

POLISH GEOLOGICAL MAP DATA AS A PART OF SPATIAL DATA INFRASTRUCTURE

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Abstract

Performing cartographical elaboration for Poland is one of the tasks of Polish Geological Institute - National Research Institute (PGI-NRI). Surface Geological Mapping Department of PGI-NRI has long experience in development of digital serial maps, covering wide range of aspects from geology, hydrogeology, engineering geology, environmental geology, geophysics and geochemistry.

In accordance to Infrastructure for Spatial Information in the European Community (INSPIRE) directive that data is reference layers for Poland. Each cartographical project is build on technical assumptions for each stage of work. Maps are based on databases with well defined, coherent structure.

In connection with INSPIRE guidelines the process of adjusting cartographical geological data to required standards has been started, starting with creation and publishment of metadata. Process is supported by PGI-NRI taking part in international initiative OneGeology with accompanying European project OneGeology-Europe. All geological cartographical elaborations are being prepared to be published in geoportal of Integrated Cartographical Geological System (IKAR).

Keywords: *Geological map data, SDI, INSPIRE, geoportal, metadata*

INTRODUCTION

Polish Geological Institute – National Research Institute (PGI-NRI) acts as Polish Geological Survey. PGI-NRI is an author and coordinator of all fundamental detailed and reviewed geological cartographical elaboration in Poland. In accordance with European Spatial Data Infrastructure, data from PGI-NRI are conform with themes situated in Annex II and III European Directive INSPIRE.

GEOLOGICAL COMPONENTS OF POLISH SDI

Fundamental polish geological map data is being developed at 1:50 000 scale. It is the base to thematic case studies and maps in smaller scale. Based on that data areas for more in depth analysis are being selected. All these resources are digitalized and they become the part of Spatial Data Infrastructure.

Detailed Geological Map of Poland at 1:50 000 scale

Detailed Geological Map of Poland at 1:50 000 (DGMP) scale is the fundamental geological map of Poland. It presents information about geological structure of the country including stratigraphy, petrography, tectonic features and their origin. It is dedicated mostly to geologists from different specialization. The whole territory of Poland is covered by 1085 map sheets. Map is published since 1954.

DGMP is created based on field works, exploratory drillings, geophysical surveys (geolectrical and gravimetric methods), and in-house and laboratory studies. Since the 1996 DGMP is digitalized using ESRI software. The team that develops the maps includes: scientist collecting data from groundworks, employees performing digitalization, substantive editorial team and a team of technical editors. Technical editors closes the process of creating and sharing maps. There is also digitalization old sheets of DGMP. Dedicated software has been developed for the needs of digitalizing team and technical editors enabling partial automatization and verification of work.

Currently authors case studies stage has been finished. Most of these sheets are available in digital version. DGMP is available in printed form and digital (file in formats *.pdf and *.shp). Data from DGMP will be the reference layer for Poland, accordance to Annex II Directive INSPIRE. Digital version of DGMP is created based on Instruction published in 1996, and a few times actualized. Architecture of database for single sheet is very complicated. Database includes polygons, lines and points layers with information about surface geological structure, hydrogeologic phenomena, tectonic, localization of drillings, documentation areas etc. and also additional raster layers with topography, hydrography, and hipsometry. Database for each sheet includes also layers with crosssections. Currently work is being done on integrating all 1085 sheets in continuous geodatabase, enforcing necessity comparisions and harmonization of borders between older, traditionally made sheets to newest sheets. Dedicated software has been created for partial automatization of harmonization. Necessity of borders harmonization between sheets GDMP enforces old map sheets renewal. Finally all DGMP sheets will be available as continous layers through IKAR geoportal.

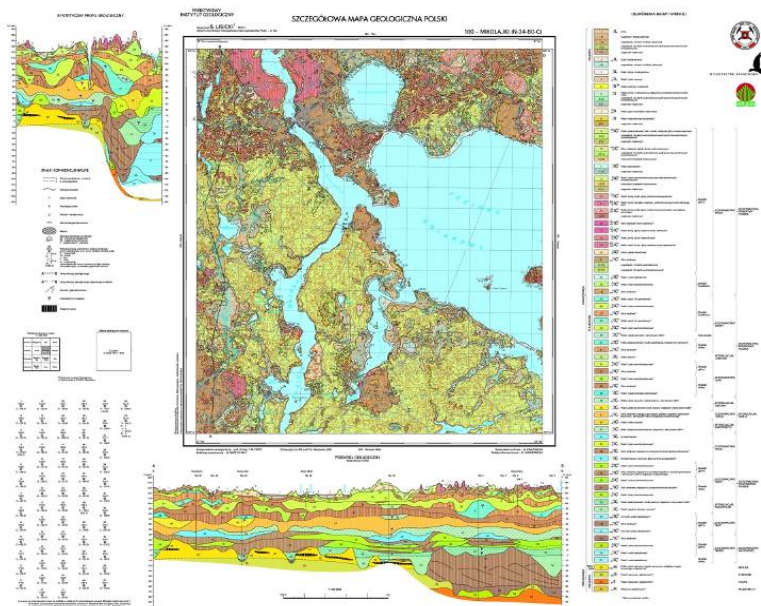


Figure 1. Sample DGMP sheet at scale 1:50 000, digitalized and published in analog form

Geological Map of Poland at 1:200 000 scale

First map sheet: Radom was printed in 1969. Since 1971, it was constructed and published systematically; since 1973, in accordance with the approved instruction. The whole edition has been completed in 1998. Map covers the territory of whole Poland. It was published as colored maps in two versions: A – covered and B – uncovered, without Quaternary sediments. Each map sheet contains also a geological cross-section, typical for the area, and stratigraphical-lithological profiles. Each map sheet of both versions is also supplemented with a common explanations text brochure, containing, among other, deep borehole logs, geological cross-sections, description of tectonics, lithology and results of cartographic investigations, performed in more detail scales.

Each map sheet, together with explanatory notes, is very useful in presentation of general geological structure and the distribution of mineral resources of the area. It may be basis for mineral prospecting, and also for regional geological, engineering-geological, hydrogeological, geomorphological and pedological studies.

Currently, since 2006 GMP at scale 1:200 000 is being renewed. It is based on updated DGMP at scale 1:50 000, in the process of its generalization, and also based on old sheets of that map. In order to renew its contents groundworks are also performed. Map is being developed with state of the art knowledge and possibilities. In 2009 new instruction for map renewsation was created, including guidelines for digital elaborations. Map is being developed using ESRI software, with supporting, customized software. As a derivation of DGMP map is being created in the same team, with the same standards implemented. Such process enabled to utilize experience gathered while developing GMP at scale 1:50 000. Currently 10 sheets has been finished (edition A and B). We are in the process of gathering data and elaboration following ten sheets.

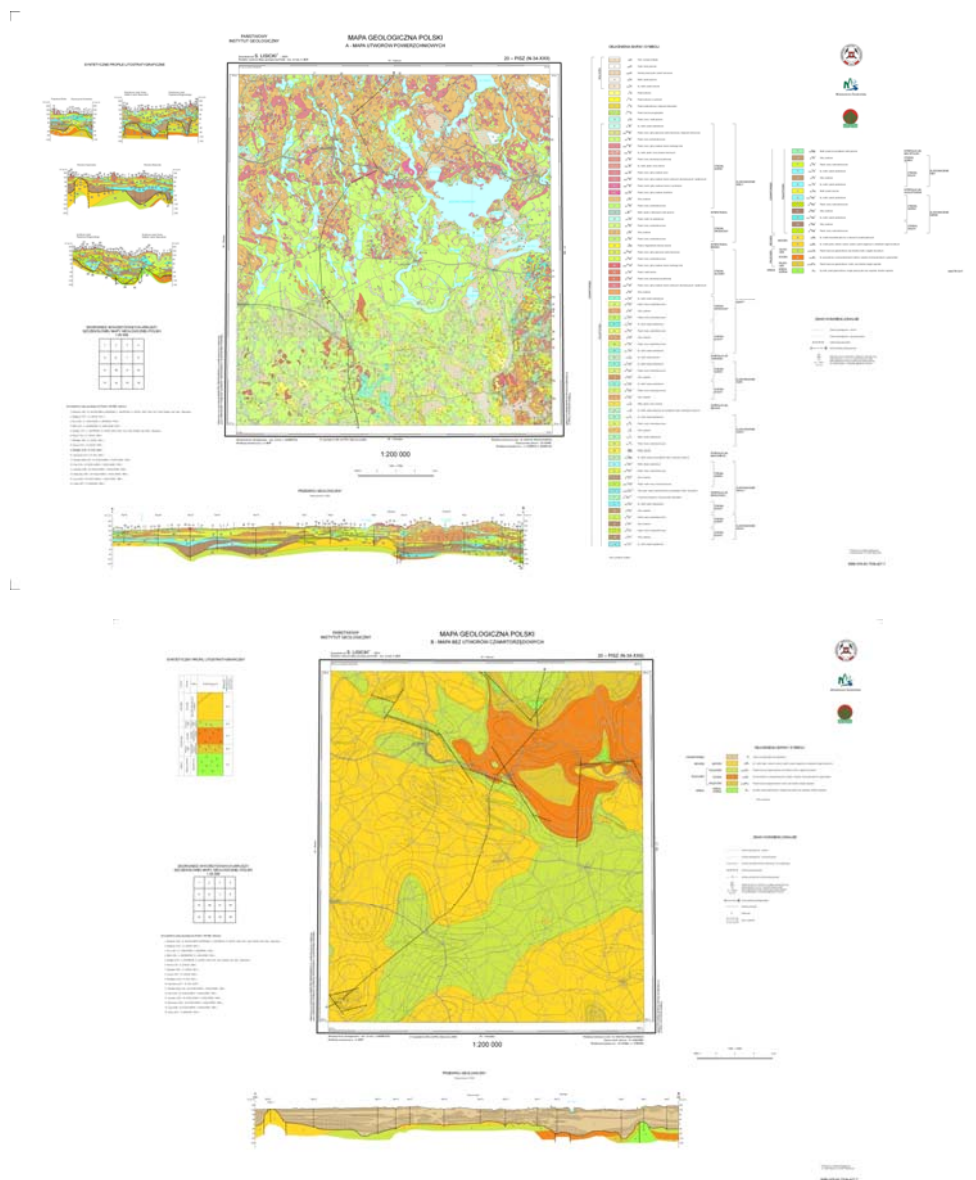


Figure 2. Sample GMP sheet at scale 1:200 000, digitalized and published in analog form: version A – covered, version B - uncovered

Geological Map of Poland at 1:500 000 scale

In 2005 Geological Map of Poland at 1:500 000 scale (GMP) has been created based on generalized DGMP sheets at scale 1:50 000. Map presents the surface geological structure of Poland. It covers following numerical thematic layers: geological structures, tectonic, glacial limits, eskers, drumlins, moreins, lines of geological cross-sections and base topographic layers (administrative borders, rivers, cities).

GMP at scale 1: 500 000 is presented on geoportal site of our Institute, <http://ikar2.pgi.gov.pl/cms/>

Lithogenetic Map of Poland at 1:50 000 scale

Derivation of DGMP at scale 1:50 000 is LMP at scale 1:50 000. LMP is designed for common use, including individuals without geological knowledge. The aim of LMP is to present the variety of lithology for the area of Poland and to provide data for land use planning and geotouristic purposes. It will also be used in the process of initial evaluation of ground for future investments and evaluation of ground for further detailed analysis.

LMP is based primarily on digital conversion, selection and generalization of information from DGMP database utilizing ArcGIS tools. LMP presents lithology and genesis of formations covering surface, and chosen geodynamical, hydrogeological and anthropogenic phenomena. LMP is accomplished with digital elevation model.

Each sheet of LMP is prepared in personal geodatabase. At first coordinator assigns sheets of DGMP to authors, and stores this information in LMP sheets db. Author develops single map, verifies correctness using tools. Finished map is sent for technical approval. If everything is correct, map is uploaded to temporary geodatabase. Technical editor download map from this temporary database and generate mock-up of a map, and prepare for publishing. After that map is uploaded to IKAR database. Specially for this map it has been created dedicated software. It allows to partially automate technical control and preparation of map sheets to publication.

At present we finished the first tranche 400 map sheets. It is planned to create 1085 sheets of that map, just like DGMP. LMP is available in analog form – plotter print, digital – raster files (*.pdf) and ArcView files (*.shp). It is possible to visualize them in a variety of free GIS software.

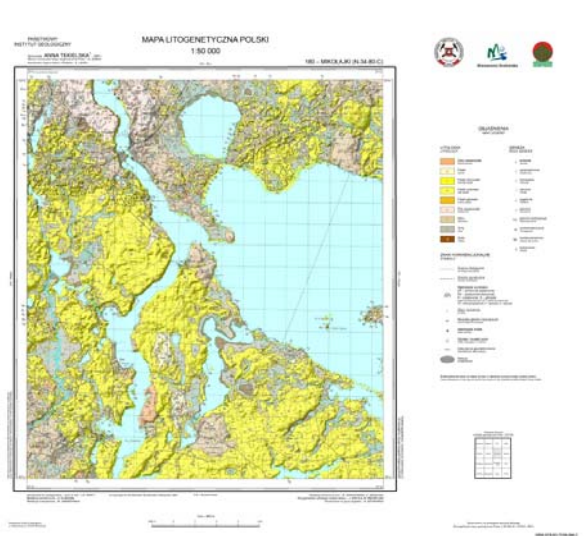


Figure 3. Sample LMP sheet at scale 1:50 000, digitalized and published in analog form

Geological Map of the Tatra Mountains at 1:10 000 scale

The most detailed serial map developed in Surface Geological Mapping Department is Geological map of the Tatra Mountains at 1:10 000 scale. To create this map using ArcGIS software, we need to have documentation from field works and laboratory works. It is created in cooperate with Slovakian Geological Survey, that is why the geological information is continuous.

Other elaborations

Data included in DGMP at scale 1:50 000 is used in creating other serial maps at scale 1:50 000. In other departments of PGI-NRI hydrogeologic, geo-environmental and geo-economical maps are being developed, including information about the geological structure from DGMP. Those maps are developed in digital form. All thematic maps at scale 1:50 000 will be available through IKAR geoportal as map services. Geospatial data about geological structure of Poland, stored in PGI-NRI databases is base for different kinds of elaborations at different

scales. Glacitectonic Map of Poland at scale 1:1 000 000, displaying glacitectonic processes for the territory of Poland has been created. Currently it is prepared to be published through the IKAR geoportal. Data is being used in the process of planning and localizing of linear objects of transport infrastructure. Maps at scale 1:100 000 of planned routes including protected areas and surface geological structures have been created.

Geo-touristical maps of Polish National Parks, presenting tourist information and protected areas against the geological structure of selected area are developed. They will be integrated with IKAR geoportal. We are taking many initiatives from the area of digital development of geological maps in cooperation with other countries. As a research institute we develop standards of creating the geological maps and share the knowledge with other countries. Example of such cooperation is the creation of Geological map of Angola at scale 1:1 000 000.

Creation of the map initiated the process of creating digital maps in Republic of Angola. PGI-NRI hold many trainings from ArcGIS for geologists of Angola. Currently on the basis of our developed methods, together with geologists from Belorussia, we are creating geological map of Poland and Belorussia borderline at 1:250 000 scale. The aim of this project is developing continuous geological map without divide through countries borders. Map will be in digital version, with similar spatial data structure, which was verified during previous realization of geological map series. Documentation prepared to create sheet of map was juxtaposed from DGMP data, which is part of PGI-NRI database. They are the base to generalization data. This project is on the initial stage of realization. Case studies above are only a small part of activity PGI-NRI, since it is difficult to present all activities we take part in such short article.

FROM POLISH SDI TO INSPIRE

Since May 2007 INSPIRE directive obliges UE member countries to prepare spatial data and associated metadata in order to popularize them, and make them publicly accessible. Above geological mapping elaboration of PGI-NRI are part of Polish, and therefore european infrastructure of spatial data. Cartographical data is integrated within IKAR system. IKAR is the response of PGI-NRI for the INSPIRE directive. Realization of the project is carried out with consideration to the guidelines of the directive and with special care that every technology used is compliant with up-to-date standards (ISO, OGC). Certain geological and thematical maps are already published in form of web map services (WMS) through IKAR geoportal. Geoportal is the part of IKAR project, aiming at standarisation and harmonisation geological spatial information being part of PGI resources.

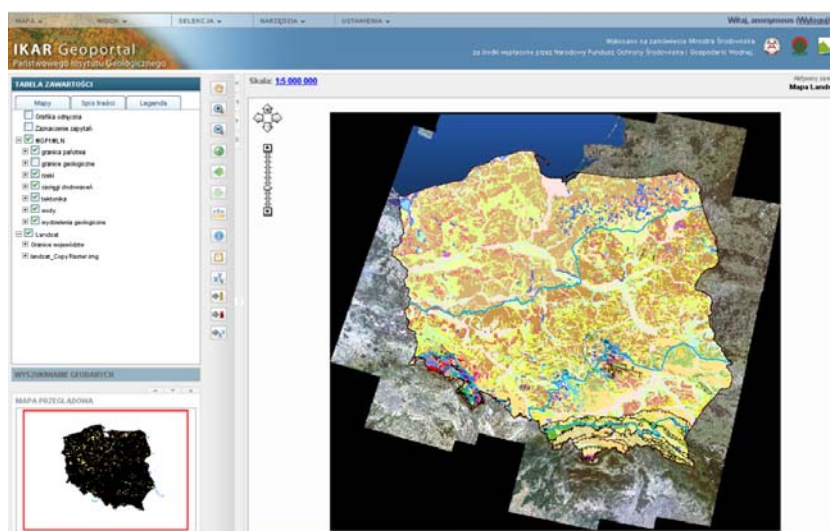


Figure 4. Geoportal IKAR (ikar.pgi.gov.pl)

IKAR system has been created in accordance with INSPIRE directive and conforms to standards not only for CSW services (Catalogue Service for Web), WMS (Web Map Service) and WFS (Web Feature Service) services, but also for metadata. Architecture of the system is based on ESRI software. IKAR system integrates geological data gathered and processed in GIS software and databases solutions (both commercial and open source), which are implemented in different parts of PGI-NRI. Requirements for geoportal necessitated in depth analysis of spatial geological data, based on which geological profile of metadata has been developed, including the specification of data. Profile includes not only INSPIRE specific data, but also additional elements, such as geological time, or vertical range of geological information. Accordingly to INSPIRE schedule by the end of this year metadata for digital data will be made accessible through IKAR.

TO MAKE GEOLOGICAL DATA INTEROPERABLE

Creating spatial data infrastructure has a purpose of not only increasing the accessibility to data, but first of all possibility to combine resources from different sources, prepared in different standards. An international initiative of the geological surveys OneGeology (www.onegeology.org) plays very important role for geology. The aim of OneGeology is to make web-accessible digital, harmonized, cartographical geological data.

Currently geological maps between 1:500 000-1:5 000 000 scale are being presented. The target scale is 1:1 000 000. OneGeology wants to increase group of participants, as in prospect a few following years it wants to cover all Earth by geological maps.

The next stage is data standardization in technical aspects to make in future the geometrical and substantive geological data harmonization worldwide. Initiative tasks are a testing ground for developing and testing language of the exchange of geological data GeoSciML. OneGeology milestones defined through participants will provide interoperability of geological mapping data. It put the geology across borderlines and makes possible of the research and observations continuous geological structures.

Prepared under the OneGeology initiative portal allows to view geological maps, reading their attributes, on and off layers and change the transparency. The presented maps can be converted to KML, which allows to watch them even in Google Earth. Furthermore, it is also possible loading of external map services, provided that they compatible with the standards. OneGeology portal functionality will be gradually extended in order to view geological maps which gives user a greater opportunity to create their own compositions and perform simple analysis. All solutions must be intuitive, which will allow to popularize and interest geology wide range of customers who are not geologists.

The response of European geological surveys, acting under the auspices of EuroGeoSurveys is European project OneGeology-Europe (www.onegeology-europe.eu), ending this year. The experience gained during the implementation of GIS standards, GeoSciML, first test to harmonize the semantic cartographical elaboration will be base for the subsequent actions, created in this year INSPIRE expert group. The aim of this expert group is to develop guidelines for the topics covered in Annex II and III of the directive on the geology and science related.

PGI-NRI is involved in both of these initiatives. PGI-NRI is trying to convey acquired experience to geological surveys with which it cooperates, and trying to create their own SDI. Currently PGI-NRI works on the implementation GeoSciML and publication Polish Geological map at 1:1 000 000 scale in the form of WMS and WFS.

In addition, the data is analyzed in the border areas in order to attempt to harmonize the geometric and semantic age, lithology and genesis. The results of the work will provide a good example for other countries that would like to get rid of the "faults" along the borders.

CHALLENGES OF GEOLOGICAL DATA SPATIAL INFRASTRUCTURE

The Polish Geological Institute – National Research Institute, as in many other geological surveys for several years developing methods of numerical modelling and computer graphics that create new opportunities for deep structures geological mapping, including multidimensional visualisation 3D and 4D. Two-dimensional geological mapping in geological sciences makes impossible to present all relationships and processes that occur deep within the Earth. Numerical modelling not only creates new opportunities for the development of geological research, but also brings new quality into the development of spatial data infrastructure.

In 2007, The numerical spatial model (3D) of geological structure of Poland – from -500 m b.s.l. to surface (www.pgi.gov.pl/3d) was developed. This model has low resolution and performs a role primarily for demonstration and education, however, constitute the basis for the creation of more detailed models.

Also a pilot project of the geological structure in highly urbanized area was performed, the only source of information were exploratory drillings documentation and an archival data (literature). Developed model for fragment of the central part of Warsaw, near the PGI-NRI. The model was realized using Open Source Software – GIS-GRASS.

In project following things have been developed: methodology of semi-automatic digitalizing geological cross-sections, created a database of geological 3D data and numerical 3D model at 1:10 000 scale. Also, like in LMP, segregation of geological structures to lithology and genesis was used, which greatly increased the readability of geological information.

SUMMARY

The mere creation of geological spatial data infrastructure in the present-day computerisation world does not pose major problems. With wide range of Open Source software also financial issues are not a decisive barrier. However, the challenge is to ensure the interoperability of accumulated resources, and this means not only to standardized data and tools, but also the need to ensure the consistency of describing the defined area.

This implies a need for harmonization of data within the geological structures, above the administrative division that are "artificially" divided into geological units as described by other segments of separate rules for each part.

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European project OneGeology-Europe: www.onegeology-europe.eu

Biography of authors:

M.Sc. Bożena Gastol-Palechowska works as a Senior Research Specialist at the Polish Geological Institute – National Research Institute. She graduated with her MSc from Warsaw Institute of Technology, Department of Land Surveying and Cartography in 1979. After degree she has worked as Sr. Assistant at Warsaw Surveying and Cartographic Enterprise in charge of elaborating Local Perceptual Models for Topological Maps. From 1993-2001 has worked at Private Enterprise as Mfg Deputy-Manager. co-authored mapping applications used to digitize data into „master maps”, performed Q.A. tasks on digitized maps scaled 1:500, performed data base integration per client needs.

Since 2001 works as an editor in PGI-NRI performed editing of Geological Maps of Poland. She an author mapping application used to digitize geological data for maps in scale 1:200 000. Her main research interests includes Geoinformation, Cartography and GIS systems.

M.Sc. Joanna Przasnyska graduated from Interfaculty Studies in Environmental Protection at Warsaw University in 2002. Since 2003 he has worked for the Polish Geological Institute – National Research Institute, Surface Geological Mapping Department. She worked as researcher research-lithological petrographical for DGMP. Currently working in a team coordinating the process of creating Lithogenetic Map of Poland at 1:50 000 scale, and also creates sheets that map. Prepares technical assumptions for the new series of maps, she interested in spatial databases, GIS and cartography.

D.Sc. Urszula Stepien works as a adjunct in Polish Geological Institute-National Research Institute, Surface Geological Mapping Department. She graduated from Geological Department of Warsaw University where she worked on GIS and geostatistic methods in structural analysis of a part of Holly Cross Mountain area. In PGI-NRI she's developing usage of GIS and geoinformation standards in geological cartography and implementation INSPIRE rules. She is a coordinator of Polish part of OneGeology and OneGeology-Europe. Urszula Stepien is one of authors of geological metadata profile prepared in PGI-NRI and she is responsible for metadata of geological mapping data, series and services developed in Surface Geological Mapping Department. She is also a member of internal PGI-NRI INSPIRE working team.

M.Sc. Anna Tekielska graduated from Warsaw University, Faculty of Geology, Engineering Geology in 2005. In 2007 she graduated postgraduate studies Silesian University of Technology, Geographic Information System, INSPIRE, SDI. She is employed at Polish Geological Institute – National Research Institute in Warsaw (Poland), Surface Geological Mapping Department as an older specialist. She fulfilled her duties as a GIS expert in a very professional way. Her knowledge, skills and ability to cope with working under stress became a success not only to her, but of entire section. Mrs. Anna Tekielska took part in many projects and is responsible for: Lithogenetic Map of Poland 1:50 000 – instruction how to make the map, technical assumption, study and design; The numerical spatial model (3D) of geological structure of Poland – from -500 m b.s.l. to surface – verification, analysis of archive documents, digitalization, 3D modeling; Numerical verification Geological Map of Poland 1:500 000 for OneGeology project – technical assumption, GeoSciML, Geological-tourist Map of national parks – technical assumption, study and design and other projects currently running involving 3D modeling in site planning and international projects One Geology and One Geology Europe.