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**The use of retrospective data for creating 3D models on the example of the Balakhivka graphite deposit**

**N. Safronova** (*Geological Service Company LLC*)

**SUMMARY**

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The creation of an electronic archive, database of retrospective data and their use for creating 3D model is considered on the example example of the Balakhivka graphite deposit.

**Introduction**

Exploration of most geological facilities in Ukraine took place more than 20 years ago, after which they were mostly not in demand. After exploration, the facilities were mostly forgotten. All primary information (geological journals, laboratory analysis reports, core samples) was stored in the archives of state geological enterprises. It is currently very difficult to access this information for a number of reasons. Firstly, it is partially lost, and secondly, there is no mechanism for its receipt even with all permits in land. All that is usually preserved is a report on the evaluation of the deposit, which is in the funds of Geoinform of Ukraine. It summarizes the results, which are difficult to apply for deposit reevaluation.

Balakhivska deposit is located in the Petrove district of Kirovograd region of Ukraine. It is confined to the rocks of the Radionovskaya suite of the Ingul-Ingulets series. Graphite-containing gneisses of various compositions: biotite, amphibole-biotite, sillimanite-biotite, garnet-biotite. Ore bodies traced down to a depth of 300 m (Nechayev and Yesipchuk, 2006).

**Method**

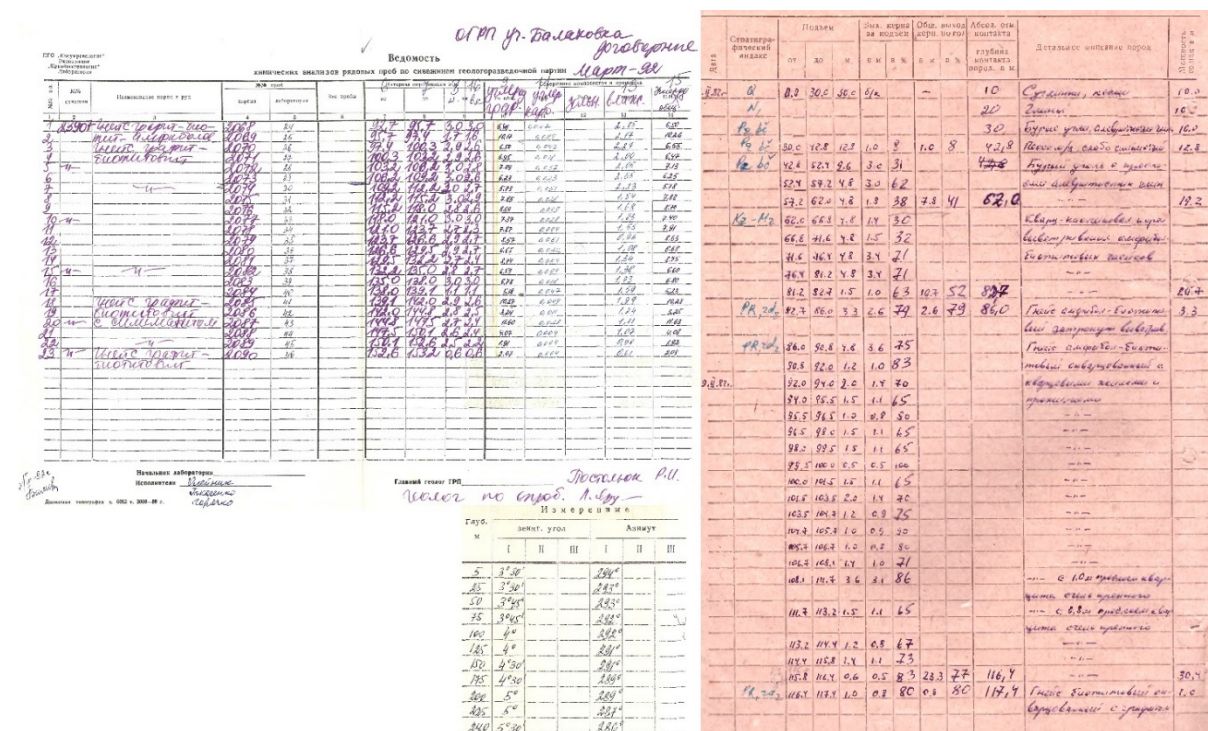
Let us consider in detail the use of retrospective data (Fig. 1) for creating a model of the Balakhivka graphite deposit.

In preparation for modelling, the following work was performed:

- an electronic archive of available primary geological information was created;
- a database compiled;
- A preliminary 3-dimensional model was built.

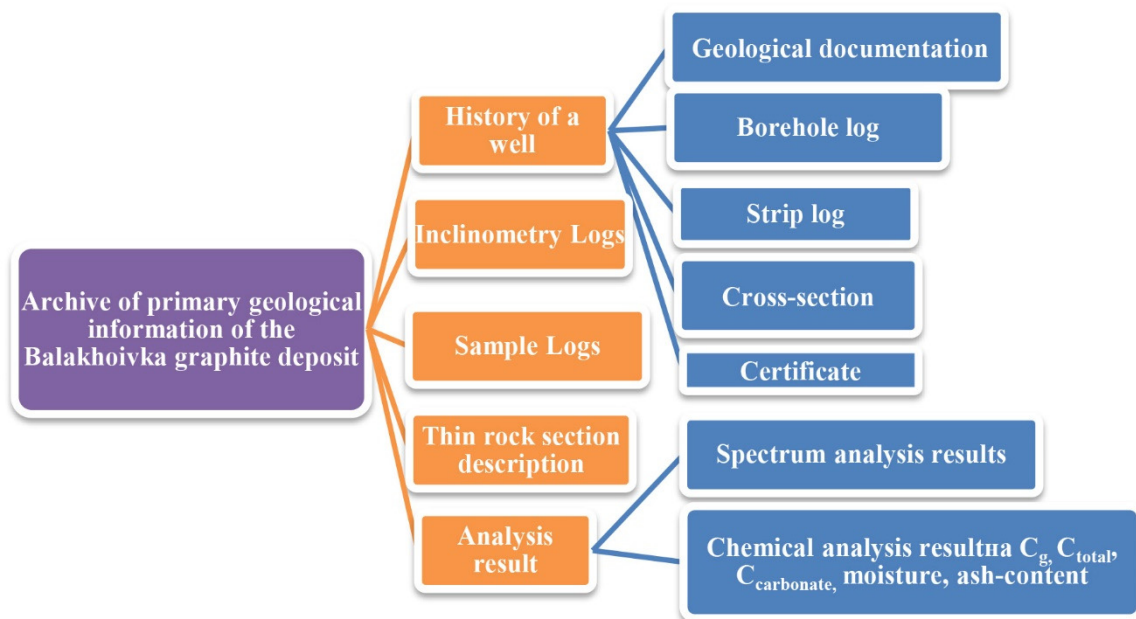
The following information was added for drill holes whose data were used to reserves estimation:

- spatial distribution of 95 drill holes;
- inclinometry results, 95 drill holes;
- laboratory research results - 2,340 values;
- geological documentation of drill holes 1,250 intervals.



**Figure 1** Primary Information Examples

All paper-based materials were scanned and put in folders with the corresponding names. The archive structure is shown in Fig. 2.



**Figure 2** Archive structure

In the raw database, description of the rocks was given in free form in terms of the original version. For convenience of further work, all interval rock names were unified and divided into 16 lithologic varieties, the names of which in the database are given in English (Fig. 3). For all lithological varieties, a color coding has been developed (Fig. 4) for visual expression in the three-dimensional environment.

As a result, the database consists of four main files (Collar, Inclination, Geology, Assay).

The **Collar** file contains general drill holes information. Main information fields: *CR-SECT* - profile number; *Hole-ID* – drill hole number; *East, North* - the coordinates of the collar in the coordinate system GK42; *RL* - altitude above sea-level; *Depth* - depth.

**Inclination** file - spatial position of drill holes. Main information fields: *DHID* - drill hole number, *Depth* - measurement depth, *Dip 90* - angle of drilling, *Azimuth* - direction of drill.

**Geology** file - a file containing results of geological documentation of core samples with a description of lithological varieties of rocks. Main information fields: *Hole-ID* - well number; *Code* - unified breed code (in English); *Core recovery, m* - core output; *Core recovery, %* - core output; *FROM* - depth of the beginning of the interval (m); *TO* - depth of the end of the interval (m); *Interval* - power (m); *Geology* - breed description (in Russian); *Graphite* - information about graphite contents visually indicated in the documentation.

**Assay** file - sample interval data and corresponding laboratory test results. Main information fields: *Cross Section* - profile number; *DHID* - drill hole number; *Rock* - breed; *ID sample* - sample number; *FROM* - depth of the interval start (m); *TO* - depth of the interval end (m); *Interval* - thickness (m); *C (graphite)* - graphite grade (%); *C (carbon)* - carbon grade (%); *C (general)* - total carbon grade (%); *Moist* - humidity; *Core recovery, m* - core output; *Core recovery, %* - core output; *East, North* - sample coordinates; *RL* - altitude.

Collar.DAT x							Inclination.DAT x			
Hole_ID	East	North	RL	Depth	DHID	Depth	Dip 90	Azimuth		
1	18126	6516173.40	5371596.50	140.0	224	10	19670	125 -86.25	266	
2	18127	6515778.60	5371593.10	135.1	185	11	19670	150 -86.25	221	
3	19670	6516509.70	5372037.10	147.0	173.6	12	19670	170 -85.50	196	
4	19671	6516640.90	5372024.60	147.0	300	13	19671	0.00 -88.58	265.8	
5	19672	6516417.00	5371750.60	144.9	160	14	19671	43.51 -88.58	265.8	

Assay.DAT x													
Cross Section	DHID	Rock	ID sample	From	To	Interval	C (gfafite)	C (carbon)	C (general)	Moisture	core recovery, m	core recovery, %	
74	4	21856	Гнейси графіт-біотитові	1122	175.00	178.00	3.00	5.86	0.05	5.91	0.7	2.4	80.000
75	4	21856	Гнейси графіт-біотитові	1123	178.00	181.00	3.00	8.25	0.05	8.3	0.5	2.6	86.667
76	4	21856	Гнейси графіт-біотитові	1124	181.00	184.00	3.00	5.42	0.05	5.47	0.8	2.5	83.333
77	4	21856	Гнейси графіт-біотитові	1125	184.00	187.00	3.00	3.99	0.05	4.04	0.6	2.65	88.333
78	4	21856	Гнейси графіт-біотитові	1126	187.00	190.00	3.00	5.04	0.05	5.09	0.7	2.5	83.333

Geology.DAT x									
Hole_ID	Stratigraphy	Code	Core recovery, m	Core recovery, %	From	To	Interval	Geology	Graphite
176	23761	Sand	10.500	77.770	36.000	49.500	13.500	Песок светло-сер	Чешуйки графіта
177	23761	Graphite wc	14.390	96.570	49.500	64.400	14.900	Кварц каолінова	Рідкі чешуйки графіта
178	23761	Graphite wc	7.600	100.000	64.400	72.000	7.600	Інтенсивно виве	Візуальне содержание графіта
179	23761	Graphite wc	13.000	100.000	72.000	85.000	13.000	Кора виветриван	Чешуйки графіта
180	23761	Graphite gneiss	35.000	94.590	85.000	122.000	37.000	Графіт-біотитові	Содержание графіта 2-4%

Figure 3 Database of the Balahivka deposit – table structure

The geological interpretation was performed by contouring the geological bodies in the profiles using lithological control and composite samples, with cut-off grade 1% (Fig. 4) (Bariatska et al., 2018).

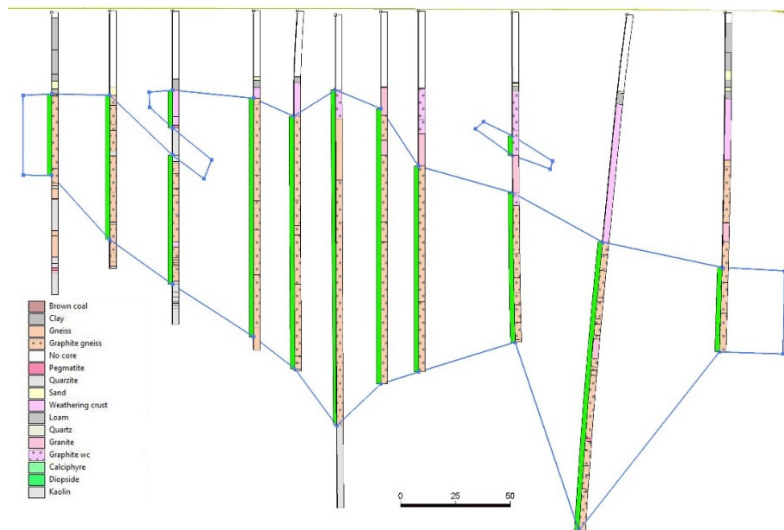


Figure 4 Delineation of geological bodies in profile

The wireframe modeling method was used to create a three-dimensional model of the Balakhivka graphite deposit (Fig. 5) (Bariatska and Safronova, 2019).

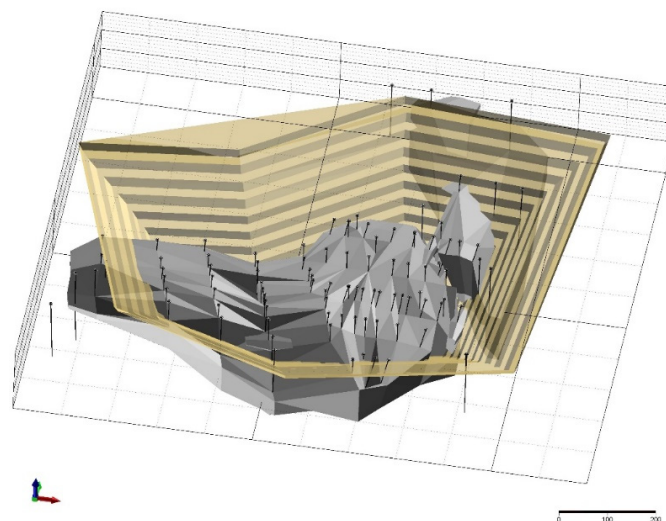
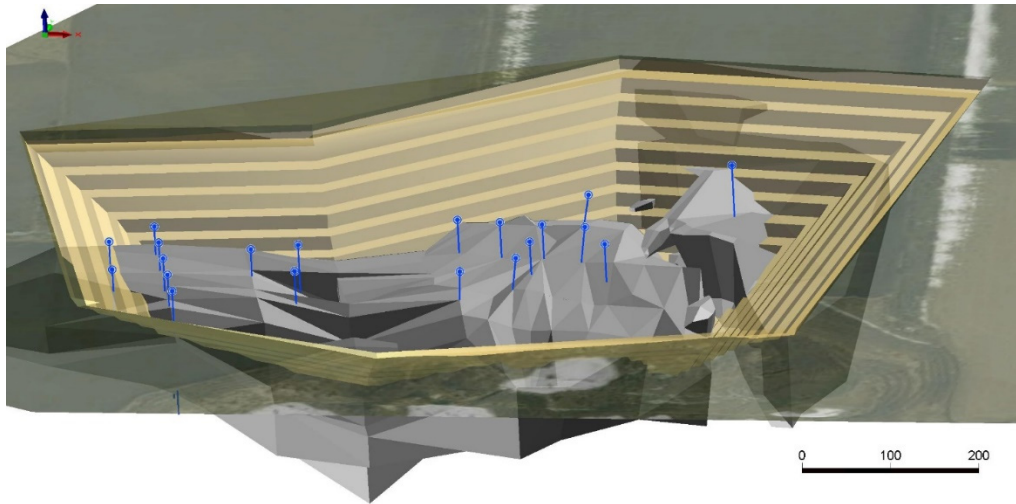


Figure 5 Wireframe model of the Balakhivka graphite deposit

Exploration work on the Balakhivka graphite deposit was not carried out in full scope- there is no data on the graphite grade in some drill holes (the results of logging were used). The drilling program based on a 3D model was created to verify the geological data (Fig. 6). Geological sections and columns were constructed with an indication of rock depths, drillability categories.



**Figure 6** Project drill holes

## Conclusions

Currently, drilling is in progress, the results of which showed good convergence with the design data.

The data obtained as a result of drilling and laboratory work will more accurately delineate the deposit and reserves estimation using the 3D block modeling method.

## Acknowledgements

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