A STUDY ON INTEGRATING GEOLOGY DATA, SURVEYING DATA, MINERALS DATA AND ESTABLISHING VISUALIZATION APPLICATION SYSTEMS

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ABSTRACT:

This paper proposes an architecture for integrating geology data, surveying data, minerals original data and establishing visualization application systems in mine. In this architecture, geology data, surveying data and minerals data are classified and integrated in the original database. The original database and corresponding database management system (DBMS) can provide a common and standard data resource platform for various application researches. Required data views for a special application system can be abstracted from original database and saved in a special database. Furthermore, some visualization application systems are developed Based on the special databases. Finally, A practical example is presented with the architecture.

1. INTRODUCTION

In order to meet the challenge of 'Digital Earth' (Al Gore, 1998), many researches on " Digital Mine " have been done in local and outside. As the foundation of various special applications in mine, It is important to integrate geology, surveying and minerals original data in the database and develop the database management system (DBMS). The original database and DBMS can provide a common and standard data resource platform for various application researches. According to the application purposes and characteristics of various researches, required data views are abstracted from original database. Furthermore, on the basis of the data resources, various visualization application systems are developed. With the development of various mine producing management information system, particularly along with the application of GIS technique in mine, more vast foregrounds for the integration of geology data, surveying data, minerals data and the establishment of visualization application systems can be seen.

But not only exists much two-dimension data in mine, but also some geometric entities have to be expressed in three-dimensional forms. However, there are not three-dimensional GIS platform in the current market. So the realization of some geometric modelling functions has to depend on bottom developments of customers. It is the subject of this paper to investigate the integration of geology data, surveying data, minerals data and the establishment of various visualization application systems (called as the whole system in the next sections) Based on current techniques.

This paper discusses the establishing methods of geology, surveying and minerals original database, the development of geology, surveying and mineral database management system in section 2. The data flow, architecture and functions of the whole system are discussed in section 3. A practical example which focuses some issues about the integration of geology data, surveying data, minerals data and the development of some application systems for Dachang Mining Area in Guangxi Province is given in section 4. Finally, we present future research work in the summary.

2. GEOLOGY, SURVEYING AND MINERALS ORIGINAL DATABASE AND DBMS

It is known that data is the foundation of software functions development and realization forever. In mining area, the data means geology, surveying and minerals resource data. In order to manage the data conveniently by computer and abstract some data to handle a certain practical task in time, It is necessary to establish the original database to integrate geology data, surveying data, minerals data and develop database management system (GSMDBMS). In this section, we will focus some issues about establishing original database and developing GSMDBMS.

2.1 Geology, Surveying and Minerals Database

There exists much geology, surveying and minerals original data and different data categories in a large mining area, including the geology engineering data for drill holes, mine openings (test pits, shafts, adits, and so on), all kinds of exploration and reserve data, geographic surveying data etc. In the past, some data is saved in paper reports, forms, charts and filed notes, other is inputted into computer as files. Thus, visiting and applying the data are not convenient. So it is necessary to manage the data by a database management system from which required data views for special application can be abstracted. For this, we must establish the geology, surveying and minerals original database firstly Because it is known that the geology, surveying and minerals original database is the foundation of database management system function realization as the core of the whole system, as well as the data for special subject application system is come from the original database.

Before establishing the original database, original materials should be classified and sorted actually according to customer's needs and possible applications in the future researches. Because the data organization and integration will affect the development of DBMS and various application systems, It is important that the database structure should be defined precisely and the data should be organized validly.

According to the characteristics that the categories of original data are too many and a large category contains some subcategories, the first author of this paper proposes that data should be organized by tree-structure Catalogue and geology, surveying and minerals original data should be classified in detail based on the current management method. At the same time, corresponding data dictionary, concept model and relation model as the metadata should be built up and the database structure should be designed carefully to meet the need of data extension. We may choose to use the large database system (e.g. SQL Server, Oracle) for managing the attribute data. The software also provides BLOB data-type to save raster or vector graphic data which can be downloaded to access the other system (e.g. GIS) by changing data format.

Moreover, Considering the need for establishing a certain visualization application system, we must get some vector geographic and geology maps from existed raster map by commercial digital software (e.g. Epscan, GeoScan) and our own developed Mine Geology Aided Drawing System.

2.2 Geology, Surveying and Minerals Database Management System

The geology, surveying and minerals database management information system provides some general functions, such as data organization, input, saving, query, report, maintenance etc. A commercial object-oriented program language (e.g. VB) can be selected as the development tool for GSMDBMS. Because the number of data tables is quite large in the original database, it is important to develop some common functions. Generally including:

• Common data input

GSMDBMS provide various data input functions and save the data in different relation data-tables by common data input interface.

• Data modification

Customer can position the record in a certain table quickly and modify corresponding data-value under legal function priority.

• Common data query and report output

The data classification querying and indexing can be carried out in GSMDBMS, as well as SQL language querying can be executed. At the same time, corresponding report output function is provided by common output interface.

• File input and output

A graphic file and document can be carried into database as binary data and also download as a file from the database.

• Data maintenance

GSMDBMS provides general data maintenance function, for example, the data-category or data-table extension, data structure modification and adding or deleting data-table etc.

• Database general operation

Some basic operation to database can be performed in GSMDBMS, such as adding, deleting, saving, renewing a data record.

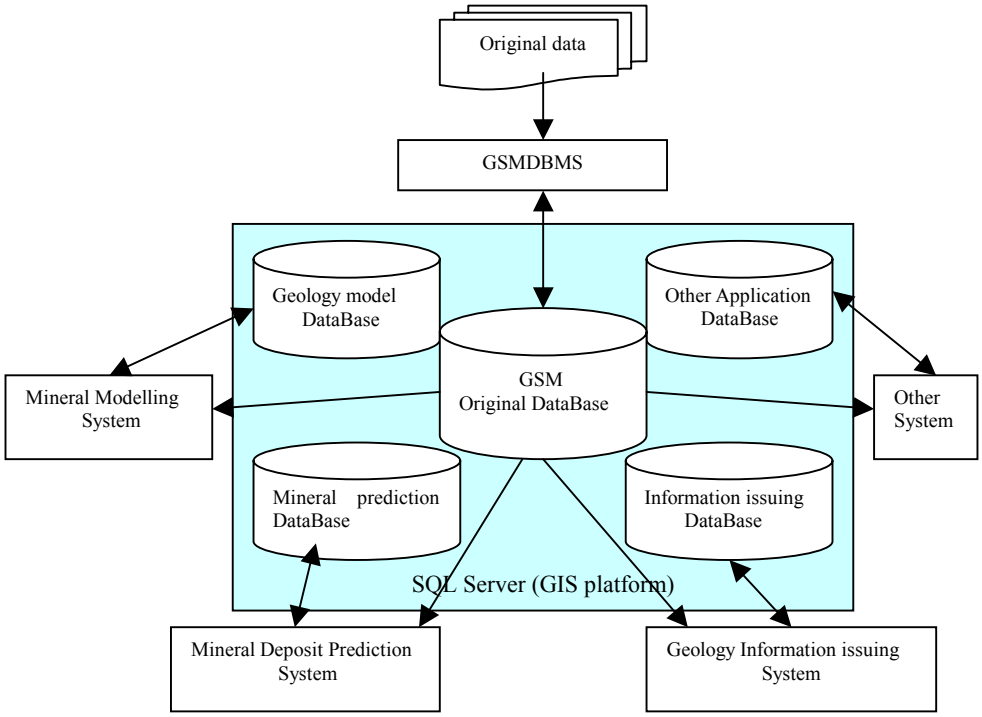

Figure 1. The data flow analysis of the whole

3. THE DATA FLOW AND ARCHITECTURE OF THE WHOLE SYSTEM

Geology, surveying and minerals original database and its management system provide a common data resource platform, so that required data for various special application can be taken from the original database by mathematical computing or geometric change. In the section, we will analyse the data flow, the architecture and functions of the whole system.

3.1 Data Flow Analysis of the Whole System

A proposed data flow diagram is depicted in Figure 1. In this figure, Mineral model database, mineral deposits prediction database, Information issuing database and other application database stand for some special databases which contain required data views for special application. The special data is abstracted from geology, surveying and mineral original database based on database system (SQL SERVER). Of course, we can also use a commercial GIS platform to manage graphic data according to the need of special application. Geology Modelling System, Mineral Deposit Prediction System, Geology Information Issuing System and other system represent some visualization application systems based on various special databases.

3.2 An Architecture of the Whole System

According to the data flow analysis of the whole system, a proposed architecture of the whole system is indicated in Figure 2.

The architecture is described by several layers: The first layer is the total controlling layer which depends on hardware, operating system and database system. The choice of hardware and software can be made based on the current conditions. The second layer is the first class of function realization. In this layer, the functions of geology, surveying and minerals database management system can be realized. The third layer and higher layer, realize some special application functions according to data classification and required function of various application systems. Here, the visualization application systems include mineral deposit modeling and predicting system, geology information issuing system etc. Every visualization application system can be developed independently. Finally, all visualization application systems integrate together as components.

3.3 Functions of the Whole System

The above architecture describes a layer-construction of the whole system function realization. The general functions of GSMDBMS have been displayed in the section 2. In this section, We will discuss the function of some visualization application systems.

A visualization application system which brings some benefits for mine should be developed to resolve some practical problems and the results are presented by a visual method. In mining area, the research work about geology modeling and mineral deposits prediction has been done for many years. Due to the development of computer science, some new technology and methods, such as geographic information system (GIS), geological expert system, computer-based mapping and so on, are applied in geology and improve the research work. Therefore geology modelling and mineral deposits prediction system should serve the next work: to analyse the characteristics of geological body and build mathematical model for the geological body; to find out the various factors and their relationship in the geological process and present geological bodies and geological phenomena visually by establishing the geometric and statistics model; to build up the statistical prediction model of mineral reserve and generate the diagraph of mineral deposits prediction. Finally, the model should be evaluated and verified in the system.

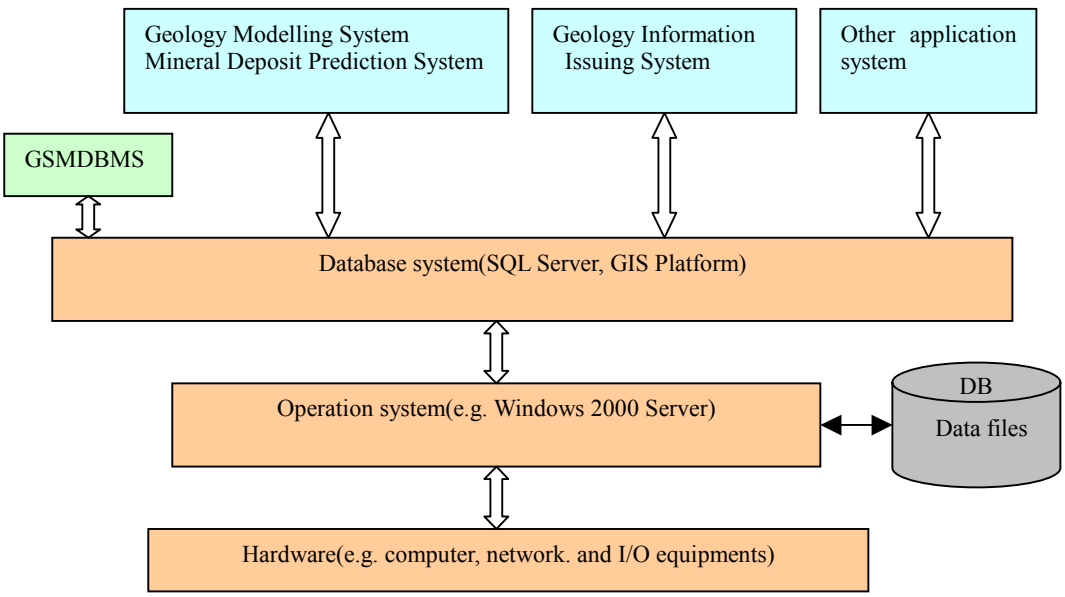

Figure 2. The layer- construction architecture of the whole system

With the development of "Scientific Visualization"(MCCO, 1987), we can also use some commercial development tools(e.g. IDL,VIP) to extend modelling and visualization functions of the whole system. Furthermore, It is possible to issue visualization geology information in Internet.

4. A PRACTICAL EXAMPLE

DaChang mining area which has been mined for forties years is an important mineral resource base in China. Based on the analysis of its original data, we build up the geology, surveying and mineral original database and develop GSMDBMS of DaChang mining area. At the same time, geology modeling and mineral deposits prediction system is researched

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4.1 Establishing the Original Database for Dachang Mining Area

Considering much geology, surveying and mineral data and various data categories for DaChang mining area, we choose SQL Server to manage the original data and build up the geology, surveying and mineral original database in which the data is organized by tree-structure Catalogue based on the current management method.

In the tree-structure Catalogue, the leaf nodes stand for the data tables which save the original data, while the branch node represent the catalogue table. every record in the previous branch node is used to record the relational information of each next branch node. Thus, the original data in the database can be indexed easily according to the current data classifying method

From the point of view of data management, the original data is divided into attribute data and graphic data. Naturally, the attribute data may be inputted into the data table directly. SQL Server also provides 'Image' data-type to manage graphic data. So raster and vector data can be saved in the database as binary data and be downloaded as files to access other systems (e.g. GIS) by data transformation. Considering the need of vector data for special application later, we develop Mine Geology Aided Drawing function Based on AutoCAD 2000(as shown in Figure 3) to produce vector geology map. In the system, the vector geology signs with actual coordinates can generate automatically according to the corresponding data in the database or the raster data in the screen.

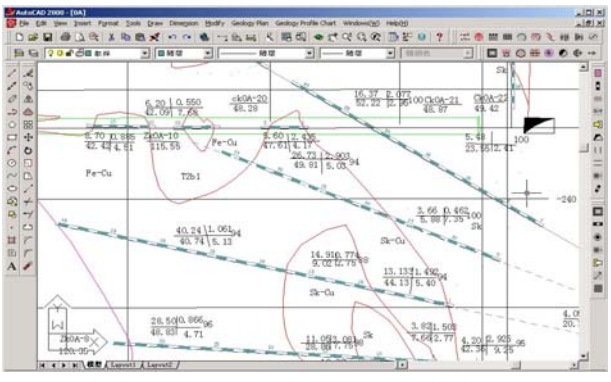

Figure 3. Mine Geology Aided Drawing on AutoCAD 2000

In addition, the geological logging data tables for drill holes, test pits, tunnels and aids are built respectively according the logging diagraphs. Finally, the data dictionaries of all tables are saved as the metadata.

4.2 GSMDBMS for Dachang Mining Area

GSMDBMS for DaChang mining area(called as DCDBMS in the next text) provides an interface in Client for customers to manipulate the original database located in Server.

As illustrated in section 2.2, DCDBMS has some general functions: common data input, saving, query, report, maintenance etc. At the same time, we also develop the following functions according to customer's needs and the data organization method.

• Data catalogue tree-structure organization and display
As the interface of resource manager in Windows operation system, all branch nodes of the data catalogue tree display in the left window according to the catalogue table in the database, while the leaf nodes on the selected branch node arrange in the right window. The system manager can add, delete, edit and modify the tree nodes so that the data categories and tables can be extended and modified.

• Management of the data in BLOB field
The vector or raster data for geology, surveying maps and scanned documents can be carried into the database and saved in BLOB field (e.g. Image data-type) as binary data, as well as downloaded to a file.

• Common interface design for data input and output
Because there are too many tables in the database and the table structures are different. It is important to realize the common interface input and output by programming.

• SQL query generator
Some complicated relation queries of the data can realize by generating SQL query language automatically according to some customer's chooses in SQL query generator.

• Some utility tools
DCDBMS has some mathematical computing functions by generating corresponding math formula automatically for some special tables. In addition, function priorities management and data backup functions are also provided.

DCDBMS and the original database provide a common data resources platform for various special applications. Now, DCDBMS is being used by customers and a part of the original data has been inputted into the database.

4.3 Researches on Dachang Geology Modelling and Buried Deposits Prediction System

Some researches about mineral deposits prediction have been done in DaChang mining area since mineral exploration began. The purpose of developing DaChang geology modeling and mineral deposits prediction system is to rebuild geological bodies visually, compute and predict ore values more precisely by some new techniques. Now, we are developing the model functions of geology modeling and mineral deposits prediction system. Some of them are being tested. In the section, we will mainly discuss the process of building the system. The process is divided into the following steps:

(1) Geology model and mineral deposits prediction data is abstracted from the original database by coordinate Transformation and data classifying according to special application. The middle database with the special data provides the data source for geology model and mineral deposits prediction system, and its changes have no effects on the original database.

(2) Based on the analysis of geology characteristics, various indexes about geological bodies and the mineral space are obtained. Moreover, some geometrical and statistic models are constructed to quantitative imitate various geological bodies and the boundary of mineral space.

(3) According to the quantitative analysis of some geology factors and prospecting mark indexes aided by statistics analysis and spatial analysis of GIS, the quantitative relations of various indexes are built up. Furthermore, mineral mathematical models are constructed by some methods, such as regression analysis, logistic formulation etc. Finally, these models are evaluated and verified.

(4) The mineral reserve values of predicting area in a defined geological field are estimated by using the above models, and prediction results are evaluated precisely. In the last, a buried mineral deposits prediction diagram is drawn.

In the system, every model function is realized by a control which is developed by VB or VC++ language. We can also use GIS components to extend system functions. So it is unnecessary to worry about function integration of the whole system.

5. SUMMARY

In this paper, we propose an architecture for integrating geology, surveying and minerals data and establishing visualization application systems in mining area. Based on the architecture, we establish the original database for DaChang mining area, also develop corresponding DBMS and some functions of an application system. Of course, many functions are not yet complete in the system. Further study will focus in the following researches: (1) building the geometric models for geological bodies and presenting three-dimensional geological bodies; (2)The application of spatial analysis methods in mineral deposits prediction; (3) The new methods of mineral reserve calculating.

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