



Digitization of mining maps in the Polish underground hard coal mines

Cyfrowanie map górniczych w polskich podziemnych kopalniach węgla kamiennego

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Treść: This paper presents a compendious study on methods of vectorization of maps (mining maps in particular). The introduction contains a compiled encyclopedic definition of a map (from Latin *mappa* = tablecloth) and explains the subject of digitization from the mining geology point of view. The types of mining maps occurring in archives of surveyor-geological divisions of hard coal mines were distinguished and briefly characterized. The methods (manual digitization with a digitizer, manual digitization from the screen, automatic vectorization) and advantages of digitization of mining maps (convenience, easy access to data collected on maps, easy modification and updating of maps) were presented. “Environments” of vectorization were described and compared (with determination what for and where to digitalize, which system should be used and what should be chosen?). The author of this paper made a review of methodologies, in the meaning of the existing, on the domestic market, main GIS (*Geographic Information System*) and CAD (*Computer Aided Design, Computer Assisted Drafting*) tools, and indicated the differences between them, their advantages and disadvantages. In the similar way traditional and digital methods of drawing mining maps were compared. The author presented the current level of digitization of documents and briefly described the types of mining maps which are at the mines’ disposal (analog maps, “hybrids” – semi-digital maps, digital maps). It was determined that nowadays the most frequently occurring types of mining maps are the “hybrid” maps, linking together the elements of raster and vector maps. The design of “hybrid” maps often uses connections of several computer programs. The most frequent solution is to combine the Surfer and AutoCAD software, which fulfills the needs of the whole surveyor-geological divisions, i.e. requirements of mining surveyors (AutoCAD) and geologists (Surfer). This combination enables a fusion of scalability (freedom to choose a scale/format) of maps and proper selection of mining-geological details (from the AutoCAD software) with different methods of drawing isolines (from the Surfer software). The paper outlined a method of cooperation of the said software and their advantages and possibilities. It was determined that superposition of several parameters of isolines in one seam on the maps allows to look for an interdependence of changes of different parameters values in the coal seam/deposit. The superposition of maps of one parameter of isolines in several seams allows to search tendencies of changes of the particular parameters’ values on depth of the coal seam/deposit. Furthermore, the superposition allows to draw a map of coal types according to the Polish Standard PN-82/G-97002 and observe changes to the borders of the area of occurrence of particular coal type in the deposit. In the conclusion, the author discussed a question whether digitization should comprise only maps or whether one should aim for a comprehensive numerical documentation of the deposit, which will totally eliminate working on documents in their traditional (analog, paper) form.

Abstract: Artykuł przedstawia zwięzłe studium poświęcone metodom wektoryzacji map (w szczególności map górniczych). Na wstępie zestawiono encyklopedyczną definicję mapy (z łac. *mappa* = „obrus”) z ujęciem przedmiotu cyfrowania z punktu widzenia geologii górniczej. Wyróżniono i krótko scharakteryzowano rodzaje map górniczych występujących w archiwach działów mierniczo-geologicznych zakładów górniczych wydobywających węgiel kamienny. Przedstawiono metody (digitalizacja ręczna za pomocą digitizera, digitalizacja ręczna z ekranu, digitalizacja automatyczna) i zalety cyfrowania map górniczych (dogodność przechowywania zapisu, łatwy dostęp do zgromadzonych na mapach danych, łatwy sposób ich modyfikacji i uzupełniania). Omówiono i porównano z sobą “środowiska” wektoryzacji (z określeniem po co i w czym cyfrować, jakim systemem się posługiwać, co wybrać?). Dokonano przeglądu warsztatu pracy, w rozumieniu istniejących na krajowym rynku głównych narzędzi GIS (*Geographic Information System*) i CAD (*Computer Aided Design, Computer Assisted Drafting*) oraz wskazano różnice, wady i zalety. W analogiczny sposób porównano ze sobą tradycyjną i cyfrową metodę kreślenia map górniczych. Zaprezentowano aktualny stopień cyfryzacji materiałów dokumentacyjnych oraz krótko opisano jakimi rodzajami map górniczych dysponują zakłady górnicze (mapy analogowe, „hybrydy” – mapy półcyfrowe, mapy cyfrowe). Stwierdzono, że najczęściej spotykaną obecnie formą map górniczych są „hybrydy” łączące ze sobą elementy mapy rastrowej i mapy wektorowej. Do konstrukcji map „hybrydowych” nierzadko wykorzystuje się połączenia kilku programów komputerowych. Najczęściej jest to kombinacja programów Surfer i AutoCAD łącząca potrzeby całego działu mierniczo-geologicznego, tj.: wymagania mierniczych górniczych (AutoCAD) i geologów (Surfer). Kombinacja taka

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pozwala bowiem na zespolenie skalowalności (czyli dowolnego doboru skali/formatu) map i odpowiedniego doboru detali górniczo-geologicznych (z programu AutoCAD) z różnymi metodami kreślenia map izolinii (z programu Surfer). Zwięźle omówiono metodę współdziałania tych programów oraz jej zalety i możliwości. Stwierdzono, że superpozycja map izolinii kilku parametrów w jednym pokładzie umożliwia poszukiwanie współzależności zmian wartości różnych parametrów w pokładzie/złożu węgla. Superpozycja map izolinii jednego parametru w kilku pokładach pozwala natomiast poszukiwać tendencji zmian wartości danego parametru od głębokości zalegania pokładu/złoża węgla. Superpozycja pozwala również na wykreślenie mapy typów węgla wg PN-82/G-97002 i obserwowanie zmian granic obszaru występowania danego typu węgla w złożu. W konkluzji poddano rozważaniom zagadnienie czy cyfryzacja obejmować ma jedynie mapy, czy też należy dążyć do pełnej numerycznej dokumentacji geologicznej złoża, pozwalającej na całkowite wyeliminowanie prac na mapach w ich tradycyjnej (analogowej, papierowej) formie.

Key words:

digital maps, mining maps, geology maps, Upper Silesian Coal Basin, underground mining

Słowa kluczowe:

mapy cyfrowe, mapy górnicze, mapy geologiczne, Górnośląskie Zagłębie Węglowe, górnictwo podziemne

1. Introduction

A map (from Latin *mappa* = tablecloth) is a generalized picture of the surface of the Earth or its part (also of another planet, the sky or a heavenly body) put on a plane surface, scaled according to the rules of cartographic mapping, with the use of graphical symbols. That is what an encyclopedic definition says.

However, a definition of a map as regards mining geology is not so clear-cut (Maciaszek et al. 2010). A map is a result of all actions performed by a geologist, that involve geological mapping of underground workings and sampling of the deposit. It is a basic document used for designing a coal mine, proper designing and performing of the deposit exploitation or correct estimation of its economic value. The map is a basic form of transferring geological information. It is an element combining the range of works performed by a geologist and a mining surveyor – the surveyor creates a map which is filled with content by the geologist.

2. Overview of the application of digital maps in mining geology

Among other works, the overview of the market of software used for documenting the Polish mineral deposits has been presented herein (Kozuła, Szymański 2000; Zawadzki 1998). It is undeniable that geological documentation in a numerical form brings measurable profits to the mining industry. Furthermore, such a documentation allows for a better exploration of the deposit and provides improved integration of all units involved in the exploration, design and exploitation of the same.

The matter of applying digital mapping techniques in the assessment of the potential of ash dumps resulting from coal combustion has also been addressed. The locations of the most productive areas were established, comprehensive sampling was conducted (with boreholes) and maps have been charted that show the trends of material distribution in the dumps while giving consideration to particle size and the content of carbon (Tyra & Groppo & Robl & Minster 2003). In opencast mining, quick and safe periodic stock-taking of the exploited headings – including the cutting depth and geometry of the dump – is conducted by use of short-range photogrammetry (slope vectors and dispersed points). It also allows to ensure work safety and better control of the operation of the basic machines as well as for the analysis of

subsidence of the dumping ground and the drainage including the range of the cone of depression (Gawin 2009).

It is also worth noting the stratigraphic and geochemical databases developed for the Pittsburgh (USA) coal deposit. This deposit was also subject to an analysis of the sulphur content distribution by means of geostatistical methods using a combination of geological models and GIS (Watson et al. 2001).

The estimation of the mineral quality in the deposit – the determination of the quality parameters and sizes of the resources – is an important area of application for the 3-D techniques and relates to opencast, underground and borehole mining.

Among other things, the paper presents the possibility to apply the combination of AutoCAD and Surfer software for developing digital maps with isolines of coal quality in a deposit. The simultaneous application of both programs may constitute an alternative to the commercial software. The proposed methodology was used to design maps of technological, chemical and petrographic parameters of coal, giving consideration to both national and international standards of estimating the coal quality in the deposit (Probiez, Marcisz, 2000, 2007, 2009, 2010a, 2010b). PredCoal is a particularly useful software to estimate the hard coal quality in deposits (Marcisz et al. 2014). The program combines databases relating to the quality of coal in the deposit, functioning in the measurement and geology divisions of the USCB coal mines and the functionalities of the AutoCAD and Surfer software. It allows to predict the quality of the coal mine in the deposit, in a selected group of seams, in a single seam, and – to a certain extent – it allows to estimate the quality of the feed directed for dressing in the coal processing plant. The visualization of the coal quality in a given deposit/seam encompasses both horizontal changes – in the form of digital maps of individual quality parameters and the areas of occurrence of coal types classified in line with the Polish Standard, as well as vertical changes – mapped using geological profiles along the established line of the cross-section. The set of functionalities provided by the software is aimed at supporting the measurement and geological divisions of underground coal mining plants in estimating the quality of minerals as well as in optimizing and automating the works related to the quality of the hard coal deposits, especially in the conditions of the multi-seam deposits of hard coal in the Upper Silesian Coal Basin and specific conditions of underground exploitation. Furthermore, the changes of the coal quality in the mining plant's production process between the manufacturer and the client was subject to analyses which used visualisations (Whateley 2002).

3. Types of mining maps

On the basis of the content presented on maps, they are divided into:

- surface maps – presenting the surface of the Earth projected on a plane surface,
- geological maps,
- mining working maps – presenting the location of underground workings and some devices in those workings, as well as more important information concerning deposit structures (seam profiles, dip angles, faults, folds, pinches and seam splittings etc.). In underground coal mines two types of such maps are made:
 - seam maps – being a projection of a seam floor on a horizontal (seams with dip $< 60^\circ$) or vertical (seams with dip $> 60^\circ$) plane. Such maps are created separately for each of the seams, while the following elements, among others, are put in there: borders of mining areas, seam profiles, dip angles, contour lines of seam floors, fault lines, fold axis, seam pinches, splittings and fadings, water hazard zones, water reservoirs, shafts, drill-holes, workings, places of seam sampling and the like,
 - level maps – maps of a mining level with mining workings, with the addition of seam profiles, seam dip angles, fault lines, fold axis etc.

According to their scale, maps can be divided into:

- basic maps – created directly on the basis of the results of geological mapping of underground workings. They are scaled 1:500 – 1:2000 (usually 1:1000 or 1:2000),
- survey maps – made by reproducing or reducing basic maps, containing all or only some elements of their contents. They are scaled 1:500 – 1:25 000 (usually 1:5000 or 1:10 000),
- special maps – made by reproducing, reducing or enlarging basic or survey maps; they are supplemented with details of special significance for a mining company.

It should be remembered that, apart from maps, mining cartographic materials also include:

- profiles (of workings, shafts, drill-holes) – being a graphic presentation of geological structures present in those workings. They are scaled 1:5 – 1:2000,
- geological sections – presenting geological structures on a vertical plane. They are scaled 1:500 – 1:5000.

4. Sources of data for drawing mining maps

All mining maps are made on the basis of data obtained from geological mapping of underground workings, since each result of such mapping must be adequately written onto maps, profiles and sections. Information obtained as a result of mapping is used to update the abovementioned cartographic materials, and more often than not it is also the basis for their creation (Chelmicki 2006, Frankowski et al. 2000, Nita et al. 2004).

Mapping of underground workings is performed by a mining geologist during deposit recognition and exploitation. It involves a graphic presentation of geological phenomena occurring on the longwalls of underground workings in order to explain stratigraphic-tectonic relations, the structure and form of the deposit and its relation to the surrounding rock formations in an extent sufficient to exploit the deposit safely and effectively.

Each mapping is accompanied by coal sampling.

A basic type of samples collected by a geologist in order to perform coal quality assessment – the determination of

coal quality parameters – are pillar samples. Pillar samples are thought to be the most accurate method of the deposit sampling, as such a sample represents all the elements of the deposit in the actual proportion they really have in a given place. The collected coal samples are registered in the samples and analyses book according to the order in which they were collected, and then, packed in small sacks with proper labels and sampling protocols, they are sent to the laboratory. The results of laboratory analyses are presented in the form of a coal sample analysis chart. The place of the collected samples location and their numbers are written onto the maps. The data is often additionally supported with selected results of laboratory analyses, e.g. of ash and sulphur content, calorific value etc. (Marcisz 2011).

5. Digitization and the review of tools for map drawing

Some of the main aspects for creating maps with the use of digital tools are, among the others:

- convenience,
- easy access to data collected on maps,
- easy modification and supplementation (updating) of maps.

Map digitization is a procedure requiring market recognition, as regards available software and its applicability (and thus also its price) and hardware demands, necessary to be fulfilled in order to work with the given software. It should be remembered that such software requires a high-class computer equipment and uses a lot of space on a hard disk. Therefore one needs to make some choices. The first and most important question is connected with the so-called work environment, i.e.: a system in which a digital map will be created. Currently one can choose between two available software solutions:

- GIS – Geographic Information System – information system used to enter, collect, process and visualize data. In other words, it is a system of spatial information, presenting a collection of objects, in which a coordinate system is a global system of world coordinates (longitude and latitude) allowing for an exact presentation of object location in the area.
- CAD – Computer-Aided Design or Computer-Assisted Drafting – designing aided by the use of advanced software that enables to create virtual models of 2-D and 3-D objects. It is, therefore, a system which makes it possible to create a model of a single object, where the coordinate system is a global system of coordinates measured in mm or m, used in order to achieve a schematic drawing (Blachowski et al. 2014, Chelmiński et al. 2006, Chodyń 2004, Dudek 2013, Frankowski, Gądek 2009, Gościowski 2008, Kamran, Majid 2006, Kecojevic et al. 2005, Pozzi, Lewandowski 1996, Ruppert et al. 1999, Skowronek 2000, Winkler 2002, Winkler et al. 2007, Wojciechowski 2007).

Both “environments” differ, as do software programs connected to each of them.

The representatives of GIS are, among others, ArcGIS and ArcInfo (made by ESRI company), MicroStation Geographics (by Bentley Systems), MapInfo Professional (by MapInfo Corp.), MGE and GeoMedia (by Intergraph), Vulcan 3D (by Maptek IT), SoftMine and IMine Modeller (by Przedsiębiorstwo Robót Geologiczno-Wiertniczych sp. z o.o.), and also AutoCAD Map 3D and AutoCAD World (by Autodesk).

The CAD system is represented by: AutoCAD (by Autodesk), GeoPlan and GeoStar (by Soft-Projekt), GEO-MAP (by GEO-SYSTEM) or Mapa_SG 2000 (by INFOGEO) and others.

Apart from the system in which the programs work, they are assisted by other software of a specific character, e.g. GeoEAS (Geostatistical Environmental Assessment Software), by United States Environmental Protection Agency, assists GIS and CAD programs in geostatistical work (among others in drawing histograms, semi-variograms etc.); Surfer (by Golden Software) draws maps of isolines of any parameter on the basis of a given method of isarithm outlining (among others the method of reverse distances, kriging, minimal curves, natural and closest neighborhood, movable mean, triangles with linear interpolation, modified Shepard method), Modflow (by Scientific Software Group) and Voxel Analyst (by Intergraph) help to design roads of pollution migration as well as the direction and dimension of its spreading, Surpac Minex and Surpac Vision (by GEMCOM) assist the activities of mining.

Apart from the supporting software, there are also overlays to the existing programs, whose aim is to facilitate the use of the program, directing it towards a chosen range of activity (e.g. modelling of deposits, drawing maps etc.) or automation of the most common commands, options or tasks (Dzedzej 1996, Galon 2009, Kuś 2002, Małek 2000, Myrda 1997, Pikoń 2013, Tański 1991, Urbański 2012).

6. Numerical mining maps

The development of computer tools enabled geologists to create documents in an electronic form. However, although digital methods are more and more common, yet most of documentation materials in a mine are preserved in their original (analog) form. There is also no account of research done on a wider scale that would be connected with database creation, the construction of digital quality maps of a research area etc., which is probably also related to the lack of one, generally accepted standard of data collection and digital maps creation (Maciaszek et al. 2015).

Currently surveyor-geological divisions of mines possess three types of maps:

- analog maps – preserved totally in their original form: sheet of paper, foil or a sheet with aluminum foil glued underneath,
- “hybrids” – semi-digital maps – created through scanning of an analog map and completing it digitally from the moment of scanning,
- digital (numerical) maps – created by means of computer programs: either created digitally from the beginning or totally digitalized analog maps.

The most common forms are semi-digital maps (“hybrids”), connecting raster maps with vector maps.

Raster maps (bitmaps) rely on the resolution of a net of points (the more points on a unit of length, the better the quality). The dimensions of points in a raster (or bitmap) is constant, thus, as the map extends, its quality deteriorates (which does not happen to vector maps). The source of a raster file is usually a scanner – the recording of a map is created while scanning. There are a lot of formats of raster files used for different things. They differ in the number of „remembered” colors and the degree of compression (the better image quality, the bigger the file is). Most common raster formats are: *.jpg, *.tif, *.bmp. Raster graphics are thus very large – they occupy a lot of space on a disk. The instability of the original medium of a map (i.e. a change in paper dimensions due to humidity) and the distortions taking place during scanning are the source of a decreased accuracy of a map.

The opposite of raster maps are vector maps – representing objects, for which great accuracy is needed. Vector write

is used commonly in CAD systems, and the coordinates are expressed for example, in mm or m, instead of geographical coordinates. The size of a vector map is usually several times smaller than a bitmap. The greatest advantage of vector write is its scalability. The quality of a vector map does not depend on the scale in which it is presented – contrary to raster maps, where the best quality is achieved with a scale close to the original. It results from the fact that a vector map is created by manual entering of each point, which, however, is a time- and effort consuming process.

The relationship between digital and analog maps is presented in the chart showing the function of costs and time (Fig. 1). High investment costs incurred as to digital maps (software and hardware), together with the abovementioned time and effort needed to create a map, are compensated over time with minimal expenditures connected with reproducing and scaling of digital cartographic materials. On the other hand, in case of analog maps created in a conventional way, it has been observed that relatively low costs of entering data and little time and effort are then met with high expenses on the reproduction of maps, profiles or cross-cuts constructed in such a way.

Hybrid maps are thus a reasonable solution – being somewhere in between analog and digital maps.

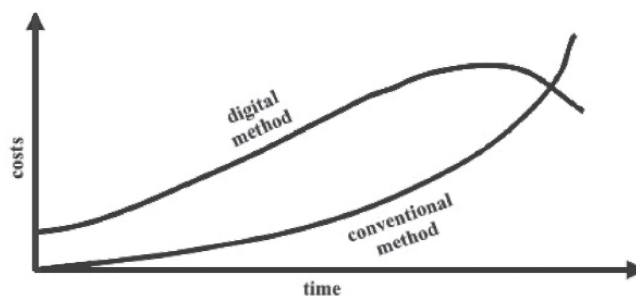


Fig. 1. Draft of relationship between conventional and digital methods of map drawing

Rys. 1. Szkic zależności między tradycyjną a cyfrową metodą kreślenia map

In order to create “hybrid” maps, more often than not several computer programs are used jointly. The most popular tool to describe geological elements for mining geologists is Surfer – a program which perfectly co-operates with AutoCAD. Options of both programs do not provide, however, sufficient possibility to draw and interpret geological data. On its own, Surfer allows a mining geologist, for instance, to prepare quality maps by means of various implemented methods of isolines drawing. AutoCAD, on the other hand, is a tool used mainly by mining surveyors, thanks, among others, to the possibility of rescaling, large format printing, drawing on layers connected with a proper details selection or high accuracy, resulting from the vector format. The application of both programs fulfills the needs and requirements of the whole geological-surveyor division of a mine, and covers a few stages:

- an analysis and determination of geological data structure – geological mining maps are made in order to picture changes in values of coal quality parameters in particular seams. The criteria for choosing those parameters are domestic and international standards, based on technical and elementary analysis indicators, coking indicators, physical (optical) indicators and petrographic composition. Those parameters are: water content in an analytical sample W^a , %; ash content in the dry state A^d , %; volatile matter content in dry and ash-free states V^{daf} , %; calorific value in dry and ash-free states $GC V^{daf}$, MJ/kg; total sulphur content in the

- dry state S_t^d , %; Roga Index, RI , -; Swelling Index, SI , -; contraction a , %; dilatation b , %; reflectance of vitrinite R , %; the content of macerals from the vitrinite group V^{mmf} , % vol.; the content of macerals from the liptinite group L^{mmf} , % vol. and the content of macerals from the inertinite group I^{mmf} , % vol. The data stating the values of those parameters usually comes from drill-holes charts and the seam samples analysis charts (Marcisz 2013, 2014);
- a creation of a tabular database – entering, writing in data (in a chosen spreadsheet);
 - a creation of a numeric seam map (in AutoCAD) – there are three basic methods of entering vector graphics into the computer (Kura, 2007):
 - manual digitization with a digitizer – a simple, although time-consuming method of entering data with the use of the digitizer, demanding a lot of work,
 - manual digitization from the screen – manual redrawing (with a mouse) of a map on the basis of its raster image obtained in the process of scanning,
 - automatic vectorization – a method consisting in the application of programs for automatic vectorization. The basis is a raster image obtained in the process of scanning, and a vector image is obtained thanks to an image recognition program which isolates single elements of a raster image and saves them in a vector form;
 - a construction of an isoline map with quality parameters values with declaring a selected method of isarithmic contouring (in the Surfer);
 - applying proper Surfer's layers on the AutoCAD's matrix – in this process simple copying and pasting options, as well as the method of „blocks” creation are used, or it can be fully automated, joining a spreadsheet with Surfer and AutoCAD with the help of AutoLISP and a selected programming language.

There is, of course, a possibility of superposition (applying one on another) of isolines of particular parameters in a seam. Similarly, maps of the same parameter in different seams can be put together to observe their changes with depth.

The way of map construction presented above allows, in a relatively cheap way, to make coal quality parameters maps. The possibility to apply layers one on another makes it easier to present only relevant data, which prevents „information overload”. Scalability enables to print complete maps in any format. A digital form of map writing, on the other hand, facilitates maps' storing, modifying and making accessible (Probiez, Marcisz 2000, 2009, 2010a, 2010b).

The process may be called a traditional method i.e. manual, where the actions are time- and effort consuming. The lack of specialist tools that would interpret geological elements and difficult conditions of Polish coal deposits brought about the use of AutoLISP – an internal programming language of AutoCAD – and programming language Visual Basic for Applications to combine both programs in order to draw digital isoline maps. Such application enables full automation of the process of isoline maps construction (Marcisz et al. 2014, Fig. 2).

The analysis of the situation presented above suggests a question whether digitalizing should be used only for cartographic materials (including maps, profiles, geological cross-sections). It seems that in spite of some justified concerns about the simplicity in modifying and possible interference in digital materials, they should be introduced in all geological documentation (which indeed occupies quite a lot of space in any mine's archives). Geological documentation in a digital form is a long-term investment which gives a mining entrepreneur calculable economic benefits and allows to integrate all the divisions of a coal mine that take part in the process of documenting mining economic activity. As regards the



Fig. 2. The interface and menu of a copyrighted application for drawing isoline maps of coal quality parameters from 2008 (up) and main screen of PredCoal software and its II module: Seam from 2014 (down)

Rys. 2. Interfejs i menu autorskiej aplikacji do kreślenia map izolinii parametrów jakości węgla z roku 2008 (u góry) oraz ekran główny programu PredCoal i jego II modul: Pokład z roku 2014 (na dole)

abovementioned concerns about unintentional or purposeful interference in digital materials, it should be regulated by proper legislative bodies in the form of regulations, rules, acts etc. which will be carried into effect by computer specialists (Blajda et al. 1992, Gawin 2009, Goldsztejn, Skrzypek 2004a, 2004 b, Kozula, Szymański 2000, Łozińska, Probiez 2000, Marcisz, Sobolewski 2015, Pilecka et al. 1998, Probiez et al. 2006, Tyra et al. 2003, Watson et al. 2001, Whateley 2002, Zawadzki 1998).

7. Conclusions

Modern computer techniques allow to gather all geological data in one environment, as well as to store it safely and analyse it in a comprehensive way. The information collected is reinterpreted over time due to more and more exact deposit recognition, and the development of geological studies and computer techniques. Application of those techniques allows for a much wider interpretation of geological activities and consideration given to a great number of alternative solutions in a relatively short period of time, taking into account all information about the deposit available. The interpretation of data is a basic task of a geologist. The data is not changed, but the way of its interpretation is an aggregate of knowledge, experience and geological intuition. The basis of the interpretation is the data, stored and constantly protected in the frames of a digital database. The interpretation brings about quality and quantity models of the deposit which may take the form of maps, profiles, charts, comparisons etc. All the services in a mine collect data about the deposit in order to work out the best way for its exploitation. The mining-surveying division has full knowledge about the deposit and individual seams (it is the task of the surveyors to create maps and save facts about the geometry of workings and the morphology of surface, and it is the task of the geologists to create maps and collect information about the deposit: its form, geological structure, lithostratigraphy, tectonics, and the quality, distribution and resources of minerals). The division of production preparation is able to simulate exploitation of particular parts of the deposit on the basis of data received from geological-surveying division (its task is to create maps and short- and long-term simulations of exploitation). Applying economic information on geological-mining data, on the other hand, makes it possible to control production in a rationally justified way, as regards both technical and economic aspects (Marcisz 2010).

The introduction of digital technologies will totally eliminate working on maps in their traditional (analog, paper) forms.

Computer techniques – thanks to their flexibility – allow to select the most effective tools in order to optimize „the work on the deposit” on each stage of its management: searching for a deposit, recognizing the deposit, exploitation of the deposit, and closing the mine as well as taking care of the post-mining areas (Probiez, Marcisz 2007).

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