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# Near-mine exploration via soil geochemistry multivariate analysis at the Almas gold province, central Brazil: a study case

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## Abstract

Common multivariate methods such as factor analysis, hierarchical cluster analysis and k-means cluster analysis were employed to analyze a high-dimensional geochemical dataset. The dataset is composed of 2,908 ICP-MS multi-element analysis of soil samples. The aim is to identify potential near-mine prospects in a gold mineralized area where outcropping ore is no longer available and tropical soils cover the area. In order to accomplish that aim, the study targets on identifying anomalies of elements indicative of distal alteration (propylitic alteration), since the encapsulated nature of the mineralization makes distal alteration an indicative of ore at depth (phyllic alteration). The main methodological objective is to demonstrate the importance of adapting the methods to the specific geological reality, especially when working on near-mine environments, by adopting a method of local spatial validation of multivariate analysis results. An objective approach was adopted. By objective approach we mean that objects (geological data) from a well-known mining area (control area) were used to validate the analysis results and ensure their quality. The control area is surrounded by unexplored terrain, which is the exploration target of this study. This unexplored terrain was covered by a soil grid comprising an area of 88 $km^2$. By the proposed approach, final factor analysis results were able to provide 5 correlation factors explaining 71.2% of the total variance of soil composition. These factors identified distinct elemental associations with high correlations, influenced by the parental materials: ultramafic, mafic, pegmatitic, distal and proximal hydrothermal alteration. Hydrothermal alteration occurs mainly on tonalitic parent material, since the mafic/ultramafic and pegmatitic emplacement were late or posterior events. Hierarchical cluster analysis was able