SEMANTIC ANALYSIS AND GENERALIZATION PROCEDURE OF GEOLOGICAL MAPS

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Abstract

During analysis and generalization of geological - cartographic model of principal significance is the approach to geological boundaries as the objects which concentrate information on space-time relations, conditions and time of emplacement and alteration of geological bodies. Interpretation of boundaries as lines of coincidence of the outlines of adjacent bodies is of great significance during the use of computer technologies in geological cartography.

1 Semantics of geological boundaries

Use of GIS technology in geological cartography makes one pay attention to the semantic specialization of the geological-cartographic model. First, it is necessary to emphasize the specific character of geological boundaries.

Unlike geographic boundaries, geological ones represent intersection lines of boundary surfaces of three-dimensional geological bodies with the Earth's surface. The boundary surfaces proper are, as a rule, inaccessible for direct observation. The second feature of geological boundaries is their belonging to the neighbouring geological bodies, which, in a general case, are of different age. These are age boundaries.

The boundary surface of adjacent bodies can be regarded as a mathematical surface,in which physical surfaces of two bodies are combined. The surface of a younger geological body is always undisturbed, formed "in situ". It also reflects morphological features of the surface of a more ancient body. The surface of the latter can be undisturbed only in case of concordant occurrence of a younger body on it, which is observed in sedimentary rock sequences. In all other cases the surface of an older body is disturbed: eroded or broken up. Therefore, the surface of geological bodies contains information on the time and character of their emplacement and alteration. Such an approach to the boundary surface brings us back to the reasoning of the classic of geology, the Danish naturalist of the 17th century N.Stenon, who defined the principal features of relationships between geological bodies of different age as "solido intra solidum naturaliter contento".

The considered approach to geological bodies and their boundary surfaces can also be extended to cover the geological-cartographic model, which is represented by the geological map. By analogy with the boundary surface, the geological boundary in the map represents a mathematical line, which combines outlines of exposures of two adjoining bodies of different age. The pattern of geological boundary reflects information on morphology and genesis of the surface of geological bodies. The known feature of geological boundaries is the association of their configuration with morphology of the Earth's surface: in case of low bedding angles of boundary surfaces relative to horizon, the configuration of boundaries is regularly determined by relief of the Earth's surface;and in case of horizontal occurence of boundary surfaces, it coincides with relief contours.

Age relationships of bodies can be determined from the pattern of geological boundaries near the point of their junction. Here, the outline of a younger body is always a flowing line and commonly "cuts" the geological boundary of more ancient bodies (Fig.1).

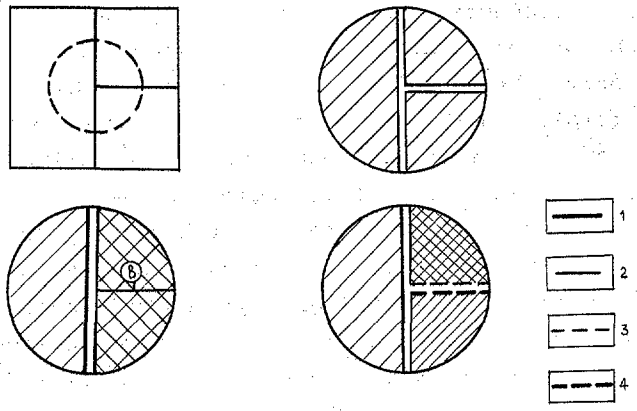

Fig.1 Anatomy of junction point of boundaries

A - Boundaries near the junction point;
B - Boundaries as outlines of three bodies;
C - Outlines of the youngest body and older bodies, devided by the boundary (b);
D - Outlines in the junction point: 1, of undisturbed surface of the youngest body; 2, of disturbed surfaces of an older bodies;3, of disturbed surface of the oldest body; 4, of disturbed surface of the body of intermediate age.

Therefore, the pattern of geological boundaries in the map should be perceived as a morphologically, genetically and chronologically significant presentation.

An essential problem of geological cartography is the semantic stability of presentation of boundaries. The stability test can be realized in the procedure of "minor movements", i.e. the *minimum mental mutual* displacement of outlines of bodies relative to their junction point.In case of a correct presentation of boundaries the sense of geological relationships should remain unchanged. The research conducted has demonstrated, that in the junction point of boundaries in the map, space-time relationships of only three geological bodies are semantically stable (a triple junction). Appearance ofjunction points of four or more bodies in the map indicates a cartographic error and the disturbance of geological sense.

Understanding of the specific genetic character and space-time parameters of boundary surfaces of geological bodies and, correspondingly, geological boundaries in the map plays the most important role in professional perception of the geological- cartographic model and in generalization of initial cartographic materials.

2 Objects of generalization in geological maps

The main object of generalization are geological boundaries, mainly outlines of relatively younger bodies. Generalization of outlines during transition to smaller scale is based on understanding of the semantic essense of the outline as a morphogenetic element of the body.The generalization of outlines of bodies of the cover class in case of a relatevely undisturbed occurrence is conducted in full accord with the accompanying generalized topographic base.During generalization of outlines of bodies of the cutting class account is taken of the morphogenetic features and geometric parameters of bodies. In case of its gently sloping occurrence account is also

taken of the character of generalization of the topographic base.

The object of generalization are also the geological chronicles, which is due to the fact, that it is impossible to reflect on a small scale certain age groups of geological bodies. The constructive age intervals and the corresponding geological events should not be excluded from geological chronicles, however small their duration might be. In the course of generalization these intervals should be semantically correctly combined with other intervals into larger intervals,reflecting stages of geological evolution of the mapped territory. If this procedure is impossible,the corresponding bodies are presented as extra-scale ones or on an exaggerated scale at the level of geometric qualification.

The object of generalization is also a geological structure,recorded in the character of combination of bodies. During generalization, the orientation of the main structural elements should be retained, as well as morphogenetic specific character of structures reflected in configuration of geological boundaries. Generalization of structures is conducted in accordance with zonation of the territory on the basis of age correlations. Simplification of geological structure, particularly rejection of certain faults, separating geological bodies, should be accompanied by reconstruction of outlines in accordance with geological nature of younger bodies.

One of important criteria of generalization is the number of junction points of boundaries, in which relationships of geological bodies can be determined. In a general case, this number should not increase as compared to initial materials. Besides, in the composite map formally correct relationships, not recorded in any point of the mapped territory, should not appear. On the other

hand, during generalization,the reliably recorded relationships of bodies, observed in initial materials, should be retained and clearly demonstrated.

Finally,the generalized geological- cartographic model should combine the semantic correctness, information saturation, geometric accuracy with the possibility of perceiving its content at several hierarchical levels.

3 Conclusion

The considered approach to geological boundaries as boundary elements,concentrating information on space-time relations, conditions and time of shows of stages of emplacement and alteration of geological bodies, can play an important role in development of computer technologies for the studies of geological maps. Particularly, it will allow input of geological boundaries into information systems not as simple lines, separating map areas with different values of certain parameters, but as the lines of coincidence between outlines of two bodies, which have individual characteristics of the corresponding adjoining surfaces. The authors presume, that the proposed approach can be extended, with the corresponding corrections, to cover other types of thematic maps.