

# **Planning and Implementation of the Information Management System of the Mining Sector of Ghana**

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**Key words:** Database, Ghana, GIS, Mining, Web Site

## **SUMMARY**

The mining sector in Ghana contributes about 39 % to the total export value of Ghana and employs directly more than 36,000 people. Despite the fast growth of the sector over the last years, the known reserves of minerals have depleted rapidly due to the introduction of effective mining methods and new deposits are not being discovered due to lack of funds. The mining companies will require support from the mining sector institutions to cut down on their exploration budgets through:

- provision of geo-scientific information such as reports, drilling results, evaluations, geological, geophysical, and geochemical maps,
- execution of state funded exploration and investigation activities,
- provision of up-to-date information about the existing mining and exploration leases,
- formulation and implementation of policies, which will be investor friendly.

The project “The Design, Procurement and Commissioning of the Information Management System at the Ministry of Lands, Forestry and Mines and its Agencies“ deals with the creation of the information technological pre-requisites for this support. A complex database is under construction that will enable access from various authorities in Ghana to provide easy access to valuable geo-scientific data and topographical base data such as geo-referenced maps and other data layers. Basic GIS functions are included. In addition, complex user rights settings allow data entry for qualified users. In terms of good governance, it will create more transparency and efficiency with regard to geological and mining related business activities, and provide a strong support to the activities of the mining sector institutions. Some geo-scientific information will be available to the general public on the new web site of the mining sector institutions which is envisaged to contribute to sustainable and environmentally friendly mining and land use planning procedures.

## ZUSAMMENFASSUNG (German)

Der Bergbausektor von Ghana trägt zu 39 % zum Exportwert Ghanas bei und beschäftigt mehr als 36.000 Arbeitskräfte. Aufgrund von effizienten Abbaumethoden und mangels finanzieller Mittel für neue Explorationen haben die erschlossenen Lagerstätten trotz des großen Wachstums des Sektors stark abgenommen. Die Bergbaubehörden können über die folgenden Maßnahmen Unterstützung bieten, um die Explorationskosten zu senken:

- Bereitstellung von geowissenschaftlichen Informationen (Berichte, Bohrdaten, Analysen, geologische, geophysische und geochemische Karten)
- Durchführung staatlich finanzierter Exploration
- Bereitstellung aktueller Information über bestehende Bergrechte und Lizenzen
- Schaffung von investorfreundlichen politischen Rahmenbedingungen.

Das Projekt "The Design, Procurement and Commissioning of the Information Management System at the Ministry of Lands, Forestry and Mines and its Agencies" legt die erforderlichen IT-Grundlagen für diese Unterstützung. Die derzeit in Entwicklung befindliche komplexe Datenbank wird den verschiedenen Behörden in Ghana Zugang zu wertvollen geowissenschaftlichen Daten und georeferenzierten topografischen Grundlagenkarten ermöglichen. GIS-Grundfunktionen sind in der Anwendung integriert. Zusätzlich erlaubt eine komplexe Nutzerrechteverwaltung die Dateneingabe für autorisierte Nutzer.

Aus der Sicht von „Good Governance“ wird durch die Einführung dieses Informationssystems mehr Transparenz und Effizienz in Bezug auf geologische Daten und Bergbauaktivitäten hergestellt. Für die Bergbau-Institutionen bedeutet dies eine starke Unterstützung.

Ausgewählte geowissenschaftliche Informationen werden auf einem neuen Internet-Portal der Allgemeinheit zur Verfügung gestellt. Dies soll zu einer nachhaltigen und ressourcenschonenden Entwicklung von Bergbau und der zukünftigen Landnutzungsplanung beitragen.

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## **1. INTRODUCTION**

This paper describes the goals, technology and status of the development of an Information Management System (IMS) for the Mining Sector of Ghana, financed by the Mining Sector Support Programme (MSSP) of the European Union (8<sup>th</sup> European Development Fund) and supervised by the Minerals Commission of Ghana. With this project, the Mines Section Agencies of the Ministry of Lands, Forestry and Mines, i.e. the Geological Survey Department (GSD), the Minerals Commission (MC), the Mines Department (MD) and the Precious Minerals Marketing Company Ltd. (PMMC) shall be put in a position to tackle the problems of managing heterogeneous data such as topographic and thematic maps, mining licences, production figures, environmental geological data, drillhole data, histories of licence areas, bibliographic data etc. In addition, the IMS is designed to support and improve the existing working procedures at the Agencies, e.g. the licensing process with a modern tool. This enhances both the interaction of the Agencies which will be linked with a secure radio-transmission based (internal) intranet system and the communication with other state agencies, mining companies and the general public using a web site. This new “Mining Portal” of Ghana will be linked to the database of the IMS and provide non-classified data to the general public.

## **2. DATA MANAGEMENT - REQUIREMENTS OF THE MINING SECTOR**

### **2.1 The Mining Sector of Ghana**

The mining sector in Ghana contributes about 39 % to the total export value of Ghana and employs directly more than 36,000 people. Despite the fast growth of the sector over the last years, the known reserves of minerals have depleted rapidly due to the introduction of effective mining methods and new deposits are not being discovered due to lack of funds. The mining companies will require support from the mining sector institutions to cut down on their exploration budgets through:

- provision of geo-scientific information such as reports, drilling results, evaluations, geological, geophysical, and geochemical maps,
- provision of up-to-date information about the existing mining and exploration leases,
- formulation and implementation of investor friendly policies.

## 2.2 Administrative Issues

The Mining administration of Ghana is currently subordinated to the Ministry of Lands, Forestry and Mines. Different agencies, partly with regional offices, are concerned with the management of the mining affairs and the provision of data for both governmental decisions and for the exploration companies (geo-scientific data).

The **Geological Survey Department (GSD)** of Ghana was established in 1913 as the 'Gold Coast Geological Survey'. The GSD is responsible for the provision of reliable and up-to-date geological information for national development through geological mapping, research and investigations. It performs the following functions:

- Identification and provision of authentic maps and records on the country's geological resources to stimulate mineral exploration and for optimum land use planning;
- Geo-hazard assessment, including earthquake monitoring and seismic zoning, dam site seismicity, monitoring of mine site seismicity and improvement of risk analysis in urban or populated areas;
- Research into geology (nature and structure of rocks), geophysics, clay minerals etc.

Through the years, the GSD has made major contributions to the understanding of the geology of the country, which forms the basis of exploration and exploitation of mineral resources. The GSD organises and executes the geological and economic geological investigation of the country, provides relevant information to any interested state or private party. Among its duties is the information of government, industry and public on relevant geological issues, such as minerals, groundwater, land use and geohazards. A special concern of the GSD is to customise geological data, e.g. for mineral exploration and exploitation, water supply companies, general land use planning, agriculture, industry and civil engineering. The special importance of the GSD for Ghana is their extensive stock of maps and geological information. The GSD has a total number of staff of 320.

The **Minerals Commission** is a government agency established under Article 269 of the 1992 Constitution and the Minerals Commission Act. The Minerals Commission (MC) as the main promotional and regulatory body for the minerals sector in Ghana, is responsible for "the regulation and management of the utilization of the mineral resources of Ghana and the coordination of the policies in relation to them".

Specifically, the Commission is required by law to carry out the following functions:

- Formulate recommendations of national policy for exploration and exploitation of mineral resources with special reference to establishing national priorities having due regard to the national economy and advise the Minister on matters relating to minerals;
- Monitor the implementation of laid down Government Policies on minerals and report on this to the Minister;
- Monitor the operations of all bodies or establishments with responsibility for minerals and report to the Minister;
- Receive and access public agreements relating to minerals and report to Parliament;

- Secure a firm basis of comprehensive data collection on national mineral resources and the technologies of exploration and exploitation for national decision making.

Currently, 116 people are employed in the MC. The main source of information the MC receives and deals with are reports that the mining companies have to send in on a regular basis. The Minerals Commission evaluates the reports and, partly, presents it to the public. In addition, the Commission executes projects through both local and international funding agencies.

The **Mines Department (MD)** was first established in 1902 at Tarkwa. It derived its mandate from enactments made over the period until 1986 when these enactments were largely replaced by the Minerals and Mining Law, PNDCL 153. Under the provisions of the law, the Chief Inspector of Mines is appointed by the Minister responsible for mines, in consultation with the Minerals Commission. The Chief Inspector of Mines is charged with general responsibility to supervise “the proper carrying out of the provisions of this Law”.

In practice, the Department is responsible for instituting and enforcing health and safety and environmental standards in the mines. Its function is to ensure compliance with Ghana’s Mining and Mineral Laws and Regulations through effective monitoring.

The Mines Department (MD) supervises and controls the activities of the mining and exploration companies. The MD does the certification of some of the mining equipment and is concerned with the safe working order. Monitoring is mainly done by reviewing the reports of the companies and by field inspections to verify the provided information. In total, 49 members of staff are working in the MD, 40 of those in Accra.

The head office in Accra also functions as regional office for the Accra region. In total, there are 4 offices in the regions.

The **Precious Minerals Marketing Company (PMMC)**, formerly Precious Minerals Marketing Corporation was established in 1989 by PNDCL 219 of 1989. The law states the functions of the company as:

- to grade, assay, value and process precious minerals;
- to buy and sell precious minerals;
- to appoint licensed buying agents for the purchase of precious minerals produced by small-scale miners;
- to promote the development of precious minerals and jewellery industry in Ghana.

The PMMC (52 employees) runs a jewellery manufacturing section and an in-house workshop for gold. In addition, The PMMC is the supervisor of the gold exporting companies and is issuing a yearly licence for the traders that are buying gold and diamonds from the small-scale mining operations.

### **2.3 The need for an Information Management System (IMS)**

As can be seen from the task description of the Ministry and its Agencies, there is a certain degree of overlapping of tasks and data between the agencies despite their individual work profiles. However, there is no common (digital) communication infrastructure. At the

TS 17 – Mine Issues – Ecological and Environmental Issues

5/14

B. N. A. Aryee, R. K. Afenu, P. Y. O. Amoako, P. Awuah, K. O. Boamah, A. Barth, A. Barth,

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TS17.1 Planning and Implementation of the Information Management System of the Mining Sector of Ghana

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moment, reports and maps are exchanged as paper copies on demand or, in the case of some types of reports, on a regular basis. Several archives are run by the agencies without a common inventory. Huge amounts of valuable data both geo-scientific and economic or technical are not used since they are unknown to the potential users. In contrast, some work is done in duplicate in order to provide the necessary data for the responsible members of staff. Work flows such as the licensing procedures include paper files circulating through various offices and even agencies. The processing personnel need to query data (mostly paper files) from different offices for their decisions and further processing.

Potential investors in the mining sectors have to find their way through the different agencies and their responsibilities although the Minerals Commission was created to serve as a “one stop” shop for investment in the mining sector.

The IMS project was started to build an IT-infrastructure that will allow easy communication between the Ministry and each agency under its supervision. The goal is that every officer will have access –immediately and from his desk- to all data necessary for his special task as long as he is qualified to see the data, e.g. topographical and thematic maps, geophysical data, licence areas, drillholes, environmental measurements, production figures (original and derived summary statistics) and addresses of companies, agencies and other stakeholders.

The IMS will provide

- access to data such as text, tables, scans and interactive maps (“GIS-Viewer”);
- data storage facilities for database and GIS applications for all data of the agencies;
- mechanisms for the provision of data security (against loss and non-authorised use);
- accessibility for remote users;
- an interactive web portal for all stakeholders and the general public.

### **3. DEVELOPMENT OF THE IMS GEO-DATABASE GHANA**

#### **3.1 Principles of the Database**

The core of the Information Management System “Geo-database Ghana” (GDG) will be a relational database. It consists of a highly structured system of entities linked in a network-like structure. The main entities of the database are displayed in Figure 1. The entities (such as drillholes, sampling points and analyses, legends, mineral occurrences and deposits, mines and licences) are linked by n:m relationships representing either spatial or logical relationships (e.g. sampling points related to a certain licence site, licence applicant to a certain licence). Spatial data is linked to the appropriate factual data. In most cases, the linkages are established using (link) tables. Where (link) tables are not appropriate, SQL-queries are used to identify relationships between different entities. The linkages are the prerequisite for a comfortable use of the database, i.e. effective inquiries.

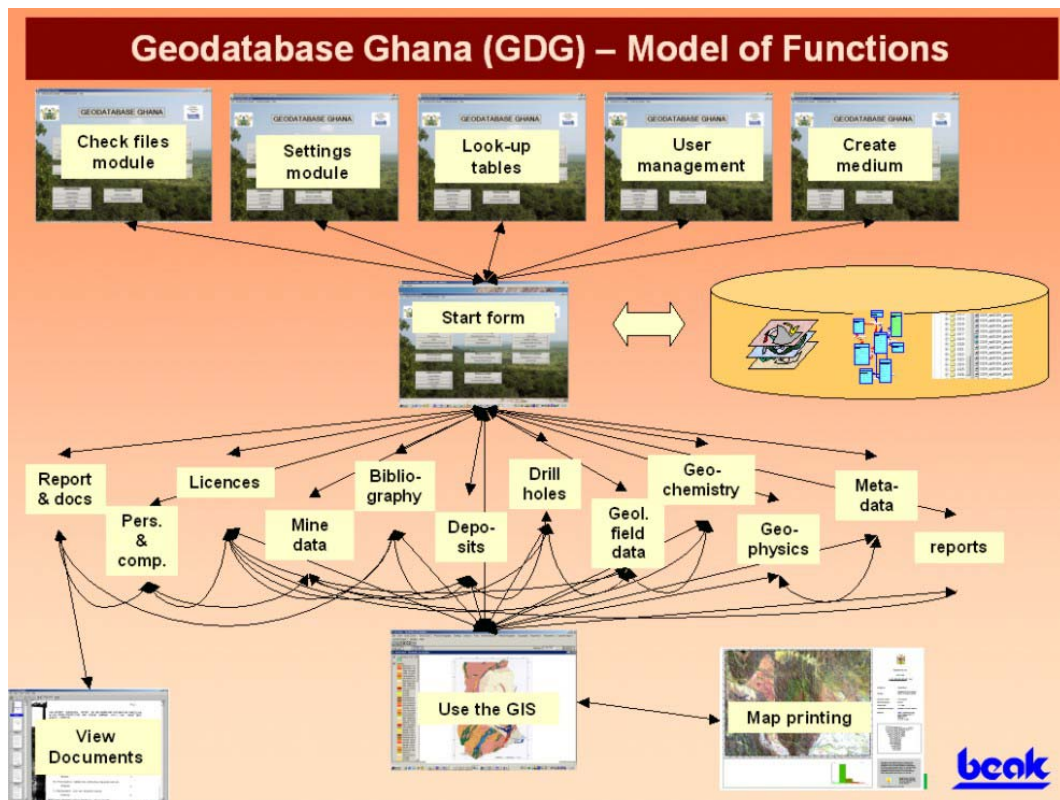


Figure 1: General design of the data model

### 3.2 General Architecture

The IMS will consist of 5 LocalAreaNetworks (LAN) connected via a wireless WAN (radio transmission between the Ministry and its agencies). Regional offices can access the system via dial-in connection using existing phone lines and a terminal server. However, they are restricted to processes that do not require extensive bandwidths (as the GIS viewer will do).

Two large servers in the two main agencies are the backbone of the data management system. Here, all database-stored data are replicated in-between each other. This provides more security and ensures the availability of the data within the frame of the fast and broadband LAN for most of the users.

The user rights will be managed in order to assign the right data to the respective personnel.

The data storage system consists of a MS SQL-server database and a file system. The database contains the structured data and most of the spatial data, while the file system manages the non-structured information, such as reports, scans, etc. File-based data will be stored locally on the servers of the agencies involved. Redundancies are possible. The storage of the spatial data will be supported by the software ArcSDE (ESRI).

The front end software that will be installed on 50 computers at the various agencies throughout Accra consists of a combination of the following parts:

- customised VB.Net 2003 application for the factual data,

- customised ArcView 9 application for the spatial data with a wide range of functionalities (such as map printing, mineral licence editing, creation of customised maps etc),
- customised GIS application for the daily work with spatial data on a read-only basis.

The database interface will be easy to use and provide the following functions:

- data entry,
- inquiries,
- import and export (flat tables for further processing with other software),
- compilation of reports and statistics for frequent data evaluations,
- presentation of data on maps (on-screen),
- fast and easy printing of user defined maps,
- alert functions for selected important events (e.g. expiry of licences).

An interface (metadata of spatial data) will manage the different kinds of sets of spatial data, their import into the database/ file system and their presentation in the spatial data user interface.

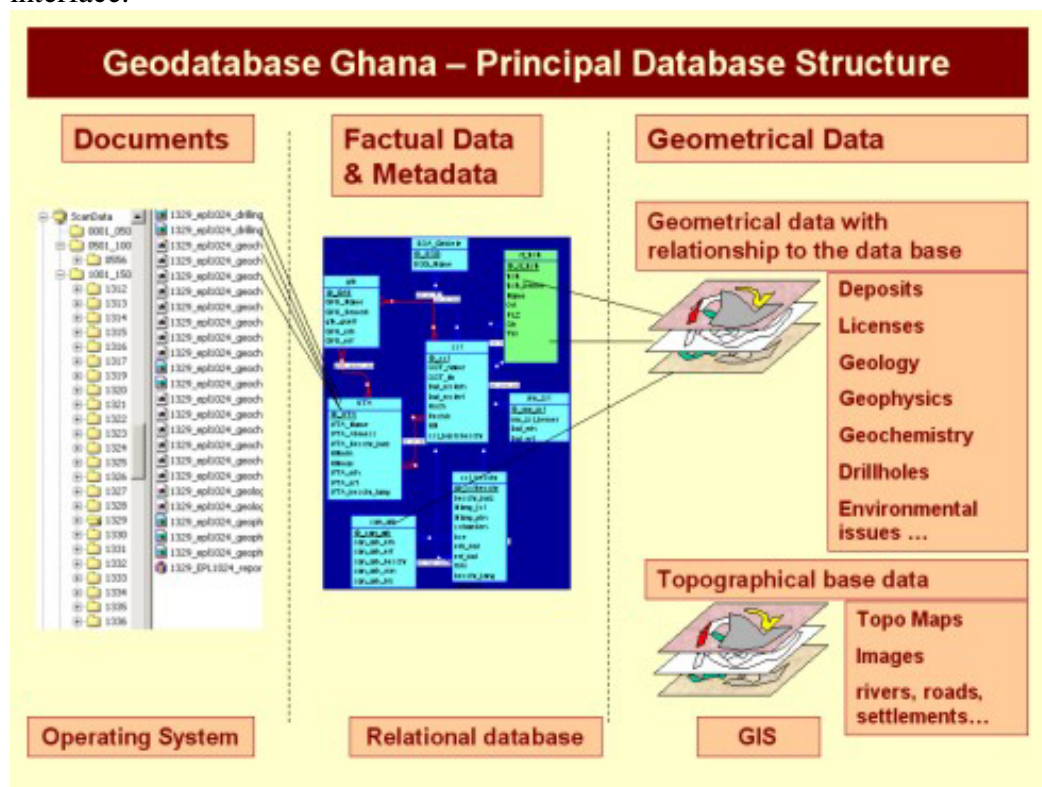
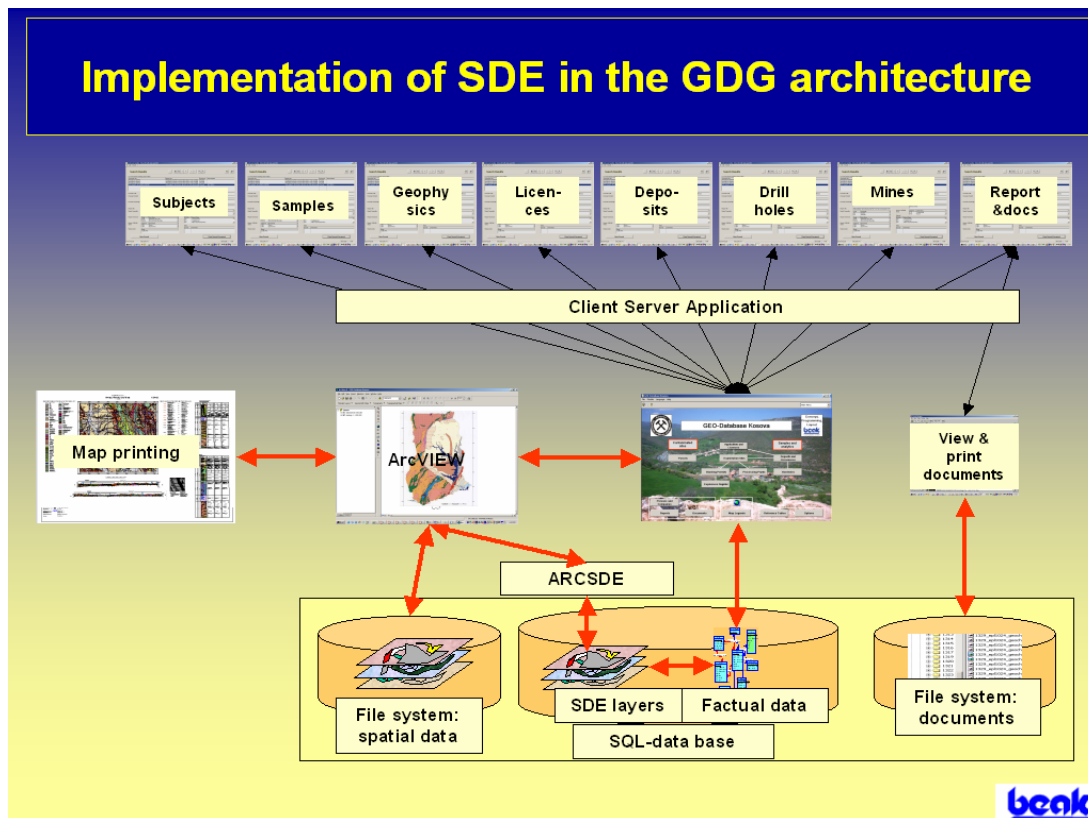


Figure 2: Database structure





**Figure 3:** Integration of ArcSDE into the data storage system and c/s application

### 3.3 Applications of the Database

The most important functions of the IMS are complex inquiries with spatial and/or logical background, e.g. “show all Gold occurrences of potential economic importance in a certain part of the country”; “show all sampling points and related Manganese values for a certain mineral licence/ for all licences of a certain applicant”; “show all reports and maps with regard to airborne geophysical data in a certain area” etc.).

The presentation and export of the inquiry results is another important function. It consists of different functions for the automatic creation of user defined maps (content, scale, size), the generation of text files (tables) for further customised processing (e.g. with other software).

Important administration functions are tools for a customised user management (setting of access rights to different modules of the system) and for data security reasons (backup system and protection against the loss of data and unauthorised data manipulation).

#### 4. THE WEB SITE - TRANSPARENCY AND INVESTOR ATTRACTION

The objective of the new Mining Portal of Ghana in the internet (*Figure 4*) is to enhance the communication between the Mining Administration and the target groups such as potential investors, companies involved in the mining business, State Agencies in Ghana and abroad, researchers and students, the geological community, people interested in visiting Ghana and the general public. The web site has to allow easy communication with the mining administration, direct people to the right agency to contact and demonstrate transparency of its institutions. The main attraction of the web site will be an interactive map viewer that allows to query topographical background data, geological data and mining data such as licence areas or locations of existing drillholes for registered users (see *Figure 5*). The registration is free and for statistical purposes only. The web site will be an important source of up-to-date information on opportunities, events and data related to the mining sector.



**Figure 4:** General design of the web site [www.ghana-mining.org](http://www.ghana-mining.org)

From the technical point of view, the web site has to meet three main requirements:

- user-friendly (both for the administration and external users),
- easy to update (even for a non-computer expert),
- sustainable (towards future expansion).

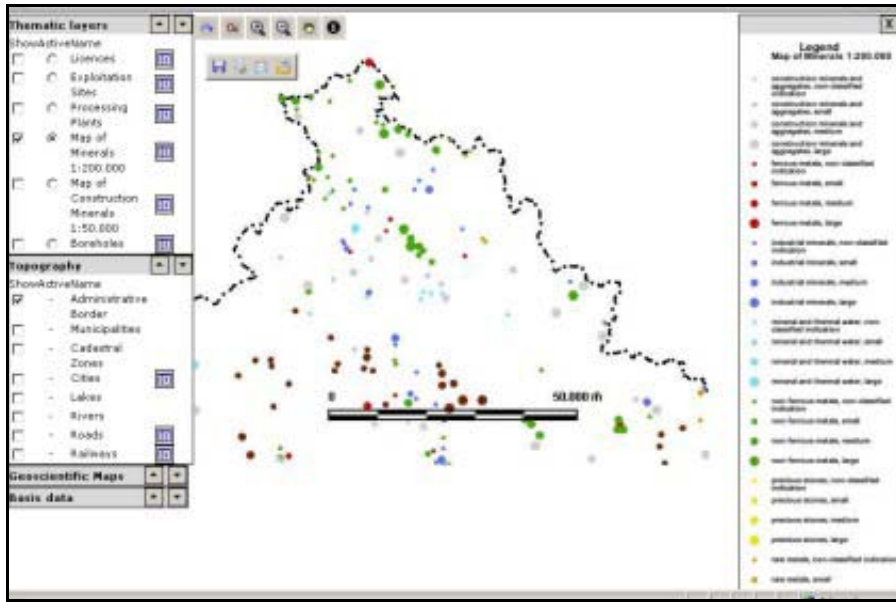


Figure 5: Interactive thematic map

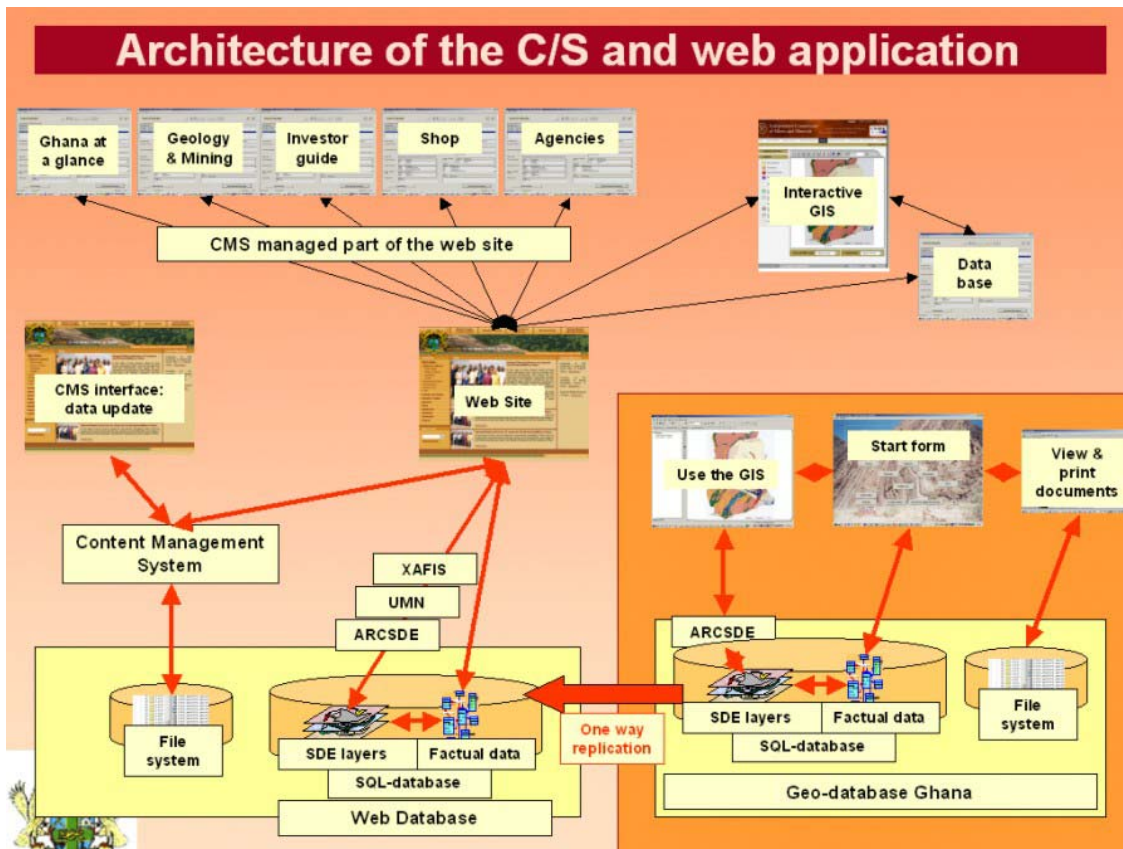


Figure 6: Integration of the web site into the database system

In addition to the general information about Ghana and specific mining-related information linked on the left-hand side (*Figure 4*), e.g. mineral deposits and an investor's guide for business in Ghana, including application forms and a description of the licensing process, the top line of the web site allows a permanent access to the Ministry and its agencies directly.

A part of the information on the web site is provided by the database of the IMS and will be generated and up-dated automatically (*Figure 6*). Statistical figures that will be up-dated by the IMS are, among others:

- number of companies with specific licences
- summary production of the main commodities for individual years
- Ghana's total mineral export for various years, separated into main minerals
- labour figures, assigned to commodities
- investment figures

Excerpts of annual reports as overview of the mining sector will be offered for download as pdf file.

The DataPortal section and the interactive maps will provide a huge amount of technical information that is currently only in a few countries available to the general public. The transparency gained by this open policy is important to attract investors and to improve good relations with the mining communities. However, internet access is needed by all target groups. The success of the Mining Portal is highly dependent on the management and up-date of the database.

The provision and up-date of the pages is supported by a content management system and, thus, easy to manage (both changing texts and adding pages or sub pages) by the responsible representative of the agencies. The main idea of content management systems is the separation of a web site into the three parts: structure, layout and content. Thus, it is possible to save the content separately and adjust the items individually as needed.

The layout of the web site is based on several templates that allow adding content at defined places only. Adjusting the layout of the whole web site requires only the modification of the templates.

## **5. OUTLOOK AND CONCLUSIONS**

With the system outlined here, the Mining Authorities of Ghana will possess a profound tool for managing, editing and analysing spatial and factual data and to share a huge pool of geo-data, mining data and reports among the various agencies that fulfil different tasks but partly use the same background information.

This will help to build up a sustainable and more efficient management of geo-scientific knowledge and decision-making.

## BIOGRAPHICAL NOTES

**Dr Andreas Barth**, born in the German Democratic Republic, studied Geochemistry at the Moscow State University (Lomonosov-University) in the former Soviet Union 1974 – 79. Dr Barth reached a PhD in Geology at the Freiberg Mining Academy (Germany) in 1983. From 1979 – 1990, he worked mainly in geological exploration in Yemen and Mongolia. Since 1994, Dr Barth is Managing Director of Beak Consultants GmbH, Germany, and conducted projects in the area of mining, environment and development of information systems in Germany, Kosovo, Ghana, South Africa, Namibia, Jordan, Albania, Kyrgistan, Bolivia and other countries.

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### **Beak Consultants GmbH (Freiberg, Germany)**

**Mr André Barth** (Computer Scientist), **Mr Thomas Berndt** (Geophysicist) and **Dr Frank Schmidt** (PhD in Geoinformatics) are associated with the development of the database and the web site.

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