Regional engineering geological mapping for planning purposes

Cartographie géotechnique régionale en vue de la planification

General report / Rapport général

REGIONAL ENGINEERING GEOLOGICAL EVALUATION FOR PLANNING PURPOSES
ÉVALUATION GÉOTECHNIQUE RÉGIONALE POUR LA PLANIFICATION

MATULA M., Department of Engineering Geology, Comenius University, Bratislava, CSSR*

Summary

To meet the growing requirements for more exact interpretation, prediction and recommendation, methods of quantitative evaluation are being rapidly developed also in regional engineering geology. The paper deals with some questions of how to increase the level of exactness in all the main phases of processing information on regional geology: in acquisition, storage and retrieval of primary data; in classifying the relevant attributes of phenomena shown on our maps; in special purpose oriented transformation of engineering geological and geotechnical maps; and in optimization analyses when evaluating regional units and systems.

Résumé

Pour satisfaire les demandes croissantes concernant plus d'exactitude d'interprétation, de prédiction et de recommandation, les méthodes de l'évaluation quantitative se développent rapidement aussi en géotechnique régionale. La rapport traite de certaines questions: comment améliorer l'exactitude dans toutes les phases principales du traitement de l'information de la géologie régionale: dans l'acquisition, le stockage et la gestion des données primaires; dans la classification des caractères importants des phénomènes présentés dans nos cartes; dans la transformation des cartes géotechniques pour des usages particuliers, et dans les recherches d'une évaluation optimale des unités et des systèmes régionaux.

Introduction

It is well proved by the analysis of recent trends in engineering geology that the centre of new developments in this discipline has moved from narrowly limited "site investigation" to a wider field of "regional studies", oriented to the solution of constantly more comprehensive environmental problems. Encouraged by the growing geological requirements of planners and designers, methods of quantitative evaluation and qualified prediction of changes have been developed within the field of regional engineering geology. Its ability to provide realistic interpretations instead of merely geological statements is nowadays largely recognized in planning extensive infrastructures fully in overall harmony with regional conditions.

Considering the questions of increasing the level of exact and quantitative evaluation of engineering geological information as the most relevant ones in all phases of regional data processing, I would like to deal with them in more detail in this brief report. The following phases are mainly implied: acquisition, storage and retrieval of primary data; quantitative classification of phenomena in engineering geological maps; transformation of engineering geological and geotechnical maps; and optimization analyses in the evaluation of regional systems (units). With regard to the limited scope of this contribution I am presenting in it only some examples from Czechoslovakia.

Acquisition, storage and retrieval of primary engineering geological data

The innovation induced by newly developed investigation techniques in the field of geological and geophysical subsurface exploration, remote sensing, computer use, etc., can be fully efficient for regional engineering geological studies only if there is also a parallel development in our methods of interpretation, evaluation and utilization of the acquired data. The substantial increase in precision and in applying quantitative criteria are here the key problems. In other words, we are facing nowadays the acute problems of how to improve our ability to use exact criteria and classifications in adequately

* Prof. Milan Matula, Dept. of Engineering Geology, Comenius University, Zádunatská 15, CS 81100 Bratislava (Czechoslovakia)
quantified engineering geological terms, in order not to lag behind the possibilities which are provided by the rapid developments in observation and exploration techniques.

For advancing the precision of accumulated primary information data, which has always been and will be the fundamental starting point to a successful solution of all theoretical and applied tasks in our discipline, of decisive importance at present is progress mainly in the following two trends:

- a) preparation of a precise terminology, based on scientifically proved definitions, as well as of exact evaluation of all phenomena shown in engineering geological maps;

- b) preparation of internationally agreed quantitative and semiquantitative classifications for the main attributes of the phenomena being observed and measured, as an efficient tool for limiting the subjectivity of data on our maps.

Much has already been said about the indispensability of unification in terminology and this task belongs to our fundamental duties within the national and international sphere. It is a particularly appropriate time to see more evident progress in this field in the IAEG.

In regional engineering geology it is necessary to work with a great quantity of diverse data. That is just why their exact evaluation and classification is far more necessary, as well as more difficult than in site investigation. An appreciable help in storing and retrieval of large amounts of data is exerted by the systems of various computerized data banks. Their fundamental requirement, however, is that the primary information data must be formalized, but formalization is efficient only when based on a suitable quantitative analysis and on precise rules and standards.

In the phase of the acquisition and formalization of primary data it is usually necessary to overcome many obstacles resulting from extreme diversity in filing and format systems, and in the different organization of data collected from various sources, and also in accuracy and incompleteness of information by different authors or agencies, and/or from various time periods. Critical selection and re-evaluation of the data, their reclassification in new and exact terms usually represent here bigger problems than the acquisition of new original data by applying unified and standardized observation, exploration and testing methods. The latter, however, are naturally also substantially more expensive and therefore it is necessary to use as much as possible the old accessible data in spite of the above mentioned difficulties.

The best way towards a systematic and exact acquisition and documentation of primary data obtained by observation and measurement of the engineering geological attributes (even those taken from older existing archives) is the use of unified and formalized record sheets. In Czechoslovakia, for example, engineering geology in general uses the standard forms of the State Geofond for primary records of drilling results, for observation of geological conditions and processes in individual localities, for hydrogeological data, etc. The results are made according to detailed manuals which contain definitions and classifications, as well as coding systems for all attributes stored in a unified Engineering Geological Data Bank.

The advantages may be multiplied by using data not only from the specialized engineering geological data base, but also from the similarly organized subsystems for such related disciplines as Geology of mineral deposits, Hydrogeology, Geomorphology, Environmental protection, etc., which are in my country the individual sections of the Automated Information System for Geology (forming a part of the Integrated System of Data on the State Territory).

The efficiency of unified databanks may be fully demonstrated in regional investigation only when they are employed to a great extent for collected data and for vast territories by all users of engineering geological information. Thus, for example, in Czechoslovakia, the State Geofond Data Bank Rules apply by law to every author compiling a multipurpose engineering geological map at a scale of 1:25,000. Thus a higher efficiency is attained of a multiple use of investigation results, and duplications in exploratory works for other new projects may be prevented.

The engineering geological information stored in the data base may be processed by applying various specialized programs to receive outputs presented in the form of: verbal documentation, tables listing required data and parameters, geological sections, maps of documentation points, different analytical and synthetic maps, etc.

The growing importance of computerized databanks was highly acknowledged by the IIIrd International Engineering Geological Congress in Madrid and it is appreciated also by the IAEG Mapping Commission, where a special group (led by Dr. Sanepojuard) is preparing a review of achievements in this field.

Quantitative classification of data presented in engineering geological maps

From all that has been said above on the formalization of engineering geological data, it also follows that the preparation of a system for quantitative classification of mapped phenomena is an indispensable condition of increasing the exactness of regional engineering geological investigation and mapping. Such a classification system should be prepared for all fundamental components representing engineering geological conditions (i.e. rocks and soils, groundwater, landforms and geodynamic phenomena), as well as for all their current attributes, and for various scales of maps.

This, however, is an extremely difficult task, surpassing the difficulty of unified terminology, and its efficient solution can be achieved only by international cooperation. The IAEG Mapping Commission, aware of this, is preparing at present a suggestion for quantitative classification of various characteristics of rocks (i.e. engineering rocks and soils) important for engineering geology. Part I of our report dealing with the classification of rocks and soil materials is published in the present Symposium Proceedings. A first draft of Part II on rock and soil mass classification has been discussed by members of the Commission, but it is felt that more work needs to be done before an agreed version can be presented for comment to the chairmen of other IAEG Commissions.

Multipurpose engineering geological maps and their special purpose oriented transformation

In regional studies it is most reasonable, both technically and also economically, (1) to acquire a rather comprehensive set of engineering geological data, (2) to map systematically larger areas, and (3) to collect the comprehensive information in special data banks. This makes it possible to prepare synthetic and very detailed multipurpose engineering geological maps for various parts of the territory.

Following the recommendations of the UNESCO-IAEG Guide to the Preparation of Engineering Geological Maps (1976), two types of multipurpose map are of the greatest importance as the fundamental models of the natural conditions: (a) maps of engineering geological conditions, and their equivalents transformed in terms of (b) engineering geological zoning (Fig. 2).

Using a broad and well organized data base, as well as the fundamental multipurpose maps (as described above), it is possible to prepare subsequently any special report (with money and time spent only for some inevitable additional field work), and also various special purpose engineering geological and geotechnical maps can be prepared by transformation procedures.