in the investigated profile are indicated by high metal contents in the Si-Phytoliths of the selected species. Using different species, the metal concentration at different depths can be determined.

Key words: Si-Phytoliths; prospection; metals; Cerrado; plants

1. Introduction

Prospecting new mineral occurrences is a very expensive and extensive process. Many direct and indirect methods are in use. We will show here a new possibility of biological prospection using native plants to obtain information about metal concentration in subsoil by surface - soil evaluation of metal leaching during weathering. The transport and the enrichment processes in plants s.l. is described by a lot of authors such as Raven (1993), Turnau (2007) and Wuana and Okieimen (2011).

1.1. Basic data

Plants use the ions concentrated in soil to obtain their nutrients. In this process, all ions present are brought into the plant, heavy metals included. The excess of this elements, which are dangerous for the organism, is refused by the plant, which fixes them in Phytoliths of opal or oxalate composition. These fixed elements are trapped and permanently retained from the bio circuit.

These concentrations remain nearly uninfluenced by the changes of the external factors, like climatic changes, rainfall etc., in opposite compartment to the organic parts of plants that show changes in their metabolism (Fig. 1).

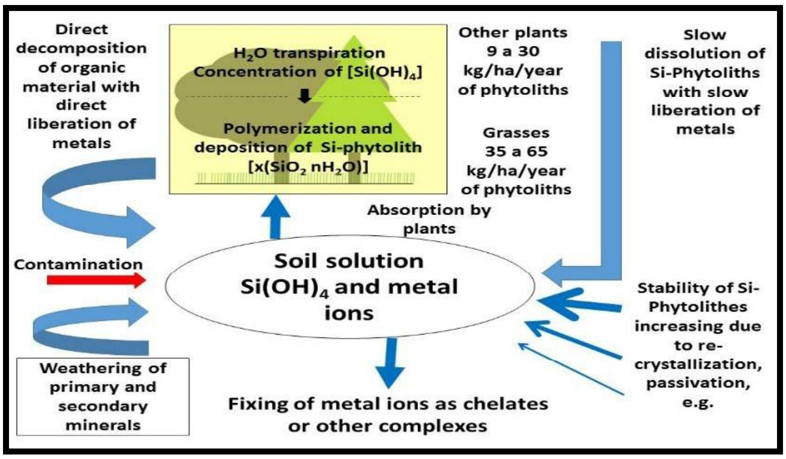

Fig. 1. Schematic flux diagram for Si-Phytoliths formation and process of trapping and stabilization of the metal ions. This organogram is the compilation of own results and data from literature (e.g., Iler et al., 1997; Wüst and Bustin, 2003; Fernandes-Horn et al., 2016).

1.2. Studied area

The studied area is located southwest of Riacho dos Machados and northeast of the mining plant of Ouro Fino Mine. The area is limited by the coordinates UTM 702600E-702300E and 8230750N-8230350N. The access to the area is made from Montes Claros, by the highway BR-251 (68km), then by the State Highway MG-120 (37 km away), covering a distance of 105 km in total to the city of Riacho dos Machados. From that point, secondary roads make access to the Tião Amaral Ranch (Figs. 2, 3).

The map and stratigraphic profile (Crocco et al., 2000) show the geological setting of the region (Fig. 2). Within the target region, anomalies of three elements were selected (Cu, Zn, and Pb) to test the methodology. Sampling was done over a region of about 0.5 km^2. Eighteen soil samples were collected as well as 58 plant samples, three of each species, at each point. Figure 3 shows the sampling area and the distribution of nine batches of samples over the isoline map of Riacho dos Machados Gold Mining group.

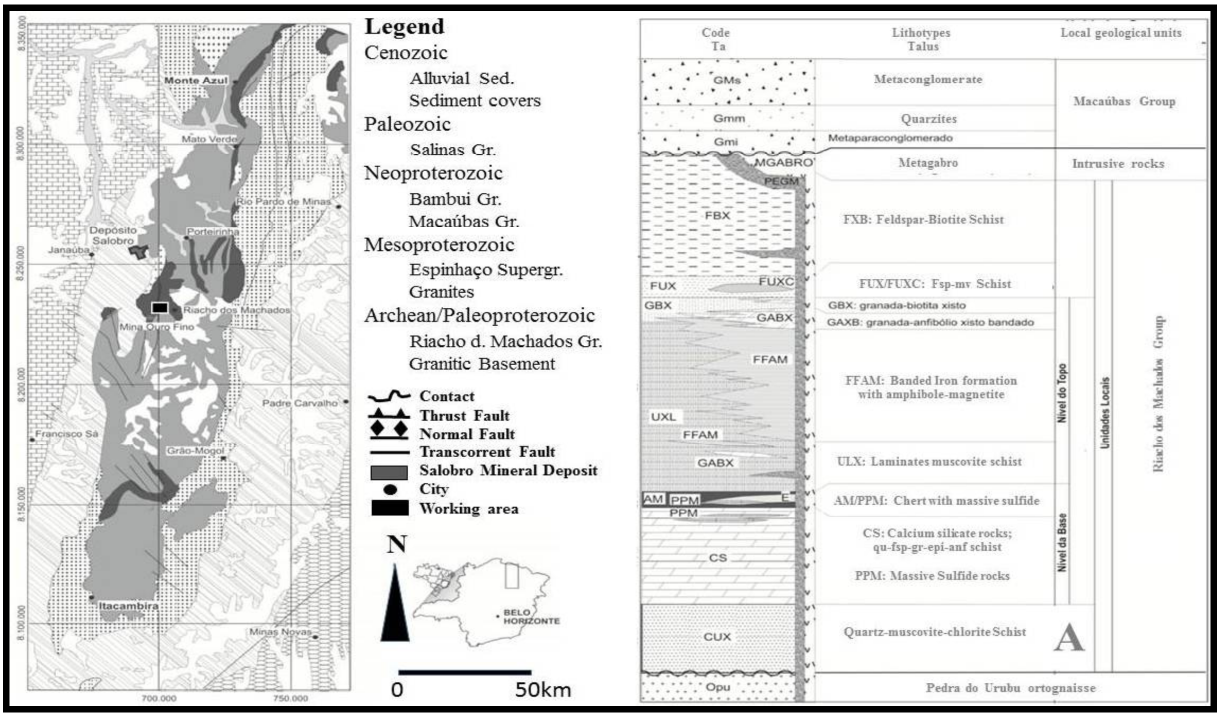

Fig. 2. Geological setting of the investigated area. The small black quadrangle indicates the investigated region and A in the column shows the stratigraphic position of the profiles (from Crocco et al., 2006).

2. Materials and methods

2.1. Sampling

Plants and soil samples were collected following two profiles oriented W-E (1 to 4) and NW-SE (5 to 9); they cross all known anomalies. The surfaces were cleaned of vegetation and every soil sample, 1 to 2 kg weight each, was taken from a depth of 3-10 cm. Five to ten plants of every different species (*Annona leptoptella; Piptadenia gonoacantha; Sida sp*) were collected close to the soil sample locations.

2.2. Sample preparation

The Si-Phytoliths from plants were separated using the method described by Parr et al. (2001), then dissolved within HF/HNO_3, retaken by 10% HNO_3, filtered and stored in a freezer at low temperature. After drying, crushing and sieving to <0,634 mesh, the soil samples were preserved at low temperature.

2.3. Analytical procedures

The solutions were analyzed by an ICP-OES spectrometer, type SPECTRA, using internal and international reference standards. The analyses were executed at the NGqA-IGC-UFMG.

The soil samples were submitted to XRF-analyses, using a Shimatzu spectrometer, at the Laboratory of LIPEMVALE-Federal University of Jequitinhonha and Mucuri Valleys (UFVJM).

2.4. Data treatment

The analytical data were submitted to a statistical evaluation, in order to homogenize group data, obtain usable mean values, to detect, and to separate the incorrect data from the set. The analytical soil and Phytoliths data were compared to the anomaly element data obtained from Carpathian Gold Inc.

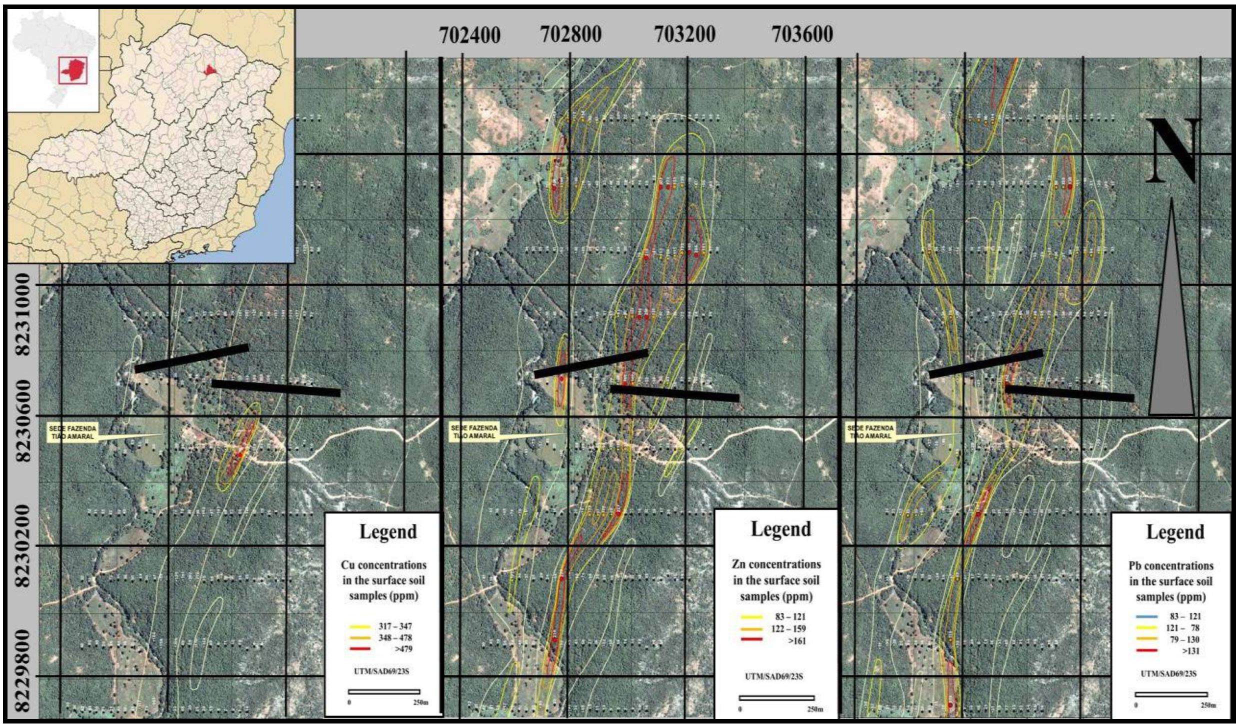

Fig. 3. Situation on the investigated site. Maps showing Pb, Cu and Zn distribution of the soils, provided by the Mining Corporation. The samples were taken on two E-W profiles (black lines; unified), cutting the metal-enriched zones (originals from Carpathian Gold Inc.; modified).

3. Results

The study consists in an integrated approach, which used field GPS information, analytical data of plants and soil samples and isoline-information from Riacho dos Machados Gold Mine (former: Ouro Fino Mine). The plants accumulate metals in different concentration, in their biominerals. For this purpose is used mean values of whole plant Si-Phytoliths concentrations, which are very close to the high contents found only in the leaves. The analytical data on soils show a good correlation with the isoline data of maps. Beside the three main elements (Pb, Zn, Cu), other ones were also evaluated (Mg, Al, Ca, Cr, Fe, Co, Cd, Ti, Mn, Ni, and Ba). Figure 4 shows the correlation between the different concentrations for the

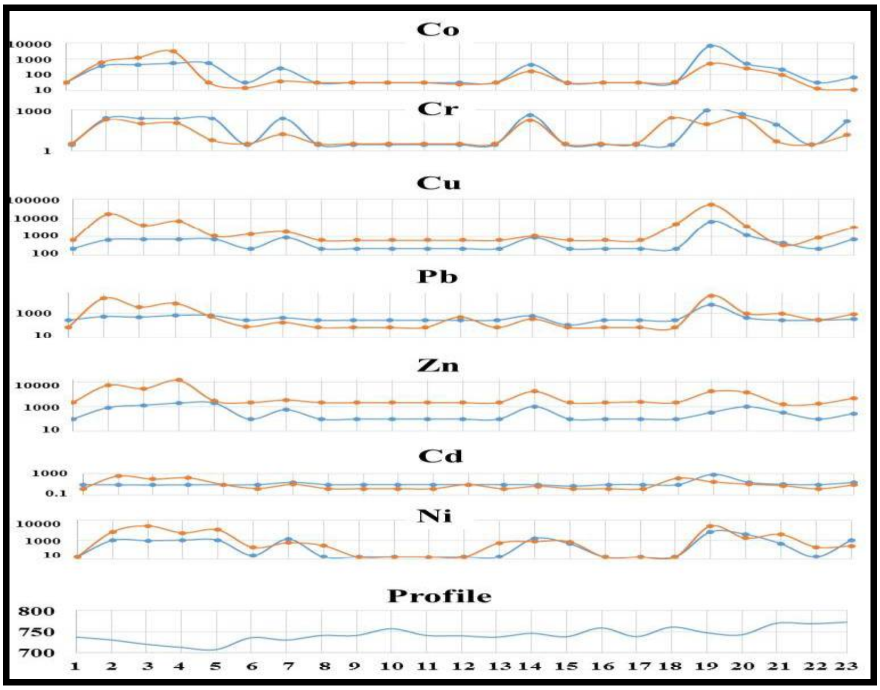

Fig. 4. Selected element concentration (ppm) in soils and Si-Phytoliths from plants along an E-W oriented profile (blue: soil samples; brown: Si-Photoliths data). The lowest profile shows the altitudes of sampling points (m). The numbers are the profile sampling points.

selected elements. Elements concentration in Si-Phytoliths from plants shows a slightly more complex behavior than that of soil samples, while a correlation between the two data sets were also found. The changes of natural factors like rainfall, insolation, and temperature changes influence the Si-Phytoliths less than the whole plant biomass.

4. Discussion and conclusions

The dense distribution of the selected plants and their high Si-Phytoliths production allow their use in the Cerrado/Caatinga region of whole Brazil.

This first investigation may stimulate the search for other plants of other biotopes for the same purpose. The information are more exact than the soil sampling method due to the peculiarities of soil evolution and transforming process.

The variation of natural factors like rainfall, insolation, and temperature changes influences less the Si-Phytoliths than the whole plant biomass.

Si-Phytoliths show metal enrichment correlated with soil metal concentration.

The plants can assimilate metals at various concentrations, due to their physiology, the physical-chemical conditions of and the form of the metal compounds.

The Si-Phytoliths, due to their inorganic nature, are less sensitive to extreme weather changes, like poor precipitations/lack of rain, insolation or temperature changes.

5. Acknowledgements

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