

QUALITY OF GEOLOGICAL CARTOGRAPHIC MATERIALS AND ITS MAPPING

Sergey I. Strelnikov,

Alexander I. Burde

Russian Geological Research Institute (VSEGEI)
74 Sredny pr. St. Petersburg, 199026, Russia

Abstract.

Issues concerning quality assessment of geological cartographic materials are considered. The latter can be classified under phenomenological (geological, tectonic maps etc.) and analytical (geophysical, geochemical maps etc.) materials. It is shown, that an indirect mapped indicator of quality of phenomenological maps can be the time of their compilation and(or) publication. For analytical maps, quality can be assessed from measurement precision in the integral form, which is also reflected by the time of conducting initial surveying.

1 Introduction

Geological cartographic materials are used for a rational planning of geological research, evaluation of mineral-raw material resources and environment of the country and its regions. The necessary condition for such a use is the availability of maps of geological-cartographic coverage. However, a simple presentation of areas, covered by certain geological - cartographic materials on different scale, in these maps provides only a part of the necessary information. The maps of coverage should also reflect quality of the materials available.

2 The criteria of map quality assessment

Quality of maps can be regarded as a combination of properties, ensuring their fitness for meeting certain needs of the society [3]. Of great significance for geological cartographic materials is the prognostic possibility of their practical use in the process of prospecting for minerals and evaluation of environmental factors, associated with changes in geological environment.

All geological cartographic materials can be classified under two types. Maps of the first type mainly reflect the qualitative and, to a lesser extent, quantitative data with the use of non-formalized or partly formalized procedures (geological proper, geomorphological, tectonic maps etc.). Maps of this type can be called phenomenological. Maps of the second type reflect quantitative (digital) data, generalized on the basis of strict mathematical procedures (analytical maps). This type also comprises maps of geophysical fields, geochemical and some other maps.

For quality assessment of geological cartographic materials the same characteristics can be used, as for classical geographic and other thematic maps. At the same time, there are several specific characteristics of certain features, typical only of geological cartographic materials. Further, we shall describe only those properties which characterize the materials as information-carrying media without consideration of the quality of geological cartographic materials as technical items.

3 The main characteristics of map quality

Necessary and sufficient for quality assessment of maps as an information-carrying medium are such features,

as accuracy, reliability, up-to-dateness, fitness, corresponding contents, readability, cartographic design [3,4].

Accuracy is the degree of conformity between location of points and objects in the map and their location on area.

Reliability is the correctness of information given by the map for a certain date. For geological cartographic materials this is the date of compilation of the map.

Up-to-dateness is the degree of correspondence between the contents of the map and modern theories of geological science and modern state of knowledge on geology of the mapped area. For geological cartographic materials the requirement of up-to-dateness includes the necessity of a complete use of all the available information sources as of the date of map compilation.

Accuracy, reliability, up-to-dateness form an integral feature - dependability, i.e. the property of the map to retain in time within certain limits, all parameters, ensuring the fulfilment by the map of its function.

The notion "dependability", as applied to geological maps, also includes "longevity", non-becoming obsolete in terms of contents. The interpretation of age can become outdated in the map but not the outline of boundaries of geological bodies. Interpretation of the structure might change along with preservation of the main contents of the map. Certain attributes of this notion were previously included in the notion "informativeness". However, dependability is a broader notion. For instance, in terms of details of subdivision of geological formations we can

perceive this map as quite an informative one. However, insufficient reliability associated with incomplete account of modern schemes of subdivision of stratified and magmatic formations, clearly delimits the time interval during which the map remains up-to-date.

A very important factor for quality assessment of composite maps is also the correspondence between contents and the initial cartographic materials. The essence of this feature consists in a scientifically grounded presentation of geological objects and phenomena, their typical features and relationships with regard for the genesis and inner structure of illustrated objects. Correspondence is ensured by the completeness and reliability of initial information, as well as by a correct procedure of generalization, based on principles of semantic analysis of geological maps (see the paper by E.Zablotsky and S.Strel'nikov in this issue).

Fitness - correspondence of the compiled map to the pre-assigned norms or the accepted standard. For geological maps such standards are: Instruction on compilation and preparation for publication of State Geological Maps, which presents both the requirements to map contents, and type symbols. For analytical maps the notion of fitness primarily includes metrological requirements to surveying. The criteria of fitness are the same as those of dependability (accuracy, reliability, up-to-dateness), however they are determined relative to the earlier formulated requirement, but not relative to the object of cartography [3]

Of great significance for quality assessment of geological cartographic materials are such single features

as readability and map load.

Readability is the distinction between elements and details of cartographic presentation. Not only a purely visual possibility to distinguish two or more closely located symbols is borne in mind, but also distinction of details of presentation in terms of the possibility of understanding their contents.

Maps load is filling of the map with symbols, i.e. the number of symbols per a unit area of the map.

The combination of readability and load results in such an important complex quality characteristic as clarity, i.e. the possibility of a correct perception of spatial distribution and relationships of geological bodies based on the map, as well as geological structure formed by them. Clarity of the maps, particularly composite ones, is determined by a correct generalization of initial data.

On the other hand, improvement of perception of the information contained in the map is favoured by a successfully chosen cartographic design, i.e. a system of artistic methods of map presentation and a rational arrangement of elements of the map, which promote the perception of their content and creation of a certain emotional impact on the user in accordance with the purpose of the map [3].

In a generalized form the quality of geological cartographic materials can be described by a hierarchical tree of mutually related features (Fig.1).

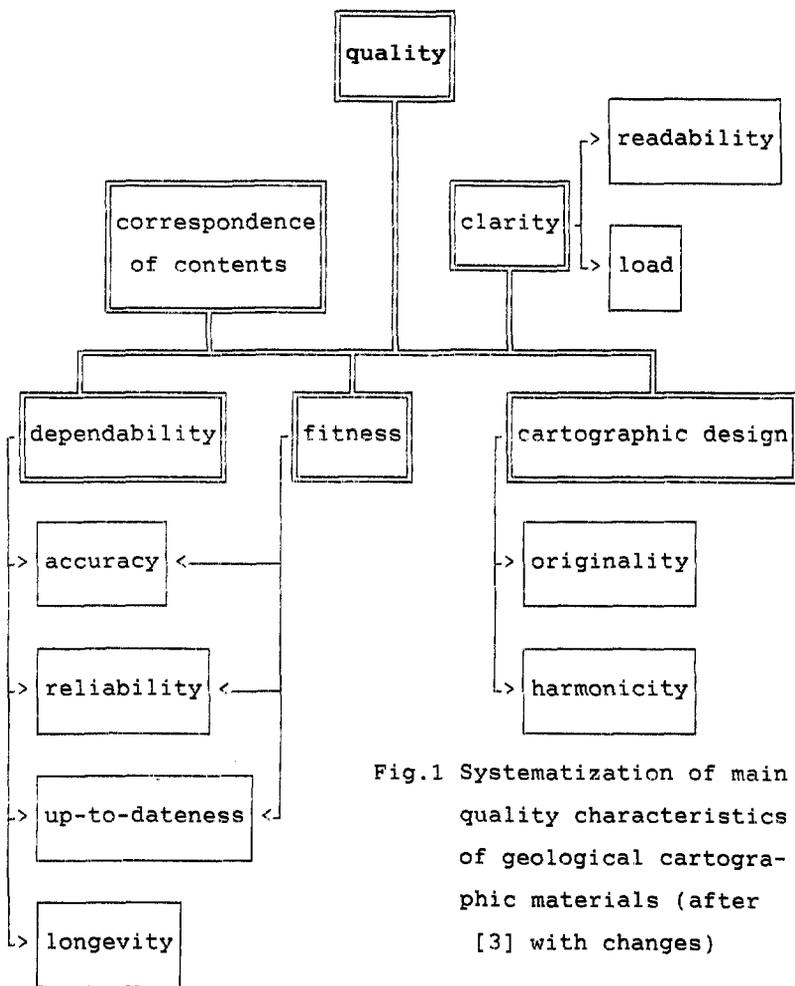


Fig.1 Systematization of main quality characteristics of geological cartographic materials (after [3] with changes)

The above features have different significance for phenomenological and analytical maps. For phenomenological maps, the most important features are dependability and correspondence of contents. The quality of analytical maps is, to a greater degree, determined by fitness, particularly by observation of metrological characteristics of measurement in the course of surveying (accuracy, sensitivity, mean-square error).

4 The map quality mapping

Among all the above characteristics, only the accuracy and load can be assessed quantitatively. For assessment of all the other characteristics, for each specific map, it is necessary to conduct special research, which would result in development of quantitative scales, enabling to reflect a certain feature in the map. If there are files of thousands and tens of thousands of maps (a file of maps on 1:200 000 scale in Russia is more than 4000; and that on 1:50 000 scale, more than 60 000), such an analysis of the contents requires a lot of time and material resources, without guarantee against serious errors. All this forces one to look for such methods of assessment, which, on the one hand, would be rather simple and, on the other hand, the chosen characteristics could be presented graphically.

The analysis of contents of quality characteristics enables to reveal the general invariant property, which determines both the value of characteristics, and their mutual relationship. Time is such an invariant property. In fact, time appears in definitions of reliability and up-to-dateness, i.e. the main single characteristics, making up complex characteristics of "dependability" and "fitness". To a major extent the time factor is also important for such feature as "the correspondence of contents". Changes in features result in the loss of the prognostic value of maps. This leads to the necessity of their renewal and re-edition. In this connection, an indirect assessment of the quality of geological cartographic materials can be given proceeding from changes of characteristics in time, rather than from their absolute values.

For phenomenological maps such assessments can be made using the analysis of the time of compilation (or publication) of maps and their re-compilation (re-edition). Unfortunately, the material on the geological maps of Russia is insufficient for revealing reliable statistical data on their renewal due to the fact, that systematic geological mapping on large and medium scale started in Russia only in 1954. For a major part of the territory of Russia the compilation and publication of the first generation of maps even on 1:200 000 scale has not yet been completed. Therefore, the process of renewal of geological maps is analysed using the example of maps of the UK, France and Italy, where they were multiply renewed [1,2]. Research has shown, that in order to assess the rate of this process, one can use the notion "the period of semi-renewal", i.e. the period of time during which 50% of the general file of maps are renewed (this is, to a certain extent, an equivalent of the citing index). This period in the late 19th - early 20th century was 30-50 years; in the second half of the 20th century, 15-20 years. From this analysis it follows, that if the time of publication of a certain map exceeds the above period, its quality would no longer conform to modern requirements. In connection with quick accumulation of new information, which is due to intense implementation of new procedures and technologies into geological prospecting production, the time periods for renewal of geological maps are quickly reduced as the modern period is approached.

Therefore, the quality of phenomenological maps (including geological proper ones) can be mapped as the reflection of the time of their compilation or publication, similar to other scientific publications. This approach

was realized in the Atlas of geological cartographic studies of the USSR (1991) and in the Map of geological-cartographic studies of Russia on 1:10 000 000 scale in the Geological Atlas of Russia (see the paper by A.Smyslov et al. in this issue).

Quality assessment of analytical maps as "conformity to modern requirements" can be given on the basis of the time of introducing new metrological requirements, resulting from appearance of more precise and sensitive devices, methods of analysis etc. Due to this, surveying of different quality, can be classified on the basis of the time of introducing new requirements and (or) appearance of new technical facilities with higher precision and sensitivity. Such an approach to quality assessment of analytical maps is realized in the Map showing quality of geophysical studies in Russia on 1:10 000 000 scale in the above mentioned Geological Atlas of Russia.

Time, as an indicator of quality, can be easily reflected in maps by various cartographic means (colour, hatchings, specs, digital symbols).

The above process of renewal of maps and bringing their quality to conformity with new requirements imposed by society can be regarded as the process of quality management. For optimization of this process it is necessary to gradually pass on from periodical renewal and re-edition of maps to their permanent renewal, which fully conforms to the ideology of GIS.

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