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Research article

Identification of gold mineralization in the Qara Cher area using multi-element singularity mapping method

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English Extended Abstract

Summary

Singularity is the characteristic of various non-linear phenomena, such as hydrothermal processes in the Earth's crust, which produce deposits with high metal concentrations. The final result of these processes is the appearance of fractal or multi-fractal features, and several methods exist to identify these features. The singularity distribution mapping method is one of the multi-fractal analyses developed based on the singularity index and as a tool for separating anomalies from the background or for separating local anomalies in a region. In this study, the multi-variable singularity mapping method was used to determine geochemical anomalies to establish the relationship between various elements in the Qara Cher exploration area, located 42 km southwest of the city of Saqez in Kurdistan province. The database contains 1104 litho-geochemical samples with 10 analyzed elements, including Au, As, Ag, Cu, Sb, Sn, Bi, Mo, Zn, and Pb. Due to the compositional nature of the variables and subsequent false correlations in the closed system, principal components analysis (PCA) was applied to the data under isometric log ratio (ilr) transformation. The relationship between As and Cu on the first and second principal components shows the independent function of gold in the study area. The application of the singularity mapping method has highlighted some promising and potential areas for future explorations. These areas could be important for mineralization due to the presence of phyllic alteration, iron oxides, sulfide minerals, and high-grade gold cells. Based on the singularity mapping results, two different hydrothermal mineralization systems of intermediate (mesothermal) to high thermal and epithermal to mesothermal are proposed, respectively; for the southern and northern parts of the Ghare Char area. Nevertheless, due to the mesothermal (orogenic) gold mineralization systems in the known Kervian and Ghlgholeh gold deposits, located in the vicinity of the Qareh Char area, and also the high concentration of As and Sb in these deposits, the possible presence of orogenic gold mineralization is more compared to the other types. Therefore, it is recommended to use the exploration criteria of the orogenic gold deposits for further exploration in the Qareh Char area.

Introduction

The accumulation of an anomalous amount of energy or mass is called a singularity [1,2]. Singularity is a general feature of nonlinear natural processes that often leads to fractal or multi-fractal results [3.4]. For instance, hydrothermal processes in the Earth's crust can lead to the formation of mineral deposits with a high concentration of metals with fractal or multi-fractal properties [5,6]. To identify these features, several fractal and multi-fractal analysis methods have been developed. The singularity mapping is one of these methods, which was developed based on the singularity index. In this method, using a moving window, the effects of the edge are reduced in the results [1,7-11]. However, the main objective of this research is to apply

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the singularity mapping method to the transformed geochemical data of the Qara Cher area in Kurdistan province by using principal components analysis (PCA) and isometric log ratio (ilr) transformation to identify high potential areas for further gold exploration.

Methodology and Approaches

The singularity mapping method was designed based on a moving window and performed according to the flowchart shown in Figure 1. In this way, an interpolated map of the geochemical data is first created and then the average concentration values are calculated using a moving window on this map. This process is repeated until all points on the map are covered. Finally, the alpha values are calculated according to the relationship shown in Figure 1, and the corresponding map is drawn. If the indicated positions on the final map are located in less than 2 singularities, they are categorized in the anomaly groups, and if they coincide with more than 2 singularities, they are categorized in the background groups.

Results and Conclusions

Based on the correlation of the identified geochemical anomalies by singularity mapping method with phyllic hydrothermal alteration, iron oxide related to the sulfide minerals, and the high-grade gold cells, some potential areas were proposed for future exploration in the Qareh Char area (Fig. 2). The two elements of arsenic and copper showed a better correlation with gold. This mineral association, hosted by altered metamorphic rocks, could be indicative of an orogenic gold mineralization in the Qare Cher area. Therefore, the exploration criteria of the orogenic gold mineral systems can be used for further exploration in the Qare Char area.

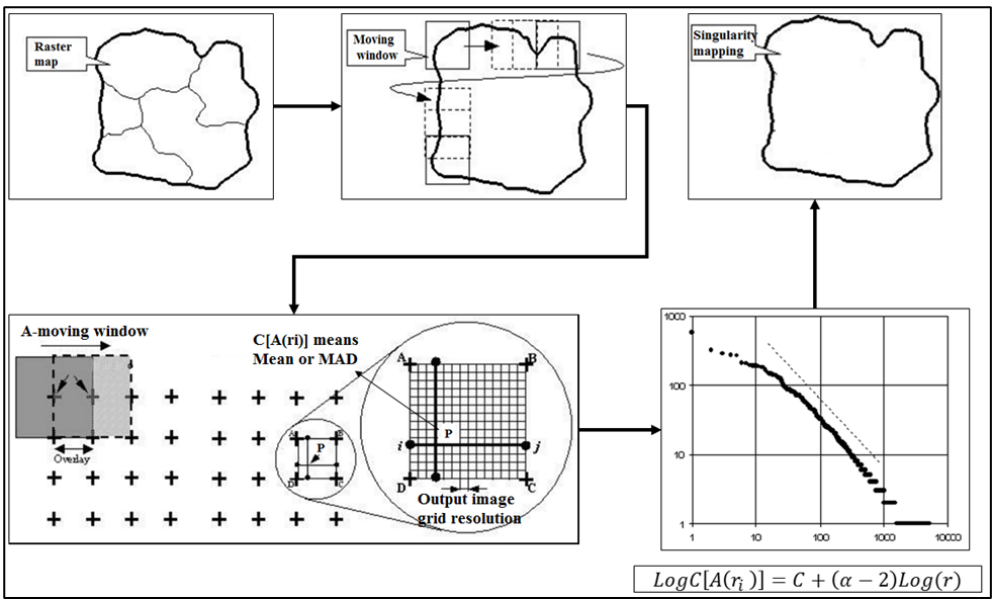

Fig. 1. Singularity mapping with moving window method

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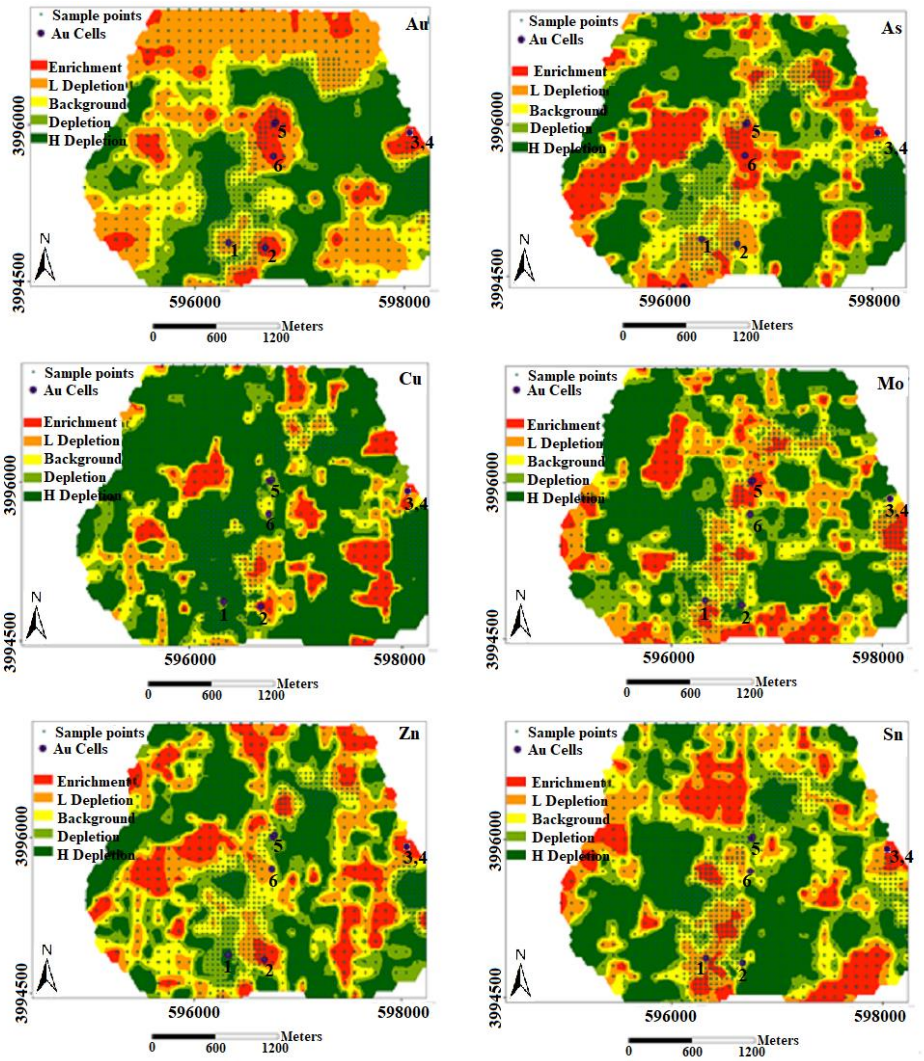

Fig. 2. Singularity distribution maps of Au, As, Cu, Mo, Zn and Sn elements in the Qareh Char area

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