Geo-information work at China Geological Survey

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Abstract

Geo-information project has been continuously carrying out in China Geological Survey(CGS) since 1999 and huge of data are accumulated and databases are developed on various purposes. This paper outlines techniques and standards on geo-databases development, maintenance and data dissemination, including GIS database infrastructure, metadata and the policy on data release. Professional software system development and secondary development on the basis of GIS packages within CGS is also introduced for data analysis, processing and integration of different disciplines aimed at data management, regional resource assessment, mineral exploration, etc.

1. Introduction

China Geological Survey (CGS) has become national largest geoscience agency since its reconstruction in 1999 who takes the duty of the country's basic, public and strategic geological investigation and mineral exploration over the whole territory, and geoscientific research and international cooperation. Accordingly, geoinformation work were carried out on the purposes of, (1) to raise informationalization level in main procedure of geological survey, including field data acquisition, data processing and database management, mineral assessment and information dissemination, (2) to further strengthen fundamental geological databases construction in the environment of geographic information system, (3) to push forward standardization works on metadata and geological data model for information exchange within the survey and for information dissemination to the public.

Development Research Center of CGS and six regional centers are the main work forces for database development, updating and maintenance, computer network construction. CGS also establishes tight working relations with the provincial geological surveys and industry agencies through the projects contract and professional direction to maintain a strong national force of geological survey.

2. Geoinformation Work Frame

China Geological Survey (CGS) has continually carried out digital land and resource project (DLRP) since 1999 for the informationalization in the survey, which including two main parts, national geo-scientific databases development and digital informationalization of main work procedure in geological survey. Each part consists of roughly 6 main projects, and each of them was then divided into several sub-projects. Some projects on field mapping data acquisition, geoinformation strategy and data service are newly setup since 2003. Project frame of CGS geoinformation is thus described in three parts as in table 1.

Table 1. CGS main projects and sub-projects carried out under the DLRP project

No.	*Main project name*	*Percentage*
1	**Development of geo databases**	**40**
	Spatial database of regional geological maps	
	Spatial database of regional hydro-geological map	
	Database of regional marine geology	
	Database of thematic fundamental geological data	
	Spatial database development for digital products of geological work	
	Systematic management and maintenance of CGS geological databases	
2	**Informationalization work procedure**	**45**
	Standards for CGS digital informationalization	
	Geological data analyzing, processing and modeling	
	CGS computer network system development	
	Achieves and information dissemination system development of CGS	
	CGS achieves and information dissemination to the public	
	Field data acquisition toolkit for geological mapping	
	Field data acquisition toolkit for hydro-geological mapping	
	Field data acquisition toolkit for solid mineral exploration	
3	**Strategy, database maintenance and data dissemination service**	**15**

3. Achievements in the development of national geo-scientific databases

3.1 Geological map databases

Apart from main project in CGS and that for provincial work procedures, geological map compilation and database construction have been put into a key position. In the year 1999, China has finished 1:5,000,000 scale geological map database and released freely to the public. In the scale of 1:500,000, China spatial geological map database was completed and also released to the public in 2000. In 2002, 1:200,000 digital geological map database which contains 1163 quadrangles or sheets has been completed. 1:200,000 hydro-geological maps and 1:50,000 hydrological, engineering, environment and geological maps of provincial cities and eastern metropolis and economic zones have also been completed in 2003. Also in 2003, 1:2,500,000 scale geological map database is developed and to be released in 2004. This year, a newly developed spatial geological map database, 1:250,000 scale in the way of integration with ongoing digital field mapping PDA data is on the way. Also, 1:50,000 geological map database development is continued and geared to focus on main mineralization zones following national exploration plan of the survey, which is mainly of digitization to the previous maps. Newly carrying out 1:50,000 and 1:250,000 field geological mapping data are collected in digital format. China national chronicle geological work database will be completed also in 2004, which involved 40 geological survey teams and organizations in the work of materials collection, filling out data attribution cards and database development.

3.2 Geological thematic database

1:200,000 nature heavy mineral database has completed in 2003, which contain roughly 2 million sampling sites. National isotopic element dating database, containing 15300 sampling sites, is also finished in 2003. The work of rock property database, which contains too much work of both in data checking and original achieve cards retrieving is going to be summarized this year.
The construction of “national solid mineral deposits and its distribution database” was carried out under CGS by different geology bureaus and centers form different industries around China with the coverage of metal, coal, building materials, chemical industry and radioactive. This database is completed and had been put into use in the survey in 2003.It is being updated this year.
China continental scientific drilling (CSD) data has also been achieved each year.

3.3 Geophysical and geochemical databases

In the field of geological investigation and exploration, a series of databases have been completely developed and some of them are being updated each year. And most databases of this kind are integrated with its data processing system, such as regional gravity database in 2000, geophysical Borehole database in 2001, and aeromagnetic database at 1:1,000,000 scale in 2002. Aero-electromagnetic database is completed in 2001, which contains former survey data all around the country. Data collection of regional geochemical database will soon be completed. Stream sediment data were come form different 31 provinces around China. Multi-purpose geochemical data are also planned to collected into database, which were collected over the past three years both at regional agriculture strategy, environment study and city plan.
Table 2 is a brief list of these databases developed in China, mostly in CGS.

Table 2. Data format and database released by CGS

No.	Databese Name	Software based	status
1	1:500,000 digital geological map spatial database	MapGIS	Available
2	1:200,000 digital geological map spatial database	ArcInfo, MapGIS	Partly available
3	1:2,500,000 digital geological map spatial database	MapGIS	Available
4	1:5,000,000 digital geological map spatial database	MapGIS	Available
5	1:250,000 digital geological map spatial database	ArcInfo, MapGIS	On going
6	1:50,000 digital geological map spatial database	ArcInfo, MapGIS	On going
7	1:6,000,000 digital hydrogeological map spatial database	MapGIS	Available
8	1:5,000,000 national geochemical anormaly	ArcInfo, MapGIS	Available Partly available
9	1:5,000,000 national gravity anormaly	MapGIS	Available
10	1:5,000,000 national aeromagnetic anormaly	MapGIS	Available
11	1:200,000 digital hydrogeological map	ArcInfo, MapGIS	On going Partly available
12	Geophysical parameters of rocks	ArcView	Partly available
13	1:200,000 heavy mineral database	MapGIS	Partly available
14	1:50000 digital hydrogeological, engineering geological and geo-environmental maps	MapGIS	Partly available
15	1:500,000 digital geo-environmental maps	MapGIS	On going
16	National solid mineral deposits and its distribution	ArcInfo, MapGIS	Available
17	Dynamic monitor of groundwater	MapGIS	Partly available
18	1:50,000 hydrology, engineering, environment and geology of key cities and economic areas	ArcInfo, MapGIS	Partly available
19	Rock property and distribution	ArcInfo, MapGIS	On going
20	National solid mineral drill core		Partly available
21	Geophysical Logging	ArcView	Partly available
22	National isotopic dating of rocks	MS Access	On going

23	China Litho-stratigraphy/strata	ASCII	Available
24	Aero-magnetics data	Geosoft,	Partly available
25	Regional gravity	MapInfo, MS Access	Partly available
26	Regional geochemistry (stream sediments)	OpenInfo, SQL server	Partly available
27	Aero-electromagnetic	SQL server	Available
28	Aero-radioactive	SQL server	On going
29	Remote sensing	PCI, Erdas	Available
30	Marine geology and mineral resources	ArcInfo, Oracle	On going
31	Geological Trans section	ArcInfo	On going
32	Digital geological reports and bulletins	MS Word and image	Available
33	Catalog of geological achieves	MS Word and image	Available
34	Catalog of national geological library		Available
35	National geological relics		On going
36	National geological hazards	ArcInfo, MapGIS	On going
37	National geothermal and mineral water	MS Access	On going

Spatial data in these databases are stored in multi-formats due to different managing software used, mainly in ArcInfo, ArcView(*Coverage* or *Shape*), MapGIS(a Chinese domestic GIS package,*Wt, WP* and *Wl*), and MapInfo(*Tab and Mif*). Most of the database system are based on MS SQL server, some on MS Access based, a few on Oracle.

3.4 Systematic management and maintenance of CGS geological databases

Update and maintenance of all the developed databases have been done in time each year. The database of national solid mineral deposits and its distribution, for instance, has been keyed in more than 2000 metal, nonmetal, coal etc. mineral deposits that were discovered in 2002. Aeromagnetic database has updated to cover Tibet in 2003. Regional gravity data is covering Tibet and western areas within two years.

Geological map databases at the scale of less than 1:250,000 will be updated every three or four years not only new data added, but data format and managing system software. 1;500,000 Geological map database is been updating this year for data format and managing system so as to catch up with the GIS users.

Software on the purpose of data utilization is also developed ever since the beginning of database development. ArcView GIS based aero-electromagnetic survey database (*GEMD*1.0) and geophysical logging database system(*GLDB* 1.0) had been developed in 2001. GIS system for geophysical, geochemical remote sensing data processing (*PCR/GIS 1.0*) has been put into use. Regional geochemistry database information system (*GeoMDIS2003*) is now running at almost all the provinces over the country. No-seismic geophysical interpretation system(*GME/GIS*) and gravity data coordination and processing system(*RGIS* 2.0) are tested and meet with users this year. Figure 1 and figure 2 shows examples of *PCR/GIS* 1.0 and *RGIS* 2.0.

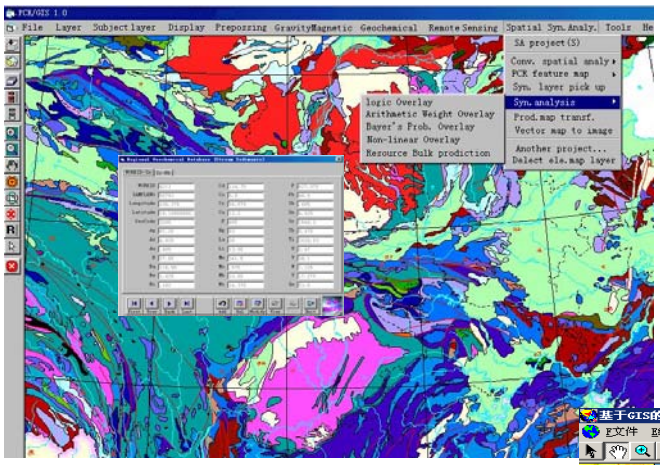

Fig.1 User interface of PCR/GIS 1.0. Geochemical element data table and data analysis manus are shown.

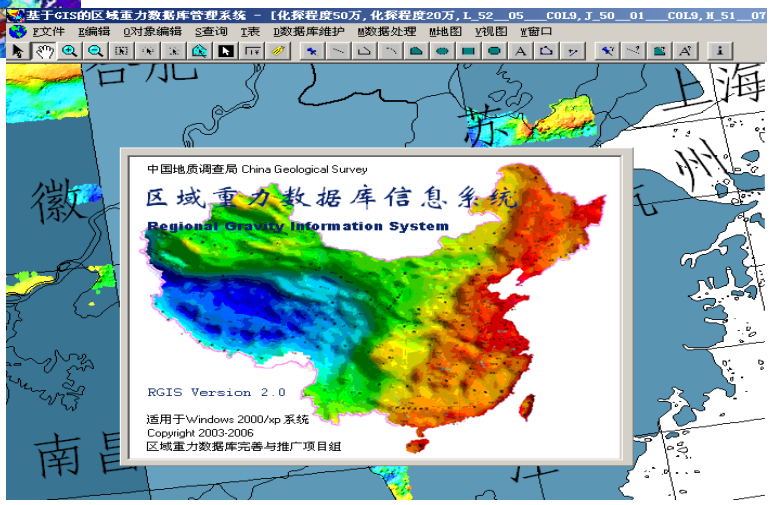

Fig 2. Main user interface of RGIS version 2.0. Pull down manuals from left to right are File, Edit, Object Edit, Quary,Table,DataCoordination,DataProcessing,Map, View and Window in turn.

A system work team for these database updating maintenance is also being development both staff and technical procedures within CGS projects.

4. Achievements in geoinformation work procedures

4.1 Standards for CGS digital informationalization

The standards of CGS informationalization include fundamental standards, database standards and specifications of software system development. Database standards and specifications of software system development are technical standards and can be directly adopted in project work. Database standards are the guarantee of data exchange and sharing, which are used to determine contents of database, management modes, data formats of storage and data exchange**.**Technical standards are used to instruct systematic design, including data collection, system running and system maintain. To support the database development and informationization in CGS, a series of standard are issued since 1999, include data collection, storage, processing, integration, expression and management. For spatial databases, CGS adopts uniform national geographic space reference coordinates system. Planar control system adopts 1980's national ground coordinates system; elevation control system adopts 1985's national elevation benchmark. Some 30 standards are issued and some of them are already released and put into use since 1999, mainly for database development and digital geological map production. The following table 3 shows these standards in brief.

Table 3. CGS standards for informationalization up to 2003

No	*standard name*	*Satus*
1	Guide to Lithostratigraphic database development	in use
2	Standard of digitized information exchange	ongoing
3	Guide to standard issue of CGS	completed
4	Standard for the design of software engineering projects	completed
5	Technical guide for data hazard prevention	ongoing
6	Guide for geographical information storage based on data house	ongoing
7	Guide to field data collection of regional geological investigation	completed
8	Guide to field data collection of environmental geological investigation	in use
9	Guide to data collection and management of groundwater resources	in use
10	Standard of information and data charging price	ongoing
11	Database of geological map frame and legends	completed
12	Guide for rock database	trial
13	Guide to spatial geological map database development (Version 2.0)	in use
14	Guide to map layers and attributes of regional hydrological map database	in use
15	Guide to solid mineral deposits and distribution database development	in use
16	Guide to drill core database development of solid minerals	completed
17	Guide to natural heavy mineral database development	in use
18	Standards of content and structure for geological map metadata.	in use
19	Core-metadata standard of CGS database	in use
20	Technical procedures for digital geological map production	completed
21	Guide to GIS application in mineral resources assessment	completed
22	Technical procedures of CGS web system construction	released
23	Standards for geological map frame format and legends	in use
24	Guide to the database development of isotopic dating of rocks	in use
25	Production managing procedures of CGS software development	completed
26	Management procedures and guidelines for develop and test of software in CGS	completed
27	Quality monitoring procedures of geological map digitalization	in use
28	Technical procedures for managing geological data of multiple disciplines	ongoing
29	Guide to rock property and distribution database development	in use
30	Software developing project design standard	completed

4.2 Field data collection system toolkit of geological investigation

Digital geological mapping PDA toolkit (*PRB*) is now widely used now in the field mapping projects. The second generation of field data collection system equipment was developed in 2002 and tested in the field in 2003. This PDA CE platform based toolkit is integrated with GPS and fundamental GIS functions for digital mapping. To replace traditional field notebook, this system can be used in field for digital geological mapping, and transfer data directly to a workstation database after daily fieldwork.

4.3 Achieves and drilling specimen database of geological survey.

Tens of thousands of reports and bulletins on geological survey and scientific research were handed in and collected in CGS. About 50 thousands kinds of catalog and abstract were compiled and keyed in database. The Development Research Center in charges of professional training of software use and digital archive management to the staff working in the six region center, provincial geological surveys, colleges and industry agencies. The catalog and abstract database is now being updated in most of these organizations.

5. Information dissemination of CGS

5.1 information dissemination

CGS has provided the public with fresh and fruitful geoinformation products to the public, including digital geological map, geophysical data, digital geological achieves, etc.

China Litho-stratigraphy database was completed in 1996. This unique database contains about 80,380 files of different rock type and stratum. The most authoritative national stratigraphy database had been available since 2000 on the website of CGS. 1:500,000 geological map database for example, more than 500 copies both in Chinese and English version have been sent freely to Chinese government and geoscientist since 2000. It is the first digital version of geological map that covers the whole nation. 1:5,000,000 geological map database also sent freely to Earth scientists in China. And, 1:2,500,000 geological map database will also release to the public this year. Regional gravity database, geochemical database and 1:200,000 geological database have also been utilized by more than 100 projects ever since their development work had started within and outside the survey and for mineral resource potential assessment, fundamental geological researches, and other purposes, such as agricultural planning and environment investigation. Development of digital geological maps at scale of, 1:250,000 and 1:50,000 are continued and served the work plan of CGS each year.

Library of digital geological reports and bulletins was developed and put into used in the autumn of 2002. Catalog of geological achieves can be retrieved on the website since the end of 2002. Catalog of national geological library are quite familiar to many readers both domestic and overseas.

5.2 Metadata

In order to support the dissemination of these geo-databases and other achievements made by geological survey, CGS has launched several projects on metadata in reference to that of national metadata information, and some international information. Some metadata, however, were issued by the staff who working on a database development individually in the past due to the shortage of metadata standard.

The metadata work now is being adjusted and standard is being strengthened in CGS to follow the information center of The ministry of land and resources, and that of national spatial information infrastructure. A metadata database architecture and managing system is now being studied, which will become a part of national architecture of clearinghouse for geological information management, application, sharing and exchange.

Core-metadata in CGS today is following the standard of CCOP. An example is shown in table 4, which can also be found at http://www.cgs.gov.cn/Ev/gs/metadata.htm. A standard for detail metadata is being drafted this year.

Table 4 Core-matadata of 1:1,000,000 Regional Gravity Database in CGS

Metadata file identifier	Metadata of 1:1000,000-scale Regional Gravity Database of China
Title in English Translation (Full)	1:1000,000-scale Regional Gravity Database of China
Edition	Published in Dec. 2002
Series name	Regional Gravity Database of China
Reference date	20021200

Responsible party organization name	Development Research Center, China Geological Survey
Postal address	No.45 Fuwai Street, Xicheng District
City	Beijing
Postal Code	100037
Country	CN
On-line resource linkage	http://www.cgs.gov.cn/
Electronic mail address	metadata@mail.cgs.gov.cn
Voice telephone	86-010-68999883
Fax number	86-010-68999884
West bounding coordinate (Generally Lat-Lon decimal degree)	73
East bounding coordinate	136
North bounding coordinate	56
South bounding coordinate	16
Geographic extent name	China
Resolution level (Map scale)	1000K
Access constraints	No restriction of access
Use constraints	The copyright of this database is legally owned by the China Geological Survey
Spatial reference system (Description)	Geographic Coordinates System
Distribution data format name(like Shape, Raster, DXF, etc.)	MAPINFO, ACCESS
Distribution media	CD, Printed map
Language of metadata code	en
Metadata character code set (ASCII)	ASCII
Metadata date	20031017

Metadata of eight databases of CGS are released at Internet Website last year. The released and will soon be released metadata are listed in table 5 below.

Table 5 Metadata release by CGS in 2003

No	***Name***	***versions***	***time***	***Status***
1	1:500,000 digital geological map spatial database of China	Chinese/ English	2001	released
2	China Litho-stratigraphy/strata database	Chinese	2001	released
3	1:200,000 digital geological map spatial database of China	Chinese	2003	released
4	1:1000,000 Regional Gravity Database of China; 1:500,000 Regional Gravity Database of China; 1:200,000 Regional Gravity Database of China.	Chinese	2003	released (in China)
5	1:2,500,000 digital geological map spatial database of China	Chinese	2004	released
6	Chinese catalog of geological archives	Chinese	2002	released
7	1:200,000 Heavy Mineral Database of China	Chinese	2003	released
8	National Isotopic Dating Database of Rocks	Chinese	2003	released

5.3 Databases released to the public

Geological archives are utilized daily by users from different organizations all over the country, especially those who are carrying out a project form CGS. The same time, CGS database services have also been provided to all users in the country. In 2003, thousands of 1:500,000, 1:200,000 digital geological map dataset, have been provided. Other databases, e.g. 1:5,000,000 series digital geological maps, include regional geological maps, regional mineral resource maps and hydrogeological maps etc., regional gravity database, etc., have been provided more than six thousands datasets to the public within China.

6. Geoinformation work of CGS in the near future

So far, more than 30 country wide fundamental geo-databases are developed. Most of them are released within the survey and to the public. There is still a gap, however, exist between the database and the public, due to both data utilization policy and data exchange standards are not yet properly issued in detail. Geo-database development, maintenance, especially database management and issues of metadata and data exchange model are thus become now very important and crucial. It is the key work on the agenda of geo-information work of the CGS. The most important three tasks for 2004 are systematic and standardized database maintenance, field investigation data collection toolkits development and geoinformation standards issue and release. Data dissemination policy is also critical to geoinformation work in CGS.