The Detailed Geological Map of Poland, 60 Years of the Project: From a Traditional Cartography to a Digital Processing

Katarzyna Jóźwik

Polish Geological Institute – National Research Institute

Abstract. The Detailed Geological Map of Poland in the scale of 1:50 000, published by the Polish Geological Institute since 1954, is the most complex geological elaboration in the country. Because of comprehensive subject area this is a unique map in the world scale. The field work to collect the geological data for DGMP started in 1953. Thus, the project has been already lasted for 60 years. Due to a technical development, the map compiling process has significantly changed. Methods used for preparing the map for publication are quite different than they were few decades ago. However, the final DGMP compilation has remained compliant with prior principles.

Keywords: Detailed Geological Map of Poland, ArcSMGP application, geological database

1. Introduction

The Detailed Geological Map of Poland in the scale of 1:50 000 is one of the most important undertakings of Polish geology. The field work of mapping started in 1953. The map is published by the Polish Geological Institute since 1954. Since the beginnings, a large group of people has reviewed carefully each map sheet. The fact that this project has already lasted for 60 years makes it a very prestigious map as the map with a very long tradition. It has to be emphasized that during those years process of preparing map for printing has been significantly modified. The way we perceive a map has also changed from traditional paper maps to the present digital databases. DGMP survived all those changes. The map content and final map composition have remained compliant with the prior principles independently on applied methods, which have changed.

The whole DGMP edition comprises 1069 sheets. Each map sheet consists of geological map in the scale of 1:50 000, geological cross section, synthetic geological profiles, explanations of colors and symbols and borehole profiles. This is published together with explanatory text, which describes geology of particular areas in details and includes thematic sketches, results of laboratory analyses and additional attachments. Because of wide subject area this is a unique map not only in Europe but also worldwide.

Process of compiling the particular DGMP sheet comprises several stages, starting from creating a geological design up to preparing each map sheet for printing. Principles of construction procedures on every single stage are defined in the instruction issued by the director of the Polish Geological Institute. The instruction was published for the first time in 1957 (Ber 2005), then subsequently updated (in 1977, 1991, 1996 and 2004) appropriately to technological changes and experience gathered during the years. Technological development played a significant role in the applied methodology and efficiency of the DGMP production process.

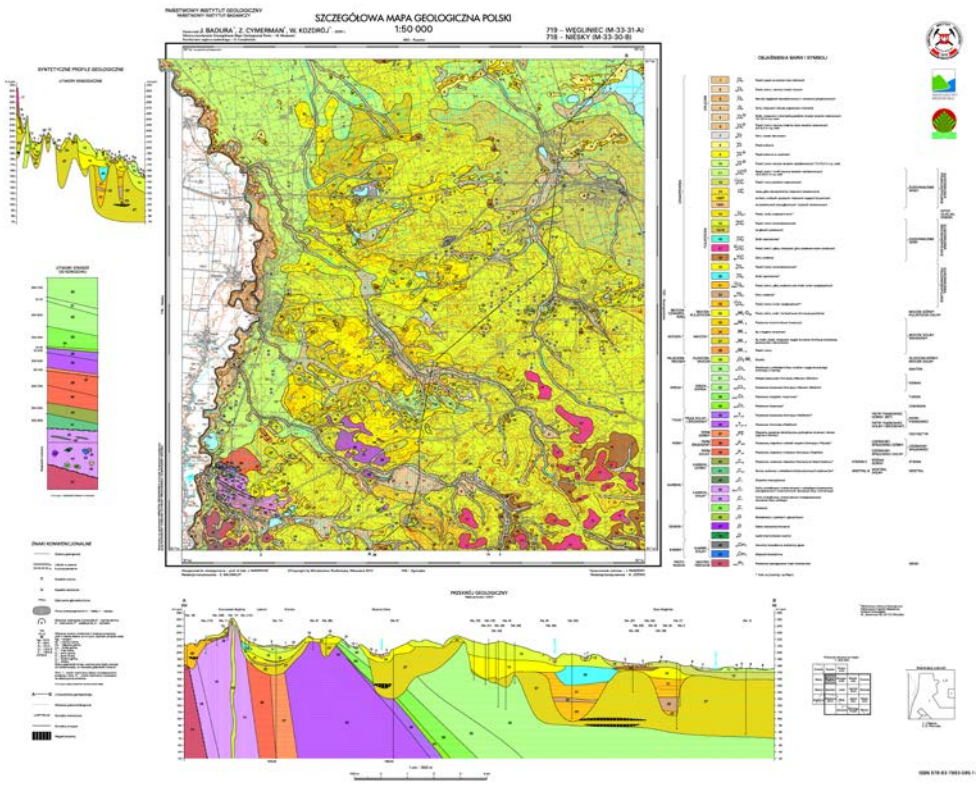

Figure 1. Sample map sheet (DGMP digital archive).

2. Completed Stages of the Map Compiling Process

2.1. Geological Design

Process of creating every DGMP sheet started from designing a field work. Geological design was accomplished on the basis of available archival results of the geological researches. The author of the particular project collected as many information about specific area as possible, performed initial geological interpretation of aerial photographs and then planned future geological itineraries (Instrukcja... 1977, 2004). Philosophy of this work designing hasn't changed during the past half-century, but thanks to digital databases this task has became much easier. Person who planned field work no longer had to look through large number of paper documentation, because the opportunity to use digital information has appeared. In the last version of the map instruction (2004), there is a note, which obliges researchers to use data from PGI digital databases when designing a field work.

2.2. Preliminary Work

Preliminary work relied on conducting an initial geomorphological analysis, making preliminary geological cross sections and setting up the base topographical maps (Instrukcja... 1977, 2004). The base maps in former national coordinate system '1965' were used more often. Usually they were divided into 18 sheets, so that it was comfortable to work with them in a field.

2.3. Geological Photography

Geological photography for one DGMP sheet comprises area of approximately 300 km2. Geological and supplementary observations in the field were led along planned geological itineraries. Geologist who did the mapping studied geological sediments visible in natural or artificial outcrops. They performed excavations as well as probing and collecting samples from outcrops and documentation points. Simultaneously they paid attention to the additional elements such as: land forms, soils, springs, groundwater seepages, land cover and land use, which could be useful when creating
a map. All observations were carefully reported in the field notebook and marked at the preliminary map. In 2001 PGI implemented ArcTeren application, which enabled introducing data to database just in the field (Jaranowska 2001). This provided ready tables' templates and constant connection to dictionaries, what made map authors' work easier and standardized final compilations (Gogołek 2003).

The field work of mapping in the whole territory of Poland was performed in the scale of 1:25 000. It took about 3 years for one person to complete the entire geological terrain photography. When there was such a need, geophysical surveys, exploratory drillings and laboratory studies were carried out too (Instrukcja... 1977, 2004). It's worth mentioning here that not only the geologists from PGI took part in the geological mapping project, but the researchers from the Polish Academy of Science, universities, geological enterprises and other private companies (more than 100 authors in total) were also invited.

2.4. Indoor Work

When the field work was finished, the indoor work started. Researchers elaborated the final DGMP sheet compilation on the basis of comparing results of the field observations and surveys to archival data. All those works were finished in 2009 (Kalejdoskop... 2012).

Final authorial elaboration comprises the following elements (Instrukcja... 1977, 2004):

- **Geological map** with attachments such as: an explanations of colors and symbols, geological cross section, synthetic geological profile or profiles, conventional signs, borehole profiles, index of map authors. The map shows surface geology to a depth of 2 meters. According to the instruction arrangements, there is still a possibility to introduce data of lower sediments, when the thickness of surface formation doesn't exceed 2 meters. Moreover, the author of the compilation is asked also to add information about the anthropogenic forms, localization of chosen boreholes and documentation points, mines, open pits, quarries, natural gas appearances; crude oil seepages, groundwater effluences and seepages, springs, eratic boulders, fossil flora and fauna occurrences, archeological findings. The amount and the type of presented information depend on character of the particular area. The fair copy map is drawn on a background in scale 1:25 000. In the past, it was made on a stiff paper. Currently it is prepared in the version which enables digitalization that is on a tracing paper with copied topographical map in coordinate system '1942'. Geological boundaries have to be adjusted to the topographical background, so if the preliminary map is in different coordinate system it has to be redrawn to '1942'.
- **Geological cross section** constructed in vertical scale 1:1 000 (except sheets from the Sudetes region, where the vertical scale is usually 1:12 500), on the basis of data from exploratory drillings and documentation points as well as from archival materials. Cross section line should be led perpendicularly to main geological and geomorphological

units in the particular area. Similar to the map, the cross section and the profiles have to be drawn on a tracing paper. It also can be supplied in a digital version, for example in CorelDRAW file.

- **Explanatory text** with attachments like: geomorphological sketch, uncovered geological sketch, lithostratigraphic table, additional geological cross sections, other tables and figures. Until 1989 explanatory text also included thematic sketches of mineral deposits and hydrogeological conditions (Ber 2005). In the past typescript was submitted, today it is a computer printout with a digital version attached.
- **Documentation map** with list of used compilations, boreholes and documentation points.
- **Results of geophysical surveys**
- **Results of lithological and petrographical researches**
- **Results of laboratory analyses**
- **Preliminary field maps and notebooks**
- **Geological design**

Complete elaboration with suitable protocol was submitted to the Central Geological Archive[1] (located in the PGI).

2.5. Editing and Printing Until 1994

An editor from the Publishing Department of the Polish Geological Institute reviewed the research materials. They checked, in particular, whether geological borders are compliant with stratigraphic interpretation as well as with hypsometry and hydrography. The map compliance with neighboring sheets was also verified. After introducing suitable adjustments, compilation was given to the Geological Publishing Company, which was located in the PGI those days (Instrukcja... 1977). The map sheets were there prepared for printing using traditional, arduous methods. Drafters drew topographical backgrounds, boundaries of geological units as well as petrographical signs manually. All units on the map were stuck by hand. The whole process of preparing map for printing was led in the agreement with the editor from the Publishing Department, who checked compliance of fair copies of particular map elements with base research materials and the final sheet assemblage. Geological Publishing Company editor together with the editor from Publishing Department prepared the so-called color attempt, which

[1] Currently the National Geological Archive.

had to be approved by the main author of the compilation (Instrukcja... 1977).

The complete map sheets were prepared for offset printing, which was performed outside the PGI by the chosen printing house. This printing method was much more complicated than the present-day digital method. Materials delivered to a printing house had been specially processed by carrying out a CMYK color separation. It was done in the PGI Geological Publishing Company. The explanatory text was checked, adjusted and retyped on typewriter in the Publishing Department. Editing and preparing particular sheets for print together with the explanatory text were then a very long-lasting process. In the years 1956-1994, 338 map sheets were published.

3. Digital Map Compilation

Implementation of a digital system for storing data and for cartographical editing in the years 1994-1996 was a turning point in the DGMP production. This software was created by Neokart GIS (the Polish branch of the ESRI company – now ESRI Poland LLC) on the basis of ArcInfo Workstation and Oracle database (Zastosowania... 2011). The ArcSMGP application designed in cooperation with specialists from the PGI became the main tool for digital and editorial works (Jaranowska 2001). It has been written in Arc Macro Language (AML) and enables managing DGMP database. The application was developed in 1994, tested in 1995 and then the first 10 map sheets were digitally elaborated, in 1996. ArcTeren application, introduced in 2001, was also the part of the DGMP computer system. The first time in Poland system based on a digital database was applied for a serial map production. To these days the same technology is used.

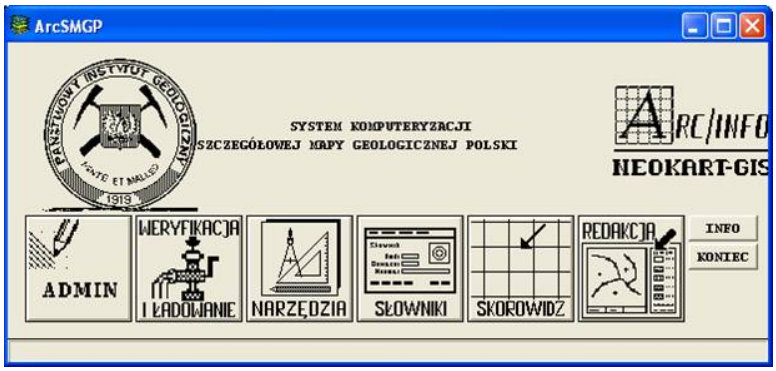

Figure 2. Start screen of ArcSMGP application (Neokart GIS interface). Application comprises the following modules: admin, verification and loading, tools, dictionaries, index and editing.

3.1. Digitalization

After scientific adjustment, the traditional paper materials are taken further to the Geological Cartography Program, where they are digitalized. It concerns mostly geological and documentation maps (explanatory text is elaborated in the Publishing Department) and relies on converting original research materials to digital version. The process begins from creating workspace for chosen map sheet. Workspaces are generated automatically by the ArcSMGP application and contain the kilometer grid in national coordinate system and the empty coverages with the empty attribute tables. Paper data are scanned to TIF files and adjusted to the proper coordinate system using kilometer grid. Raster data are converted to vectors and placed on suitable layers. For each layer appropriate tables are filled and therefore digital elaboration includes much more information than traditional paper map. Data are saved in the coverage format and loaded to the DGMP database using ArcSMGP application. The database structure is firstly systematized according to geometry of objects, then to its subject area.

The ArcSMGP application carries out automatic verification. It checks spatial extent of layers, their geometrical compliance with neighboring sheets and whether values in tables describing lithology, genesis and stratigraphy are compatible with dictionaries. Raster base maps such as topography, hydrography and hypsometry are also loaded and stored in database.

3.2. Editing and Printing Today

The last phase of process leading to publishing of a map as a plotter printout is digital editing. This editing process is divided into two stages. At first stage, the technical editors check digitally elaborated data compliance with research materials in traditional form and introduce adjustments if it is necessary. They generate workspaces for geological cross section and geological profiles (using ArcSMGP application) and prepare their vector versions. All layers are reloaded so that there is an actual data in the database. Color symbols for the geological units are selected from dictionaries, which are the part of ArcSMGP application. We can also define new symbols in CMYK system. Units' colors are repeatable for entire series. We have currently over 1500 different symbols. At the editorial stage of works a so-called editorial workspace is automatically created for

the particular sheet. We prepare a composition of each DGMP sheet element and then a composition of the whole map, which is finally available in the digital (vector or raster data) and the paper version (plotter printout).

Until 1999 the map sheets were still offset printed. When the map composition was finished, technical editors made a CMYK color distinguishing, in the separator, which is the part of ArcInfo Workstation software. As a result of this process four separate files were created (one for each color). They were next delivered to an outer printing house, which prepared and exposed diapositives for offset printing. The quality of final printout was very high, but the cost of a map production was larger than today. Since 2000 plotter printout has been applied. After finishing map composition we convert data to EPS format and plot a map with suitable CMYK sets. Usually four copies of the map are printed, but there is always a possibility to plot additional sheets on order, because prepared EPS files are stored in the National Geological Archive. This is definitely more profitable solution than offset print.

4. Conclusion

The usage of computer system for the DGMP production significantly improved efficiency. In the years 1996-2009, 461 map sheets were published (including renovation of old map sheets). Our current digital and editorial works concerns 128 sheets. According to the contract with the Ministry of the Environment, they are planned to be published by the end of June 2014 (part of them has already been accomplished). There will be other 186 sheets left to be processed and prepared for publication in near future.

Simultaneously we work to employ new technology at the editorial stage of the map production. Vector data will be loaded to the DGMP database as well as it was done before. Only a map layout will be generated in ArcMap application using specially prepared extensions. Layers creating the final map composition will be stored in the ESRI geodatabase format.

References

Ber A (2005) The Detailed Geological Map of Poland 1:50 000: the history, present and future. Polish Geological Review, vol. 53, no. 10/2

Gogołek W (2003) ArcTeren – application for field mapping. Esri User Conference. Innsbruck. http://downloads2.esri.com/campus/uploads/library/pdfs/68470.pdf

Instrukcja w sprawie opracowania i wydania Szczegółowej Mapy Geologicznej Polski 1:50 000. Wydawnictwa Geologiczne. Warszawa, 1977

Instrukcja opracowania i wydania Szczegółowej Mapy Geologicznej Polski w skali 1:50 000. Wydanie II uzupełnione. Warszawa, 2004

Jaranowska B (2001) Komputerowa redakcja techniczna i przygotowanie do druku Szczegółowej Mapy Geologicznej Polski w skali 1:50 000. Mapa w systemach komputerowych. Materiały Ogólnopolskich Konferencji Kartograficznych. Szczecin

Kalejdoskop GIS Tom I. Esri Polska Sp. z o.o. Warszawa, 2012

Zastosowania GIS w ochronie środowiska. Esri Polska Sp. z o.o. Warszawa, 2011