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Digital Model of the Basic Geological Map of the Republic of Macedonia

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Abstract

This paper presents the process of digitalization of the Basic Geological Map of the Republic of Macedonia in software package Mapinfo professional 8.0. It shows the procedure of design and implementation of a GIS project for the Basic Geological Map of the Republic of Macedonia . Design of the database table, selecting atributes and drawing graphical objects are also given.

1.Introduction

A geologic map is the principal tool that geologists use to convey information about the structure and stratigraphy of the earth's surface, the location and type of geologic hazards and earth resources. The most powerful and useful aspect of geological maps (especially large-scale) is the correct representation of rocks with added information of time. A geological map is thus a information system on a horizontal reference plane, which is crucial in understanding not only where earth resources and characteristics are located, but also how and when these earth features were formed.

The primary objective of geological map is to reconstruct the geological evolution of the area. A geologist understands the geometries of the rock bodies and their lateral and vertical relationships from the map. Idea about the three dimensional nature of the rocks and their relative ages is obtained from this information which in turn helps in interpreting the geological history of the area. Having acquired this knowledge, the geologist can then apply his understanding in solving problems related to earth resources, hazard assessment, and land-use planning.
Basic geological map of the Republic of Macedonia was produced when the Republic of Macedonia was part of Former Yugoslavia. This is the information about the authors:
It was made and printed by the Department of Cartography "Geokarta" Belgrade 1977. Investor was the Research Concil in Mining, Skopje -1977. It was compiled in the Geological Department in Skopje 1975. Authors were Jordan Pendzerkovski Ph.D and Smiljana Hadzimitrova B.A.Sc.

Basic geological map (BGM) was compiled in 1975 and is not in digital form. If we want to use this map more efficiently, we must digitalize the map. Geological maps are extremely complex documents with many different types of information displayed. So, we must be careful when we process this map through GIS software.

With the use of information technology and digital geological maps, there are new opportunities for in-depth analysis of various aspects, quick access to information, more reliable information, efficient work etc. Using and transfer digital map is far more efficient than the classical paper map.

2. Motivation and related work

In 1988 the tectonic map of the Republic of Macedonia was digitized. Publisher was the Faculty of Mining and Geologyin Stip, department of Geology and Geophysics. Authors are Milan Arsovski, Ph.D and Dr. Gose Petrov, Ph.D. The scale of the tectonic map is 1:200 000. Preparation and publishing is done by Data DATAMAP-Europe Ltd Sofija, Bulgaria and the team from Department of Geology and Geophysics from the Faculty of Mining and Geology. This project was funded by the ministry of Science of the Republic of Macedonia. Software package Mapinfro professional 3.0 was used for digitalization of the tectonic map. In addition to tectonic layers, there are layers of roads, boundaries, town etc.

Using the experience of compiling a tectonic map it was decided that software package Mapinfo professional 8.0 be used for digitizing BGM of R. Macedonia. In that manner a comparison and use of previous work of the tectonic map and new digital BGM can be done. Analysis of the two maps will give in depth presentation of the geological and tectonic area in the Republic of Macedonia.

3. Process of digitalization of the Basic Geological Map of the Republic of Macedonia in Mapinfo professional 8.0

3.1 Scanning images

Digitalization of the map starts with their scanning. Scale of BGM of the Republic of Macedonia is 1:200 000. The map is divided in 23 pieces of A4 format and scanned with HP Scan jet 9100. The scan resolution is 300 dpi in million colors. In the process of scanning the map should be well suited on the scanner to lower the error of deformation. The best practice is to use middle part of the scanner because of the scanner deformations on the sides. Scanned parts of the map should have at least 3 points with defined coordinates. In our case every scanned part of the map has 4 points with precise values of coordinates (longitude, latitude).

3.2 Registration of the raster map

After scanning, we obtain raster map. The next step is to digitalize this map in Mapinfo.The process of digitalizing of the raster map is registration. Registration of raster map in Mapinfo is done with dereferencing 3 points (in our case 4). After selection of the projection in which the map was built. Now we have raster map in Mapinfo that has geographic coordinates. The program Mapinfo shows error that is made in the process of registration. Usually, the error was between 2-3 pixels and in the worst case 4 pixels.

3.3 Defining the layers

Next step is digitalization of the map in Mapinfo. First we must analyze the information that are shown on the raster map. The goal is to make GIS project on the base of raster map. Mapinfo stores the information in layers. Typically every layer is made of geographical vector or raster object and table (table of data). Geographical vector object

is point, line, polyline or region. Every geographical object is a row in the table. Table columns are attributes that define geographical object.

By analyzing the BGM, we defined 4 layers. All layers are in longitude/latitude projection. The first layer defines geological regions. Geological region is defined with its color, pattern and label. Attributes of the geological region are

Geoind	Symbol	Period	Era	Opis_na_karpa
Integer	Char -15	Char -50	Char -30	Char -150

Geoind is integer number which is used as index. Symbol is the geological label of the region. Period defines when the geological region is made. Era defines geological epoch. Opis_na_Karpa is the legend of the rocks.

Second layer are the borders between the geological region and part of structure formation from the geological map. Every object is polilyne that is defined with line style. Table of attributes is :

GranicaInt	TipGranica
Integer	Integer

Attributes TipGranica is integer number that correspond with this table:

1	Normal border
2	Gradual transition
3	Erozive border
4	Intrusion of igneous body
5	Outflow of volcano
6	Elements of slope of layer
7	Elements of slope of foliation
8	Elements of slope of ??? axes
9	Elements of stratification slope

Third layer is representing rest of the structure formations from the geological map. The table is as follows:

RasedInt	Opis_R
Integer	Integer

Attribute Opis_R get integer values 1-8 from the table bellow:

1	Anticline axes
2	Funcline axes
3	Observed fault
4	Assumed fault
5	Determined overthrust
6	Assumed overthurst
7	Diapir contact
8	Tectonic clip

The last layer is the label. Mapinfo has options of automatic labels but it does not give good results. So it is necessary to make a separate layer for the labels.

3.4 Putting the data in the layer

After we digitalize geological regions we must put the right color, pattern and label as in the paper map. We use Adobe Photoshop CS to extract color and patter from the legend map.

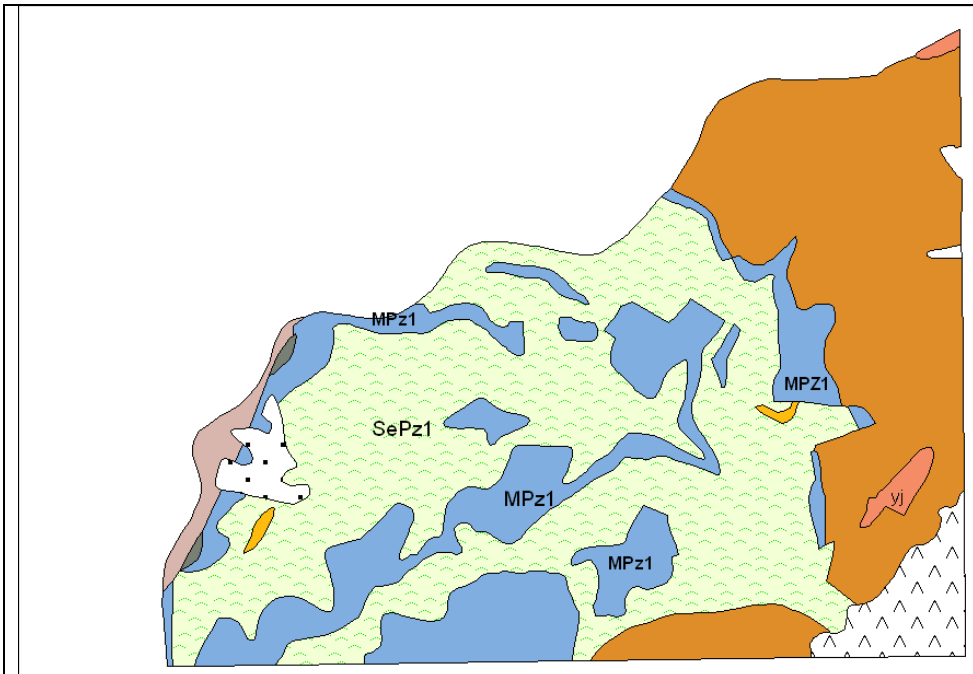
After the layers are defined, we start digitizing the raster BGM map of the Republic of Macedonia. Digitalization is process of drawing vector objects on the top of the raster map. Every vector object is represent a of the structures of the raster map. Every vector object has a row in the table and has its attributes. After we draw the vector object we fill the attributes in the table.

Geological regions are digitalized first. The geological region is draw from the regions of the raster map. When the region is drawn, we define its color and pattern. There was a problem with assigning the right pattern. Some of the patterns were not supported directly from the program so they were customized**.** Label is written in the

layer label. Label is changed by defining the text style. Other two layers are drawn with polilyne. Line style is put to every polilyne to define them so as the same as on the paper map. Then the attribute table is filled with the data.

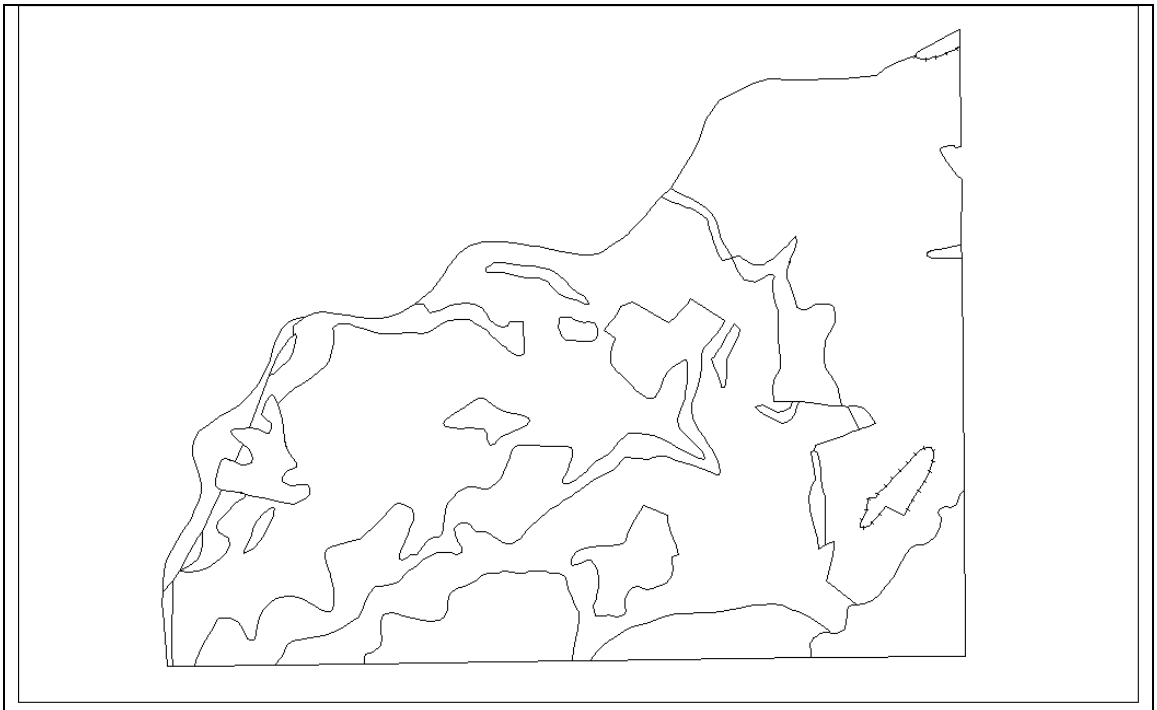
4. Results

Here digitalized layers are show on one piece of BGM. The pictures below shows all the layers. We can compare the original raster map and digital map on the picture 4.



Geoind	Symbol	Period	Era	Opis_na_karpa
1	FD	Devon	Paleozoik	Filiti, metapesocnici i konglomerati
2	Se	Jura	Mezozoik	Serpentin
3	MPz1	Metamorfni steni so neodredena starost	Paleozoik	Mermeri
4	Se	Jura	Mezozoik	Serpentin

Fig 1 Layer of geological regions and label

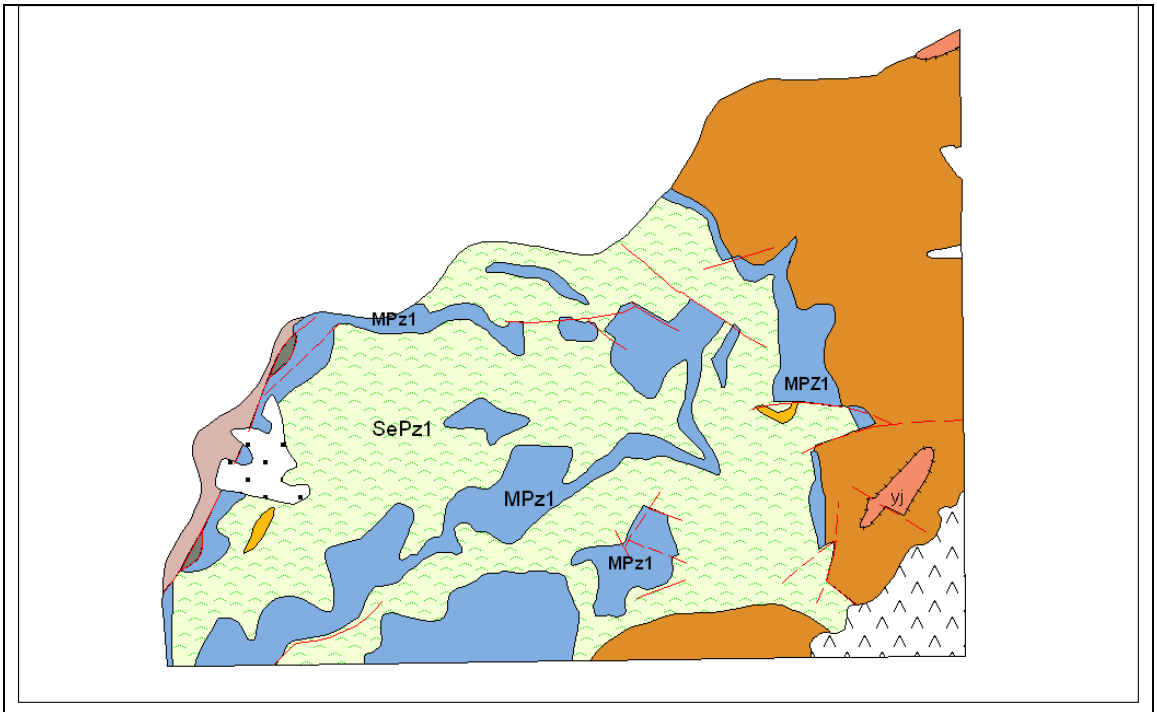


GranicaInt	Tip_granica
1	1
2	1
3	1
4	1
5	1

Fig 2 Layer borders and part of structure formation

RasedInt	Opis_R
2	3
3	4
1	3
20	3
4	3

Fig 3 Layer of part structure formations



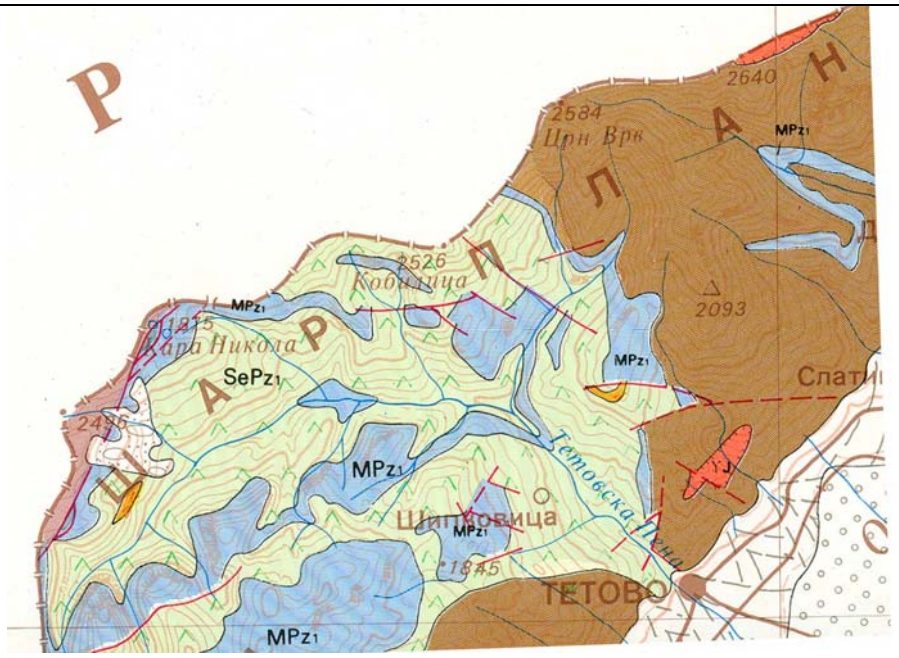


Fig 4 Comparison between digital and raster map

The result obtained a digital map of BGM which is fest copy of the paper map. Maximum error where registering the parts of the map is 4 pixels. Error connecting 2 parts of the map is between 7 and 120 meter. This means that the map is very accurate, because map with the scale of 1 : 200000, 1mm : 200 000mm = 200m. The error is below 1 mm.

The same colors from the paper map are put on the digital map. Bigger problem is the exact fill pattern because some are not supported in the Mapinfo program. They are defined by the user. Labels are put in the separate layer, because automatic labeling puts labels in the places different from the paper map.

Results are excellent concerning accuracy of the map. This map and others done before are overlapping.

Possibilities for processing the data from the digital map are enormous. We can analyze layers by some attribute, to select objects by their characteristic etc. This BGM can be used as a basic for of the geological base of the Republic of Macedonia.

5. Conclusion and future work

Digitalization of the BGM of the Republic of Macedonia provides modern access to geological data, broader possibilities for development of studies and elaborates from areas where geological data is used. In this manner we come closer to the world trends were usually maps are in digital form.

In updating BGM of the Republic of Macedonia new GPS systems can be used to give information of the exact position and explore geological area. This can be directly compared with the information from the BGM. New information on the BGM should be added, like complete geological explorations which are of interest of R. Macedonia. Digitalized BGM is the base of the geological base of the R. Macedonia that should be created in near future.

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