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Integrated cause-effect analysis of geological and geophysical maps in mineral resource assessment

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The integrated cause-effect analyses is intended for researches requiring the joint processing of qualitative and quantitative data, including those taken from conventional and contour maps. To realize the cause-effect analyses, the combination of conventional geological and contour geophysical maps must include some areas with already known manifestations of mineralization under study. The researcher specifies the form and size of these areas. Each selected area is characterized by the set of features taken from all maps under consideration. These sets are represented by rows of the binary table with symbols 1 indicating the presence and 0 the absence of a feature. Before constructing the table, quantitative geophysical characteristics are converted in qualitative form [1]. The obtained binary table is subjected to the cause-effect analysis.

Cause-effect analysis is based on the tools of mathematical logic and consists of the following components: logical modeling of knowledge; detecting the logical dependencies consistent with the theoretical model in a given data file; choosing the most consistent dependence expressed by some Boolean formula; using this formula for the assessment [2,3]. Software realizing the cause-effect analysis is an expert system with artificial intelligence capabilities [3]. The result of cause-effect analysis is the set of combinations formed by some essential features related to mineralization under study, that is, the set of favorable settings. In case the data are taken from different deeper earth's layers of the same area, the result is a set of volumetric favorable settings. As any identified setting is related to unit area of a standard size and shape, boundaries of favorable areas corresponding to these settings are determined rigorously and can be visualized on a resource-potential map. Mathematical tools of cause-effect analysis provide the minimum size of favorable domains, which may be achieved on the base of given cartographic material.

A case study of integrated cause-effect analysis is the identification of volumetric favorable settings for the assessment of the zinc, lead and copper sulphide mineralization in the Altai region of Siberia. Four sources of information have been used in this research: one conventional geological map at the scale 1 : 1 000 000; ten geophysical contour maps characterizing the deeper earth's layers; one contour map showing elevations of the topography; data about metal contents and reserves. As a result of data processing, five volumetric settings composed of features related both to the upper and deeper earth's layers have been detected. Two of them are responsible for the formation of mainly lead deposits and three others are favorable for the formation of mainly copper ones. The size of the deposits does not depend directly on the studied features. As the volumetric settings have been identified on the base of maps at the scale 1 : 1 000 000, they express only the potential of areas for the presence of large deposits. There is the correlation between the identified settings and elevations. This result can be used for the discovery of blind deposits at depth.

References:

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