GEOINFORMATICS 2020

EAGE

17773

Three-dimensional model as the basis for exploration planning (as an example, the Prutivka copper-nickel deposit)

N. Bariatska *(Geological Service Company LLC)*

SUMMARY

The area of use of the three-dimensional deposit model depends on the confidence and accuracy of the initial data. Models based on retrospective (historical) data can be used to prospective assessment of the deposit and exploration work planning. These capabilities are demonstrated by the example of the Prutivka copper-nickel deposit.

Introduction

Three-dimensional modelling is widely used by leading exploration and mining companies around the world.

“Essentially, all models are wrong” is a common aphorism in statistics (Box, 1976); it is often expanded as” All models are wrong, but some are useful”.

The area of use of any model must be clearly understood to create it. It should reflect the individual properties, parameters and characteristics of the object, with confidence sufficient to solve specific practical targets. The models used for prospective assessment of the deposit and further exploration program design may have less accuracy and confidence than the models used for resource estimation and mining planning.

Theory

Today, in our conditions, a subsoil user often receives an object that has already been partially explored, mainly in Soviet period. In this case, there is usually a need for exploration drilling to perform various tasks:

- verification of existing data with analytical studies in certified international laboratories (this is especially important when the core of the previous stages of drilling is not preserved);
- increasing the resource categories and resource estimation in accordance with international requirements (it is important for working with foreign investors);
- performing technological research using the most modern methods and approaches, etc.

If all the primary geological information (geological documentation of core, inclination data, laboratory results, etc.) is available, it is possible to perform all stages of geological modeling, including the creation of an archive and an integrated database (Coombes, 2008; Bariatska et al., 2018). But sometimes the primary geological information gets lost, and only reports, graphic materials and other secondary data are available. In such cases, the creation of a full three-dimensional model of the deposit with an accurate reflection of the grade distribution of commercial component is impossible. However, the creation of a preliminary model for prospective assessment of the object and further exploration work planning is quite possible. Consider this option in the example of the Prutivka copper-nickel deposit.

Examples

Prutivka copper-nickel ore occurrence is located in the north-western part of the Ukrainian shield within the Volyn megablock. Sulfide copper-nickel mineralization is confined to endocontact metasomatic zones of the Prutivka intrusive massif – sill-like shape massif is located among the plagiomigmatites.

The Prutivka ore occurrence was discovered during deep geological mapping 1:50 000 in 1985-1990. Geological research for nickel (32 holes were drilled) established ore mineralization in the exo-endo contacts of the Prutivka massif (Vysotskyi et al., 1994). Prospect and evaluation works were carried out in 1995-2011. The reserves of category C2 and the resources of P1 are estimated, technological studies were carried out (Vysotskyi et al., 2011).

Primary geological information, unfortunately, has not been preserved. Geological reports, graphical materials (maps, sections) and some data on technological drill holes are available. Accordingly, a preliminary database and model were created on the basis of existing retrospective (historical) information.

The coordinates of the drill hole collars and the commercial component grades (Ni, Cu, Co) were taken from the geological report. All graphic materials received three-dimensional coordinate referencing. The drill hole location was renovated according to graphical view of drill holes in the sections and plans. As a result, a spatial database of retrospective (historical) data of the Prutivka deposit was created (Figure 1).

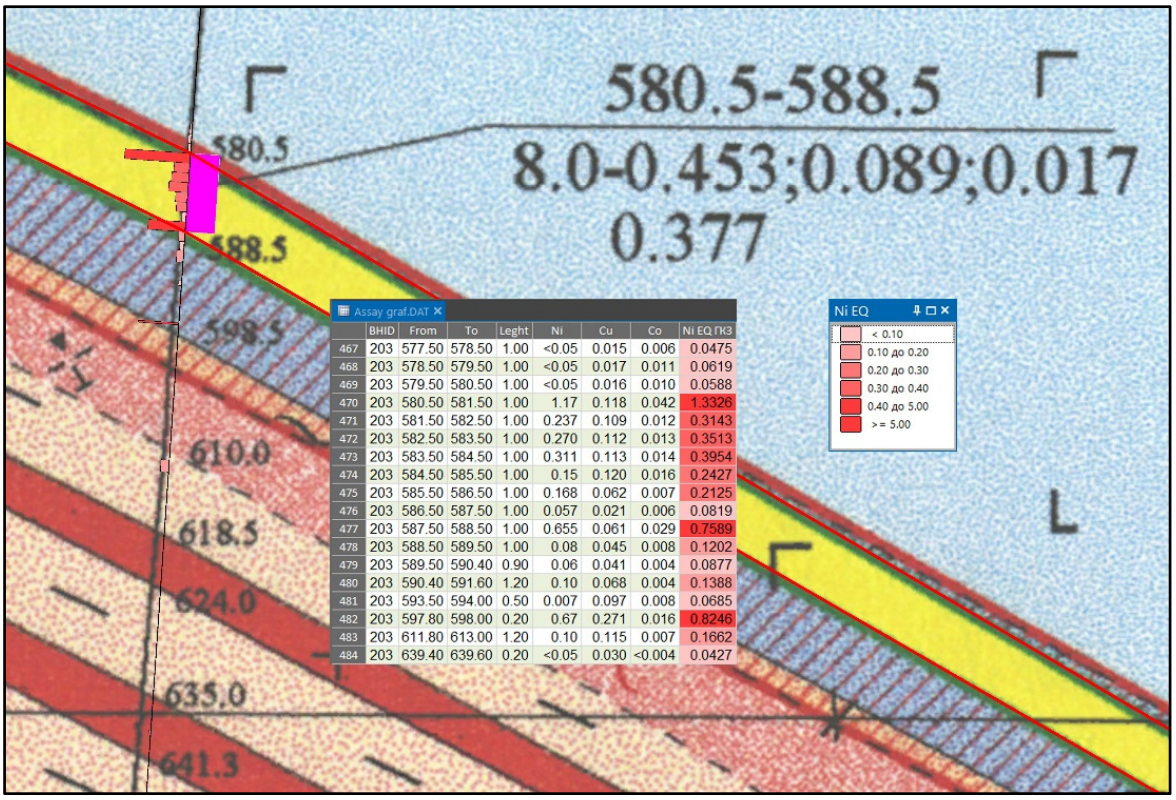

Figure 1 *Spatial database of retrospective (historical) data of the Prutivka deposit*

A three-dimensional model of the deposit was created based on a spatial database (figure 2). Wireframe modeling methods were used to create the model, as an alternative to block modeling, considering the quality of the initial data. The ore body was contoured based on the nickel equivalent grades calculated taking into account the current prices of nickel, copper and cobalt, and each commercial component yield during enrichment. The ore body is presented as a single framework, the commercial component grades was calculated by the average-weighted method. Such approaches don't allow us to estimate the local distribution of commercial components within the ore body, but they can outline it and estimate the resources of ore and individual metals over the deposit as a whole.

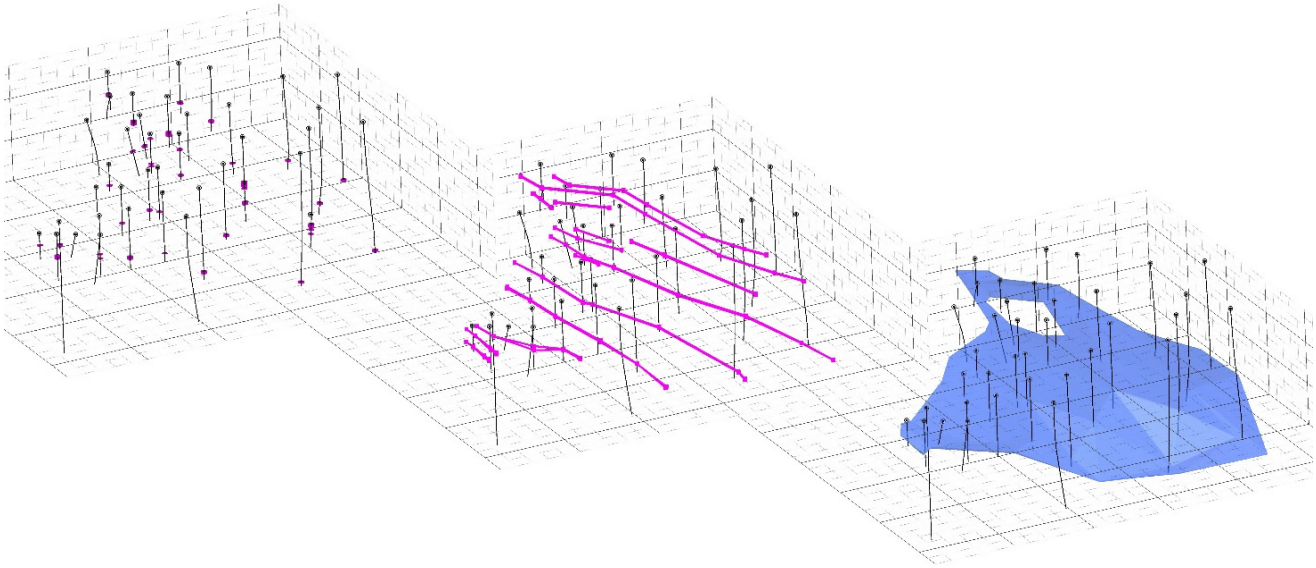

Figure 2 *Frame modeling of the Prutivka deposit*

Obtained data are quite sufficient for planning further exploration work, namely, a drilling program design for deposit exploration and planning other necessary studies.

The drilling program for exploration of the Prutivka deposit was compiled on the basis of a three-dimensional model, taking into account international requirements for the initial data and resource classification. Three-dimensional surfaces of the rocks and the ore body boundaries were used to determine the scope of drilling and separation of rocks by categories of drillability for the drilling specifications.

The drilling program consists of three stages (Figure 3). Holes with the shallowest mineralization will be drilled by wide drill hole spacing at the first stage to verify mineralization parameters at shallow horizons. The second stage involves drilling deeper holes by wide spacing for exploration of deep horizons. The third stage will include holes of infill drilling for exploration of priority mining blocks. The site for drilling holes of the third stage will be selected taking into account the results of the previous two stages. The position of individual drill holes can be corrected taking into account already obtained drilling results.

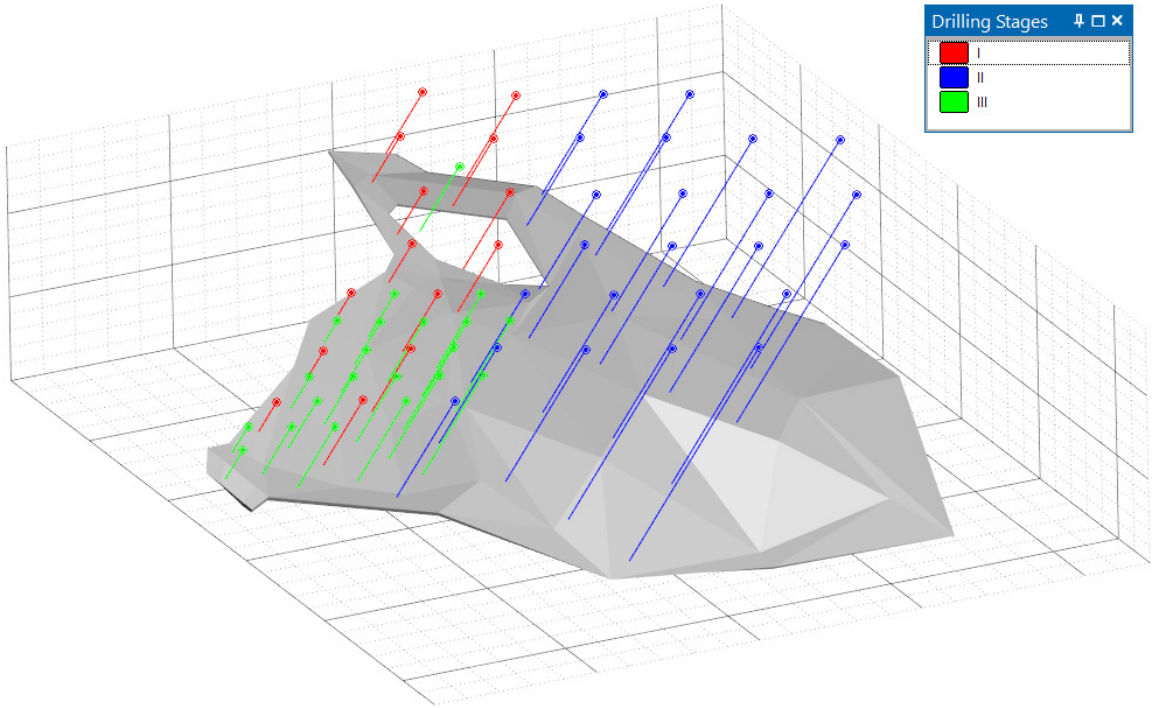

Figure 2 *Project drill holes according to the drilling program of the Prutivka deposit*

It is planned to create a database of exploration holes and updated block model of the deposit with resource estimation based on the drilling results and laboratory testing in accordance with international requirements.

Acknowledgements

The author express gratitude to Nonferrous Metals of Ukraine LLC for the opportunity to use data on the Prutivka deposit for this publication.

References

Bariatska, N., Geychenko, M., Safronova, N. [2018] Main Stages of the Three-dimensional Modelling of Ore Deposits through the Example of Shevchenko Deposit. V International Scientific and Practical Conference "Subsoil Use in Ukraine. Prospects for Investment" (Ukraine, Truskavets, 8-12 October 2018). Conference proceedings, I, 211-217 (in Ukrainian).

Box, G.E.P. [1976] Science and Statistics. Journal of the American Statistical Association, 71 (356), 791-799.

Coombes, J. [2008] The art and science of resource estimation. A Practical Guide for Geologists and Engineers. Coombes Capability, Perth, 232 p.

Esypchuk, E., Hurskyi, D., Treriakov Y. [2005] Nickel. Prutivka ore occurrence. Mineral deposit of Ukraine. Vol. I. 226-231 (in Russian).

Vysotskyi, B, Dytsul, N., Halyi, S. et al. [1994] Research for nickel within the Krasnogorsk-Zhytomyr zone and its surroundings (Prutivka and other sites). Northwest Party Report for 1988-1994. 8 volumes (in Russian).

Vysotskyi, B, Kondratenko, P., Bila, T. et al. [2011] Prospect and evaluation works of sulphide nickel within the Prutivka site and its flanks (1995-2011). 6 volumes (in Ukrainian).