

GEO-DATABASE KOSOVO (GDK) – DEVELOPMENT AND IMPLEMENTATION OF A GEOSCIENTIFIC INFORMATION SYSTEM

H. Kühne¹, A. Barth¹, J. Beutel¹, S. Duraku², R. Hengstmann²

Abstract

The GEO-Database Kosovo (GDK) has been developed for the Independent Commission for Mines and Minerals (ICMM) by Beak Consultants GmbH between 2003 and 2006. The GDK is a multi user application, created in client-server architecture. The current version 2.0 of the GDK features three main components: database, front-end application and geographic information system (GIS). The database has been developed using Microsoft SQL Server 2000. It contains 18 main tables, 66 detail tables, 47 link tables, 142 reference tables and 18 control tables and features 76 views and 15 user-defined functions. All data inside the database can be viewed and changed using the front-end application. This has been programmed in Microsoft Visual BASIC .NET 1.1 as well as ESRI MapObjects 2.3a and ComponentOne Studio .NET 2004. The application features 22 data modules which are organised into 7 logical groups covering mining data (applications and licences / exploitation sites / processing plants / blasting permits / explosives register), environment data (contaminated sites), economic geology data (deposits and occurrences / Kosovo Quarry Plan), geology data (borehole / samples and analytics / geological fieldwork / map legends), metadata (reports / documents), business data (persons and companies / parcels) and administration data. For viewing the spatial data linked to the thematic data inside the database, the application also features an internal GIS viewer. The actual GIS component of the GDK features a map document that allows the data viewing, manipulation and printing using ESRI ArcMap 8.3 and ArcSDE 8.3. It includes 10 thematic layers, 2 topographical layers, 5 geoscientific layers and several background layers (topography, aerial and satellite imagery).

Main words

Database, Geographic Information System, Microsoft SQL Server, Microsoft Visual Basic .NET, ESRI ArcMap / ArcSDE

¹ Beak Consultants GmbH, Am St. Niclas Schacht 13, D-09599 Freiberg, Germany

² Independent Commission for Mines and Minerals, Rruga Rrustem Statofci 29, 10000 Prishtinë, Kosovo

Background

Three years ago, the Directorate of Mines and Minerals, from which today's Independent Commission for Mines and Minerals emerged, asked Beak Consultants GmbH to develop a system for the handling and maintenance of mining licence related data. A simple Microsoft Access 2000 database "Baza e të dhënave" did exist already, which was developed by a courageous co-worker of DMM in 2002. Based on the existing database, Beak developed LISKOS, which was likewise based on Microsoft Access 2000. It featured the modular structure that is typical for Beak's database applications and stored data already in tables of different types like main tables, detail tables, link tables and reference tables, which allowed the storage of data free of redundancies. The first modules that appeared have been "Applications and Licences", "Persons and Companies", "Documents" and "Parcels". These modules were connected in a netted structure. When it became clear that Microsoft Access has restrictions in several ways, it was decided to migrate the database itself to Microsoft SQL Server 2000, to develop a front-end application with Microsoft Visual BASIC 6.0 and to introduce ESRI ArcMap 8.2 for the visualisation of factual data on a geographical background like topographical maps. To this GeoDatKos database, all current versions of GEO-Database Kosovo can be tracked down.

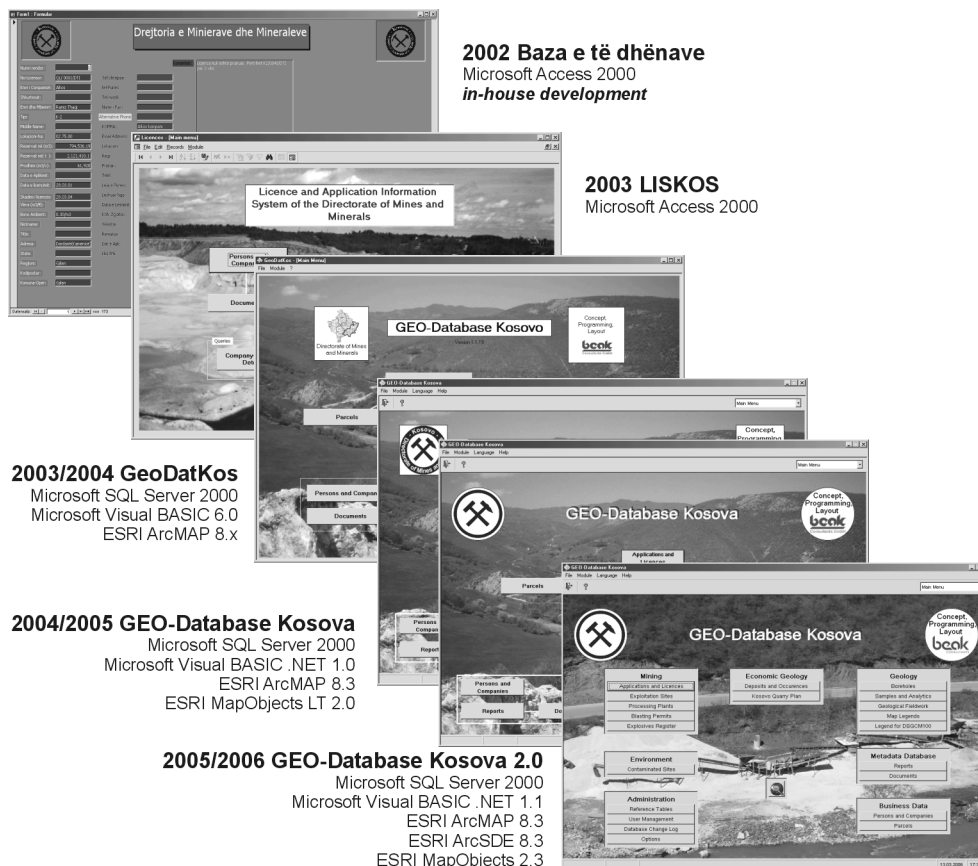


Figure 1: *History of GEO-Database Kosovo.*

At the end of 2004, the first version of GEO-Database Kosovo has been developed using the seminal programming language Visual BASIC .NET. Additionally, it featured first an external and later an internal GIS viewer, for users who do not had access to ArcMap as well as additional modules, which had to be provided for other projects Beak has been working on like the Kosovo Quarry Plan [1] and the Geoscientific Maps [2] project. Since the end of 2005, until now,

the existing database application has been significantly enhanced: new modules were developed like the "Samples and Analytics" or "Contaminated Sites" modules. The GIS data is not stored in the file system anymore, but in a sophisticated ArcSDE database. Therefore, the GIS components had to be reprogrammed as well: the ArcMap project now features an automated map generation for printing customized maps, the internal GIS viewer was changed to reflect the changes in the GIS data storage.

The front-end application and the GIS component were designed for easy and intuitive use. The front-end application is available in English language, Albanian language and Serbian language. An integrated help system is available. GEO-Database Kosovo is a work in progress and in constant development.

Principal Components of GEO-Database Kosovo

GDK consists of three main components: the underlying relational database system, the database application and a Geographic Information System.

The relational database system Microsoft SQL Server 2000 is used for the data storage. Relational databases are a tool to model the world. So-called entity-relationship models are often used to map a real-world system to Relational Database Management Systems (RDBMS). Each element of a system represents either an entity (a person, place or thing) or a relationship between entities. The data is stored in numerous tables of different types. Many relations exists between the tables that are organised in a netted structure. Additionally, database systems offer many ways for ensuring the data integrity like triggers, check constraints and user-defined functions. Databases are administered with the Structured Query Language (SQL). Even for working with data – inserting, updating and deleting data – SQL statements have to be used. Several user roles are implemented to organise the read and write access to different types of data.

While the database is working in the background, the database application or front-end application is the principal interface between user and database. It presents the data in a structured way and allows to work with it without the hassle of using SQL statements. The user is presented with a main menu that allows access to several modules organised in different logical groups.

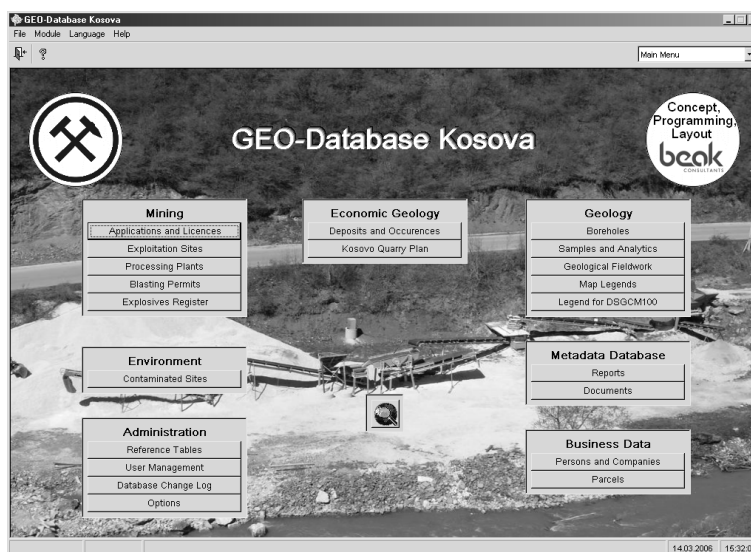


Figure 2: Main Menu of the GEO-Database Kosovo.

These modules are available in read-only mode and in write mode depending on the user access rights in the database. Each module features the typical functionality of database applications. The list of available records is presented at the bottom of the screen, while the data of the currently selected record is displayed in the main area. Detail data is often displayed in tab pages in the middle part of the module. The standard functionality for navigation between records, creating, changing and deleting records as well as for the application of filter conditions are provided in the main menu, and the most often used functions are duplicated as buttons in the toolbar.

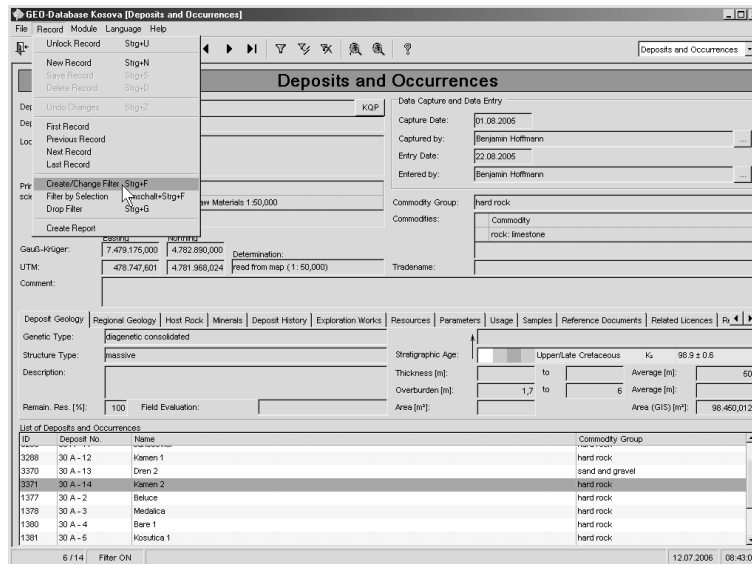


Figure 3: Typical Layout of a Module inside the GEO-Database Kosovo.

In addition to the standard database functionality, tools for switching to the GIS component and displaying the attached spatial data for a record are available.

The database application has been developed using Microsoft Visual BASIC .NET 1.1 and ComponentOne Studio .NET 2004 user interface components. Several open source libraries and public source codes have been used for accomplishing tasks that are not covered by the Microsoft .NET Framework, like Proj.4 for the on-the-fly conversion of projected and geographic coordinates, shapelib for the creation of shape files, gd graphics library for the creation of JPEG files, ping, SingleInstanceHandler etc. Other interfaces between the database application and the SDE C API, shapelib, Win32 functions and other used libraries had to be self-developed as many external libraries are written in C language and are not directly useable by Microsoft Visual BASIC .NET.

The GIS component is in reality not only one component but consists of many parts. The most important and for the user invisible part is the ESRI ArcSDE 8.3 database in which the geometrical data is stored. The ArcSDE database is set on top of Microsoft SQL Server 2000. Available geometrical data are vector data as thematic data for the several modules of the database application like applications and licences, processing plants, exploitation sites, contaminated sites, samples and analytics, deposits and occurrences or geoscientific maps (geological maps in different scales, soil map) that are directly connected to the factual data that is presented to the user through the database application. Additional vector data is available for the topography that has been acquired from the topographical map at a scale of 1:50,000 and the available aerial imagery from 2001. Several raster images are stored in ArcSDE as background data. These are scanned historical geoscientific maps in different scales from 1:100,000 to 1:500,000 that cover the area of

Kosovo, the pedological map at a scale of 1:50,000, the topographical maps in scale from 1:25,000 to 1:100,000, the available aerial images and satellite data acquired in different years ranging from SPOT to Landsat 7 and SRTM data. The second part is an ArcMap 8.3 project file that relies on internal macros written in Visual BASIC for Applications (VBA) and provides access to all available data in the ArcSDE database through a customised toolbar. It has also functions for the selection of geometrical features and switching back to the database application for the display of the attached factual data.

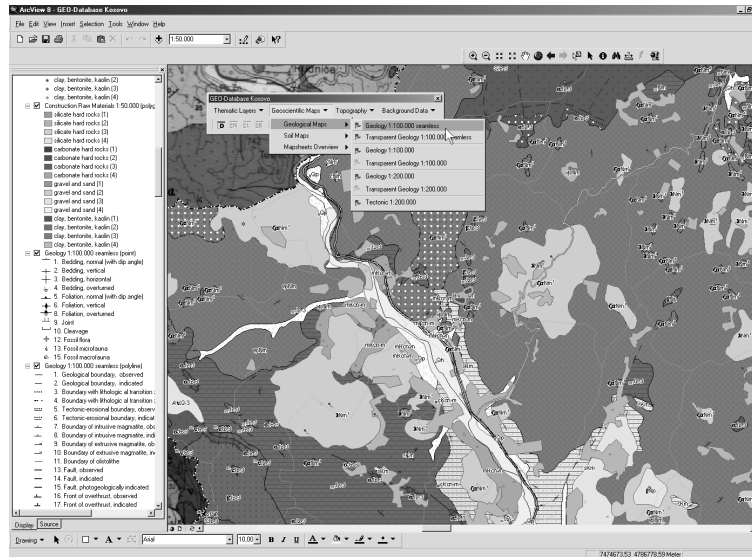


Figure 4: The GIS Component based on ESRI ArcMap.

Another feature is the printing of automatic generated map layouts. These maps can be printed from A4 to A0 including the legends on the map or as separate legend sheets.

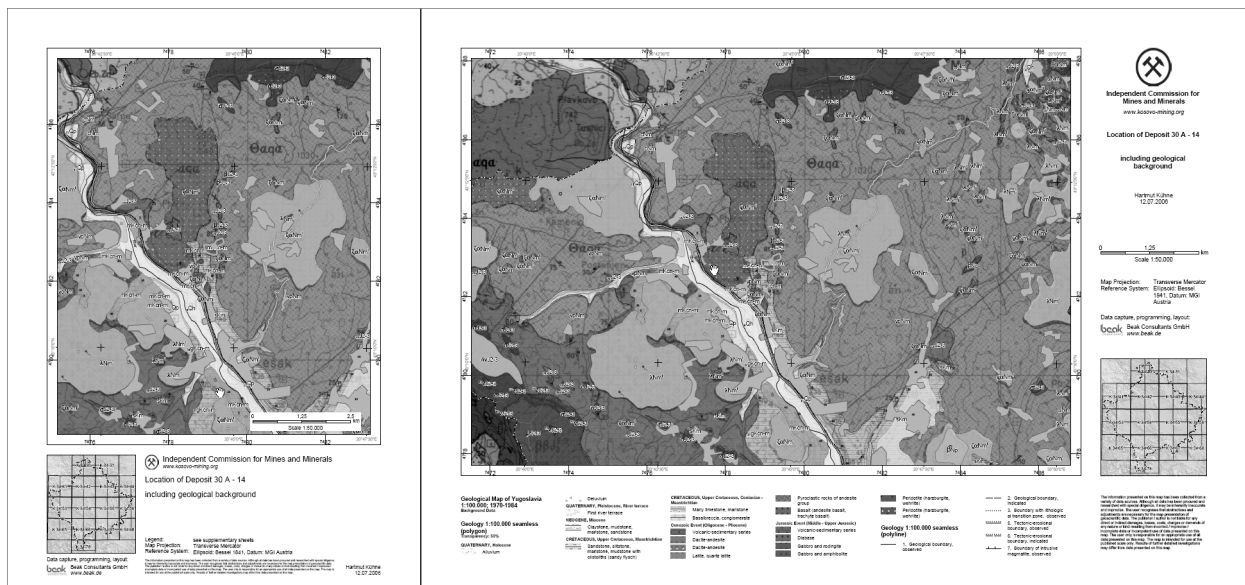


Figure 5: Predefined, Printable Map Layouts (Left Side: A4, Right Side: A3).

Since the license costs for ESRI ArcMap are not insignificant, not every user can be supplied with a copy of this GIS software. For these users and for saving licence costs, an internal GIS viewer has been developed. This viewer is based on ESRI MapObjects 2.3 that can be redistributed free of licence fees. MapObjects is able to connect to ArcSDE databases and display vector data directly in its map control. It can be used for the purposes of GEO-Database Kosovo even if it is not capable to display raster data that is stored in ArcSDE. Raster data have to be retrieved using the SDE C API and stored as JPEG files that MapObjects is able to display. When compared to ArcMap, the internal GIS viewer is relative simple but very straightforward to use.

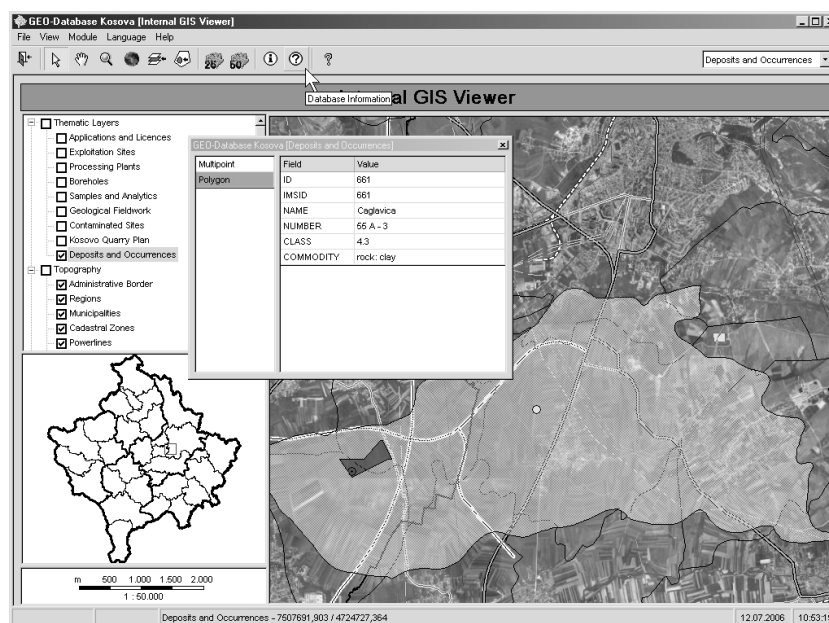


Figure 6: *Internal GIS Viewer.*

It features the standard tools of GIS software like zoom in and out, pan, select features, zoom to selected features or the complete map. Additionally, tools for automatic loading of the topographical maps at a scale of 1:25,000 and 1:50,000 and a tool for displaying the attached factual data is available. It is possible to print out a simple map from this viewer for overview purposes.

Website

The broader public can acquire base project information via the internet service: www.kosovo-mining.org. There, the data portal and the GIS viewer do not only allow to query the database on factual data but also to view spatial attributes. From the main database, information on mineral licences, companies, boreholes, mineral deposits and occurrences, construction minerals, processing plants and exploitation sites can be accessed via the internet application. As the GIS viewer is running within the browser, ActiveScript or Javascript needs to be enabled. The core functionality is known to run on the latest versions of Firefox, Mozilla and Netscape.

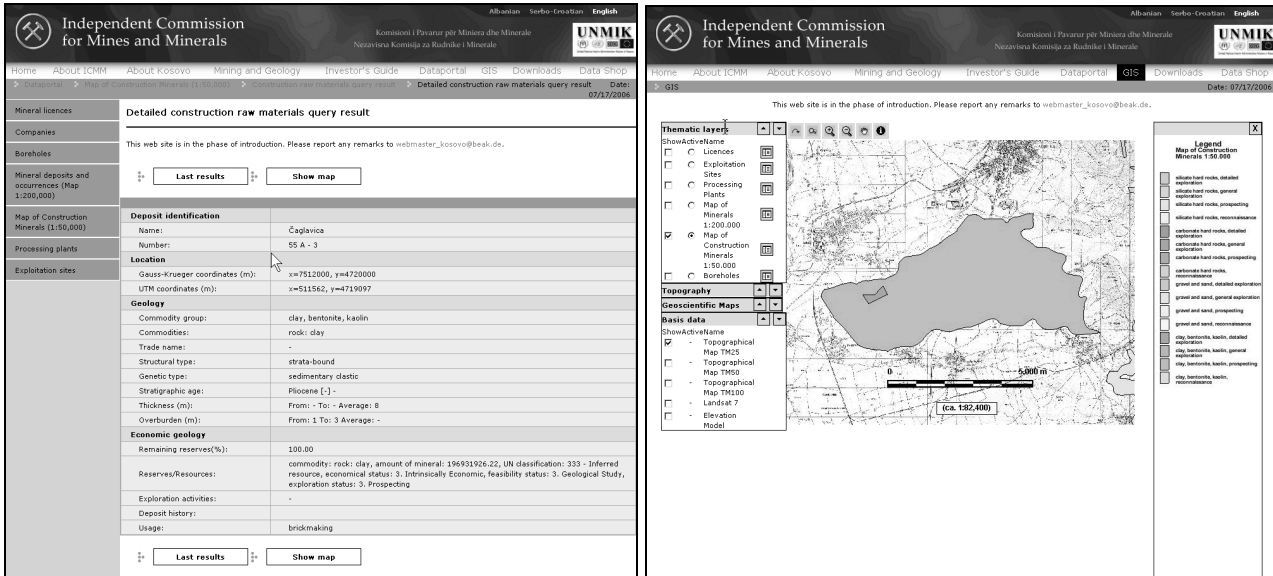


Figure 7: Website Application of GEO-Database Kosovo (Left Side: Database, Right Side: GIS Component)

Conclusions

GEO-Database Kosovo is a modern tool for maintaining several data from mining to geoscience. It allows the visualisation of factual data on a spatial background using state-of-the-art GIS software. It is easy to use and allows the quick retrieval of data.

Literature / References

- [1] The Kosovo Quarry Plan – Final Report – Review, Evaluation and Future Demand for Construction Raw Materials in Kosovo. - Beak Consultants GmbH, Prishtinë, March 2006, 248 p.
- [2] The Compilation of the Geoscientific Maps of Kosovo – The Digital Geological Map 1 : 100,000 – Description of the Map Compilation. – Beak Consultants GmbH, Prishtinë, March 2006, 175 p.