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GEOMETRIZATION AND PROGNOSTICATION OF GEOLOGICAL PARAMETERS OF IRON ORE DEPOSITS USING NEURAL NETWORKS

Ukraine is a country whose earth bowels have unique mineral deposits in terms of chemical composition; unfortunately, in terms of quantity, the deposits are limited, as are the amounts of useful components in them.

Resulting from the process of their exploration, the mineral deposits are regarded as natural systems with a predominant stochastic character. The model approach is basic because of the indefiniteness in the whole continuity "exploration – mining – preservation – liquidation". The purposes, tasks and interests of a variety of specialists form the links and the elements of a system which is financially and administratively managed by a concession owner. The principal requirement for these two systems to function in unison is to observe the safety regulations, to extract deposits fully and rationally, and to preserve earth bowels. In those two systems, definiteness becomes an element at a different stage.

As well as the methods of mathematical statistics applied mathematics used in mineral deposit investigation, geo-statistical and heuristic methods are also employed. The purposes, matter and tasks of Artificial Intelligence (methods and means which imitate the role of human intelligence) were outlined in the second half of the 20th century.

The main reasons for artificial intelligence to be used in mineral deposits investigation are: understanding and implementing of information technologies, deposit parameters modeling, evaluation of the models and using them in the designing and mining stage, earth bowel preservation, elaborating a great number of solutions and choosing the optimal solution in real time, and perceiving mineral deposits as multi-functional and multi-parametric systems.

In general, the issue of prognostication is reduced to obtaining evaluation of future values of data which are well-ordered in time and/or space and are based on already known data. Recently, along with the traditional methods (parametrical models) for regularity searching in the known data, are methods have been applied that use neural networks.

The proposed approach was used for prognostication of geological parameters which are the basic factors in the technical and economic evaluation of mineral deposits, as well as in planning the extraction operations in a mine.

Part of an iron deposit with a complex structure, extraction level was explored with a regular drill hole grid (100×100 m). Because the grade changeability is high, most of the grid density was increased up to 50×50 m. The results from mine-geometrical analysis of the basic parameter – grade of iron – show that the empirical distribution is quite different from the normal and has positive asymmetry. Investigating the character of grade changeability by the random functions theory gives reasons to affirm the presence of anisotropy in the variability of the basic parameter.

Reports can be found in the bibliography about using different types of neural networks in similar conditions. Uniform recommendations, however, cannot be found in them. Most of the investigations are often made on the artificially created mineral deposits.

Considering the quantity of initial information, the sequence of its providing and entry, and the price of unit of information, the following question is asked: “Can we train a neural network with data from the first stage of exploration so that it could prognosticate the basic parameter of the deposit - the grade of ore in the sample locations that complete the termination of the second and third stage - and what is the influence of the changing ratio of “training/testing” data on the prognostication error?”

If the second stage of exploration is partly realized, a second question arises: “With the same density of drilling grid, but with a parallel movement, do the type of neural network and its working capacity for the next stages of exploration change?”

A possible third question arises then: “Where is the threshold if information quantity resulting from the first and second stage of exploration, which provides a reliable choice of models for prognostication of geological parameters value at the third stage exploration?”

All the operations of searching for an answer to the second question are reflected in the construction of prognostication models – neural networks - through training based on the output information (located in a grid 200×200 m) and comparison of training quality.

Designing neural networks involves the following stages:

- determining a series of configurations (number of layers, number of nods in every layer, etc.);
- performing iterative experiments with every configuration;
- assessment, correction and completion of the training of selected configurations;
- final testing of the best neural network selected.

Statistical Neural Networks includes a tool for automatic creation, training and testing of a multitude of networks with different characteristics, and for selecting the best network according to chosen criteria. Experiments are made with various types of network containing different parameters (number of hidden layers, methods and phases of training, transfer functions, etc.). A number of training series with every network testing structure are performed. Applying the selection error appraisal criterion, the best network is chosen as a model. This method comprises the most advanced algorithms, such as regularization and analysis of accuracy. It can test hundreds of network combinations, concentrating on particularly promising network architectures. This method searches for optimal networks of different types (e.g., multilayer perceptions and radial basis functions) simultaneously. Another advantage of this method is the high performance speed, even if the answer is crude.

The information for iron grade includes the coordinates of the prospect hole (within the extraction level area) and the value of useful components. Thus, the neural network will have two input variables and one output. During using this method analysis, the data are divided into three groups – for training, for testing in the process of training, and for post-training testing.

So far, neural network application has not been employed extensively in estimations and prognoses concerning mineral deposits. Besides, the unique character of natural conditions, varying even within the same type of deposit, requires experimenting with different types of prognostication model.

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THE RELEVANT IMPORTANCE OF THE ISSUE OF ENHANCING THE EFFICIENCY OF ORIENTATION AND CONNECTION SURVEYS AND HEIGHT BENCH MARK TRANSFERS

Transferring height bench marks into a mine's underground workings and orientation-connection surveys are specific types of mine surveying that impact the accuracy of the surveying support for underground mining and it is therefore necessary to take into account the particular importance of their performance.

The increasing depth of mining makes rock bursts and other cataclysms more likely, so the issue of enhancing the accuracy of determining the height bench marks used to solve a wide range of problems in underground mining is becoming more relevant.

As is known, the orientation of underground mine survey networks completes two tasks: the transfer of the directional angle (network orientation) and that of the planned coordinates X and Y (network centring). The transfer of the height bench mark (the third coordinate) information is carried out independently of the results of the orienta-