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Knowledge-driven Predictive Mapping of Copper Prospectivity in the part of the Khorasan Razavi Province, NE of Iran

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Abstract

Integrate various evidential maps that obtained from spatial data set of great scientific significance and has considerable value for mineral prospectivity mapping (MPM). Mineral prospectivity mapping by considering the various aspect of data set layers and information can be used to make mineral exploration less expensive, more efficient, and more accurate, it is important to move beyond traditional concepts and establish a rapid, efficient, and intelligent method of predicting the existence and location of minerals. Over the past years, two contrasting analytical approaches have been used to produced mineral prospectivity mapping. one is a conceptual knowledge-driven approach, and the other is an empirical data-driven approach. The knowledge-driven approach in exploration is carried out by extracting the spatial factors from exploration dataset on the basis of the exploration model, quantification of spatial factors and finally integration of these factors through map combination processes. In this study the integration process includes the weighting and scoring of different layers affecting the copper mineralization at studied area (Khorasan Razavi province SE of central Iran structural-metamorphic zone.) carried out by Index Overlay method as one of the knowledge- driven approaches within GIS environment. According to obtained results, we could achieve an initial guideline for effectively prospecting copper mineralization in the studied area

Introduction

Mineral exploration is a sophisticated process that seeks to discover new mineral deposits in a region of interest. Utilization of geographic information (GIS) provides the capacity to integrate and combine multiple layers such as geological, geochemical, remote sensing and air-borne geophysical surveys and will be consequence to the mineral prospectivity mapping (MPM) that will be make the mineral exploration process more accurate and easier than exploration by conventional methods. The MPM is a multistage procedure for generation of evidential maps consisting of extracted and weighted features representing the existence of the ore deposit-type sought within combining the evidential maps and classification of prospects for further exploration. Numerous modelling methods for producing mineral prospectivity maps using a GIS or other software have been developed over the past 20 years. These methods can be divided into two basic categories: knowledge-driven as a conceptual technique and data driven as an empirical technique respectively. Data-driven mineral prospectivity mapping is appropriate for moderately- to well-sampled mineralized areas. Known deposit-type locations are a dataset of situations with great chance for mineral deposit existence in a mineralized landscape. The conventional data-driven methods are weights of evidence, neural networks, evidential belief functions and logistic regression which used for brown fields with high values of exploratory data. The other technique is called knowledge-driven which is applicable for areas with low value exploration and geological data entitled green fields In ‘green fields’ cases where no known occurrences of the deposit type being modeled or the number of the deposits is too low to make valid statistical calculations, a conceptual (or knowledge-driven) approach can be used. In techniques for conceptual spatial modeling, expert opinions are used to define the thresholds. The knowledge-driven techniques include applications of fuzzy logic, evidential belief function, the Dempster-Shafer model and the decision tree approach. In this study the integration process includes the weighting and scoring of various exploratory layers such as geochemical, geophysical, remote sensing and geological data carried out by Index Overlay method as one of the knowledge- driven approaches within GIS environment. to prepare a MPM affecting the copper mineralization at studied area (Khorasan Razavi province SE of central Iran structural-metamorphic zone) (Fig.1). According to obtained results, we could achieve an initial guideline for effectively prospecting copper mineralization in the studied area.

Index Overlay Method

In this method, the evidence (factors) consists of a set of exploration dataset (maps) and weights are estimated from the measured association between known mineral occurrences and the exploration model for a particular terrain. The hypothesis then repeatedly evaluates all possible location of the maps using the weight and in turn produce a mineral potential map in which the evidences of several map layers are combined by this map combination rule in the index overlay method, each input map (layer of evidence) to be used as evidence is assigned a different score (weight), as well as the maps are receiving different weight depending on the exploration model. An area that is geologically well explored with a relatively well-understood exploration model in hand (the present study area), assignment of weight on different themes or maps ought to be through knowledge driven approach. This not only help in developing a clear understanding of relationship between datasets (both geological, geophysical or geochemical) but this also give flexibility to an exploration geologist to manipulate weight on different elements or evidence maps through geological knowledge about the terrain in different stages of analysis. This is advantageous for developing perhaps a variety of scenarios for different weight schemes, reflecting differences in opinion amongst experts, and allows the evaluation of sensitivity of the mineral potential maps to such differences. After defining the score by knowledge driven approach for elements or maps, the average score (index weight) is then defined by

$$\bar{S} = \frac{\sum_{i}^{n} S_{jj} w_{i}}{\sum_{i}^{n} w_{i}}$$

Where S is the weighted score for an area object, Wi is the weight for the i-th input map, and Sij is the score for the j -th class of the i-th map, the value of j depending on the class actually occurring at the current location.

Discussion and Conclusion

The results obtained by the Index Overlay (Multi-Class Maps) indicate a lot of exploration targets related to the copper mineralization hosted by volcanic rocks such as andesite, dacite, and tuff that affected by the heat source and geodynamic occurrences as the controlling factors. Regarding the mineral prospectively map created by the integration of various evidence maps, we could identify and delineated 10 promising areas in the study area. These targets could be as copper mineralization anomalies as soon as possible by complementary activities such as drilling.

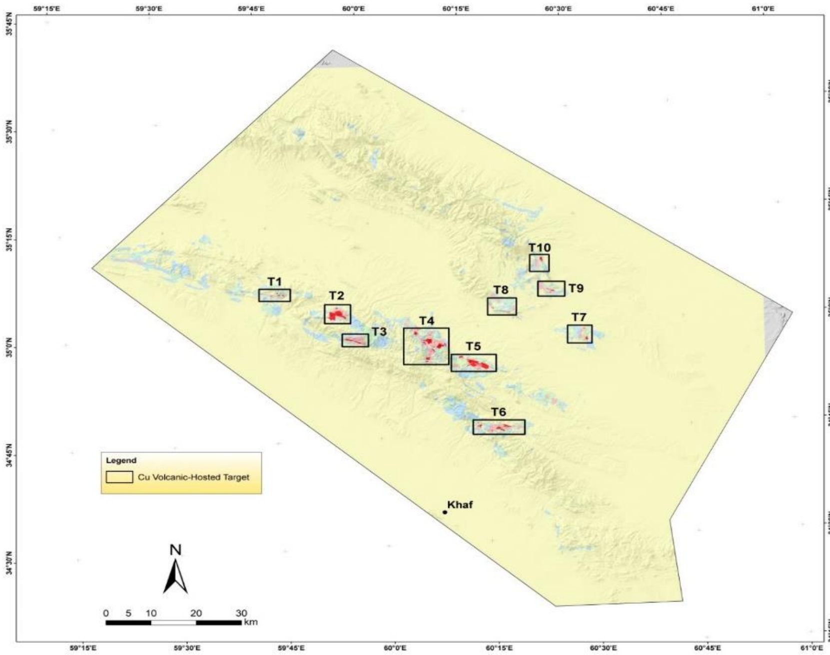

Figure 1. Mineral Prospectivety Map of coper mineralizations.

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