

WEBGIS – A FRAMEWORK FOR THE WEB PRESENTATION OF THE 1:1 MILLION SCALE GEOLOGICAL MAP

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Abstract

The GIS technology, meant to create a database of geological maps, associated with information displayed on Internet technologies, has resulted in a webGIS application able to display and query the information contained in the geological map. The server side contains a PostgreSQL/PostGIS database, Mapserver, an Apache web server and a GUI application, written using PHP programming language associated with PHPMapScript functions. Thus, the client may view and query the geological map using a web browser. In this particular case, the 1:1 million scale geological map of Romania was used, but information from maps at various scales may also be included.

Keywords: GIS, webGIS, geological map, MapServer, PostgreSQL, PostGIS.

Introduction

During its existence, the Geological Institute of Romania had designed maps at different scales. The 1:1 million scale geological map of Romania was devised in 1970 and updated in 1990. After it was digitized, the GIS (Geographic Information System) database was created (Tudor and Gheucă, 2009). The database, containing classified and symbolized spatial elements, is the cartographic presentation support of the geological map, some interrogations, 3D representations or Internet visualizations.

The software packages are represented by GIS (ArcGIS desktop, Quantum GIS etc.) desktop applications, relational databases (MS SQLServer, Oracle, PostgreSQL etc.), and applications specialized in Internet presentation (ArcGIS Server, MapServer, PHP, Apache etc.).

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The web technologies are able to facilitate the dissemination, visualization, analysis and administration of geological information (Koehl and Joseph, 2008). One can find on the market an important amount of servers specialized in maps, both commercial (ArcGIS Server, MapGuide, MapXtream) and open source (MapServer, GeoServer). The open source solutions represent an accessible alternative for the implementation of such web systems for the presentation of GIS data on the Internet. In order to access the spatial data stored in databases, the map servers need middleware-type applications, some of which have already been developed (Gmap, Maptools, Chameleon, Cartoweb), and others which need to be developed by means of PHP, Javascript, PHPMapScript (API functions for MapServer accessing).

The MapServer open source solution is widely used all around the globe in many fields, including the presentation of geological maps on the Internet. Its use, along with that of the PostgreSQL/PostGIS database and the development of the Gmap application, by means of PHP and MapScript API, provided the first version of an application for the presentation of the 1:1 million geological map on the Internet, with visualization, navigation and interrogation facilities. The end-user can access the geological information formed from spatial data associated with attribute-type data by using an Internet browser.

Data source and database structure

The database model was specifically designed by means of the general model of geological maps (MacDonald, 2001). Practically, the data types which compose the geological map were analyzed and then separated into data sets. The following were thus distinguished:

- geologic contacts (the limits of geologic units, normal or dissonant, the contact of eruptive rocks, facies changes etc.);
- faults which detach the geologic contacts;
- topographic elements: rivers, localities, lakes etc.;
- linearly-represented rock levels (limestone intercalation, amphibolites etc.);
- classification of major rocks (flysch, volcano-sedimentary formations etc.).

The design process provided three models (conceptual, logical and physical), which established the determination of the data to be stored, of the relations between the elements, and of some logical structures based on these elements. The main components of the 1:1 million geological map are determined as follows:

- geologic components (lithological limits and faults, overlapped rock units, thin rock intercalations, map limits);
- topographic components (rivers, lakes, localities, borders).

The spatial data and the associated attributes were collected in a database (Tudor, 2009) able to store spatial data (ArcGIS personal geodatabase of Access type, PostgreSQL with a PostGIS extension). Using a naming convention, three data sets were separated (PostgreSQL schemes):

- geology;
- basemap;
- legend.

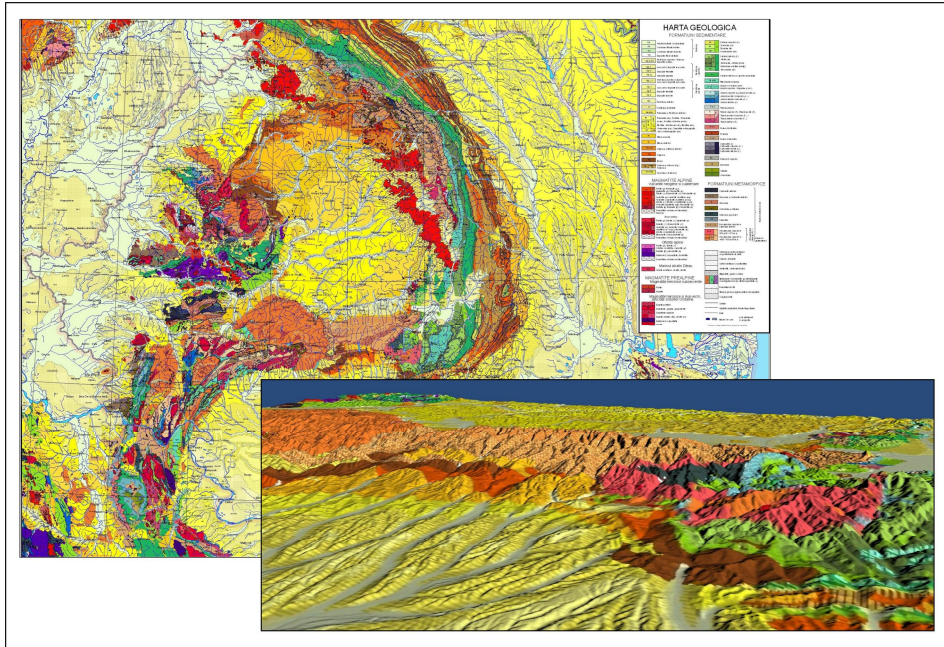


Fig. 1 Geological map of Romania, designed with an ArGIS desktop and VTP in 3D representation.

In association with these, dictionary tables containing attribute-type information, connected to the spatial objects by a key field, were created. The following were also created: subtypes and domains, the spatial data topology (with the following rules: the lithology polygons must not overlap, the geologic limits must correspond to the limits of the lithology polygons, the geologic limits must not contain dangles and must not overlap, the faults must allow the dangles and must not overlap, the lithology polygons must not overlap and must not have gaps), the relations between the spatial data and the dictionaries, the specific symbols and the settings for the labels associated with the spatial objects, the layout.

The geologic map obtained was printed on a plotter, sometimes associated with the representation of the landscape as shaded relief, or used for 3D representations (fig. 1).

The structure and functions of the webGIS system

The webGIS system has been developed with the purpose of obtaining a presentation of geospatial information on the Internet, in order to visualize and interrogate the data contained by the geologic map. The software technology is present as a client-server system (fig. 2), where the client (web browser) can access the data stored in the database by means of the server for maps (MapServer). Practically, it is a three-tier-type client-server, with the following components (fig. 3):

- the server side:
 - third-tier components:
 - PostgreSQL/PostGIS database;
 - second-tier components:
 - Mapserver;
 - Apache web server;
 - the application which interrogates the data from the database using the PHP and PHPMapscript programming languages;
- the client side (first-tier):
 - web-browser.

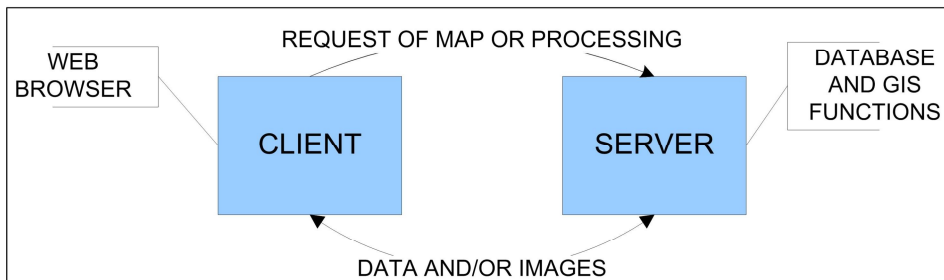


Fig. 2 Client-server architecture for the webGIS application.

Mapserver is an open source application, initially created by the Minnesota University. It runs either as CGI (Common Gateway interface) or API (Application Programming Interface) functions, used by means of a programming language (PHP). The application has the following components:

- the initialization application (written in PHP with PHPMapScript functions);
- the configuration file (mapfile);
- the template files (HTML modules with MapScript parameters and variables, used when visualizing the map or when displaying the data obtained from queries).

The configuration file (mapfile) is an ASCII file, which contains object configuration and defining information (data, graphic elements, query elements). As in the case of template files, these can be edited manually or automatically by means of specific applications.

The main application is written in PHP with PHPMapScript functions, it creates a displayed screen in the web browser (fig. 4), where the geologic map is visualized, and it has the following main functions:

- layer selection;
- geological map display;
- navigation (moving, zoom-in, zoom-out, pre-defined areas);
- queries of the map.

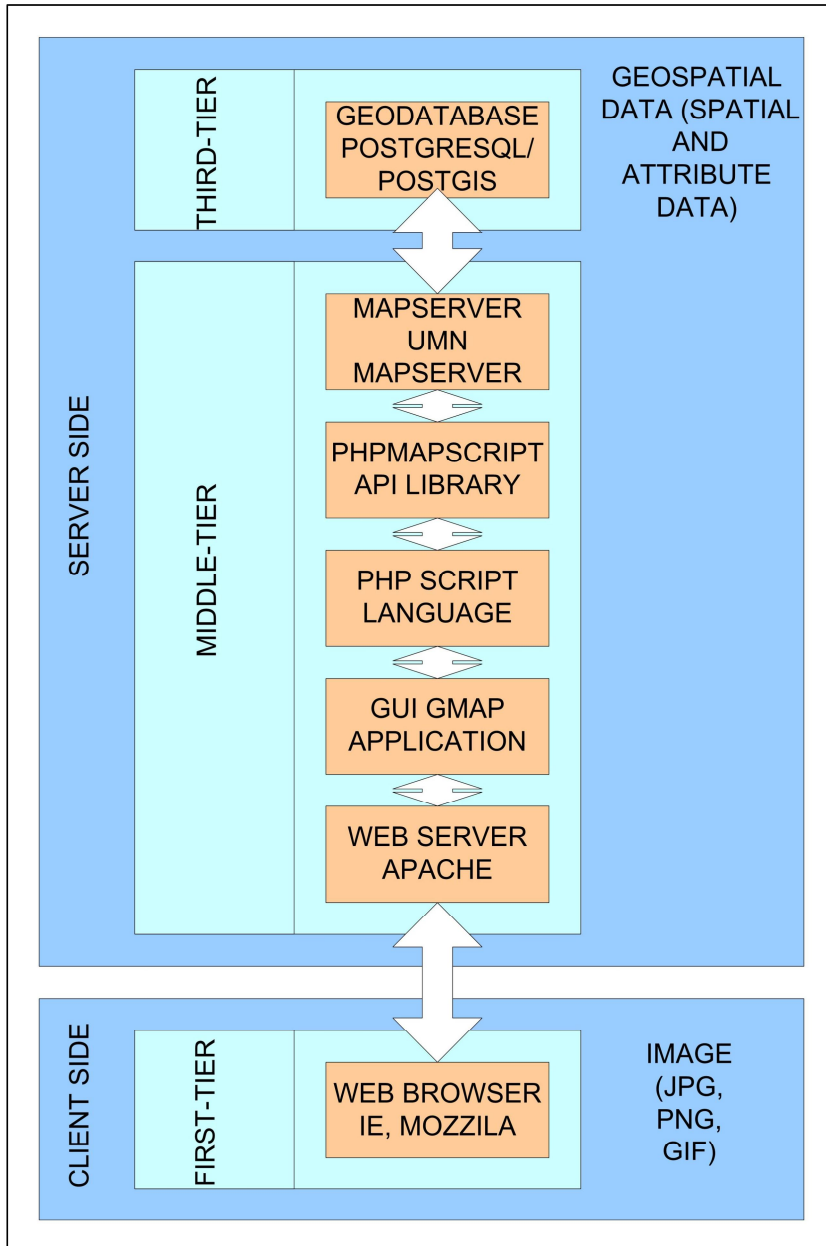


Fig. 3 Client-server three-tier-type components of the webGIS application.

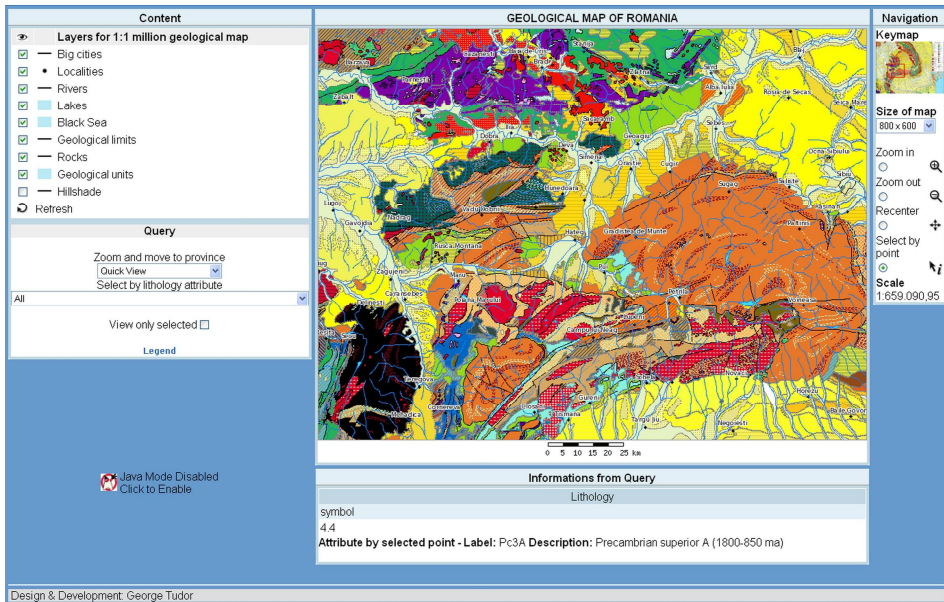


Fig. 4 The web browser webGIS application interface with the display of the selected lithology attributes.

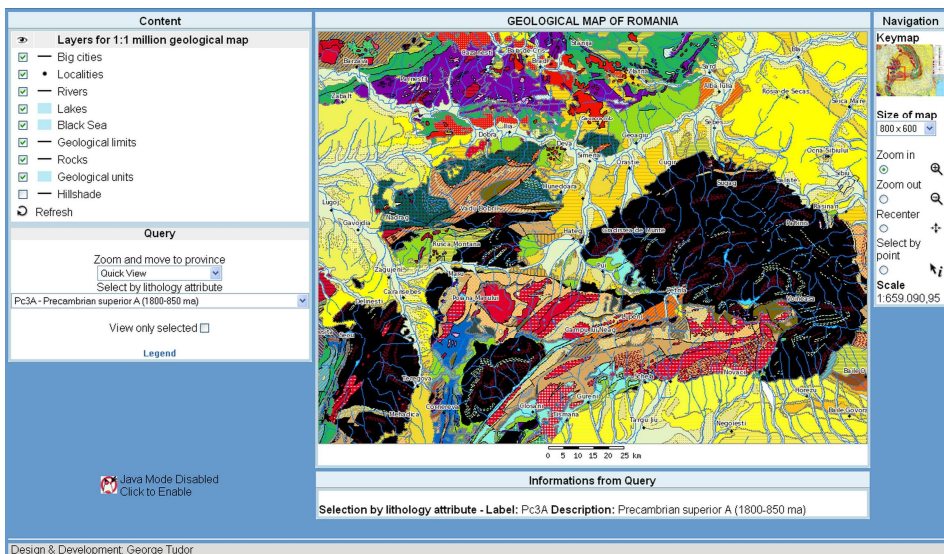


Fig. 5 Selection of a lithology type with display within the geologic map.

Practically, the Gmap open source script was used and then developed. The map-like data are displayed by means of HTML or a Java applet, one being able to switch to the other. As a principle, the spatial data stored in the database are processed by MapServer according to the received parameters and are displayed as jpg, png or gif files.

The creation of the symbols and of the captions is related to the PHPMapScript functions, which read, from the mapfile configuration file, the layers with the parameters corresponding to the representation styles.

Visualization and query

The main purpose of the webGIS applications is to provide easy access to the spatial data, in order to visualize and query the geological maps. Thus, various systems for the visualization of geological maps on the Internet can be created, so as to display attribute-type information or to select the displayed information.

The application created provides visualization facilities, depending on the desired purpose:

- zoom-in;
- zoom-out;
- moving by means of the cursor or the keypad;
- the utilization of some pre-defined areas (for instance, the entire map or various areas).

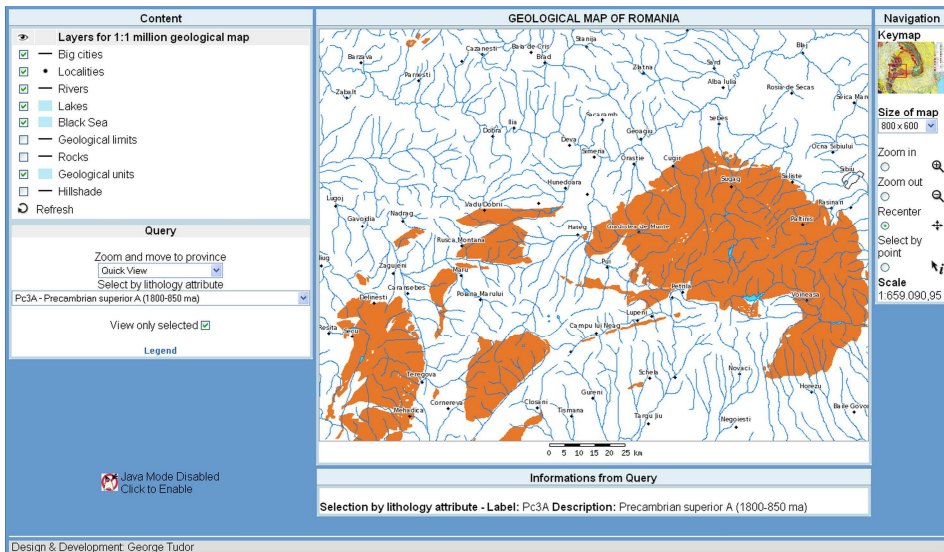


Fig. 6 Selection of a lithology type with separate display.

The interrogations provide the possibility of displaying associated attribute data or only certain selected lithological formations, as follows:

- displaying the attributes of a lithology object, selected by using the mouse (fig. 4);

- selecting a certain lithology type from the list, marking it with another color and displaying it within the geological map (fig. 5);
- selecting a lithology type from a list and only displaying it (fig. 6).

Conclusions

Given the extension of map displaying solutions on the web, the dissemination of geospatial information is a must. All the fields using geospatial data are using webGIS for Internet displaying, thus providing a more synthetic vision and a more accessible association of the geospatial data with attributes in a multi-user context.

Although the application is still in a prototype stage, it can be developed over time, in agreement with the new requirements and with the data collected. Moreover, it can be extended to various types of maps, to regional scales or within projects with a specific theme. Spatial interrogation used in carrying out complex requests is highly demanded.

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