MODELING OF THE KOVIN COAL DEPOSIT IN THE FUNCTION OF MAKING MINING PROJECTS

Expert Paper
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Jovanović Branka, Polavder Svetlana, Grujičić Sanja

Mining Institute Belgrade, Serbia
povrsinska@ribeograd.ac.rs

Abstract: *Modern design of surface exploitation of mineral deposits is preceded by modeling (or digital representation) of the deposit, which in the form of defined terrain planes and geological layers, profiles and quantities is the basis for planning mining works.*

On the world market, there are many software packages intended for deposit modeling, with a similar working principle and end result. Based on the results of exploratory drilling, a deposit database is formed, which is further processed according to certain criteria and a deposit model is created.

SOL or Deposit Processing System was developed at the Mining Institute in the 80s. The feature of this program package is that it models the deposit in a simple and efficient way from the database and provides designers with reliable bases, in the form of AutoCAD files, for further design.

Key words: MODELING, DEPOSIT, EXPLOITATION, DESIGN

INTRODUCTION

In the mid-1990s, the development and availability of personal computers and programs contributed to the transition to the complete digital creation of mining projects, instead of the manual creation of projects until then, multiplicating text typed with typewriters and hand drawn plans.

The development of projects and the design of mining works on the computer also requires digital support in the form of geodetic terrain maps and geological interpretation of deposits.

The authoritative geological basis for the design of mining works is the Geological Study on Reserves, which is also the basis for verifying balance reserves of mineral raw materials. The available Elaborate is most often not in an active digital form, it is mostly

in printed form or in the form of a PDF document and without an available digital database with the results of investigative works.

For these reasons, a necessary initial step in the design of surface mines, especially for larger explored areas, more complex deposits and new mines, is the modeling of the deposit with data from exploratory boreholes and according to the interpretation of the deposit (in terms of the position of layers and faults) defined in the Geological Study on Reserves.

There are a large number of mineral deposit modeling packages on the software market, the most commonly used in our area are SOL, GDM, Surpac, Carlson and DataMine.

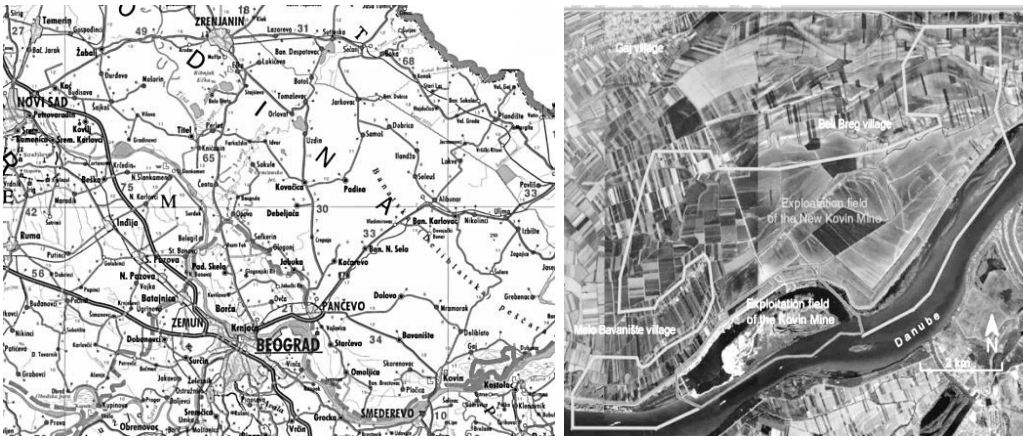
In the rest of the text, the basic data on the Kovin coal deposit are shown, as well as the principles and results of modeling this deposit with the SOL software package, which were the basis for the designers of the Mining Institute when developing mining projects for the Kovin Mine and the New Kovin Mine.

The Kovin coal deposit is part of a larger coal-bearing area that also includes the Kostolac deposit on the right bank of the Danube and are referred to in the literature as the Kostolac-Kovin coal basin.

BASIC INFORMATION ABOUT THE KOVIN COAL DEPOSIT

LOCATION

The Kovin coal deposit belongs to the municipality of Kovin and southern Banat, in the autonomous province of Vojvodina. It is located on the left bank of the Danube, about 20 km east of Kovin and 70 km from Belgrade, in the area of the Kovin's Depression and the alluvial plain of the Danube River, between the village Gaj on the north side, the Danube River on the south side and the village Dubovac on the east side (Figure 1).



a) *b)*

Figure 1, Geographical location of the Kovin coal deposit [3]

BASIC GEOLOGICAL CHARACTERISTICS OF THE KOVIN COAL DEPOSIT

Deep exploratory drilling at the location of the Kovin coal deposit limited two coal-bearing fields, west A and east B, with the space between them free of coal. Two coal layers have been identified in the coal-bearing fields: I and II coal layer (Figure 2).

Above the coal seams is located layers of sand and gravel with interlayers of clay. Between the coal layers, as well as in the bottom of the II coal layer, there is sand with interlayers of clay.

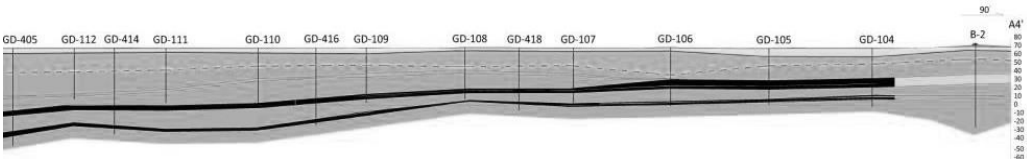


Figure 2, Geological profile of a Kovin coal deposit [3]

INVESTIGATION

Investigations of the Kovin coal deposit were carried out periodically, from 1975-2009. year, on an area of about 60 km^2. Based on the results from approximately 600 exploratory borehole (Figure 3), several geological studies were prepared, based on which the coal reserves (A, B and C categories) were verified. In addition to coal, Kovin deposit gravel is also recognized as a mineral raw material.

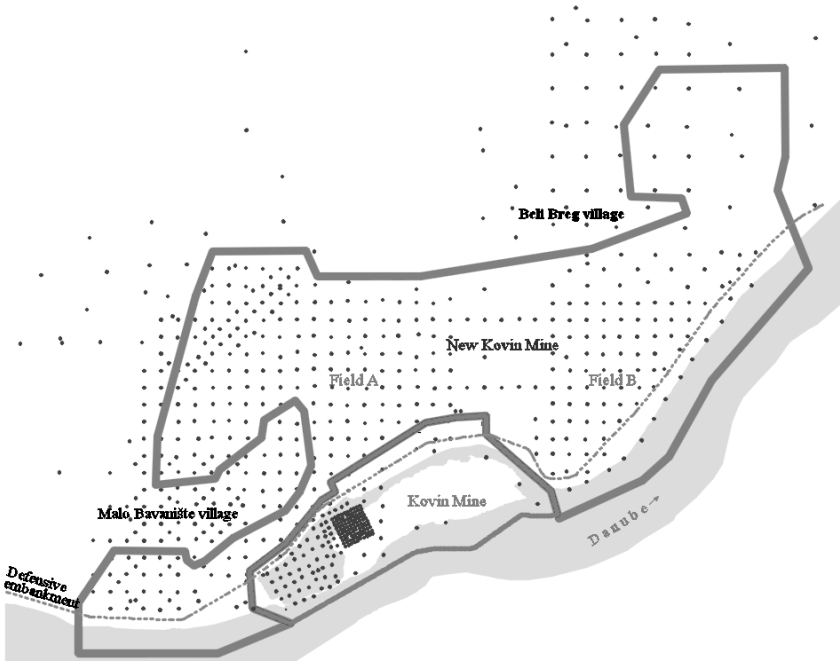


Figure 3, Exploratory boreholes of the Kovin deposit within the exploitation fields of the Kovin Mine and the New Kovin Mine [3]

EXPLOITATION

Since 1995, underwater mining of coal and accompanying sediments of the Kovin deposit has been carried out at the Kovin Mine, in the unprotected part of field A, between the defense embankment and the Danube. Preparatory activities are underway for the expansion of exploitation works on the same deposit, within the approved exploitation field of the New Kovin Mine, also in the unprotected part of Fields A and B (Figure 1_b and 3).

PROJECTS

The Mining Institute Belgrade has been present at the Kovin Mine since the end of the 80s, on preparatory, experimental and laboratory works as well as on the preparation of technical documentation. So far, several mining projects (main, supplementary and simplified) and studies have been prepared.

For the needs of the future New Kovin Mine, in 2023, the Mining Institute prepared the Feasibility Study of Underwater Exploitation and the Simplified Project of Preparatory Works, and preparatory activities for the preparation of the Main Mining Project are underway.

The aforementioned mining projects and studies were based on the geological model of the Kovin coal (and gravel) deposits, created with the SOL software package. Over time, the model was supplemented with new data, boreholes and contours. In the meantime, the SOL program itself has been modified and adapted to the new program environment.

MODELING OF THE KOVIN DEPOSIT USING THE SOL PROGRAM PACKAGE

PROGRAM ENVIRONMENT

The program package SOL or Deposit Processing System, developed at the Mining Institute at the end of the 80s, is one of the first programs intended for modeling mineral deposits in these areas. In that period, the operating system MS DOS (Microsoft DiskOperatingSystem) was used, in which SOL also functions. Meanwhile, in the 90s, MS DOS was supplanted by the Windows operating system, when the authors of the SOL program (mathematicians and programmers of the Mining Institute) extended the program in such a way that the output files in the form of tables, profiles and plans are still used in the Windows environment and automatically convert to Excel and AutoCAD files.

PROCEDURE AND RESULTS OF THE MODELING OF THE KOVIN COAL DEPOSIT

1) Database

At the very beginning of work in the SOL program, as in all programs of that type, a database is formed consisting of input files:

- individual data from exploratory boreholes, with X, Y and Z coordinates of the borehole, depths of geological layers (previously coded) and data on the quality

of the mineral raw material (for Kovin deposit coal it is moisture, ash, sulfur, thermal effect);
- a digitized terrain image, with X, Y and Z coordinates of recorded points of the terrain surface in the observed deposit area and
- characteristic contours within which are defined: mineral raw material, accompanying sediments (overburden, interlayer tailings and interlayer tailings), calculate the quantities of mineral raw material and tailings and draw profiles and maps of isolines (bootom, top and thickness) of geological layers or quality of mineral raw material.

2) Model formation: point digital model TDM, equidistant digital bed model EDM and output results

After loading the input files of exploratory drilling data, terrain and contour images (deposit, balance reserves, phase excavation, etc.), logical and mathematical manipulations with the input data from the wells are accessed, such as:

- filtering according to certain criteria, e.g. layer thickness or quality parameter;
- mathematical operations of addition, subtraction, division, etc. (for a Kovin deposit, the overburden is the sum of the layers of sand and gravel in the coal seam, the overburden coefficient is calculated as the product of the overburden thickness and the coal series, the individual thicknesses of the layers are subtracted from the elevation of the recorded terrain in order to obtain the elevations of the bottom and top of the layers, etc.).

In this way, individual data on each borehole are obtained: coordinates, elevations of the roof and floor of the layers, thicknesses of the layers, overburden coefficient, quality parameters (DTE, moisture, ash, sulfur). Those individual data in each well make up the so-called Point Digital Model (TDM) of reservoirs can be read and printed, as tables or data on plans and profiles that are written next to the well [1].

For example, in Figure 4, on the isoline map of the bottom of the coal seam, individual data (or TDM) of the bottom of the coal in each well in the observed zone are written under the well label.

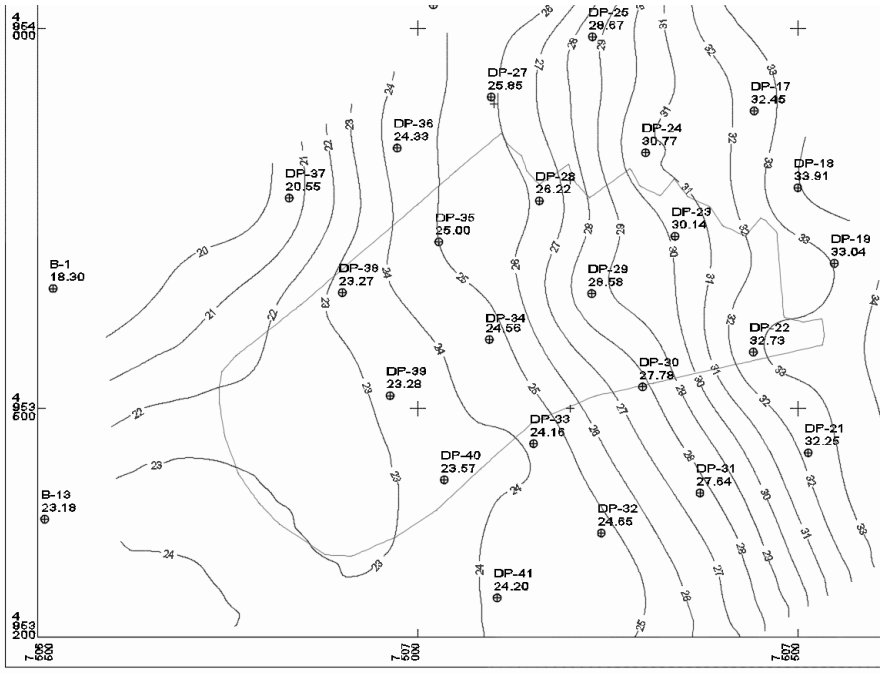
The next step in the deposit modeling procedure is the formation of the so-called EDM of specific data or Equidistant Digital Model of the deposit [1]. Based on the previously defined TDM (individual) data in the borehole, the parameters of the data network between borehole are set: distances between nodes (ΔX, ΔY) and the method of interpolation of individual borehole data (linear, inverse or quadratic polynomial method) depending on the reservoir type. For the Kovin deposit, since it is a sedimentary deposit with slightly inclined layers, the method of linear interpolation of individual data from the exploratory borehole was adopted.

When forming the EDM of certain data, logical operations of the type are performed, to adopt an EDM value that is greater or less than some constant value or some other EDM. Most often it is the relation EDM.thickness >0 or EDM.floor (of the layers)< EDM.roof.

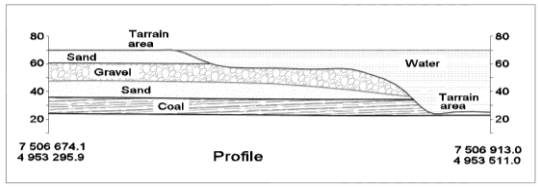
Based on the defined digital network of individual reservoir data (EDM), the final modeling results are formed, in the form of output files:

- (2D) isoline maps of certain deposit parameters (e.g. thickness of individual layers, overburden coefficient, roof or floor of the layer, quality parameters, etc.),
- vertical deposit profiles and
- tables with the calculation of quantities of individual sediments in defined contours.

Characteristic of the program package SOL is the calculation and display of the quantities of mineral raw materials and tailings in horizontal layers 1m thick (Figure 4c).



a)



b)

Level (mnv)		Quantity (m^3)		
From	To	In a layer	Cumulatively Down ↓	Cumulatively Upwards ↑
37	36	0	0	574.946
36	35	2.373	2.373	574.946
35	34	20.526	22.899	572.573
34	33	40.983	63.882	552.047
33	32	45.828	109.710	511.064
32	31	46.435	156.146	465.236

c)

Figure 4, An example of the results of the modeling of the Kovin deposit for the purposes of developing the Main Mining Project for the Kovin Mine
a) isoline map of the I coal seam, b) deposit profile i
c) part of the calculation table of the amount of coal on one part of the Kovin deposit [3]

CONCLUSION

Specialized programs intended for modeling mineral deposits, although they are not a substitute for professional knowledge and experience, greatly increase productivity, freeing designers from slow manual work and enabling activities that would be practically impossible without digital models.

The SOL software package, the principles of which, as well as the modeling results of the Kovin coal deposit, are presented in this article, is an example of how a high-quality, mathematically and expertly designed software package has its application even after 3 decades, and with minimal graphic corrections it does not fall behind the overpriced software packages of this type.

LITERATURE

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