Method of Use and Tools of Geographic Information Systems in Subsoil Use

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Abstract. This article is concerned with the methodology and tooling of applying geoinformation systems according to users of subsurface resources. Currently Rosgeolfond uses various geographic information systems (GIS) that allow accumulating, updating, verifying, and monitoring the geological and economic information used in the decision-making process at the Federal and regional levels. At the same time in recent years solutions of such systems in data maintenance of digital topographic basic principles of standard scale economic sector have increased significantly. Meanwhile the companies which are users of subsurface resources need badly both a methodology for using geoinformation systems in mineral resource management and the availability of similar tools in terms of functionality. The purpose of this article is to develop methods and tools as represented by set of logical stages for the employment of geoinformation systems in subsurface use. The work is carried out with the financial support of the grant of the President of the Russian Federation №. MD-2409.2020.5.

1. Introduction

The results adapted from the analysis of reports with digital geological information while being accepted in relevant agencies in the course of the last few years have shown that subsurface users mainly practice ESRI - ArcView GIS and ArcGIS SOFTWARE when creating digital geological information. In percentage terms, this is as follows: ArcGIS - more than 60 %; ArcView GIS - 30 %; MapInfo, GIS "PARK", GIS INTEGRO, spatial data without GIS projects - one of a kind.

The analysis carried out by the authors has proved that information provided in the reports show differing degree of GIS functionality employment:
- data supplying only (generally shapefiles);
- making integration of spatial data as a part of a GIS project on condition that data are supplied with the report;
- using formats with additional features (with the exception of shapefiles) to represent spatial data - the ArcGIS GEODATA database (geological data Bank), DBMS (MS Access);
- creating high-quality map layouts in GIS projects;
- modeling of geological information;
- configuring your own interfaces in GIS projects;
- developing and implementing new tools, additional modules, and applications in GIS projects.
The analysis is able to prove that a special form of providing digital geological information reporting is growing in popularity:

- providing maps via the Web interface - a "thin client" with a minimal GIS interface (no GIS required);
- design and provision of map layers through map services for "thick clients", such as ArcGIS, ArcGIS Pro, GIS INTEGRO (in this case data supply from the supplier requires constant support for the site, portal, service, and as for the clients the availability of licenses for the use of GIS is essential).

It should be noted that work acceptance, verification of availability and quality of spatial data (SD), as well as their further use and provision of accessing information require valid licenses given by Rosgeolfond for the use of these GIS, including modern versions.

2. Theoretical part

Let us consider possibilities of the Federal information system of mineral resources management: that concerns centralization of checking system of all available geological information about mineral resources wealth kept in Federal and territorial funds of geological information, as well as in geological information funds of RF regions, public authorities of RF and its regions, in organizations under the jurisdiction of specified state authorities and in other commercial and non-profit organizations; searching necessary geological information concerning mineral resources wealth in all sources and providing it at the request of users.

The list of an information system attributes at the Federal level contains information from the following main detail units:

1) detail unit concerning geological information accounting item relating to mineral resources wealth;
2) detail unit concerning the right holder of geological information relating to mineral resources wealth;
3) detail unit concerning the organization that stores and provides geological information relating to mineral resources wealth on behalf of the right holder;
4) detail unit concerning spatial reference of geological information relating to mineral resources wealth;
5) detail unit concerning types of geological information relating to mineral resources wealth (primary or interpreted);
6) detail unit concerning the type of media (data storage device) of geological information relating to mineral resources wealth.

The formation of the UFGI (unified Fund of geological information) Registry based on new information implies:
- adding new catalogues of geological information suppliers, determining the relationships of data from these catalogues with the structure of the Registry;
- creating XML packages for new geological information uploading into the Registry;
- checking and enhancing data concerning catalogues and new information added to the Registry;
- uploading of reliable geological information to the Registry with automatic integration of Registry and catalogue data.

The main tasks resulted from the study and being solved in trade organizations dealing with processing of digital geological information using GIS can be structured as follows: creation; storage; access; editing; integration; construction of geological (thematic) maps; solving analytical problems by means of spatial and other types of analysis; modeling of geological objects, etc.

GIS in subsurface management can be classified according to potency and solutions:
- viewers and information systems with elements for implementing specific requests and actions connected with spatial data;
- a full-featured set of GIS tools (or a platform with a number of applications) to develop systems for creating, storing, and providing geospatial data, solving spatial analysis tasks, and configuring personal interfaces performing specialized tasks.
Each of these classification elements is involved to a degree in different areas of industry work having diverse intended use and functional completeness.

The analysis showed that along with the presence of complex developments and the production of high-quality digital cartographic information, errors are usual things when using GIS tools. The quality of representation of both spatial data and its assembly in GIS projects varies. Unfortunately, the issues of correct using of GIS functionality for digital cartographic information representation remain relevant at present, they include:

- quality of digital maps (in terms of topology selection and acceptable accuracy);
- availability of spatial reference;
- reasonable usage of coordinate systems (datum, parameters) and the ability of recalculating within GIS (availability of descriptions in coordinate systems such as CS-2011, WCS-49(world coordinate system) used by GIS);
- grasp of the "correct location" when there is an superimposing of map items either resulted from different sources or maps of different scales, GPS surveys, adding up of subsurface areas contour lines and licenses with insufficient accuracy (degrees, minutes), etc.

3. Practical part

Let's consider the proposed methodology and tooling for the employment of geoinformation systems in mineral resources management represented as a sequence of stages:

1. putting the contours of objects on the topobase as a part of GIS projects (vectorization, digitization, tables with coordinates, including GPS);
2. field mapping (GPS navigation) using applications and devices (PDAs, laptops, tablets, smartphones), possibly with further replication (integration) of the captured data in the spatial data Bank (BSD);
3. integration of digital geological information in GIS projects, preparation of situational plans in the form of maps and diagrams;
4. creation of GIS projects with maps of the distributed reserves and open acreage concerning types of raw hydrocarbon deposits (solid minerals) - digitization (vectorization) of geological objects (wells, profiles, license contours, sections, etc.), their BSD connection and integration, development of interfaces and GIS project management, creation of a symbol book database, drawing up map layouts, paper and computer media output;
5. digital geological mapping - field observations, analysis of retrospective analog and other geological information, integration in GIS projects, comparison of different-scale geological maps, database support of geological legends symbol book, compilation of geological maps outfits, preparation for publication and publication;
6. construction, visualization and analysis of geological objects in GIS - automated creation of maps of geological content, interpolation, three-dimensional modeling of geological bodies, designing of sections, prognosis of minerals, geological and economic calculation of reserves, analytical processing of geophysical data, etc.;
7. configured lightweight GIS interfaces with access to GEODATA via the Web interface (using the "thin client" technology);
8. providing SD in the mode of map services - creation and support (updating) of SD, developing and maintaining interfaces and server components for "lifetime" operation of declared services WMS, WFS, ArcGIS;
9. reference and information systems with the functionality of spatial analytical resolution (usually with a Web interface) having varying degrees of complexity relating to implementation of spatial and other types of analysis and also other specialized analytical functions realization.

4. Conclusions

Thus solving problems by means of developed methodology requires selecting and developing of software toolbox. Proper functionality can relatively be observed on the ArcGIS platform. But because
of high cost and import substitution indispensability in the field of software the platform should be created by using the best available software products as things stand now. In our opinion, the matter may be considered by the formation under jurisdiction of Federal Subsurface Management Agency a continuously acting expert board dealing with geographic information technologies.

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