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Identifying geochemical anomalies associated with Cu mineralization in stream sediment samples in Gharachaman area, northwest of Iran

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ABSTRACT

The aim of this paper was to delineate Cu anomalies in the eastern part of Gharachaman 1:100,000 sheet, which was located in Sahand–Bazman magmatic belt, northwest of Iran. The sample catchment basin (SCB) technique was applied on stream sediment data to prospect Cu and its related pathfinder at Gharachaman area; then the concentration–area (C–A) multifractal model was performed on positive Cu and Mo residuals to separate different population and mapping anomalies. The spatial distributions of residuals Cu and Mo, based on threshold values via C–A multifractal analysis, showed high anomaly in the northeast and southeast of the studied area, where intrusive rocks were underlain by the basaltic breccias. Furthermore, principle component analysis (PCA) was conducted on the results of SCB technique in order to determine multi-element geochemical signatures that reflected the presence of mineralization. As a result, four components were defined which could explain nearly 83% of the variability. Meanwhile, PC3 represented a Cu–Mo association and reflected a multi-element mineralization related to the hydrothermal Cu deposit occurrence. Finally, the C–A analysis was performed on positive scores of PC3. The PC3 scores map displayed less anomalous areas than uni-element of residual Cu map, probably due to the characteristic of PCA method that eliminated false anomalies. Studies proved that using this hybrid method (SCB and PCA) could be a useful technique to recognize the stream sediment anomalies in the preliminary stages of prospecting concealed mineral deposits.

1. Introduction

Traditionally, geochemical exploration based on stream sediment data has been a useful method to identify anomalous areas, especially in the preliminary stages of prospecting for concealed mineral deposits (Yousefi et al., 2013). Therefore, many researchers have created maps of mineral potential using stream sediment geochemical data (Abdolmaleki et al., 2014; Yousefi et al., 2012; Carranza, 2010; Carranza and Hale, 1997). In this technique, the concentration value at the sampling point is considered representative of only the catchment upstream and the concentration values estimated on the two sides of sampling points (upstream and downstream) are different (Spadoni, 2006). It means that in sample catchment basins (or SCBs) modeling, the influence of each stream sediment sample is just its upstream area until the next sample upstream (Yousefi et al., 2013). Collected samples along a stream, which were genetically considered as a mixing between grains and particles of different nature, originated from erosive processes within a catchment basin (Spadoni et al., 2005). So, the geochemical characteristics of each sample were considered as a function of the composition of different geological materials and sediments of anthropogenic origin were transported along the hydrographical network (Bölviken et al., 1986; Lahermo et al., 1996).

Understanding the complex nature of stream sediments is a fundamental factor that should be considered to estimate the background concentrations and the presence of natural and unreliable anomalies (Spadoni et al., 2005). It is necessary to determine local background (predicted values) appropriate for each stream and remove this background from the observed values due to elimination of factors unrelated to mineralization (Carranza, 2004) and leave residuals from which the effects of anomalous geological processes (e.g., mineralization) may be seen (Carranza and Hale, 1997). For certain mineral deposits, modeling of uni-element anomalies is useful in the analysis of specific pathfinder elements. Therefore, it is suitable to analyze relationships among uni-element residuals in order to determine multi-element geochemical signatures that reflect the presence of mineralization in a study area (Carranza, 2009). There are different mathematical multivariate techniques for the analysis of multi-element geochemical signatures, but for

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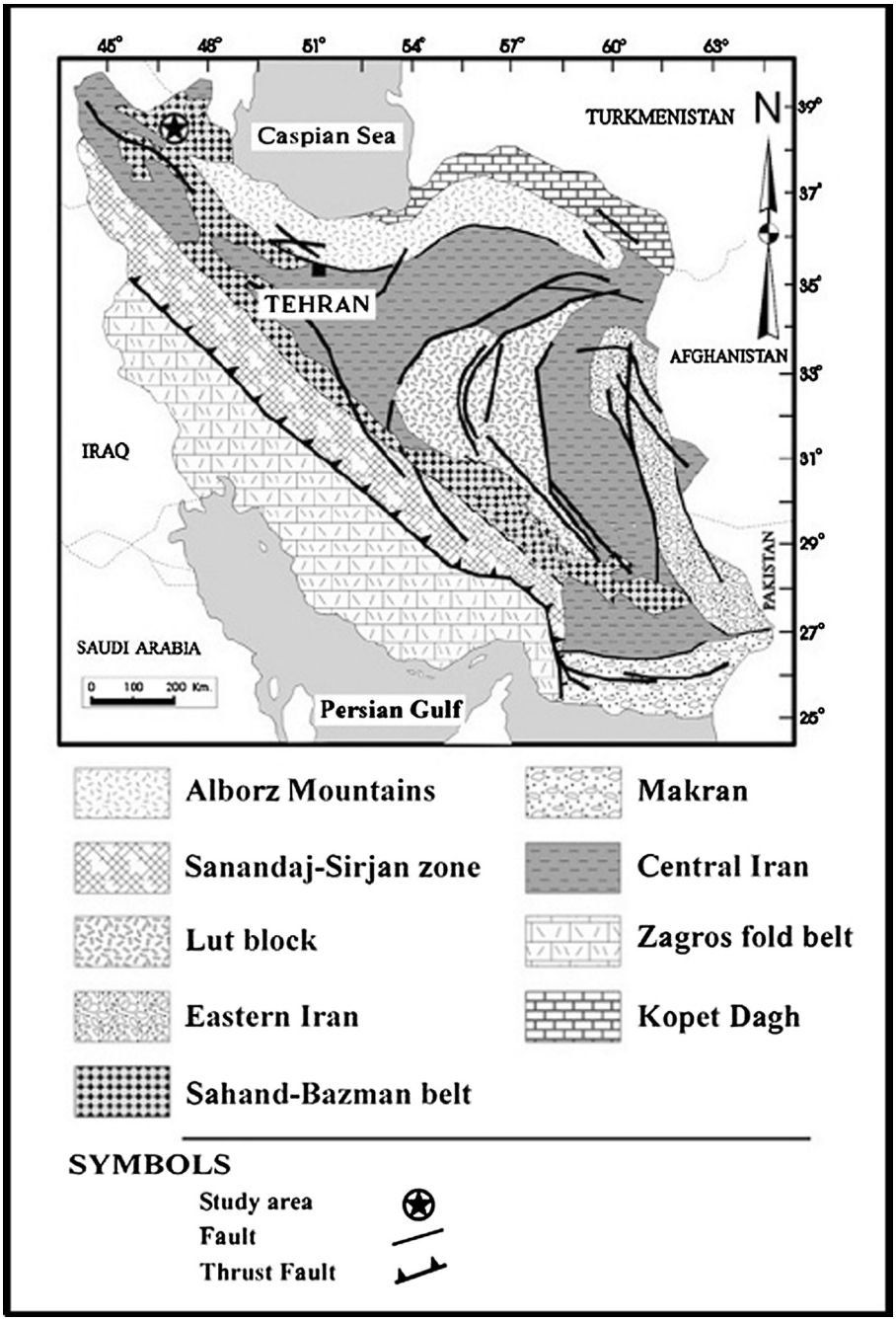

Fig. 1. Location of study area in Iran (Hezarkhani, 2006a).

a study area where there are few or no known occurrences of mineral deposits of the type sought, principle component analysis is a useful multivariate analytical technique because it serves as an exploratory approach to classify background and multi-element anomalies (Carranza, 2009).

Moreover, geochemical data which are obtained stream sediments have a multifractal nature representing geological factors such as lithological units, alterations, mineralization, and geochemical processes (Afzal et al., 2010; Cheng et al., 1994; Goncalves, 2001; Lima et al., 2003; Zuo, 2011). Consequently, concentration–area multifractal technique could be performed on stream sediment data to map anomalies. In addition, to recognize the principle components of mineralization, (C–A) multifractal technique could be used in order to identify the most promising area of mineralization.

The aim of this study was identification of geochemical anomalies associated with Cu and its pathfinders. Therefore, the SCB, PCA and the C–A multifractal modeling were applied on stream sediment geochemical data to explore optimal reconnaissance geochemical anomalies for further mineral exploration in Gharachaman area.

2. Geological setting

The studied area covered approximately 459 km^2 of 1:100,000 scale quadrangle map. It was named Gharachaman and located in the eastern East Azarbaijan province, nearly 100 km east of Tabriz city, the capital of this province in the northern part of the Sahand–Bazman (urumieh-Dokhtar) volcanic belt (Fig. 1). This