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A new Slovenian digital cartographic standard for geologic map symbolization

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Abstract

Almost four decades have passed since the last "new" graphic standard has been issued by the former Federal Geological Survey of Yugoslavia (1964). Although it was prepared for the project of Basic Geologic Map at the scale of 1:100.000, its use surpassed the primal purpose, and it became broadly used in various graphic representations of geologic information. Through years, however, the standard outdated and have therefore been sporadically upgraded. Constant changes gradually made it unsystematic and inconsistent. An effort was made a couple of years ago to revise it again, and to convert it into digital form but the result provided another conclusive evidence that a total revision of the original is needed. A new digital cartographic standard for geologic map symbolisation is therefore being prepared in Slovenia. The project is run by a team formed at the Geological Survey of Slovenia in close co-operation with contributors from other geologic institutions in Slovenia. The aim of the project is to prepare a consistent and comprehensive set of graphic symbols and rules of representation that would cover the needs of the geologic maps production in scales between 1:10.000 and 1:100.000. The focus of standard's applicability is, however, the new Geologic Map of Slovenia in scale 1:50.000.

Initial requirements

Requirements that the new Standard needs to meet are:

- uniform graphic appearance of geologic maps,
- employability in maps of scales between 1:10.000 to 1:100.000 with employability focused to the new Geologic Map of Slovenia in scale of 1:50.000,
- employability in litho/chronostratigraphic maps as well as in formation maps,
- employability in geologic cross-sections and stratigraphic/lithologic columns of adequate scales,
- strict systematics,
- employability in various application environments,
- user-friendliness (valid for the maker as well as for the reader of the product)
- applicable in solving local geologic problems yet comparable with global standards.

Methodology

A work group of 17 experts has been formed to revise existing standards and to prepare proposals by topics. The topics were distributed among group members according to their professional specialities. Each of

the group members prepared a Standard proposal on a selected topic given only the rough outlines of the expected joint product. The proposals were then co-ordinated and revised by the whole work group. After all the suggestions and corrections were taken into account, the manuscript proposals were sent to the Geologic Information Centre of the Geological Survey of Slovenia for digitalisation (transfer into the application environment). After the digitalisation is finished, the draft version will be revised again by the work group and published on the Internet for public revision. After the three-month revision period, the work group will consider suggestions, make necessary corrections and finally publish the Standard on the home page of the Geological Survey of Slovenia. The product will stay open for further suggestions through a digital form published aside.

Several Standards exist on the "market", so it has been clear from the very beginning that there was no need for introducing brand new systematics or to apply a completely different approach. The following Standards were used as the basis for the new product: ISO (1974–1989), JUS (2001), USGS-FGDC (2002), OGK 1 (Savezni geološki zavod SFRJ, 1964), the Standard proposal for OGK 2 (Savezni geološki Zavod SFRJ, 1985) and the manuscript proposal for the Slovenian OGK 2 Standard (Premru & Jevšenak, 1996). However, a simple compilation of existing standards proved to be impossible for several reasons. Some of existing standards are inconsistent by their systematics, some are not compatible with the geology of Slovenia, some are too extensive, and the others are too simple. Preparation of the new proposal therefore required plenty of authorial work, in some cases starting completely from scratch.

The structure of the standard

The Standard consists of three major topical complexes: 1) graphic and alphanumeric symbols, 2) geologic timescale and 3) rules of representation.

Graphic and alphanumeric symbols part is the major topical complex of the Standard. It comprises all graphic symbols, hatches and alphanumeric symbols that may apply on a geologic map with an exception of formation, and chronostratigraphic notations. The complex is divided into following topics: 1) sediments, sedimentary rocks and sedimentary environments, 2) volcanic and volcanoclastic rocks, 3) magmatic rocks, 4) metamorphic rocks, 5) minerals, 6) tectonics and structural geology, 7) palaeontology, 8) geomorphology, 9) hydrogeology, 10) engineering geology, 11) mineral resources, 12) special symbols, 13) natural heritage.

The guiding line through the process of preparation was the strict systematics. Namely, there are several examples of existing Standards that have failed in solving the problem of systematics adequately. By comparing them, it became evident that there are three main reasons for a failure: 1) certain geological phenomena are described by two or more symbols, 2) similar or identical symbols are applied to describe different geological phenomena, 3) basic and expanded symbol sets are put together regardless of any hierarchy.

The basic, and the expanded symbol sets are strictly divided in the new Standard. Introducing the basic (obligatory) symbol set along with the expanded set means that the mapping geologist will be able to use the Standard regardless of his field of specialisation. Vice-versa, the specialist should find all the symbols needed to conduct any specialised work with the scale of the map/profile/column taken as a limitation, of course.

All symbols are presented in standardised tables and described by a consecutive number, the name, picture, alphanumeric symbol where applicable and a short comment describing the rules of its use.

The timescale is the second topical complex. The main idea that followed the preparation of the timescale was to make a local chronostratigraphic division in accordance with global chronostratigraphic/geochronologic divisions. There is a "near-perfect" global time scale that is being constantly updated by the International Commission on Stratigraphy (ICS) of the International Union of Geological Sciences (IUGS). However, the specifics of Slovenian geology make the global timescales non-applicable in certain cases. It was concluded that, for various reasons, local particularities have to be considered for the Carboniferous, the Lower

Triassic and the Paleogene – Neogene geochrons. The main frame, however, stayed completely comparable with the (semi)official ICS's timescale. The divisions go down to the stage or to the substage where reasonable.

Beside the main timescale, the new Standard will provide links to three additional (informative) scales that are being broadly used for comparison with official chronostratigraphic units. These are: the geomagnetic polarity, $\delta^{18}O$ and the Alpine Pleistocene morphostratigraphy.

In case of the Tertiary and the Quaternary we took the conservative approach. Namely, the ICS ceased to use those two as formal chronostratigraphic units, but we found them both too well-nested in minds of geologists so the decision was made to use them. In addition, the cancellation of Tertiary and Quaternary has not been formalised yet.

Rules of representation define the notation rules for chronostratigraphic, and formational geologic units. The aim of the standard is to be applicable for all types of general geologic maps so the rules do not exclude any type of such maps.

Transformation into the digital form & GIS

To transform the analogue data into the digital form and further into the GIS environment in a effective manner, proper standards are needed. These standards have to be strict, practically perfect and upgradable enough, so that absolutely no divergence from the rules is allowed. At this junction of needs, the concept and the GIS, the consistency and applicability of standards work hand in hand.

Graphic symbols, hatches and alphanumeric symbols are transformed into the digital form in proper scales, using CAD tools. After the shape, colour and dimensions are confirmed by the author and the review group, the symbols will be introduced into the standardised procedure of the map digitalisation. For the purpose of the onscreen digitalisation of the Basic Geologic Map at the scale of 1:100.000, the CAD application "Geolog" (i.e. Geologist) was developed (Fig. 1). This standardised procedure is used to minimise the analogue-to-digital transformation errors. The operator (digitiser) uses simple, user-friendly menus in which symbols from different topics are listed and shown. With the described procedure, the basic attributes of a specific symbol are entered and can be further used for the linkage with the symbol's properties and more detailed description in GIS environment. The already adopted protocol, with necessary updates taken into account, will also be used for digitalisation of geologic maps compiled on the basis of the new Standard.

The new Standard is supposed to support production of maps in various scales (from 10.000 to 100.000), hence graphic symbols have to be adjusted to the specific scale and can not be simply scaled. Each symbol has to be defined and designed for each specific common scale used. Also colour charts will have to be defined for each of the symbols. For hatches the RGB and CMYK values need to be defined due to different screen and printer/plotter properties. For graphic symbols (objects and lines) 8-bit colour palette is advisable, to avoid unnecessary dithering on devices that can only display 256 colours (Brown & Feringa, 1999).

Standard layouts of maps, which will comprise the map itself, the title, the cross-sections, the columns, the legend(s), the design of the scale bar, the north arrow, appendices, and text, will also be defined.

With all described bearing in mind, there are several problems that arise during the process:

- non-systematic (chaotic) symbols (hatches),
- scaling of symbols,
- colour vs. black/white print,
- variable hatch orientation within a single geologic unit (bedding...),
- ironically, the inter-PC compatibility can sometimes pose big problems due to specifics of CE fonts, commonly used for Slovenian.

During the development of the new Standard, all problems stated above should be considered. Than again, geologists should participate in the process of the GIS software development more actively, since our needs sometimes differ from the needs of other spatial related sciences.

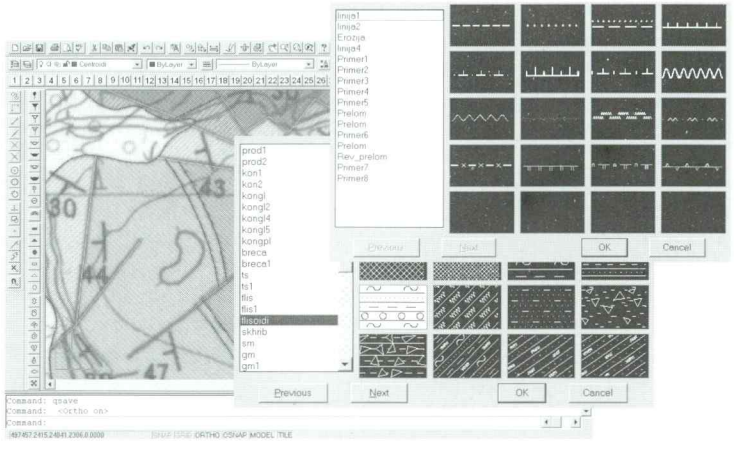

Figure 1. CAD application "Geolog" (Geologist)

Discussion

Creation of a new Standard consists, in its basics, mostly of compilation of existing standards. However, considering the specifics of regional geology and any kind of special requirements, a pure compilation is practically impossible, and the authorial approach is needed.

Two issues arose along the process of preparation that we have not solved in-full yet. The first is the problem of sytematics and division of symbols according to hierarchical criteria. The second problem, which is in-part specific for Slovenia, is the problem of translations. Beside grammatical issues that demonstrated while translating names of chronostratigraphic units, we are still discussing the decision on whether to derive alphanumeric symbols (two- to three letter) from the original (Greek, English....), from English, or from Slovene.

Prior to creating data presentation standards for the whole country, three levels of consistency have to be addressed: consistency of the original survey (standardised data collection), consistency of descriptive information (standardised data model) and consistency of coding (Johnson et al., 1997). The former two can be controlled and "enforced" up to a certain degree, while the first one depends purely on the knowledge and consistency of the field geologist.

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