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© N. Zuievska[1], T. Hrebeniuk[1], Y. Zuievskyi[1]
[1] National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute"

APPLICATION OF GIS FOR ANALYSIS OF ENVIRONMENTAL ASPECTS OF MINERAL DEPOSITS

© Н.В. Зуєвська[1], Т.В. Гребенюк[1], Ю.В. Зуєвський[1]
[1] Національний технічний університет України «Київський політехнічний інститут імені Ігоря Сікорського», Київ, Україна

ЗАСТОСУВАННЯ ГІС ДЛЯ АНАЛІЗУ ЕКОЛОГІЧНИХ АСПЕКТІВ ПОКЛАДІВ КОРИСНИХ КОПАЛИН

The aim of the article was to improve the method of visualization of the map of minerals with layers of occurrence of rocks using 3D modeling using a combined combination of google earth pro and the Surfer program.

Methodology used: 3D modeling of mineral deposits.

The results of the study were obtained, a visualization of the map of minerals using the geoinformation model of the deposit was created. With the help of a combination of Google Earth Pro and the Surfer program, the zone of the territorial location of minerals and layers of rock occurrence were obtained, which will optimize the mining process to achieve maximum profit with minimal damage to the environment, namely, to prevent unwanted land disturbance.

Originality. The integration of Google Earth Pro with the Surfer application has expanded the possibilities of visualization and analysis of mineral deposits. The combined use of these tools made it possible not only to obtain a detailed map of the location of resources, but also to determine volumes and identify the most valuable layers for extraction. The improved method has a significant positive impact on the environment, as it avoids unnecessary disturbance of landscapes.

Practical value. The application of the approach is the integration of geographic information systems to create a three-dimensional geological model of the deposit and a technique for visualizing the map of minerals. This makes it possible to more effectively solve the issues of mining planning and maximize the benefits for the enterprise while minimizing the man-made load and disturbance of landscapes. This approach has a significant positive impact on the environment, as it avoids unnecessary disturbance of landscapes and reduces negative environmental impacts. Keywords: minerals, geographic information systems, 3D modeling, visualization, maps, coordinates, ecology, landscape disturbance.

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Introduction. At present, almost no geological problem can be solved without the use of geographic information systems (GIS). There is no single universal GIS structure, so the choice of a particular system is determined by the needs and goals of the study. GIS allows for a detailed analysis of deposits, determining the volume of resources and choosing the most efficient and economically feasible ways of their extraction.

One of the most popular areas in geoinformatics is the solution of problems of analysis and modeling of geodata in order to optimize the strategy of behavior or use of available resources.

In recent years, the construction of 3D models, which are visualizations of modeling results, has become a popular and convenient tool in various fields of knowledge. This allows you to preserve landscapes as much as possible and not disturb the land with geological exploration. Therefore, the environmental component of these tasks is justified.

The result of predictive modeling of the zone should be a set of maps within the impact of mining operations, containing information on changes in the degree of man-made impact, engineering-geological, hydrogeological and geo-ecological conditions, as well as on objects on the surface that are at risk. Based on these forecasts, it is necessary to develop measures to reduce the negative impact.

Relevance of research. Understanding the potential environmental hazard of mining enterprises, entrepreneurs should use all possible ways to maintain the ecological balance in the areas of activity of their enterprises. However, for a real improvement of the environmental situation in the territory of operation, huge investments in the technological complex are required, primarily for the introduction of environmental technologies. In this regard, in order to optimize the economic costs of mining enterprises, modern means of geoinformation technologies can be successfully used.

Traditionally, forecast maps are created manually or semi-automatically, which requires a significant amount of time. Therefore, the main purpose of this work is to create a GIS system for solving forecasting problems using modern software systems that allow you to quickly carry out calculations and, if necessary, recalculate the man-made impact as a result of rock mass extraction [1].

One such tool is the Surfer app. It has been designed specifically for surface analysis and modeling, grid creation, landscape visualization, and much more. Thanks to the ability to customize any parameters, this tool allows you to create really very diverse three-dimensional maps.

Surfer provides the ability to perform analysis and modeling of various types of surfaces, which is important for many industries, including geology, geography, mining, hydrology, and others [2–8]. Grid Generation and Landscape Visualization: Surfer allows you to create grids and visualize landscapes in three-dimensional space, which is useful for analyzing and visualizing geographic data.

Developing detailed maps has never been easier and faster. And thanks to its powerful interpolation features, the program can create very accurate surfaces with the highest graphics quality. The intuitive interface makes it easy to master the program, even for those users who have not used it before. For example, to adjust any parameters of the map, you just need to double-click on its surface and set the necessary values.

Presentation of the main material of the study with a full justification of the scientific results obtained. The main idea of the article is to demonstrate the combined use of Google Earth Pro and the Surfer application.

First, you need to use Google Earth Pro to create a grid file and a contour map in surfer Google earth pro is a satellite imagery program for the entire surface of the Earth. Surfer [3, 4] is used to build two- and three-dimensional maps, mainly to represent information in the form of contour maps and surfaces.

By opening Google Earth Pro using the search, you can set the X and Y coordinate labels of our zone of the territorial location of minerals (Fig. 1). After copying the first coordinate from the file, enter it into the search.

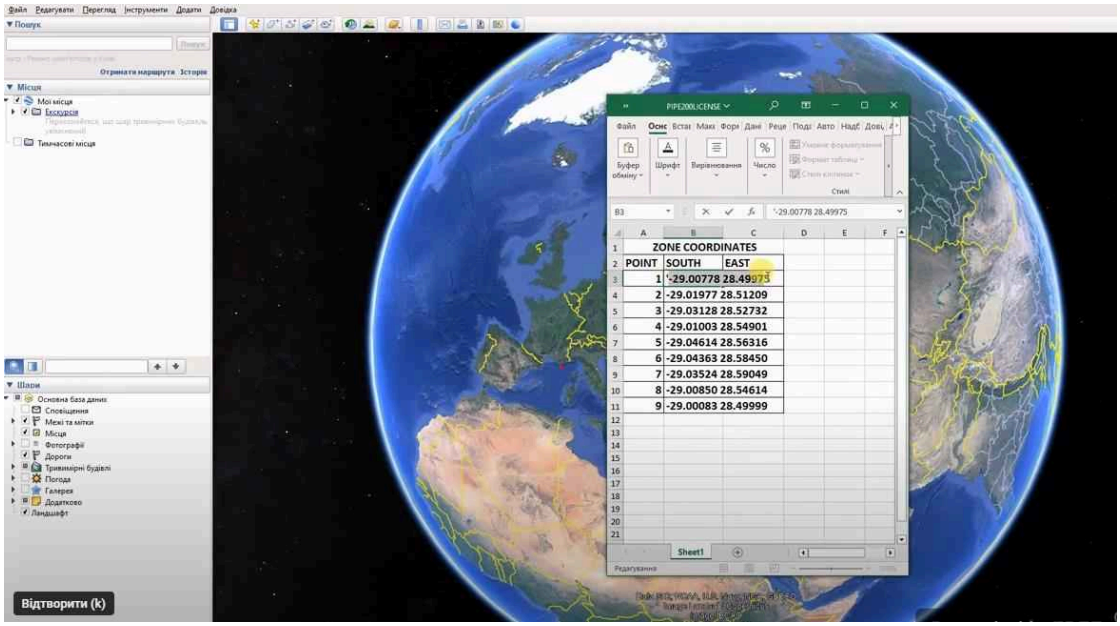


Fig. 1. Specifying the coordinates of the mineral zone

In the menu of the resulting coordinate, you can select "Save in the "My Places" section. The coordinate will appear in the "My Places" field. By right-clicking on the coordinates and renaming it to "1" for convenience, all other coordinates are specified.

As a result, you can see the zone of the territorial location of minerals (Fig. 2).

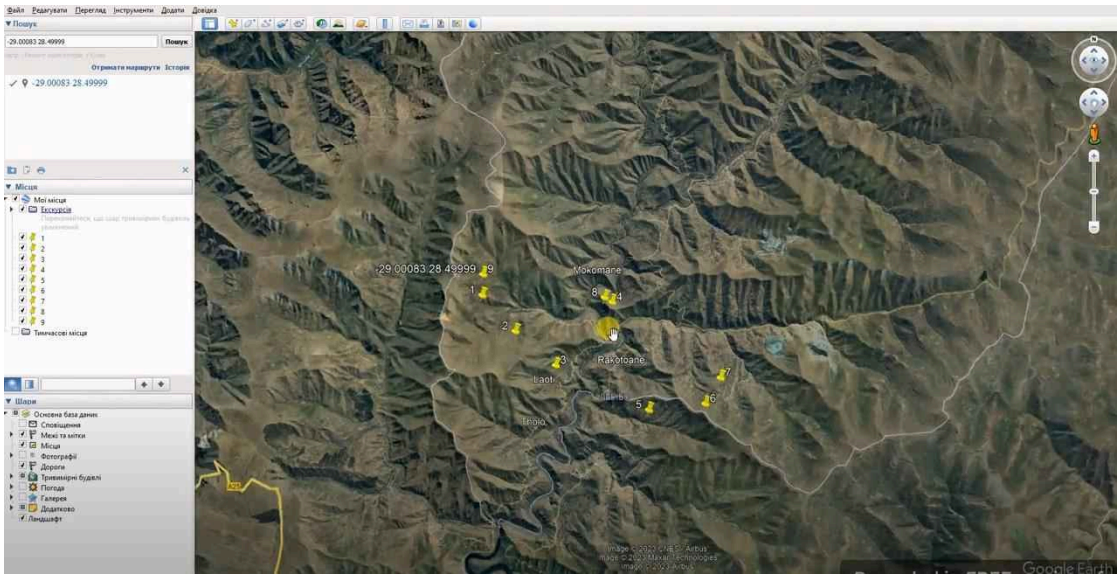


Fig. 2. Image on the map of the mineral location zone

Next, the X and Y coordinates are created by clicking the Add Path button. The name of the path is Zone. It is advisable to change the color of the line to a brighter one, in our case it is red for clarity.

Click OK. Do not touch this window, move it to the non-working area. With the left mouse button, hold it down and do not release it until you have applied all the dots. Each red dot is one of the X and Y coordinates.

The more points we have, the more accurate the grid file we will get (Fig. 3) and the more accurate the contour map will be.

Next, you need to release the mouse button. By moving the window that was in the non-working area and clicking OK, we save our zone – save as, kml file type.

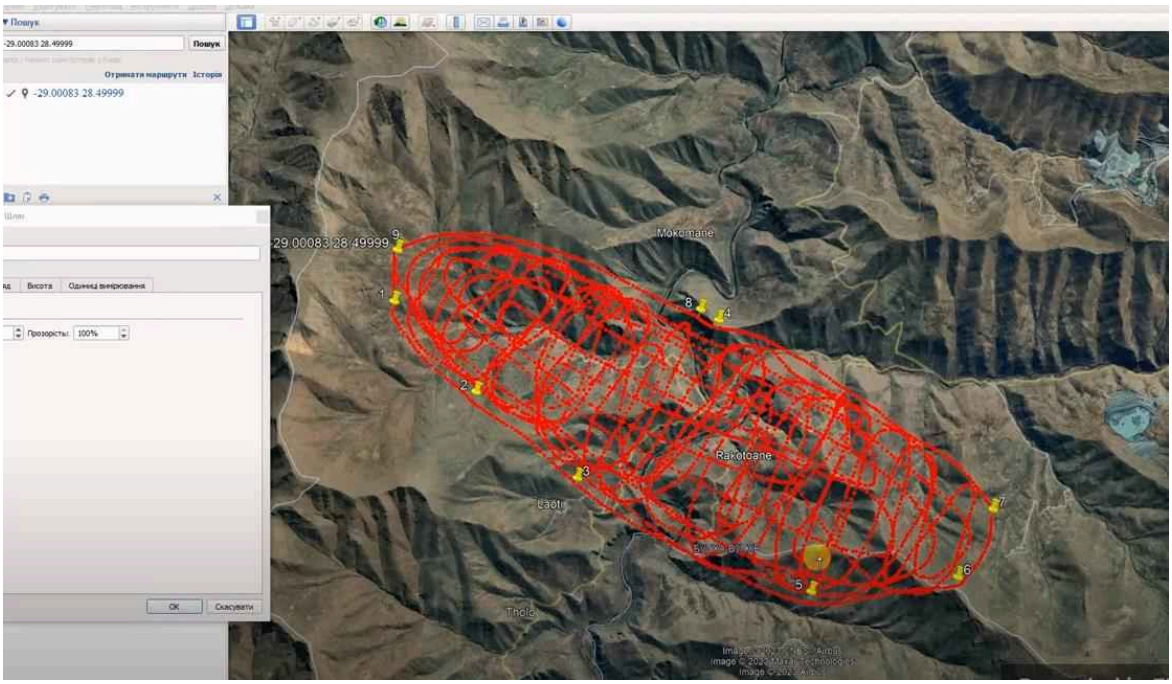


Fig. 3. Creating a grid for a contour map

So, the red dots can be used to determine the X and Y coordinates. In order to determine the Z coordinate, you need to use the www.gpsvisualizer.com website (Fig. 4).



Fig. 4. Website interface www.gpsvisualizer.com

At the top of the site, you need to click the "Look up elevation" button. In the green rectangle it is necessary to download our file that we have just created in google earth pro called – Zone. Convert to plain text and click the add elevation button, i.e. add the Z coordinate to the X and Y coordinates. Remove everything unnecessary. We have the X coordinate, the Y coordinate, and the Z coordinate. Select all the text with the Ctrl+A keyboard shortcut, then copy it with the Ctrl+C keyboard shortcut, and open the Surfer program. In Surfer, press Ctrl+W to open a Worksheet document.

So, you need to paste the copied file into it. Next, you need to swap the X and Y coordinates and save the document. The file type is DAT, save by clicking OK.

After that, we need to go to the Plot document and create a grid file. To do this, on the Greeds tab, select the appropriate Greed Data button.

What in column X will be A. What in column Y will be B. What in column Y will be C. Surfer creates a mesh file.

To create a visualization of the mineral map using the geographic information model of the deposit, go to the Home tab on the Map subtab of the corresponding Contour map. Select our file and open it. On the Levels subtab, we can customize the map (Fig. 5). You can also change the color of the contour map and add a scale and a 3D map. By pressing the 3D Surface button, you can select our file and open it.

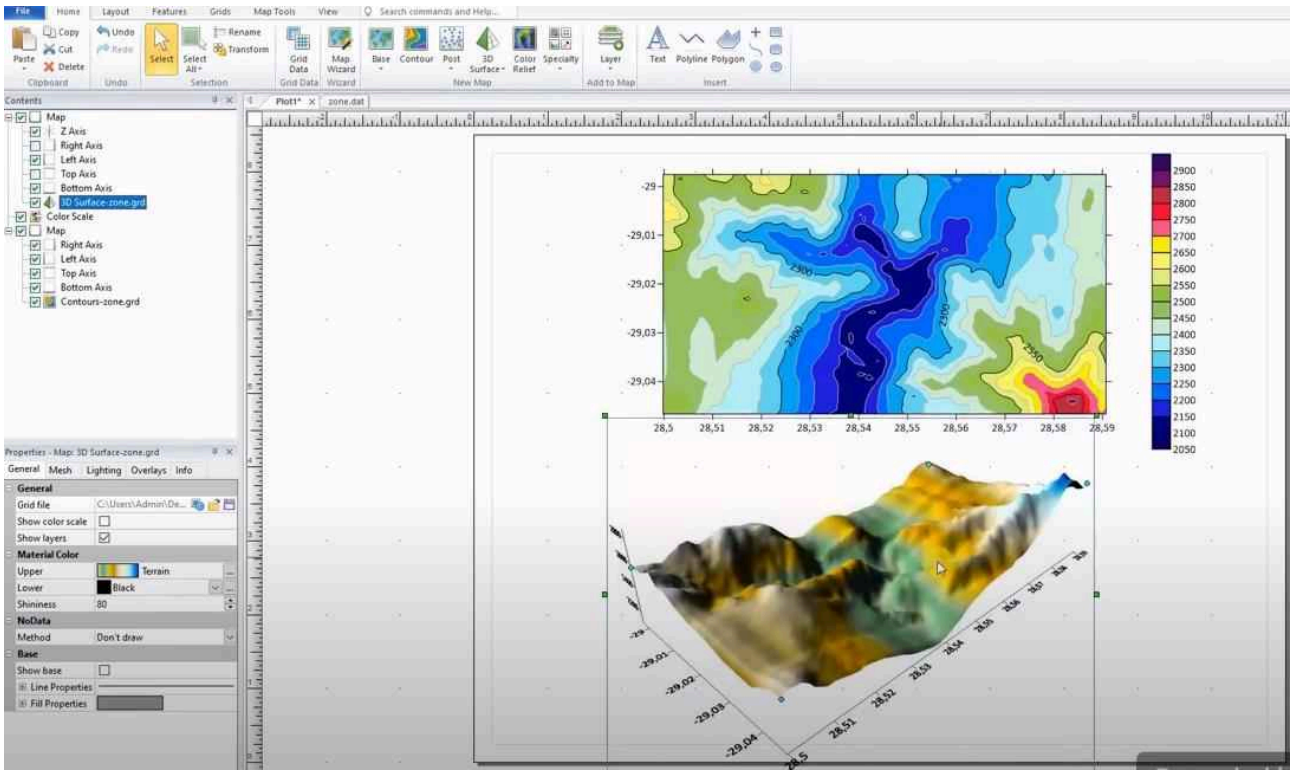


Fig. 5. A contour map and a 3D map with a scale have been created

The addition of wells to the zone of territorial location of minerals is also considered. To do this, you need to open a file with the coordinates of the wells. In Google earth, use the search to set the X and Y coordinate labels of the wells. Next, connect all the labels with the "Add polygon" function (Fig. 6).



Fig. 6. General view of the zone when adding wells

Next, you need to save the polygon as a file of type kml. In order to determine the Z coordinate of the wells, it is necessary to use the www.gpsvisualizer.com website again.

Select our file, which we have just created in google earth pro. Convert to plain text. And click the button – add elevation. Download the resulting file and open it. Having removed everything unnecessary, we got the X coordinate, the Y coordinate and the Z coordinate. Select all the text with the Ctrl+A keyboard shortcut, then copy it with the Ctrl+C keyboard shortcut, and open the Surfer program. In Surfer, press Ctrl+W to open a Worksheet document. Paste the copied file into it. You need to swap the X and Y coordinates and save the document with the file type - DAT by pressing OK.

Go to the tab where we have a 3D map of the zone built in Surfer. Click on the 3D map. In the Home tab, on the Layer subtab, select Post. Select the DAT file with the well coordinates. The wells were displayed on a 3D map of the zone (Fig. 7).

If necessary, you can adjust the display of wells, change their color and appearance. You can also change the settings of the 3D map and add wells to it.

For a clearer picture of mineral deposits, it is necessary to have an idea of the layers of occurrence of rocks. This will make it possible to optimize the extraction process to achieve maximum profit with minimal damage to the environment, namely to prevent unwanted land disturbance.

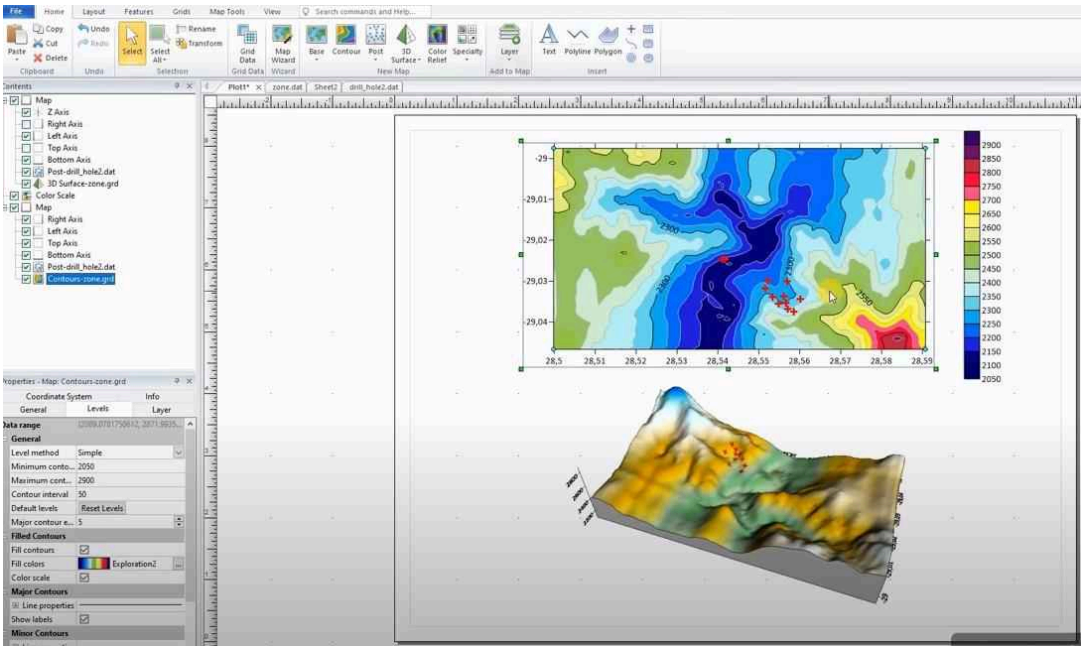


Fig. 7. A three-dimensional geological model of the deposit with plotted wells

To create a cross-section of the resulting 3D map, you can use the Profile command. This tool allows you to digitize a line on a map (Fig. 8). Profile displays the distance traveled from the first point to the last point on the X-axis and the height on the Y-axis.

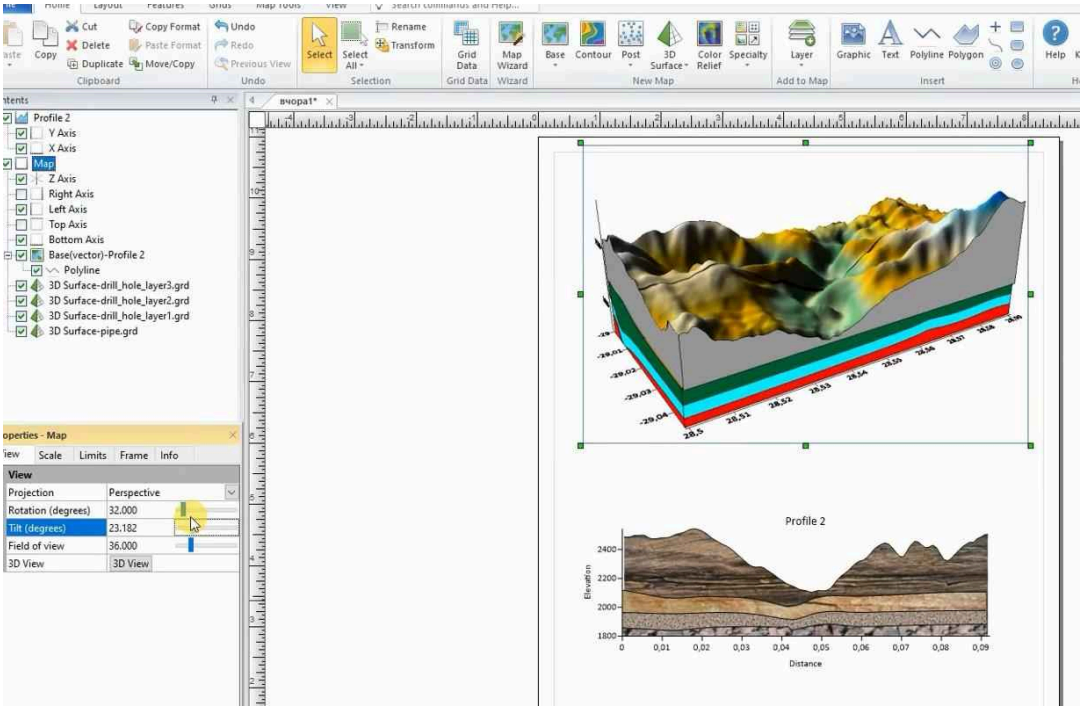


Fig. 8. Cross-sectional image of a map with layers

The Profile tool can be used to create a cross-section of a map with several layers. To achieve this goal, open the Surfer program. In Surfer, open the work list document by pressing Ctrl+W and insert the copied file with the coordinates (Fig. 9) of the layers into it.

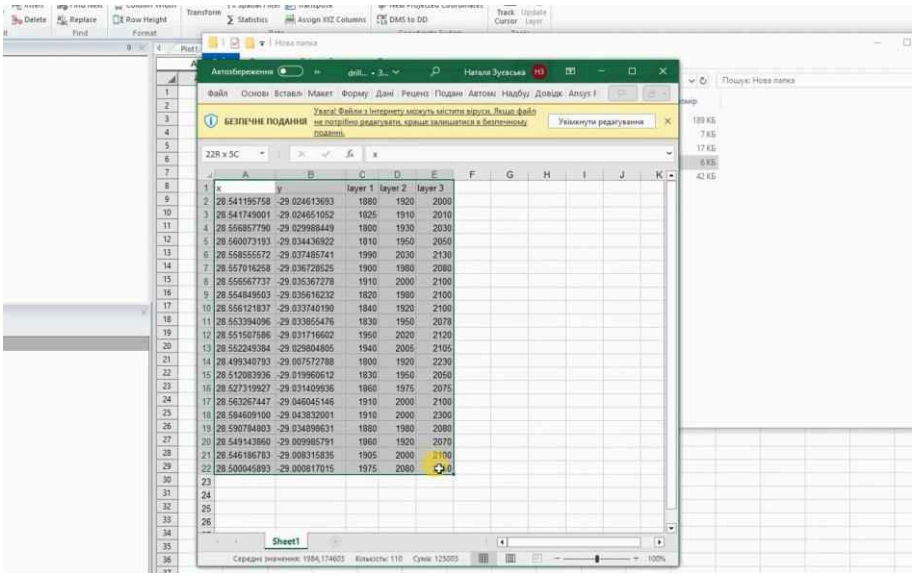


Fig. 9. Creation of coordinates of mineral layers

It is necessary to save the document, the file type is DAT. After saving the document, go to the Plot document.

To add our first layer, click on the Grid Data subtab in the Home tab and select the DAT file with the layer coordinates (Fig. 10). In the Z coordinate, select layer 1 and save the file called layer 1, then click Done.

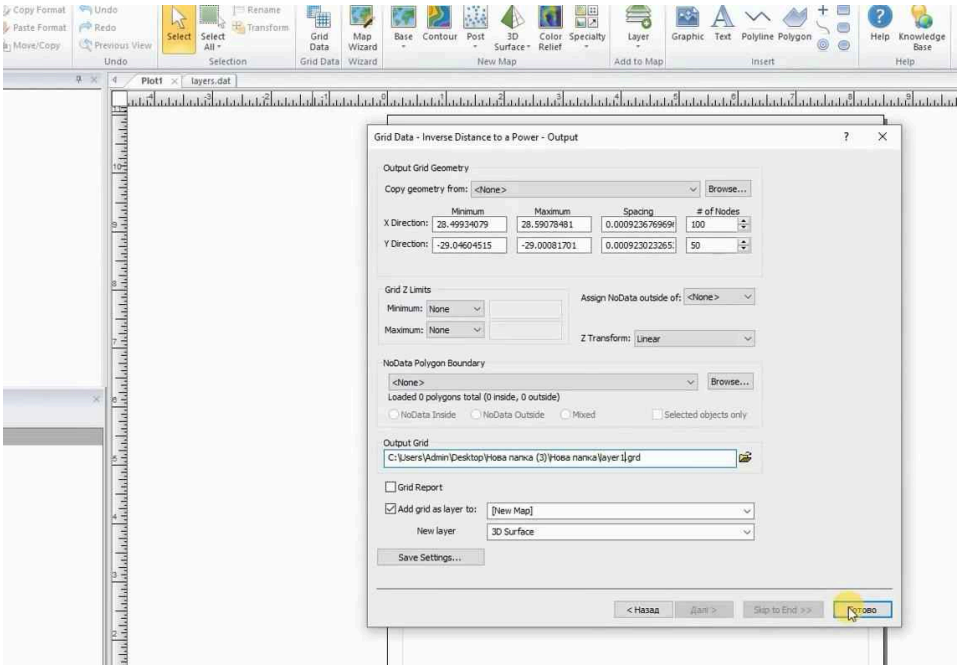


Fig. 10. Set the coordinates to create the first layer

Next, add layer 2 and layer 3 in the same way, and then combine all 3 layers with the top layer added.

Now that all the surfaces have been added to the map, add a base to each surface layer by clicking on the layer and selecting the "Show Base" option from the general tab in the properties window. Add a base for each layer. And then, to differentiate

between these layers and have a better visual appearance, you can change the colors of each base. If you can't change the color, you may need to swap the layers. Now, in the properties window on the view masonry, we will change the projection to orthographic and adjust the tilt degrees to 90 (Fig. 11).

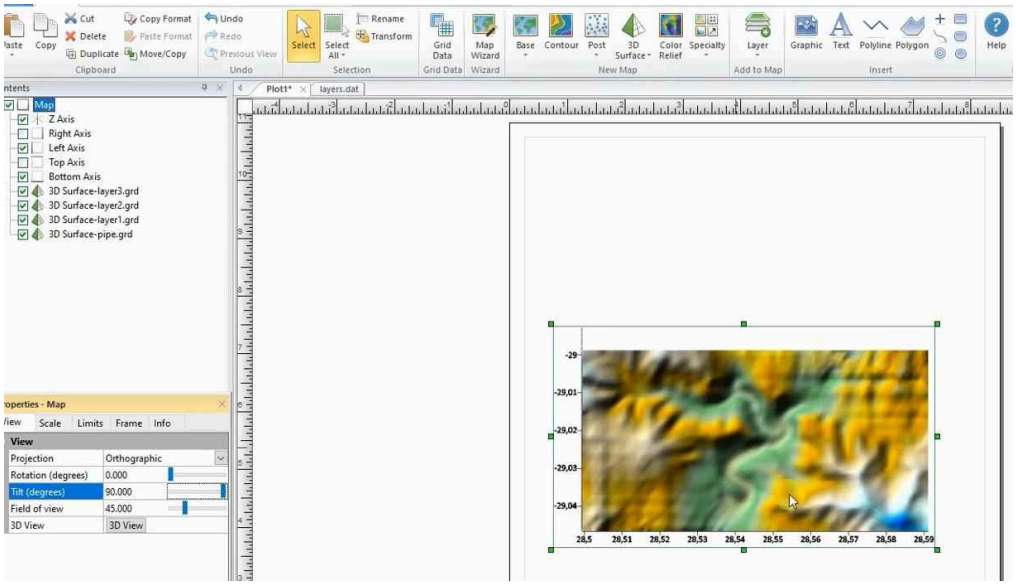


Fig. 11. Orthographic map projection

Next, you can add a Profile using the map tools. To do this, you need to add a simple straight line across the entire map. When we add a cross-section to a map that has multiple layers, the cross-sectional line automatically cuts through all the layers on the map (Fig. 12). You can also add soil texture instead of plain colors.

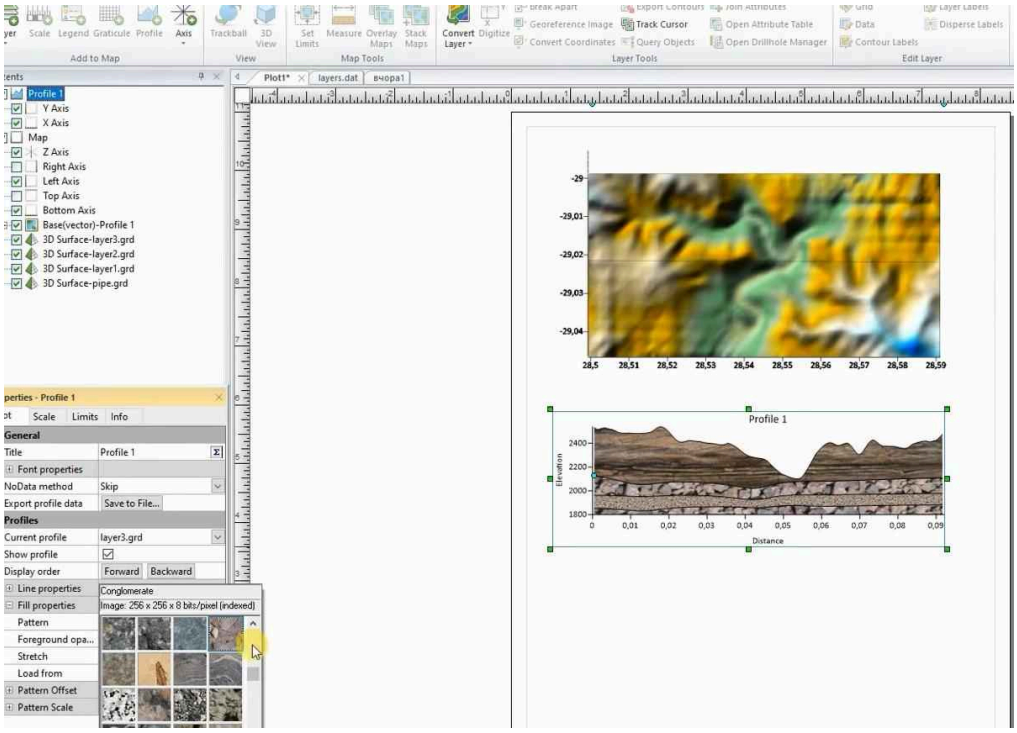


Fig. 12. Representation of mineral layers on the map

For a visual picture, you can make the layers visually similar to the underlying rocks. Layer textures can be downloaded from the Internet or select existing ones. If the difference between the layers is small, you can increase the distance with the Length function.

Conclusions. Based on the use of geographic information systems, a three-dimensional geological model of the deposit has been created, which will allow to more effectively solve the issues of mining planning.

The use of GIS allows you to plan the extraction of resources in such a way as to minimize the negative impact on the environment and landscapes. By accurately analyzing the territories and visualizing the location of deposits, unnecessary interference with ecosystems can be avoided.

The method of visualization of the map of minerals using the geoinformation model of the deposit has been improved. A map of the layers of occurrence of minerals has also been created. This makes it possible to determine the volume of minerals, the most valuable layers of occurrence and start mining with minimal man-made load and the possibility of maximum benefit for the enterprise. The ecological component is achieved by minimal disturbance of landscapes.

Thus, the obtained method of visualization of the map of minerals and layers of occurrence will allow to start mining in the place with the largest deposits. This will allow you to have the greatest profit for the mining company at once. And the main goal is the maximum preservation of landscapes, hence the achievement of an ecological and economic effect.

This innovative technique promotes a balance between mining and conservation of natural resources, promoting sustainable development and long-term environmental sustainability.

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АНОТАЦІЯ

Метою статті було удосконалення методики візуалізації карти корисних копалин із шарами залягання порід за допомогою 3D моделювання з використанням сумісного поєднання Google Earth Pro і програми Surfer.

Методика, яка використовувалась: 3D моделювання покладів корисних копалин.

Отримані результати дослідження. Створено візуалізацію карти корисних копалин з використанням геоінформаційної моделі родовища. За допомогою поєднання Google Earth Pro і програми Surfer отримано зону територіальної локації корисних копалин та шари залягання порід, що дасть змогу оптимізувати процес видобутку для досягнення максимального прибутку з мінімальними шкодами для довкілля, а саме запобігти небажаного порушення земель.

Наукова новизна. Інтеграція Google Earth Pro з програмою Surfer розширило можливості візуалізації та аналізу родовищ корисних копалин. Спільне використання цих інструментів дозволило не лише отримати докладну карту розташування ресурсів, а й визначити обсяги та ідентифікувати найбільш цінні шари для видобутку. Удосконалений метод дає значний позитивний вплив на екологію, оскільки дозволяє уникати непотрібних порушень ландшафтів.

Практичне значення. Застосування підходу полягає в інтеграції геоінформаційних систем для створення тривимірної геологічної моделі родовища та методики візуалізації карти корисних копалин. Це дає можливість більш ефективно вирішувати питання планування гірничих робіт та максимізувати вигоду для підприємства при мінімізації техногенного навантаження та порушень ландшафтів. Цей підхід має значний позитивний вплив на екологію, оскільки дозволяє уникати непотрібних порушень ландшафтів та зменшує негативний екологічний вплив.

Ключові слова: *корисні копалини, геоінформаційні системи, 3D моделювання, візуалізація, карти, координати, екологія, порушення ландшафтів.*