Iranian Journal of Engineering Geology
Autumn 2021, Vol.14, No.3

Application of probabilistic neural network method for classification of Yazd, Ali-Abad copper deposit

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Abstract

In the present research, a probabilistic neural network based on the Bayesian probabilistic algorithm was employed to classify the grade of Ali-Abad copper deposit in Yazd. For this purpose, induced polarization (IP) and resistivity (Rs) geophysical data and rock type of exploration borehole cores as geological information corresponding to four geophysical profiles, DD-1, PD-2, PD-3 and PD-4 were used as input parameters as well as the copper grade of the boreholes as target parameter. To achieve the goal, 488, 528, 188, and 456 data were randomly collected from the sections related to DD-1, PD-2, PD-3 and PD-4 geophysical profiles so that 75% of total data were selected for training and 25% to test the probabilistic neural network. The performance of the proposed approach was evaluated by confusion matrix through the ratio of summation of data on the main diameter to the total test data, as well as determination of Commission and Omission errors. The results of the research show that the probabilistic neural network could estimate the test data for DD-1, PD-2, PD-3 and PD-4 profiles with accuracy of 60, 74, 60 and 83.3%, respectively which are reasonable considering the type of available data. In addition, the results were qualitatively evaluated through plotting isograde maps of four exploratory cross-sections over the geophysical profiles. This process was carried out using the assay data of exploration boreholes, gridding and the grid interpolation with the high accurate kriging estimation method, which was leaded to favorite results.

Key words: *Yazd Ali-Abad copper deposit; Bayesian probabilistic neural network; Resistivity and Induced polarization; Rock type; Grade*

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Extended Abstract:

1. Introduction

Almost about all of the metallic mineral deposits, traditional method of drilling several boreholes throughout the area is used to determine the grade in the various points of the deposit. At the end, the spatial relationship between measurement points is investigated so that the grade can be estimated in other points of the deposit by it. However, time consuming and costly boreholes drilling operation has caused the methods that indirectly estimate the grade of deposit, to be given more attention. Of course, to achieve the goal, drilling a few numbers of boreholes in these cases is always inevitable. In order to increase information overlap and access the highest level of accuracy, some indicator parameters are usually measured on the ground surface that may not have an acceptable relationship with the target parameter alone. Employing the Bayesian probabilistic algorithm is one of these methods. This algorithm is mainly used to classify data in different categories and in the variety of studies, it has proven better performance than many other algorithms (Huang et al., 2018; Li, 2011; Adeli and Panakkat, 2009; Leite and Souza Filho, 2009).

In the present research, a probabilistic neural network based on the Bayesian probabilistic algorithm was employed to classify the grade of Ali-Abad copper deposit in Yazd. Ali-Abad copper deposit in central south of Iran, is located between longitude of 768000E to 771000E and latitude of 3503000N to 3507000N. According to the copper deposits report in Iran (2000) lithological variation is very high in this region and Shirkooh mountains with granite and granodiorite rocks studied in the east of the region are the oldest units (Khoyee et al., 2000). Form of the deposit is vein, veinlet and filling the joints and fractures. The type of mineralization is stockwork containing azurite and malachite with magnetite and rutile minerals (Saman Kav, Consulting engineers Co., 2006).

2. Materials and methods

Figure 1 shows the location of 4 surveyed geophysical profiles DD-1, PD-2, PD-3 and PD-4 as well as 26 exploratory boreholes drilled on them. To achieve the research goal, induced polarization (IP) and resistivity (Rs) geophysical data and rock type of exploration borehole cores as geological information corresponding to four geophysical profiles, DD-1, PD-2, PD-3 and PD-4 were used as input parameters as well as the copper grade of the boreholes as target parameter. To achieve the goal, 488, 528, 188, and 456 data were randomly collected from the sections related to DD-1, PD-2, PD-3 and PD-4 geophysical profiles so that 75% of total data were selected for training and 25% to test the probabilistic neural network. The performance of the proposed approach was evaluated by confusion matrix through the ratio of summation of data on the main diameter to the total test data, as well as determination of Commission and Omission errors.

3. Results

The results of the research show that the probabilistic neural network could estimate the test data for DD-1, PD-2, PD-3 and PD-4 profiles with accuracy of 60, 74, 60 and 83.3%, respectively which are reasonable considering the type of available data. In addition, the results were qualitatively evaluated through plotting isograde maps of four exploratory cross-sections over the geophysical profiles. This process was carried out using the assay data of exploration boreholes, gridding and

the grid interpolation with the high accurate kriging estimation method, which was leaded to favorite results.

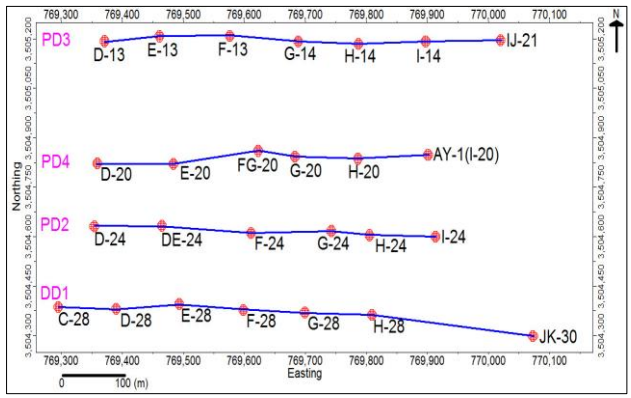

Fig. 1. Location map of surveyed geophysical profiles with exploration boreholes drilled on them.

4. Conclusion

In the present study, the feasibility of minimizing the number of exploratory boreholes in terms of time and costs of the exploration operation reduction was proved. This task was performed through estimation, determination of distribution type and classification of grade of the mineral deposit in 2-D exploratory sections on the surveyed geophysical profiles in the Yazd, Ali-Abad copper deposit using probabilistic neural network method based on the Bayesian probabilistic algorithm. This research, showed that isograde map of the exploratory sections with reasonable accuracy can be supplied using IP and Rs geophysical data acquired on the ground surface, geology information such as rock type and assay data of drilling cores from a few exploratory boreholes drilled on the geophysical profiles. Obviously, by means of 3-D exploration geophysical survey, using information of a few number of exploratory boreholes scattered at the area, first a 3-D lithology model can be created then producing a 3-D solid model of the deposit with favourite accuracy, will be possible.

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