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Development of the Serbian Geological Resources Portal

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Abstract. The Geological information system of Serbia (GeolISS) represents a repository for digital archiving, query, retrieving, analysis and visualization of geological data. The development and implementation of GeolISS is managed by a team from the Faculty of Mining and Geology at the University of Belgrade (FMG). Following the development of a geodatabase in ArcSDE and an ArcMap extension for data management, a web component was added to GeolISS. This web component is constantly being developed. The development of the portal of geological resources combines the elements of a geoportal and classical web applications. The portal (http://geoliss.ekoplan.gov.rs) features geological maps as well a web GIS maps, different multimedia content, and it also offers the possibility of online database search. This paper presents technologies and tools used to develop the portal for geological resources of Serbia, which were created as part of a project funded by the Ministry of Environment, Mining and Spatial Planning (MEMSP). The cartographic part of the portal was developed using: ArcGIS Server, HTML Image Mapper and Google Maps API.

Key words: geoportal, web mapping, web GIS, geodatabase, GIS portal, geology.

Introduction

The Geological information system of Serbia (GeolISS) represents a repository for digital archiving, query, retrieving, analysis and visualization of geological data. The development and implementation of GeolISS is managed by a team from the Faculty of Mining and Geology at the University of Belgrade (FMG) and funded by the Ministry of the Environment, Mining and Spatial Planning (MEMSP). The main goal of the implementation of GeolISS is the integration of existing geologic archives, data from published maps on different scales, newly acquired field data, intranet and internet publishing (Blagojević *et al.*, 2008). GeolISS was implemented in ArcGIS 9.3.1 technology as a collection of .Net classes, as an extension of ArcGIS.

It is now commonplace to see maps or other geologic information integrated seamlessly into websites. This is why a web component was added to GeolISS. This web component is constantly being developed. While systematizing data from different geological research funded by the MEMSP before entering them into the geological database, we realised that certain data, which by their content and structure did not correspond to the initial geological database design, could still be interesting to the expert public. Because of this, the development of the portal for geological resources combined the elements of a geo-portal with classical web applications, presenting the information from diverse sources in a unified way. This paper presents technologies and tools used to develop the portal available at http://geoliss.ekoplan.gov.rs. A geo-portal is a type of web portal used to find and access geographic information (geospatial information) and associated geographic services via the Internet.

MEMSP, as the geologic information provider for Serbia, is using the geo-portal to publish geologic information, while information consumers, professional or lay, use geo-portals to search and access the information they need. Thus geo-portals have an increasingly important role in the sharing of geologic information and can help avoid duplicated efforts, inconsistencies, delays, confusion, and a waste of resources.

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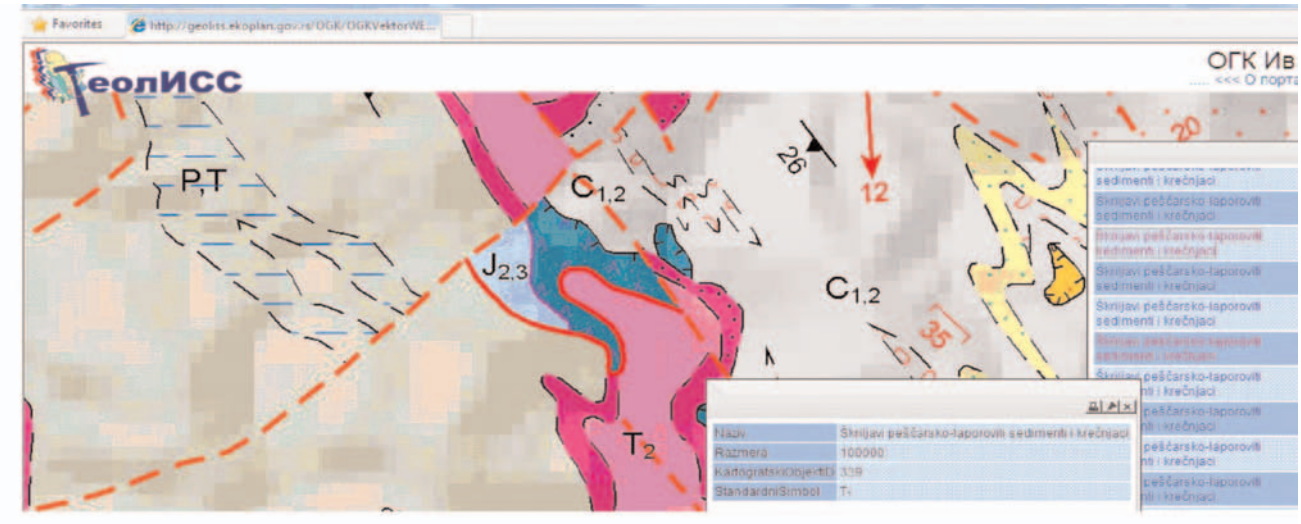

Fig. 1. One detail of General geological vector map of Serbia 1:100.000.

Development of Serbian geological portal follows the guidelines given by OneGeology[3], an international initiative of the geological surveys of the world and the INSPIRE[4] directive that aims to create a European Union (EU) spatial data infrastructure. Geological information needed for good governance at all levels should be readily and transparently available.

The web portal for geological resources of Serbia was created with the aid of modern web and GIS technologies. The largest part was realized with the use of the PHP (Hypertext Preprocessor) script language on server side and the XHTML (eXtensible HyperText Markup Language) language on the client side. In addition to this, the part of the web portal pertaining to geological terminology and nomenclature (GeolissTerm) was developed using ASP.NET web application framework (STANKOVIĆ *et al.*, 2011). In order to develop the cartographic part of the portal we used: ArcGIS Server, HTML Image Mapper[5] and Google Maps API[6]. During the development of the portal, the emphasis was placed on the use of modern technologies. Thus, the result was a comprehensive solution, visually and technologically in compliance with modern concepts in the creation of web applications, offering the user a simple and intuitive interface with cross browser support. Conceptually, the contents of the portal can be divided into the part dedicated to the cartographic presentation of spatial data, the multimedia part, and the active pages for database search.

Web GIS

For several projects online GIS maps were created with the ArcGIS extension: HTML ImageMapper NG2, allowing full control over cartographic quality and functionality. This approach was implemented for small to medium sized GIS Projects, whose geo data have little need for updating. Initial resources for web publishing were ArcMap documents, connected to geodatabases and georeferenced rasters. With flexible parameters and user friendly interface, the HTML ImageMapper NG2 allows easy presentation of geo data, both as vector and raster datasets.

The georeferenced raster datasets, can be seen in the following maps: General geological map (raster) of Serbia 1:100.000, available at http://geoliss.ekoplan.gov.rs/OGK/RasterSrbija, Geological Map Of The Carpatho-Balkanides Between Mehadia, Oravita, Niš And Sofia 1:300000, available at http://geoliss.rgf.rs/KarpatoBalkanidi and Groundwater vulnerability map of Serbia, http://geoliss.ekoplan.gov.rs/hidro/KartaUgrPodVod Web. Several ArcMap documents based on vector data sets are published: Map of geological curiosities in Serbia, available at http://geoliss.ekoplan.gov.rs/geoZanimljivosti/web, National park Djerdap, set of hydro-geological maps and related description, available at http://geoliss.ekoplan.gov.rs/?page=djerdap and General geological map (vector) of Serbia 1:100.000, with 9 sheets, available at

[3] OneGeology, 2007. International initiative of the geological surveys of the world http://www.onegeology.org

[4] European Parliament and Council, 2007. Infrastructure for Spatial Information in the European Community (INSPIRE), http://inspire.jrc.ec.europa.eu/index.cfm

[5] ALTA4 Geoinformatik AG. 2008. HTML ImageMapper NG2, www.alta4.com

[6] Google Maps API Family, http://code.google.com/apis/maps/index.html

http://geoliss.ekoplan.gov.rs/OGK/OGKVektorWEB. Figure 1 presents one detail of the vector map for sheet Ivanjica.[7]

Several maps were prepared with ArcGIS Server 9.3.1 and web services were published, compliant with the Open Geospatial Consortium's (OGC) Web Map Service (WMS) specification. The next step consisted of building web applications with GIS capabilities using the .NET Web Application Developer Framework (.NET Web ADF) an ASP .Net AJAX (asynchronous JavaScript), with both server-side and client-side controls and libraries. With the use of the above-mentioned technologies, the following was published: Map of the Tara National park available at http://geoliss.ekoplan.gov.rs/Tara (Fig. 2) and the Map of exploration and exploitation permits in Serbia (Stanković *et al.*, 2010), available at http://geoliss.ekoplan.gov.rs/geoliep. GeolIEP is a subsystem of GeoISS which deals with keeping track of exploration and exploitation permits and works in the mineral resources field, and represents a basis for archiving and efficient handling of vector, raster and related thematic alphanumeric content in one place, as well as efficient management and usage of mineral resources.[8]

Google Maps API Web Services are also used for the presentation of GeolIEP resources. Namely, the initial KML file is produced from GeolIEP resources, and is subsequently published using Google Earth web service at http://geoliss.rgf.rs/gmap/GE_GeolIEP.htm and Google Maps web service at http://geoliss.rgf.rs/gmap/GM_GeolIEP.htm .

The Geological atlas of Serbia 1:2.000.000, published both in Serbian and English, encompasses a number of maps and accompanying legends (Dimitrijević, 1996). The web edition of the Atlas, available at http://geoliss.rgf.rs/index.php?page=atlas, was created with the use of Adobe flash plug-in Zoomify, which enables zooming in real-time, without loss of image quality.

Multimedia part of the web portal

The part of the web portal pertaining to geoheritage and geodiversity of North-Western Serbia represents the Adriatic geotectonic unit through different cycles of geological history, in the time span between 390 and 65 million years. This part of the portal was

Fig. 2. Map of the Tara National park.

[7] Several projects financed by MEMSP. *Geologic Institute od Serbia*: Geo-referencing of scanned pages, cropping and linking into the national coordinate system of the Basic geological map 1:100.000, 2009, Blagojević D. *Geozavod Nemetali:* Map of geological curiosities in Serbia 2004-2005, Jovanović, J. *FMG:* Study on the hydro-geological research carried out in order to create the geological and hydro-geological information system of the National park Djerdap, Dragišić, Monitoring groundwater resources of Serbia: Drafting the map of the vulnerability of underground water resources of Serbia, 2007-2011. (together with the Institute for water management "Jaroslav Cerni"), Stevanović, Z. 2009., Translation of the published cartographic content and the content of the legend for the Basic geological map (OGK) into the format of the Geological information system of Serbia (GeolISS) 2008-2009, Jemcov, I. & Trivić, B. 2009.

[8] The project funded by the Provincial secretariat for energy and mineral resources: "Creation of the subsystem for the Autonomous province of Vojvodina within the framework of the geological information system of Serbia – GeolISS", 2009, Trivic, B. The project of hydro-geological research with the aim of creating a geological and hydro-geological information system of the Tara National park, 2008-2011, funded by the Ministry, carried out by FMG, Dragisic.

developed with the use of PHP script language, jQuery library for text animation and generation of detailed overview of objects, as well as external Adobe flash plug-ins, FlashPageFlip and Zoomify.

Database search

In addition to multimedia contents, the web portal includes several complex forms for searching cata-

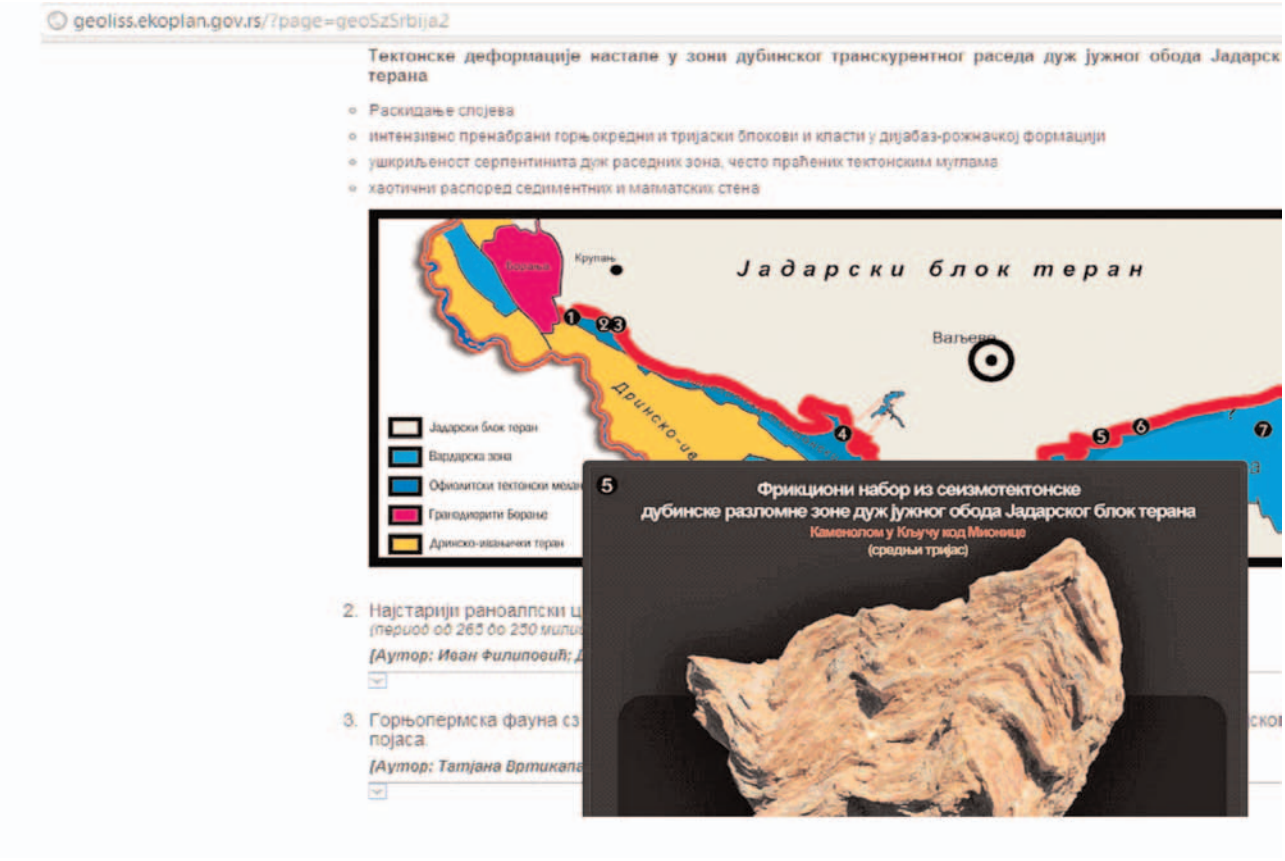

Fig. 3. Details from the webpage on geoheritage and geodiversity of North-Western Serbia.

The multimedia part of the portal is organized in several subsections: subsection consisting of the gallery of photographs, presentations, and video clips and the subsection reserved for the presentation of jewelry mineral resources of Serbia[9].

Photo gallery of geological resources of Serbia was created with the use of PHP script language with the addition of Query library for handling photographs on the client webpage. Video clip gallery was realized using the VideoLightBox library. Video clips are uploaded to the server in .flv (Flash video) format. After importing these libraries, the engine of this plug-in adds the thumbnail of the first frame of the video clip with the link to the .swf player, which plays the clip in a modal panel, adding navigation controls, as well.

logues: projects, archive documentation and bibliography, documentation of the funds and research-exploitation permits for water and solid mineral resources[10]. The above-mentioned searches were derived from the basic model which is based on multiple entry of key words, phrases, different criteria and finally, the most important part – a ranking of search results.

The search system includes advanced methods for ranking search results, based on weight factors associated with specific fields in the function of search criteria. Since the data on available search fields, as well as the weight factors for each field, are located in the database, a simple change of these values provides for dynamical adding of criteria, as well as fine-tuning of

[9] The project was funded by MEMSP, Geologic Institute of Serbia: Geo-heritage and geo-diversity of North-Western Serbia 2007-2011, FILIPOVIĆ, I. & JOVANOVIĆ, D. 2011. FMG: Synthesis of geological research of jewelry mineral resources of Serbia with the evaluation of potential 2010-2012, MILADINOVIĆ, Z.

[10] Projects funded by MEMSP. *FMG*: Geological bibliography of the Republic of Serbia

the ranking of search results, based of the number of appearances of a key word or phrase, and the sum of weigh factors of the search field. Namely, a number of entities and their attributes within the database correspond to each search criterion, and each entity/attribute has certain weight factors which determine the relevance of the appearance of a resource within the set of results.

Entering different search criteria is provided for by JavaScript functions, while the search engine was developed with the use of PHP script language and AJAX. By using HTML and CSS for markup, JavaScript for the access to DOM elements, XML (Extensible Markup Language) or JSON (JavaScript Object Notation), data is downloaded from the server and the final results are formated. Query processing on the server side expands the query by creating a matrix of keywords and field types which are searched for on one side, and a list of attributes and weight factors on the other. The query is subsequently transformed into SQL (Structured Query Language) format. Expanded in this way, the query is used to search resources on the basis of entered key words and phrases, within the subset of attributes in the database which fit the chosen search criteria. Ranking of results is performed by adding weight factors and the number of key word/phrase appearances. For example, if the search criterion "mineral resource" is chosen – first a list of entities and attributes which are being searched for the given criterion is read from the database. In this case two entities are searched, the table of documents and their descriptions. The textual field type is searched, and the list includes the title of the paper which includes the entered word, signature of the discipline, abstract of the paper, key words and paper description, with weight factors 4, 2, 3, 1, respectively. If the keyword "gold" is entered, the method on the server sums up the number of appearances of the word "gold" in the abovementioned fields in relation to the given factor. Ranking of the results is carried out in descending order according to the field containing the total sum of factors. The search method described here can be seen at: http://geoliss.ekoplan.gov.rs/index.php?page=fodib.

Geological terminology and nomenclature (GeolissTerm), available at http://geoliss.ekoplan.gov.rs/term, was developed with the use of ASP.NET technology, in combination with jQuery and AJAX. Since the dictionary has a hierarchical structure, terms are displayed in the form of a three to help the user grasp the data and to improve their visibility. When a specific node is chosen, the definition, synonyms and references related to the select dictionary entry are displayed, as well as terms of hyponym and hypernym concepts. The dictionary can also be searched with the use of key words. After entering a string of characters (word or part of a word), the user is offered a list of dictionary entries where the given string of characters appears, and by choosing from the list, the user can get a detailed view of the entry.

Concluding remarks

In this paper, we tried to give a brief presentation of the content of the GeolISS portal, designed to present the data from geological research funded by the MEMPS, as well as the technology used for its realization. Current activities in the development of GeolISS components, as well as the activities related to the portal, are focused on the migration to the ArcGIS 10 platform, the implementation and intensive use of web services and web applications which consume them. Further steps encompass the creation of a lexicon of mapped units, and integration of the dictionary and cartographic representation of spatial objects in which they appear. Further publication of results of both recent, as well as older projects is planned in the upcoming period, as well as the translation of these results into GeolISS format. We also plan to enable the export of data sets from GeolISS to GeoSciML format (http://www.geosciml.org), like BRGM French Geological Survey, CSIRO Exploration and Mining, Australian Government Geoscience portal and other national geological institutions and organizations.

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ESRI: GIS and mapping software, http://www.esri.com, ESRI Developer network http://edn.esri.com