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Research article

Separation of geochemical anomalies related to hydrothermal copper mineralization using staged factor analysis in Feizabad geological map

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Keywords

Staged factor analysis
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English Extended Abstract

Summary

Stream sediment geochemistry is one of the widely used methods for mineral exploration in the preliminary exploration stages. The accurate processing of the stream sediment geochemical data is of critical undertaking. That is due to the possibility of missing some exploration targets in cases where proper interpretation techniques are not applied. In this research, to more accurately separate the geochemical anomalies of hydrothermal-related copper mineralization, e.g., copper-gold porphyry, vein, and IOCG types in the northern part of 1:100000 Feizabad sheet, the staged factor analysis method was used. In this method, in addition to eliminating possible interfering elements in calculations, the elements unrelated to the hydrothermal copper mineralization type were also excluded to obtain non-interfering factors or so-called clean factors. The obtained results showed that factors 1 and 2 in the fourth stage of staged factor analysis can be significant factors for the exploration of copper deposits in this region. To validate the results, by using the area-prediction diagram, the staged factor analysis results were compared with the conventional factor analysis method. The comparison of the two methods showed that the staged factor analysis method in factor 1 in 22% of the area of the region reveals 78% of hydrothermal copper occurrences, while factor 1 of the conventional method, in 25% of the area, reveals 75% of the known copper occurrences. Therefore, in the staged factor analysis method, the anomalies with a smaller area and more reliability in predicting of mineral occurrences, have been detected.

Introduction

One of the effective methods for identifying mineral deposits and promising areas in the early stages of exploration is the geochemistry of stream sediments. Researchers have used many methods to identify promising areas. In this research, to separate the geochemical anomalies related to the types of copper mineralization with hydrothermal origin such as copper-gold porphyry, vein, and IOCG deposit, the staged factor analysis method was used.

Methodology and Approaches

staged factor analysis consists of two basic parts. In the first part, after performing a factor analysis step, if there are elements in the output that do not have high participation in any factor according to the threshold, those elements are removed from the data set. This continues until there are no more elements that have a low contribution to the factors. Because the effect of geochemical noise has been reduced in these factors, the output factors of this stage are called clean factors. As a result, these factors have good reliability. In the second part, according to the desired type of mineralization, the elements in factors that are not directly

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related to the deposit type are removed and the factor analysis is repeated. Similar to the previous section, if an element with low participation in the factors is observed, it is removed from the data set. In this research, 657 samples of stream sediments in the north of Feizabad have been used to conduct geochemical studies. To implement the method, first, the data distribution of collected stream sediment data was closer to the normal, then by performing staged factor analysis and considering the threshold limit of 0.5, clean factors were extracted.

Results and Conclusions

To verify the performance of staged factor analysis over the conventional factor analysis, the area-prediction diagrams were used for the prediction of 13 known copper occurrences with hydrothermal origin in the region as the definite anomaly area (Fig. 1 and 2). According to results, in the maps produced using staged factor analysis, 78% of copper occurrences were predicted in about 22% of the studied area in factor 2 of the fourth stage (Fig 1-A). Also, 60% of copper occurrences were detected in about 40% of the map in factor 1 of the fourth stage (Fig. 1-B). While, in the case of the maps produced using conventional factor analysis, 75% of copper occurrences were placed in an area of about 25% of the studied area, in factor 2 (Fig. 2-A), and 52% of copper occurrences were associated in 48% of the study area, in factor 1 (Fig. 2-B). Therefore, the evaluation of the generated maps shows that the staged factor analysis has a higher prediction rate than the conventional factor analysis method, and provides more reliable results because by removing geochemical noises and using multi-element geochemical effects, the detection of anomaly areas is done more accurately.

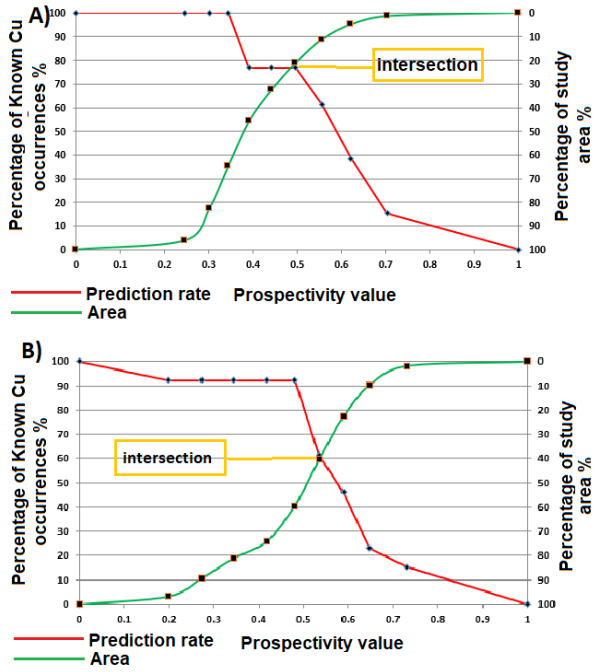

Fig. 1. Prediction -Area plot using the staged factor analysis method, a) Factor 2 of the fourth stage (Au and Cu) b) Factor 1 of the fourth stage (Sn, Mo, Sb, As, Zn, Pb)

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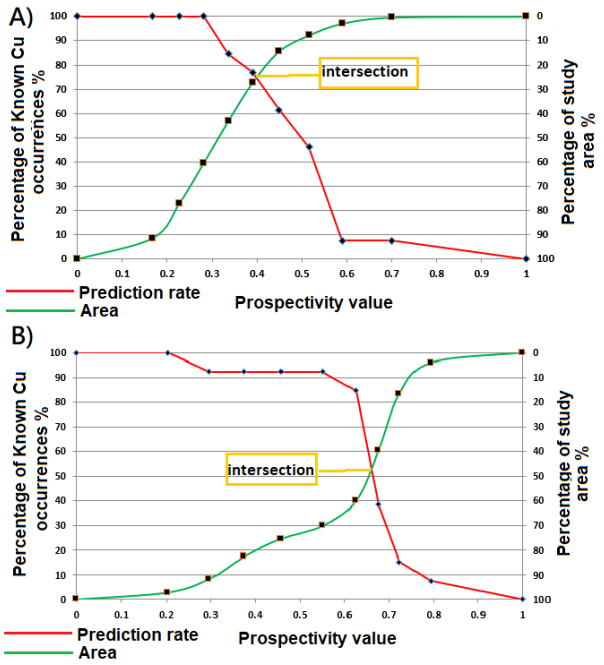

Fig. 2. Prediction -Area plot using the conventional factor analysis method a) factor 2 of the first stage (Zn, Ag, Au, and Cu) b) factor 1 of the first stage (Sn, Mo, Sb, As, Zn, Pb)

References

[1] Yousefi, M., Kamkar-Rouhani, A., & Carranza, E. J. M. (2014). Application of staged factor analysis and logistic function to create a fuzzy stream sediment geochemical evidence layer for mineral prospectivity mapping

[2] Yousefi, M., & Carranza, E. J. M. (2015). Prediction–area (P–A) plot and C–A fractal analysis to classify and evaluate evidential maps for mineral prospectivity modeling. Computers & Geosciences, 79, 69-81.

[3] Cox, D.R., Snell, E.J., (1989). Analysis of Binary Data, 2nd ed. Chapman and Hall,

[4] M. Daviran, R. Ghavami, A. Maghsoudi, and R. Ghezelbash, Identification of Hydrothermal alteration zones using ASTER data in northern parts of Doruneh fault within the Feizabad sheet. 2017 (In Persian).

[5] Yousefi, S.; Doulati Ardejani, F.; Ziaii, Karamoozian, M.; 2015; "The speciation of cobalt and nickel at mine waste dump using improved correlation analysis: a case study of Sarcheshmeh copper mine."Environment, development and sustainability, 17(5), pp.1065-1084.

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