Features of GIS technology in the Republic of Sakha (Yakutia)

Dmitrii V Andreev
M. K. Ammosov North-Eastern Federal University, 58 Belinsky str, Yakutsk, Republic of Sakha (Yakutia), Russia, 677027
E-mail: verviL@List.ru

Abstract. The article analyzes the features of the use of GIS-technologies in various fields in the Republic of Sakha (Yakutia). The authors definitely argue that GIS-technologies are effective tools for activities in certain areas of activity.

1. Introduction
GIS technology is a powerful tool for working and visualizing information. On the territory of the Republic of Sakha (Yakutia) GIS-technologies are actively used in various activities. Often they are associated with the natural or cultural characteristics of the region. GIS has proven to be an effective means of solving problems in such areas as cartography, geology, municipal management, land management, in ecology, in transport, in the energy industry, in rural and forestry. It should be noted certain examples of the use of GIS technology in this area.

2. Models and methods
The study of the features of the use of GIS technology in the Republic of Sakha (Yakutia) was carried out using the analysis of the existing state of the issue, numerical modeling, mathematical processing of experimental and production data, mathematical statistics, tensor analysis.

3. Results and discussion
It is worth giving an example of using GIS technology as a means of assessing the economic potential in the territory of the Republic of Sakha (Yakutia).

The use of GIS to assess the economic potential of the territory allowed to combine heterogeneous geological data for spatial analysis, prepare and construct basic and thematic maps, and solve problems associated with spatial analysis of geological information. The most important of these were: [1]

- Accounting for the actual location of primary deposits of noble, non-ferrous and rare metals.
- Filling attribute databases with characteristic ore deposits for subsequent metallogenic analysis.
- Creating a GIS for magmatic formations (plutons and dykes) to isolate ore-magmatic systems and establish their metallogenic specialization.
- Creation of complex geographical, geological and metallogenic maps.
- Obtaining new geological knowledge by analyzing and interpolating the available factual material.
The solution of these problems was based on the following properties of GIS:

- vector and raster methods for storing spatially distributed information;
- support of topological relations between objects;
- the ability to store thematic data in geodatabases formats ACCESS;
- powerful spatial data analysis functions (SpatialAnalyst, GeostatisticalAnalyst, etc.);
- implementation of queries on the condition of displaying objects that satisfy the specified conditions;
- advanced publishing capabilities of graphic and analytical materials.

Accounting for the actual location of primary deposits of noble, non-ferrous and rare metals is carried out in the registration cadastre of mineral deposits. Attribute databases of registration inventories satisfy the first normal form and do not contain duplicate fields. The key field stores unique names of objects, which allows you to establish relationships with other tables that contain additional analytical data. The layer of ore deposits includes about ten thousand large, medium and small deposits, ore occurrences and ore mineralization points, different in their genetic and morphostructural features, as well as a set of useful components. The attribute file of the database includes the following fields: the name of the deposit, the type of mineral, the temporary group of ore formations, the ore formation, geological and industrial type, the size of the deposit. Within the ore sites, deposits can be ranked by size (large, medium, small, etc.) and by affiliation with the ore formation.

The primary analysis of deposits by type of mineral (gold, silver, tin) shows that, taking into account all the ore formations, there are 706 gold deposits (15 large), 183 silver (8 large) and 570 tin (10 large) in the territory of Eastern Yakutia.

To analyze the patterns of placement of large deposits of gold, silver and tin, it is necessary to identify promising ore nodes and fields in which these deposits are part of large polyformational ore-magmatic systems. Taking into account the fact that ore clusters may contain rows of ore formations and can be represented not by one but by a whole series of ore deposits, at this stage of the analysis, the deposits are not separated by type of mineral (gold, silver, tin).

Ore nodes are distinguished by means of the SpatialAnalyst module by a compact arrangement of deposits, ore occurrences and mineralization points. The resulting map reflects the distribution density of all ore deposits of minerals (the field size is used as a weight factor when building the map) and can be interpreted as a scheme of large polyformational ore nodes with a search radius of 50,000 m and a cell side size of 5,000 m. As a rule, the ore cluster includes one (rarely more) large field and a number of medium and small, often different in genetic and morphostructural features, as well as a set of useful components.

Combining the obtained density map of the distribution of deposits with a layer of large and medium-sized deposits of gold, silver and tin shows promising areas for the production of top-priority prospecting works. The number of ore nodes isolated in this way reflects all potentially promising ore-magmatic systems of the Verkhoyansk folded area.

The main accumulations of gold deposits are confined to the Adycha-Nerskaya Au zone of the Yano-Kolyma metallogenic belt and include large deposits of Sentachan, Sarylakh, Badran, Khangalas and many medium and small gold deposits. In the Nizhneyansky Au-Sb-Hg zone, the Kyuchus deposit is located, in the West-Verkhoyansk Ag-Au zone, the Arkachan and Kysyltassky deposits, in the Tomponskoye Au-Cu-W zone, the Agylkinsky zone, and in the Nezhdaninsky Au-Ag ore region, Nezhdaninskoe (figure. 1) [2].
Silver deposits do not form linear metallogenic zones, grouping near small rod-like intrusions or at a considerable distance from them. In the Zapadno-Verkhoyansk Ag-Pb zone there are deposits of Kimpich, Prognoz, Kysyltasskoye, Mangazeyskoye, in the Tompot-Delininskaya Ag-Pb-Hg zone - Night, Khachakchan, Zarya, in Taryn Au-Sb and Ag-Sn zone - Dome and Kurdatskoe, in Nezhdaninsky Au-Ag ore region - Verkhne-Menkechenskoe (figure 2).

The typical representatives of the ore formations formulated above are described as standards, the characteristics of which are laid down in the algorithms of metallogenic research based on GIS technologies. Through the use of these technologies, the extraction of these minerals is simplified, which contributes to the active development of the industry.

Further, it is worth noting the experience of using the methods of GIS technologies in a typical diamond deposit in Yakutia.
The methodology and experience in the formation of physical-geological models (FGM) of sulphide deposits can also be used in the compilation of well logging data on explored deposits of other solid minerals. These include diamond deposits.

The object considered as an example is located in Western Yakutia and is still in reconnaissance. On it passed the profile of exploration wells, which allowed to present a geological section (figure 3). The deposit represents a typical cone-shaped kimberlite pipe structure for Yakutia [3].

The rocks of the kimberlite formation are breccias (eruptive, autolithic, porphyritic), formed in several magmatic stages. Kimberlites break through uneven-aged layers of clay carbonates with the formation of breccias of mixed carbonate-kimberlite composition at the periphery of the tube. The tube is blocked by sill-shaped rocks of the trap formation (several generations of dolerites, tuffs). Outcrops of terrigenous rocks are revealed among them. The tube is diamondiferous, there are breccias of early and later generation, and the latter are considered to be much more productive for diamonds.

In all the wells, the Geophysical Party of Amakinskaya GRE carried out measurements using a complex of well logging methods with measurements of magnetic susceptibility (MV), conductivity (EI), and natural radioactivity (EP). Gamma-ray logging was carried out in a spectrometric variant with the determination of the NaJ radiation of potassium (K), uranium (U) and thorium (Th) in the spectrum of the detector NaJ. An example of diagrams of a complex of methods for one of the wells is shown in (figure. 3 – a, b).

Figure 3. Geological profile of the deposit (a) and a complex of GIS diagrams well (b):
1 - dolerite; 2 - tuffs; 3 - carbonates; 4 - breccia of carbonate-kimberlite composition; 5 - kimberlite breccias. The maximum values of the scales: GK - 15 μR/h; MW - 2000 10^-5 SÌ; K - 225, U - 150, Th - 60 imp / min.

The compilation of a FGM field is based on the results of a statistical analysis of a set of GIS method diagrams for several wells with a total length of about 3000 m. The results of the analysis are presented in the form of statistical diagrams of the parameters under study. Preparation of data for their formation includes digital coding of charts recorded on wells with reflection of heterogeneity of rock intersections and use of the obtained data to study the distribution of physical parameters for each lithotype.

It is also worth citing another example of the features of using GIS technologies in the Republic of Sakha (Yakutia). At the moment in the Republic of Sakha (Yakutia) there are pressing issues that arise in the energy sector of the national economy that require sound answers. In particular, basic calculations are carried out for debugging and testing for the practical implementation of methods for technical and economic comparison and analysis of cultural and functional dependencies of indicators of compared
power supply options. At the time of calculation, key factors are established that influence the criterion values, as well as the basic technical and economic indicators of the options. This can be done using GIS technology [4].

Calculations can be done manually. With simple dependencies and indicators for approximate integrated calculations. With the help of GIS technology, you can determine the length of electrical networks, view remote areas, carry out a full study and collect a full database of information and form a model for enlarging approximate calculations.

The class of such models includes evaluation, based on the study of alternatives. For regions of the North, in contrast to the inhabited territory, a relatively small number of newly introduced energy facilities is typical. At the same time, for each object, a careful analysis of the condition and indicators of construction and operation, which are determined by the peculiarities of territorial zones of a “focal” character, is required. Under these conditions, the advantages of evaluation models are manifested. When using GIS technology provides a more correct comparison of indicators of economic efficiency of alternative options. In addition, the analysis of options for other relevant criteria is simplified. Created assessment models should serve as the basis for processing a specialized software and information base.

4. Conclusion
Thus, the use of GIS technology for the above examples contributes to the development and automation of these types of activities, which simplifies the solution of existing problems. GIS technologies are increasingly used in today's information society, representing a convenient and optimal mechanism for solving a large number of practical, scientific and educational tasks. At the moment, in the Republic of Sakha (Yakutia) there are many pressing issues that arise in certain industries, which, of course, requires sound answers.

References
[1] Bavlov V N and Mihajlov B K 2008 Results and main directions of development of the mineral resource base of solid minerals in Russia Materials YOU All-Russian Congress of Geologists
[2] Vahromeev G S 1998 Fundamentals of the methodology of integration of geophysical research in the search for ore deposits (Moscow: Nedra)
[3] Kostin A V, Golcova A S, Lysenko M S and Trufakina T V 2006 Forecasting of noble metal ore clusters of the Western Verkhoyansk region (Eastern Yakutia) using the GIS YuTikhiokean geology 25(5) 62-72
[4] Sapozhnikov V M 2010 Complexing and geophysical methods (Ekaterinburg: UGGU)
[5] Sapozhnikov V M 2005 Using logs for petrophysical mapping of ore-bearing rocks Methods of prospecting and exploration of deepening ore deposits in Interzvuz. scientific the subject. Sat. (Sverdlovsk: UPI) pp 20–7
[6] Serkov V A and Shumakov M S 1988 Study of the features of two electrode logging caused by polarization (Sverdlovsk) pp 148–52