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GIS database for mineral resources: case study – map of mineral resources from Romania at the 1: 500.000 scale (after Borcoș M., Udubașa G., Săndulescu M., Lupu M., Tudor G., Găbudeanu B.)

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Abstract

The updating of the map of the mineral resources from Romania by a team of researchers led to the need for a GIS database. This database contains information on the sites with mineral resources, geological data describing the associated geological map, as well as topographic and hydrographic data. Associated attributes include general data, identification data, geographical data, geological data, economic data, descriptions and references. Spatial and attribute data were organized following the relational database model previously developed for the geological map. Associated dictionaries allow the effective classification of the information, easy queries, as well as the use of various symbols for the sites. The results can be presented in either printed form or digital format, by means of 3D images or by using WebGIS applications or WMS services. Given the structure of the database, the information will be constantly updated and associated with other data.

Keywords: GIS, mineral resources, database, Romania.

Introduction

The use of the GIS (Geographic Information System) in the geological sciences has increased considerably. As far as mineral resources are concerned, the GIS is used extensively worldwide, as a classical means of creating databases containing spatial data. The ability to manage and analyze the spatial data associated with attribute data has enabled the devising of mineral resources databases, associated with different data types, for instance topographic, geological, administrative, environmental etc.

The development of the mineral resources GIS database was achieved as a result of the updating of the mineral resources map of Romania at the 1:500.000 scale, and it was

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carried out by a team of specialists who considered that the representation of the map by means of a GIS database would support proper development, various changes, spatial analyses and queries made in order to meet existing targets, as well as the implementation of various versions of the map of mineral resources, and the extension to other types of related information.

The data collected from previous works regarded metallic, non-metallic and radioactive resources. These were classified based on several criteria and mapped having as substrate a geological map updated with the latest concepts, designed to serve this particular purpose.

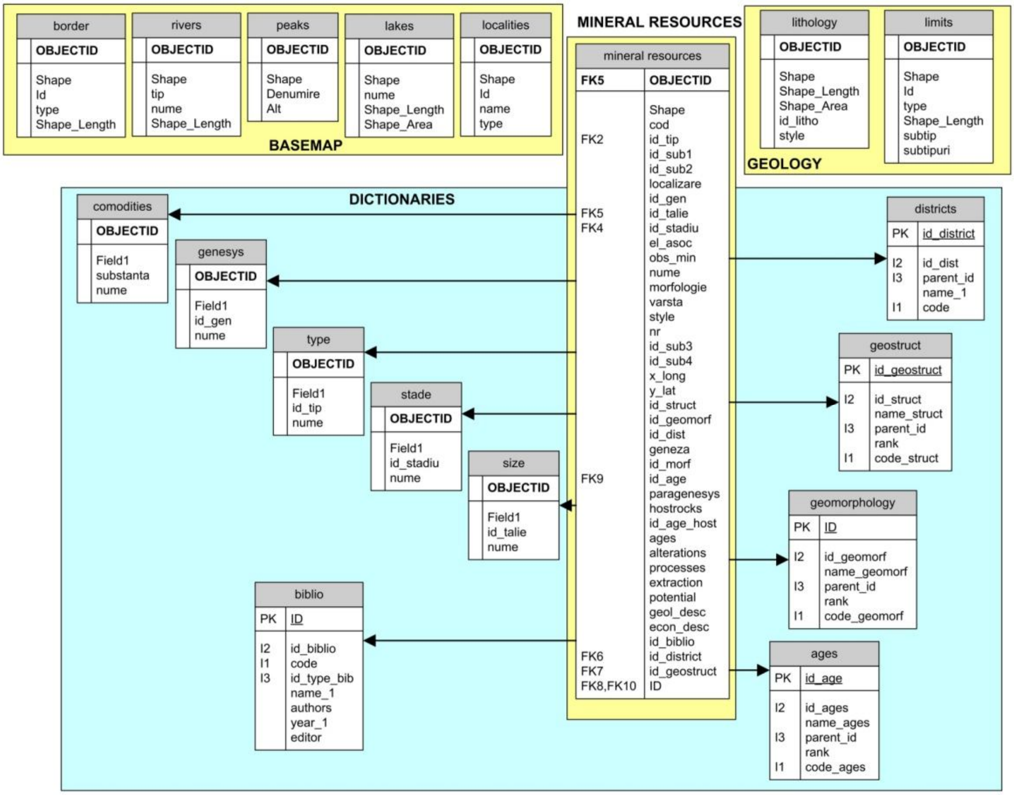

Fig. 1 Logical model for the geodatabase on the mineral resources from Romania.

Database design

The design of the database containing geological data was based on a previous project (Tudor, 2009; Tudor and Gheucă, 2009). The attributes were classified using the same classifications as those contained in specific dictionaries. For an easier update of attribute data, a client-server software application that accesses databases was devised.

The GIS database can serve as support for the mapping of mineral resources, but it can also be extended to encompass all types of information regarding mineral resources. Its usefulness derives from the following:

- the efficient management of spatial and attribute data;
- the ease with which mineral resources maps for different topographic scales can be obtained;
- the possibility of combining layers with different types of information;
- the potential development of spatial analyses and complex queries resulting in either tables or new thematic maps;
- automatic processes achieved by developing specialized software for managing, queries and spatial analysis;
- the development of digital cartography elements so as to achieve layouts for printed maps;
- the possibility of adding various classifications, including international standards;
- support for devising metallogenic maps;
- the possibility of developing WebGIS applications (Tudor, 2010) or map services through which to make the information available on specialized Internet portals;
- the possibility to scale the database on a dedicated server, with special facilities for accessing, managing, saving and securing information;
- the possibility of increasing the level of detail in relation to each site, which allows the processing of the information using specialized software for 2D and 3D representations.

The source data comes from analogue maps and tables of attribute data characterizing the sites with mineral resources. Classifications are also important. Based on the analysis of the data for geological maps (Tudor, 2009; Richard, 2003), a logical database model was devised (Fig. 1), serving as framework for the development of the database. The present version of the database is simple, but it can be modified appropriately for complex data regarding sites with mineral resources.

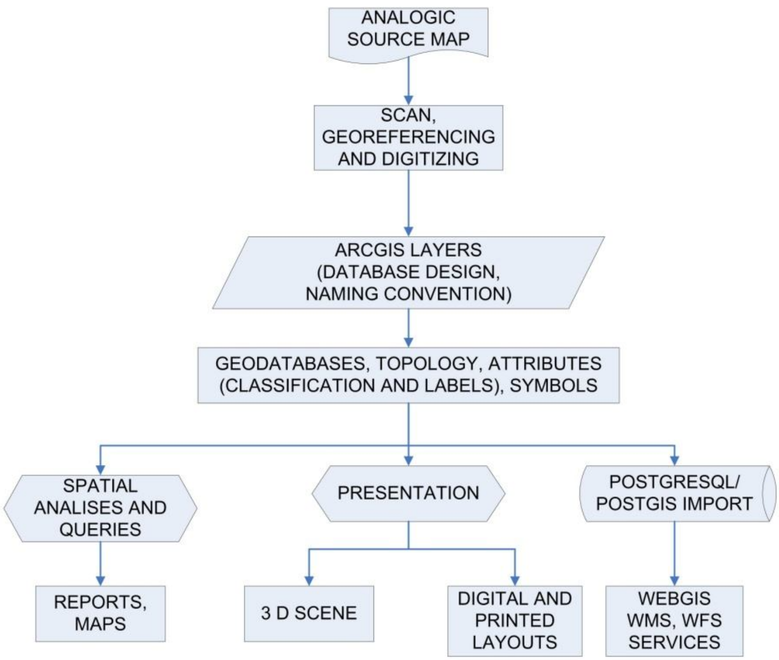

Fig. 2 Flow diagram of the main operations and uses for the GIS database for mineral resources.

Data sets are classified as main (represented in the diagram) and secondary (required for the representation on the mineral resources map). The main sets are the following:

- the geology, with layers for lithology, geological boundaries and mineral resources sites;
- the basemap, with layers for boundaries, rivers, lakes, the sea, localities, and peaks;

Secondary sets (symbols for geological substances and their genesis) include layers representing the polygons, lines and text necessary for legends.

Attribute data can be classified into:

- identification data (number, name, district);
- geographical data (geographical coordinates, geomorphological classifications);
- geological and metallogenic data (genesis, morphology, paragenesis, alterations, age of mineralization, host rocks and their ages, mineralogical characteristics);
- economic data (size, stage, useful substances, associated elements, historical production, potential – reserves and resources);
- descriptive data (geological and economic);
- bibliographic data.

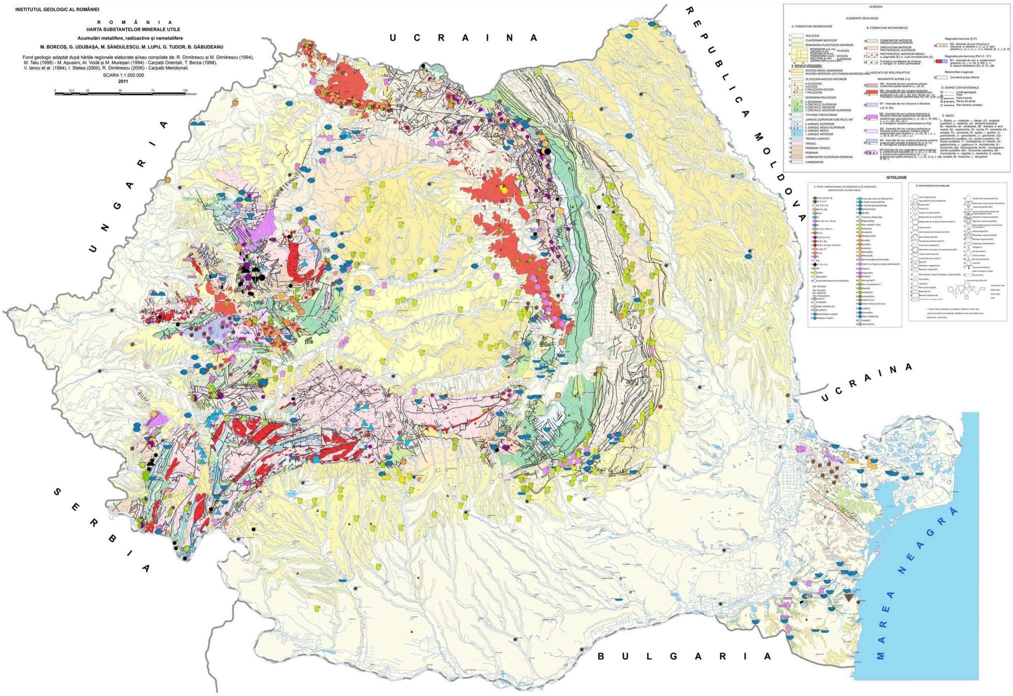

Fig. 3 Layout of the mineral resources map printed from the ArcGIS software.

Spatial data sets are accompanied by classified or descriptive attribute data. Originally created in the “shp” and “dbf” formats, the data were imported into the personal geodatabase, the information of which is stored in the Access database. Practically, the entire data flow was developed for the creation and development of the database (Fig. 2). The source of spatial data in analog form was scanned, georeferenced, and then each type of spatial data was digitized, creating the specific layers. The latter were imported into the database (geodatabase), the topology was created, and the attributes were added (according to certain classifications). Depending on their destination, a series of operations were subsequently performed for the presentation of maps in digital or printed format or in the form of three-dimensional images, as well as their display on the Internet through WebGIS applications or WMS map services. The symbols and layout required to display the map were devised. Using spatial analyses or queries, various other specialized maps specific for certain sites can be obtained.

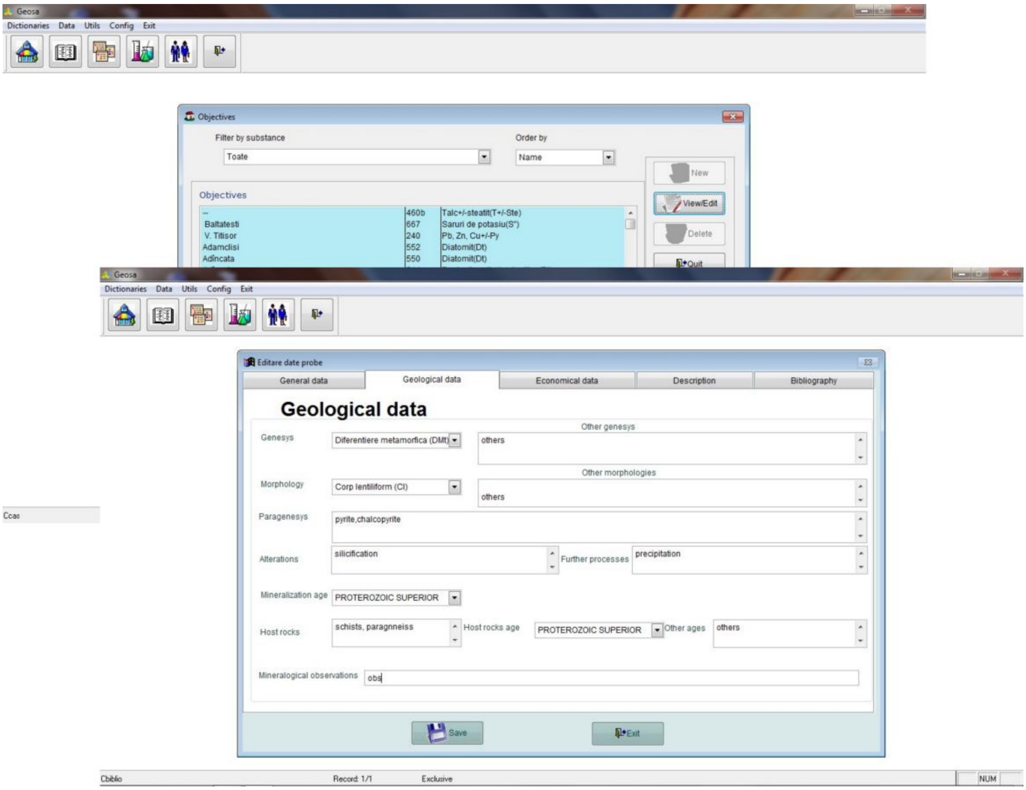

Fig. 4 Software application for managing attributes from the GIS database.

Dictionaries

Dictionaries are data sets (tables) related through a key. They can be either dictionaries with attributes for the representation and symbolization of objects on maps, or dictionaries with classifications of geological concepts. Entities contain a primary key that uniquely identifies the object, and foreign keys that are related to other dictionaries. There are simple dictionaries (including genesis, lithology, stages, substances, size, types and districts) and complex, hierarchically-structured dictionaries (including morphology, age, and geotectonic units). The first type of dictionaries uses relational tables for normalizing databases. The second type uses recursive tables where an item records its own parent. It also uses an associated table describing the hierarchical level, a field that records a complex alphanumeric key, and a table which can store the type of classification. Such dictionaries allow database queries based on classifications, so as to reduce data redundancy. The resulting maps can contain purpose-filtered sites with mineral resources.

Presentation of the mineral resources map

In order to be displayed, the sites with mineral resources can be symbolized using various criteria, such as substance, genesis and size. When substances or geneses overlap, complex symbols are needed. The legends, however, contain the simple symbols. Several sets of such symbols may exist, depending on the purpose and content of the map.

The layout for printing is set to different scales and it includes the following: map, legend, title, scale, details, location sketches, texts (Fig. 3). For the 1:500.000 scale, drawings that can be combined were made.

Data management

Spatial and attribute data related to mineral resources are managed within a specific project (ArcMap), with all the data sets for the constituent layers. In this context, spatial or attribute data may be changed or added, and applications from the Visual Basic environment may be used. In order to change the attribute data, a client-server application which connects to the Access type database (geodatabase) was devised (Fig. 4). The application in question allows the updating of dictionaries and descriptive data. Mineral resource sites can be filtered based on different criteria, and the desired site can, thus, be accessed. The window displays several tabs regarding general data, geological data, economic data, description and bibliography. Classified data can be updated by selecting from lists, thereby reducing the number of editing errors. The application can be developed with windows that allow database queries, and the results are written in specific reports.

Conclusions

The GIS database for mineral resources allows the efficient management of spatial and attribute data. The mineral resources can be associated with additional layers (lithology, topography etc.), presented in various forms (printed or digital-format charts, 3D images, webGIS, WMS services), and included in models of spatial analyses and queries.

The framework represented by the GIS database allows the constant updating of the information, depending on the type of data or the objective.

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