Journal of Mineral Resources Engineering, 8(3): 1-14, (2023)

Imam Khomeini International University

Vol. 8, No. 3, Autumn 2023

نشریه مهندسی منابع معدنی

Journal of Mineral Resources Engineering (JMRE)

Research Paper

Presenting a Model for Distinguishing Between True and False Anomalies Using Data Classification

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Received: 09 Feb. 2022 **Accepted: 04 Sep. 2022**

Abstract: Data integration can be used to conduct exploratory studies on a regional scale simultaneously on all available data from the study area. The results obtained by considering all the data and the relationship between them are more accurate and reliable. In these cases, mineral potential modeling is utilized to determine promising areas. Although GIS-based mineral prospectivity mapping methods have been established, it is important to review which methods of geochemical data analysis result in anomaly maps that, in turn, lead to better models of mineral prospectivity. In this study, instead of using anomalies of pathfinder elements, using geochemical zonality anomalies as one of the several evidential maps resulted in the improved mapping of mineral prospectivity. In addition, whereas weights-of-evidence analysis was used in this study, other methods of data representation and integration for mineral prospectivity mapping can be used. In this study, a part of Arasbaran metallogenic zone was selected and one-element geochemical control maps, geochemical maps produced by zonality, structural, alteration and geological maps were weighted and produced using the position of known indices by the method of weights-of-evidence. In the next step, weighted layers were combined with logistic regression (LR) method to prepare mineral potential models.

Keywords: Porphyry copper deposit, Weights of evidence, Mineral potential model, Geochemical zonality.

How to cite this article

Kharashadi Zadeh, M., and Ziaii, M. (2023). *"Presenting a model for distinguishing between true and false anomalies using data classification"*. Journal of Mineral Resources Engineering, 8(3): 1-14.

DOI: 10.30479/JMRE.2022.16891.1576

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INTRODUCTION

Mineral deposits and associated primary halos are characterized by variations in chemical compositions along both vertical and horizontal directions. Most methods of analyses of anomalies in stream sediment data are concerned with variations in surficial chemical compositions along horizontal directions. However, the concept of the geochemical zonality method allows distinction between sub- and supra-ore anomalies. Therefore, application of zonality indices in mineral prospectivity allows further interpretation about whether delineated favorable areas are attractive for exploration of outcropping or blind mineral deposits. This added value information from zonality indices is essential in planning exploration activities.

METHOD

Although methods of GIS-based mineral prospectivity mapping are now mostly well investigated, it is important to review which methods of geochemical data analysis result in anomaly maps that, in turn, lead to better models of mineral prospectivity. In this study, instead of using anomalies of pathfinder elements, using geochemical zonality anomalies as one of the several evidential maps resulted in the improved mapping of mineral prospectivity. In addition, whereas weights-of-evidence analysis was used in this study, other methods of data representation and integration for mineral prospectivity mapping can be used.

FINDINGS AND ARGUMENT

Several methods currently exist for GIS-based mineral prospectivity mapping, whereby various relevant evidential data layers are integrated [1]. The most widely used of those methods is weights-of-evidence (WofE) analysis [2]. The WofE is a data-driven method that provides a simple approach to integration of diverse geodata set information. In this study, the geochemical zonality and WofE are used to build a model for porphyry–Cu deposits in the area covered by two 1:100,000 scale map sheets of Varzaghan and Seah-Road (East Azerbaijan province, NW Iran) that are favorable for porphyry copper deposits. Porphyry copper deposits, due to their large and important reservoirs, have been well studied. Furthermore, these types of deposit have a special pattern, which is very good for regional exploration [2].

From various spatial data bases of the Geological Survey of Iran (GSI), the following datasets were used for regional-scale data-driven predictive mapping of prospectivity for porphyry–Cu deposits:

- Locations of 20 porphyry–Cu deposits/occurrences.

-Fault/fracture lineaments digitized from the1:100,000 scale geological/structural maps and from Aster satellite images.

- Lithological units from the1:100,000 scale geological/structural maps

- Map of hydrothermally altered rocks interpreted from Aster satellite images.

- A sub set of stream sediment geochemical data (analyzed for Cu, Zn, Pb, Mo) pertaining to the study area.

WofE analysis was applied to quantify the spatial associations of known porphyry–Cu deposits in the study area with individual layers of spatial evidence. In this analysis, a unit cell size of 200 m was used for spatial representation of porphyry–Cu deposits [1]. In WofE analysis with a large number of deposits (say >20), a maximum positive contrast(C) for presence/absence of evidence is considered a cutoff level for converting evidential data into binary predictor maps. However, in WofE analysis with small number of deposits, say <20 [1,2] the studentized C (i.e., the ratio of C to its standard deviation) is used to judge the strength or statistical significance of spatial association and to select cutoff level for converting evidential data into binary predictor maps. A studentized C greater than 1.5, for example, suggests a statistically significant positive spatial association at 95% confidence level [2]. This criterion was used for judging the strength of spatial association and for converting individual data layers into binary predictor maps.

In this study, instead of using anomalies of pathfinder elements, using geochemical zonality anomalies $(Pb\times Zn)/(Cu\times Mo)$ as one of the several evidential maps resulted in the improved mapping of mineral prospectivity for porphyry–Cu deposits (Figure 1). For comparison, Cu and Mo maps were used instead of the zonality map in the WofE analysis (Figure 2). The zonality-in-WofE prospectivity model shows only high values in the Soungun (blind mineralization) area, whereas the WofE map portrays shows high values in both Astamal (zone dispersed mineralization) and Soungun prospectivity in that part of the study area. The zonality-in-WofE prospectivity model outperforms the Cu-Mo in-WofE prospectivity model. The results demonstrate the usefulness of the zonality-in-WofE for regional-scale targeting of blind mineral deposits.

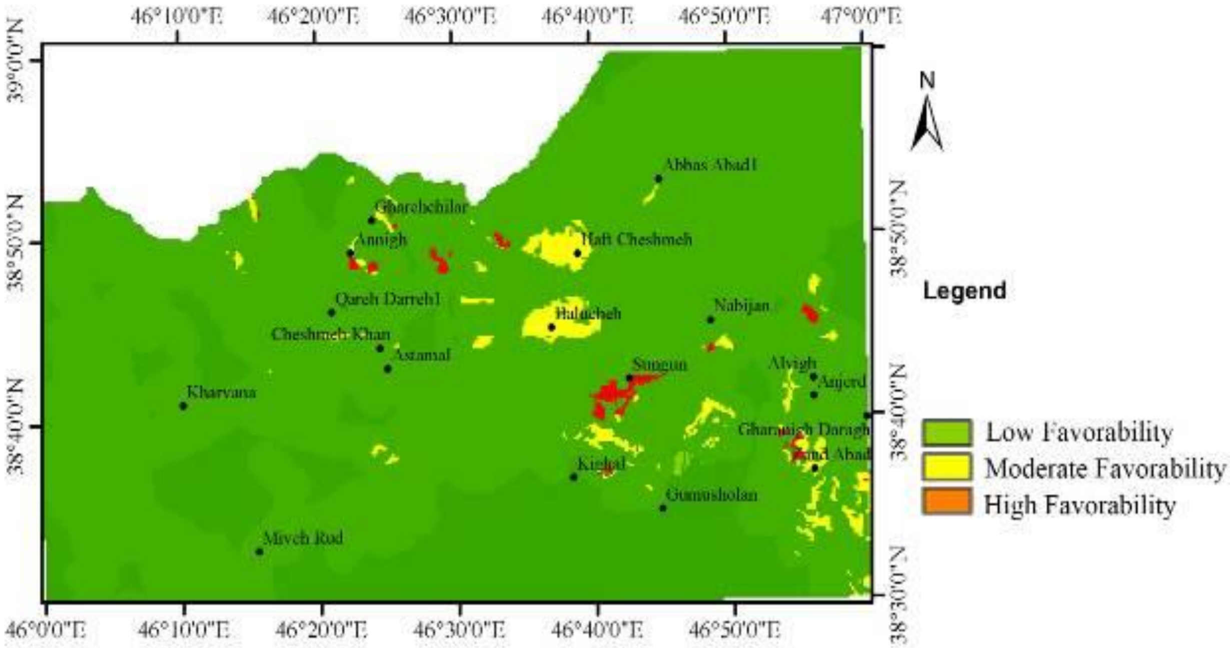

Figure 1. Porphyry–Cu prospectivity models: zonality in WofE

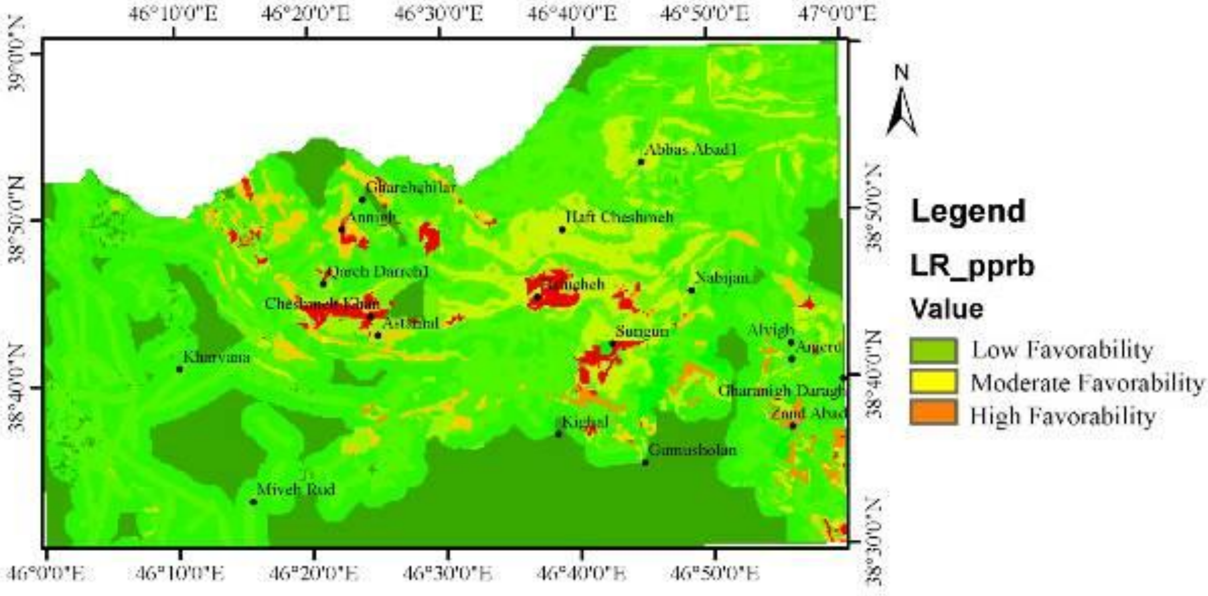

Figure 2. Porphyry–Cu prospectivity models: Cu-Mo in WofE

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