METHODS AND PROCESSING PATTERN OF GEOLOGICAL INFORMATION IN GIS TECHNOLOGY

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Abstract

A scheme of a rational succession of geological data processing with the compilation of a map set is proposed. For each stage of processing the preferential use of a certain set of processing methods in GIS technology is indicated. The pattern of changes in the amount of statistical information and its value during processing are revealed.

1 Introduction

Geological information includes data on geological environment, evaluation of its economic,environmental and other significance for human activity and life of society. In a non-obvious form this information reflects geological theories and characteristics of observation means and procedures for treatment of materials. Obtaining of final results in the form of systematized data on geological environment and practical recommendations on its use is connected with application of diverse procedures for processing geological models.

In this connection, the tasks of looking for a rational succession of information processing and of an optimal set of processing methods used come to the fore. The solution of these tasks is essential for a successful application of GIS technology in geological cartography.

2 Succession of information processing

A rational succession of information processing is determined by a successive complication and increase of diversity of mapped objects and their logical relations in the process of creating geological cartographic materials and their use.

1. Recording of observation ; files and maps of primary observations;

2. Relation "Equivalence"; maps, showing field isoline and contents of minerals, lithological maps;

3. Relations "Neughbourhood and inclusion" ; maps, showing associations of elements or minerals and rock complexes;

4. Relation "Order (including age order)";maps,showing succession of association of elements or minerals, geological map, maps of mineral deposits etc.;

5. "Cause-and-effect relations"; schemes of geological interpretation of geophysical and geochemical fields, facies and formational, tectonic, mineragenic maps etc.;

6. Relations "Prediction"; maps of prediction of minerals, geological hazards etc., recommendations for subsequent works etc.

3 Methods of information processing

Methods of processing geological information can be classified under three main groups:

methods of generalization and simplification, i.e. extrapolation, interpolation, continualization, discretization, smoothing, decomposition, zonation;

methods of studying links between objects, i.e. statistical methods and cartographic correlation;

methods of getting new information,i.e. overlapping,

classification, structural analysis, generalization, mathematical-cartographic and theoretical-cartographic modelling (including prediction).

This methods are to a certain extent used at all stages of processing. However, for each stage the prevailing areas for application of each group and each method can be indicated.

1. Recording of observations. Generally, it does not comprise methods of processing. However,in case of transferring analog data into digital form, methods of discretization and decomposition are applied.

2. Establishment of equivalence relations.A group of methods for generalization and simplification and methods of studying links (primarily statistical ones) for the purposes of simplifying the set of used features and creating generalized characteristics of different parts of the set of studied objects.

3. Establishment of neighbourhood and inclusion relations. Methods of generalization and simplification (continualization, smmothing, grouping, zonation) and methods of getting new information (overlapping, structural analysis, mathematical-cartographic modelling, generalization).

4. Establishment of the order relations. Methods of studying links between objects (primarily,statistical and cartographic correlation) and methods of obtaining new information (classification, structural analysis, theoretical-cartographic modelling).

5. Establishment of cause-and-effect relations.Mainly,methods of getting new information.To a lesser extent, methods of studying links between objects are applied.

6. Prediction. Methods of getting new information, and primarily theoretical-cartographic modelling (partcularly, prediction using formalized and non-formalized

techniques). To a lesser extent, at this stage the other methods of this group are applied. Within restricted limits, methods of statistical and cartographic correlation are used.

4 Pattern of information processing

Two major trends can be outlined in the described system of processing:

1. A successive increase of the role of geological theories, empirical models (for instance, predictive-prospecting models during prediction of mineral deposits[2]) and qualitative judgements based on geologist's experience. Correspondingly, the reliability of constructions is frequently reduced;and they should often be regarded only as verisimilar judgements.

2. A regular change in the amount of statistical information. This amount successively diminishes from stage 1 to stage 3 at the expence of simplifying the initial data file. At the stages 4 and 5 it increases due to involvement of conceptual information, which is not contained in the initial data file and getting new, predominantly genetic information. At stage 6 the amount of information is again reduced due to a decreasing diversity of the tasks solved and the objects studied. At the same time, there occurs a continuous process of a successive increase of the scientific and practical value of the results obtained.In this connection, processing of geological data in GIS technology can not be restricted by stages 1-4, since only taking into account stages 5 and 6 one can get the most valuable, though less reliable results.

A special problem of processing is non-coincidence and different reliability of information obtained using different methods of studying geological enviroment. Non-

coincidence is, to a major extent, associated with the fact, that geological and geophysical methods mainly record statical properties of geological environment,whereas geochemical and remote sensing evidence contains a significant share (over 50%) of data on dynamic process in this environment.In this connection,it is necessary to conduct separate mapping of static and dynamic characteristics, representing them by means of different cartographic materials, as well as to assess the reliability of data obtained using different methods.The task of evaluating reliability can be also formulated as applied to processing procedures, since they can result in the appearance of artefacts. Such an evaluation can be conducted using the probability theory techniques, particularly Bayesian approaches [1]. These techniques should be included into the package of programs on GIS technologies.

References

[1] Burde A.I., 1990. Cartographical research method for regional geological works. 251 pp,Leningrad.(In rus.)

[2] Burde A.I., Stolpner M.N., 1991. Methodology of forming predicative-prospecting models. Soviet Geology, No 2, pp.88-92, Moscow. (In rus.).