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Research Paper

Gilsonite Mineral Potential of Gilan-e Gharb to Qasr-e Shirin using FAHP-FTOPSIS Prediction Model

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Abstract: Gilan-e Gharb region has been located in the west of Iran and it has special features in terms of geology. Remote sensing data (satellite images), geology, tectonics and mineral data sets of the region were used to prepare an innovative integrated method for the exploration of Gilsonite mineral. Effective criteria and sub-criteria in the exploration of this mineral were identified and evaluated according to the available exploration data. Afterwards, these criteria were weighted using Fuzzy Analytical Hierarchical Process (FAHP). Accordingly, the ideal positive and negative solutions were ranked using a Fuzzy TOPSIS method to prepare a mineral potential mapping (MPM) of Gilsonite in Gilan-e Gharb region. The product of this paper is a potential map used for optimal identification in the early stages of exploration of Gilsonite mineralization that reduces the time, cost, and risk of exploration. Finally, the field's visit and investigation has been accomplished for the regions with a high potential of Gilsonite mineralization to evaluate the proposed method. The results showed that 82% of the identified points had proper adjustment to the MPM. This high adaptation showed that the proposed method has good performance in Gilsonite exploration.

Keywords: Integration of exploratory data, FuzzyAHP-FuzzyTOPSIS, Mineral potential detection, Gilsonite, Gilan-e Gharb region.

INTRODUCTION

As Gilsonite industry is a strategic component in the world and Iran, Gilsonite deposit's exploration has a high priority. Exploring new Gilsonite deposits and recognizing prospective zones within the predefined region is the main purpose of prospecting level in the mineral exploration. To attain this goal, multiple data-sets should be collected, analyzed, and integrated for the mineral potential mapping (MPM) in the region of interest [1,2]. MPM is a typical multiple criteria decision-making (MCDM) function that results in a predictive model of prospective zones within the region of interest. Generally, there are two main types of modeling in MCDM. The first type is known as data-driven methods. In these methods, the variables of the model are determined with consideration of available evidence as well as explored models in any study area [3]. In the second type, known as knowledge-driven methods, the model's variables are estimated with exploratory purpose and other influential factors by the experts. Usually, when the exploration data is limited and not significant; a knowledge-driven method based on the expert opinions is used [4]. In these methods, the importance of the control maps is based on experts' experiences [5].

One of the more popular MCDM methods based on the knowledge-driven for MPM is the Fuzzy Analytical Hierarchy Process (FAHP) [6]. In this method, a set of criteria and sub-criteria is made and weighted according to their importance of the model. Input data are evaluated based on these criteria and receive the final scores that indicate the weights [7]. Another method that is also well-known is the Fuzzy Technique for Order Preference by fuzzy Similarity to Ideal Solution (FTOPSIS) [8]. In this method, the data are compared to an ideals (positive and negative) under fuzzy environment. This simulator is a process of common in humans, in which people evaluate things that are not based on some criteria, but compared to the ideal instance of the same type. In this paper, to get all the benefits of these methods, these two methods have been integrated as the FuzzyAHP-FTOPSIS and applied to MPM of Gilsonite in the exploratory Zone (Gilan-e Gharb).

STUDY AREA AND DATASETS

The area of the Gilan-e Gharb exploratory zone is 1277 Km^2 and is located in Kermanshah province, between the cities of Qasr-e Shirin and Gilan-e Gharb. This zone is located mainly in the Shak-e Maydan region, which is one of the most susceptible regions of Iran for the exploration of bitumen and Gilsonite. This zone is structurally located in the folded Zagros zone, where the eastern parts is the portion of the Lorestan sedimentary basin and the western part is the portion of the sedimentary basin of the northern Dezful. In terms of hydrocarbon potential, the studied area includes surface potential that is mainly Gilsonite.

Most of the known hydrocarbon resources in the Gilan-e Gharb zone are related to the structures of the anticline. In identifying and exploring the potential of Gilsonite, the study of folding processes, faults, fractures and their formation mechanism is of great importance. In this area, anticlines are the main structures that are host minerals. Also, the important and abundant structures in the zone are faults and fractures that control mineral deposit location in the anticlines. The main anticlines of this zone are: the anticlines of Imam Hassan, Visionan, Oshtoran, Darwana, and Siya Kouh. The criteria used are grouped into three types of geological data, mineralization data, and remote sensing data and totally, eight layers of different data-sets were produced and used. Furthermore, knowledge of five experts were used in this process and the opinions of these experts were combined to gauge the overall score for different data-sets.

METHODS

An integrated FAHP–FTOPSIS was proposed to combine the input exploration data and to create the final MPM of the Gilan-e Gharb zone. In this regard, a hierarchy structure for Gilsonite exploration in the studied area was prepared using the input exploration data (Figure 1). In the phase I, the criteria and sub-criteria were identified and evaluated, and 8 pairwise comparison matrixes were created and 21 input sub-criteria were compared to indicate Gilsonite potential in the Gilan-e Gharb zone. In the phase II, using the FAHP method, weights of criteria and sub-criteria were determined. Consistency Ratio (CR) values for this pairwise comparison were less than 0.1, hence, these matrixes are consistent and thus these weights of criteria and sub-criteria are acceptable [9,10]. In the phase III, using FTOPSIS the alternatives have been ranked in the case study.

FINDINGS AND ARGUMENT

A final MPM for Gilsonite mineralization was created and reclassified into ten classes. In Figure 2 the corresponding red color corresponds to the high-potential regions of the Gilsonite exploration. The brown solid circles shown on this map (Figure 2) are the locations of the mineralization explored on this zone, which are used to evaluate the output of the method. As can be seen, explored mineralization points are consistent with the output of MPM.

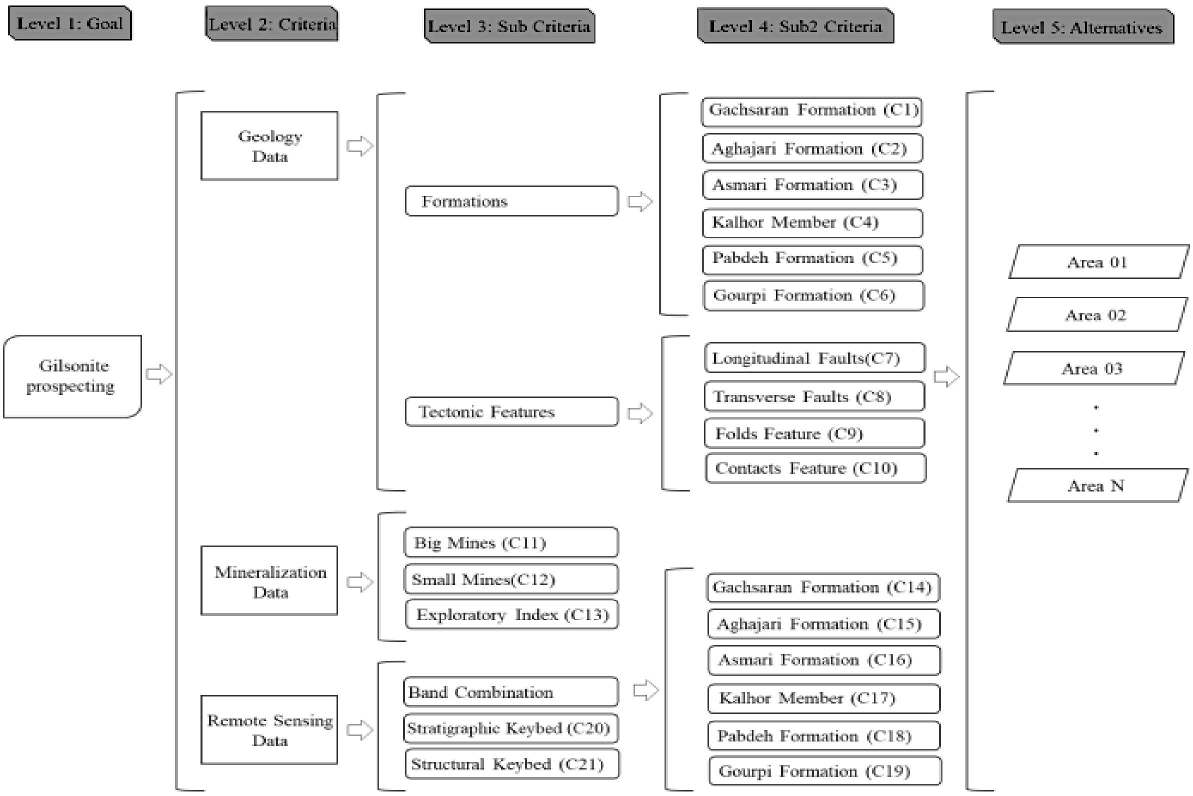

Figure 1. A hierarchy structure for Gilsonite exploration in the proposed method

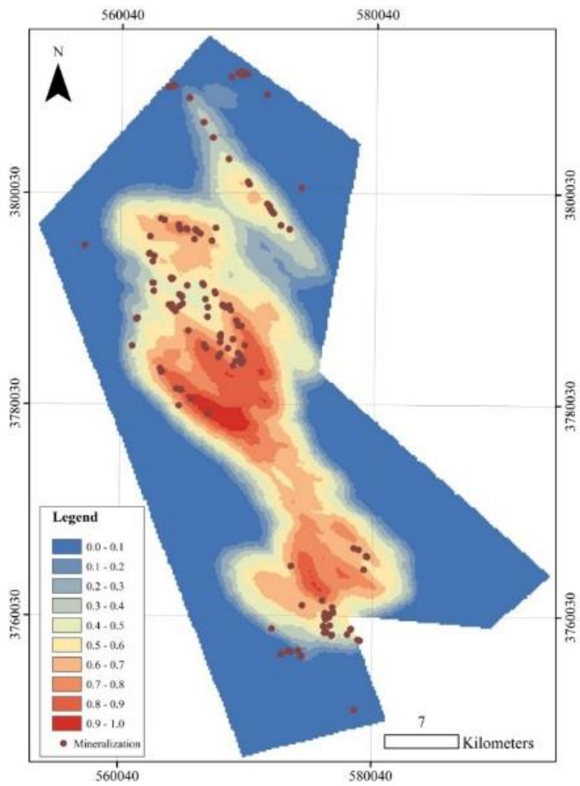

Figure 2. Potential mapping for Gilsonite mineralization in the Gilan-e Gharb zone

A noteworthy point in discussion of preparing potential maps is that due to the involvement and influence of various factors in the formation and formation of minerals and the impossibility of access and use of all these factors, there is no expectation of full compliance of potential maps with reality and there is always a percentage of uncertainty. But the percentage of compliance in the area designated as potential areas should cover a significant number of points that can be identified in the future. This issue in determining and explaining whether the method used is suitable or not is very important. After the integration process, the exploratory team identified 109 points (locations) with a high potential of Gilsonite mineralization. These points were used to evaluate the method. The results showed that 82% of the identified points have proper adjustment to the MPM. This high adaptation showed that the method is of good performance for use in Gilsonite exploration.

CONCLUSION

In this paper, successful application of an MCDM method called FAHP-FTOPSIS is evaluated for a variety of exploratory data to the Gilan-e Gharb zone in the west of Iran. This method is based on the two most popular MCDM methods known as the Fuzzy AHP and the Fuzzy TOPSIS. In this method, the criteria and sub-criteria weights were obtained based on the pairwise comparison matrix of FAHP method and the alternatives were ranked by the FTOPSIS method. The pairwise comparison matrix was prepared by five experts in the field of Gilsonite exploration. Then, the alternatives were ranked by the FTOPSIS method. The raster map pixels were prepared based on the results of the method.

The FAHP-FTOPSIS method used here is similar to the knowledge-driven and data-driven methods. This method as a knowledge-driven algorithm needs a criteria weight vector but does not use the inference system as the knowledge-driven methods (such as fuzzy logic). Moreover, the ranking strategy is only based on an ideal positive and negative alternative distance, similar to fuzzy clustering, which results in the similarity of each alternative by comparing with cluster samples (the prototypes of clusters are positive and negative ideal solutions). Therefore, the proposed method is not a pure data-driven or knowledge-driven method, but a hybrid method. Accordingly, by identifying the potential points of the Gilesonite mineralization in a good achieved performance, it is advised to follow up and explore.

REFERENCES

[1] Geranian, H., Tabatabaei, S. H., Asadi, H. H., and Carranza, E. J. M. (2016). *"Application of discriminant analysis and support vector machine in mapping gold potential areas for further drilling in the Sari-Gunay gold deposit, NW Iran".* Natural Resources Research, 25: 145-159.

[2] Geranian, H., Tabatabaei, S. H., Asadi, H. H., and Carranza, E. J. M. (2016). *"Application of discriminant analysis and support vector machine in mapping gold potential areas for further drilling in the Sari-Gunay gold deposit, NW Iran".* Natural Resources Research, 25: 145-159.

[3] Abedi, M., Torabi, S. A., Norouzi, G. H., and Hamzeh, M. (2015). "ELECTRE III: *A knowledge-driven method for integration of geophysical data with geological and geochemical data in mineral prospectivity mapping".* The *Journal* of *Applied Geophysics*, 117: 138-140.

[4] Beikkhakhian, Y., Javanmardi, M., Karbasian, M., and Khayambashi, B. (2015). *"The application of ISM model in evaluating agile suppliers selection criteria and ranking suppliers using fuzzy TOPSIS-AHP methods".* Expert Systems with Applications, 42: 6224-6236.

[5] Asadi, H. H., Sansoleimani, A., Fatehi, M., and Carranza, E. J. M. (2016). *"An AHP–TOPSIS predictive model for district-scale mapping of Porphyry Cu–Au potential: A case study from Salafchegan Area (Central Iran)".* Natural Resources Research, 25(4): 417-429.

[6] Lee, S., Song, K. Y., Kim, Y., and Park, I. (2012). *"Regional groundwater productivity potential mapping using a geographic information system (GIS) based artificial neural network model". Hydrogeology* Journal, 20: 1511-1527.

[7] Carranza, E. J. M. (2010). *"Improved wildcat modelling of mineral prospectivity".* Resource Geology, 60: 129-149.

[8] Feizi, F., Ramezanali, A. K., and Mansouri, E. (2017). *"Calcic iron skarn prospectivity mapping based on fuzzy AHP*

method, a case study in Varan area, Markazi province". Journal of *Geosciences,* 21: 123-126.

[9] Saeedpoor, M., Vafadarnikjoo, A., Mobin, M., and Rastegari, A. (2015). *"A Seroquel model approach integrated with fuzzy AHP and fuzzy TOPSIS methodologies to rank life insurance firms".* Proceedings of the American Society for Engineering Management. International Annual Conference, Indianapolis, Indiana, USA.

[10] Kannan, D., Jabbour, A. B. L. D. S., and Jabbour, C. J. C. (2014). *"Selecting green suppliers based on GSCM practices: Using fuzzy TOPSIS applied to a Brazilian electronics company".* European Journal of Operational Research, 233: 432-447.