收稿日期：2017-07-22
改回日期：2017-08-09

项目：中国地质调查局地质调查项目“(中华人民共和国) 1：250 万数字地质图空间数据库”(200183101) 资助。

doi: 10.12029/gc2017Z103

论文引用格式：叶天竺，黄崇轲，邓志奇 . 2017. 1：250 万中华人民共和国数字地质图空间数据库 [J]. 中国地质，44(S1):19-24.
数据集引用格式：叶天竺，黄崇轲，邓志奇 . 2017. 1：250 万中华人民共和国数字地质图空间数据库 [DB]. 全球地质数据，DOI: 10.23650/data.H.2017.NGA121474.K1.1.1.

1：250 万中华人民共和国数字地质图空间数据库

叶天竺[1]　黄崇轲[2]　邓志奇[1]

(1. 中国地质调查局发展研究中心，北京 100037；2. 国土资源部咨询研究中心，北京 100035)

摘要：中华人民共和国 1：250 万数字地质图空间数据库，于 2000 年立项，2001 年完成，历时 2 年。该数据库除主数据库外，还有地理底图数据库及地理内容属性库，地质内容属性库、色标库、线型库、花纹库、符号库、图例库等构成。具有可按地质内容、行政区、任意空间范围及地理内容进行检索和自动输出成图、自动绘制地质体符号、自动形成图例等功能。1：250 万比例尺数字地质图空间数据库的建成弥补了该领域的空白。对显示和提高我国大陆地质研究程度，总结和体现我国地质的总体特征，为经济建设、国土资源管理、地质调查研究等方面提供基础地质资料，具有重要意义。

关键词：1：250 万地质图；空间数据库；MapGIS; ARC/INFO

数据服务系统网址：http://dcc.cgs.gov.cn

1　引言

计算机制图又称机助制图或数字制图，是随电子计算机的出现发展起来的制图新技术。1963 年，美国学者 Howard T .Fisher 首次实践用计算机制作地图的思想，并在哈佛大学领导开发了最早的制图程序 SYMAP 。随后，大量计算机制图系统在世界各国相继开发出来（Goodchild et al.，1991）。GIS 自诞生之日起，就与数字地图制图密切相关。王勇毅于 1998 年上半年完成的“世界前寒武纪成矿分带图集”就是一次采用计算机数字制图与 GIS 技术制作地质图的成功范例。该项目为国际地科联世界地质图委员会 (CWGM) 世界成矿图分委员会 (SCWMM) 制定的国际编图计划，主要包括中国、朝鲜、韩国、蒙古、尼泊尔及越南与印度北部等地区，由 1：1000 万主图及一幅 1：250 万副图组成。图件采用 MAPCAD 完成输入矢量化及编辑工作，然后采用著名 GIS 软件 ARC/INFO 建成地理信息系统，其中的矿产属性利用了现成矿产资源数据库（王勇毅，2000）。

1999—2003 年开展数字地质填图方法研究，取得了突破性成果。数字地质填图是应用计算机技术，以电子文档的形式将数字化的地质图诸要素存储在计算机中，便于进行地质图的编辑、使用、维护和更新。在区域地质调查中，应用 GIS（地理信息系统）、GPS（全球卫星定位系统）、RS（遥感技术）技术对野外地质调查所获取的各种地质成果进行数字化处理并存储的技术。通过创新研制出具有我国自主知识产权的数字填图设

第一作者简介：叶天竺，男，1941 年生，教授级高级工程师，博士生导师，主要从事矿产资源勘查与研究工作；E-mail：ytz999@126.com。

备（新五件five new devices for digital mapping），实现了全过程数字地质填图（高秉璋等，1991；陈克强，2011）。

本次1：250万数字地质图数据库的建成，不仅能满足国土资源大调查，国土资源管理、国民经济建设的需求，而且填补了我国1：250万数字地质图空间数据库和1：250万地质图的空白（张艳玲等，2004）。本文从数据库建设与组成的角度介绍中国1：250万数字地质图空间数据库建设过程与构成，为经济建设、国土资源管理、地质调查研究等方面提供基础地质资料，具有重要意义。该数据库基本信息见表1。

表1　数据库（集）元数据简表

条目	描述
数据库（集）名称	1：250万中华人民共和国数字地质图空间数据库
数据作者	叶天竺，中国地质调查局发展研究中心 黄崇轲，国土资源部咨询研究中心 邓志奇，中国地质调查局发展研究中心
数据时间范围	2001—2002年
地理区域	全国范围
数据格式	MapGIS和ARC/INFO两种数据格式
数据服务系统网址	http://dcc.cgs.gov.cn
基金项目	中国地质调查局地质调查项目“（中华人民共和国）1：250万数字地质图空间数据库”（编号：200183101）
数据库（集）组成	1：250万万数字地质图空间数据库，总数据量0.7GB。包括属性库、图例库、线型库、符号库、地理底图库等相关的数据库子库。

2　数据采集和建库流程

1：250万数字地质图空间数据库建库流程见图1。

3　数据源

为了保证从1：50万数字地质图数据库中提取并编制1：250万数字地质图数据库的地质信息和地理底图信息的一致性，1：250万数字地理底图数据库国内部分以1：50万数字地理底图数据库数据为主，国外部分采用1：250万《中华人民共和国全图》为基本资料，同时以国家基础地理信息中心编制的《全国分省图》做参考更新国内部分国道、高速公路、行政区划，尽可能保证了地理底图数据库的现势性。数据库建设数据源主要来自1：50万数字地理底图数据库数据和1：250万《中华人民共和国全图》。其中1：50万数字地理底图数据库于1999年12月完成，地名及行政区划代码更新截止日期为1999年底。新建铁路、高速公路及部分行政区界更新截止日期为1996年底。采用地理坐标系建库，以度为单位表示，国外数据未做选取。1：250万《中华人民共和国全图》由国家测绘局编制，中国地图出版社、西安地图出版社1997年7月出版。为九拼纸制地形图挂图，正轴等角圆锥投影，中央经线110°，标准纬线25°、47°。

为了提高1：250万数字地理底图数据库的现势性，在数据采集过程中，根据最新出版的《全国行政区划简册（2000年）》及国家基础地理信息中心编制的《全国分省图》对地级以上行政区划、新建铁路、高速公路做了局部更新，资料截止时间为2000年6月。

从数据量和易于使用的角度出发，1：250万数字地理底图数据库主要以ARC/INFO COVERAGE分层存放。考虑到国内部分的数据来源于1：50万数字地理底图数据库，

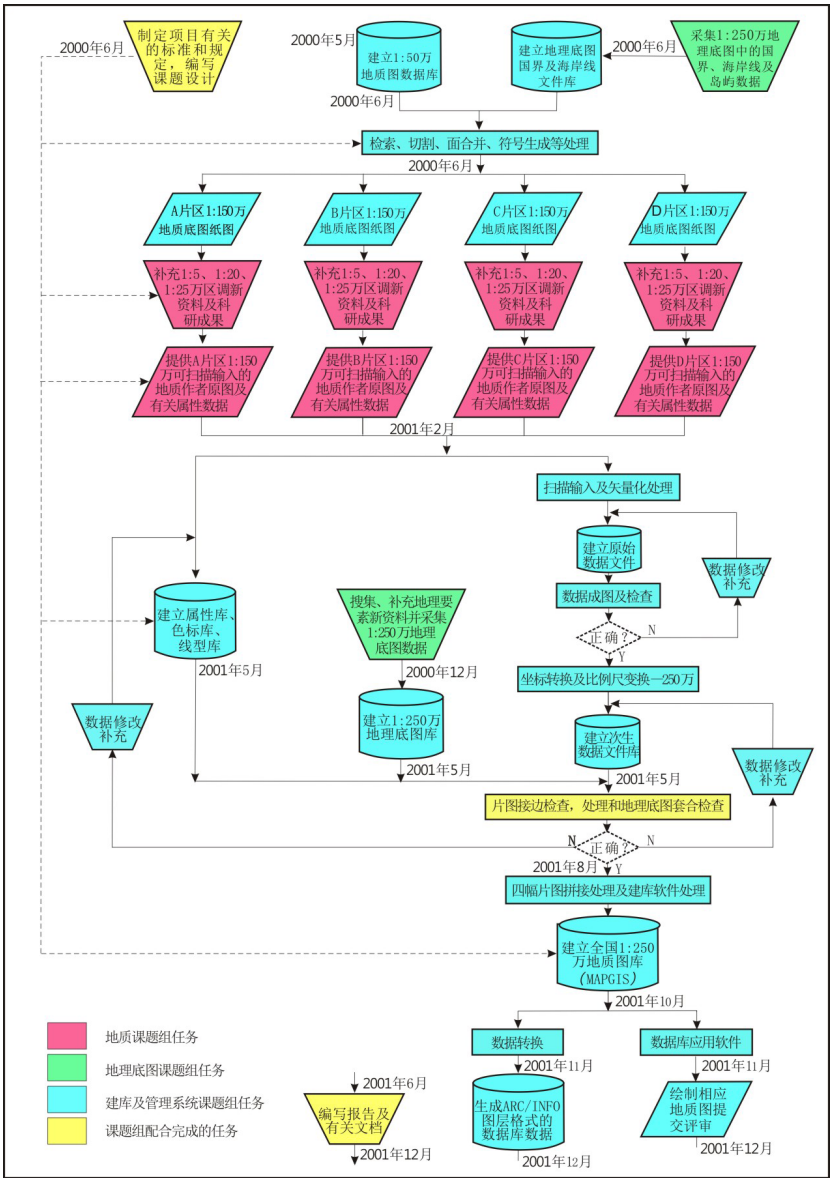

图 1　1：250 万数字地质图空间数据库建库流程

在数据分层和命名上尽可能与 1：50 万数字地理底图数据库保持一致。此部分数据主要用于建立 1：250 万数字地质图数据库 , 因此在建库时建立了数据的拓扑关系和完整的属性数据。国外部分数据主要来源于 1：250 万《中华人民共和国全图》，作为编制地质图的背景数据，建库时只以点、线结构存放，并增加相应的代码，以利于出图时进行数据编辑。为便于 1：250 万数字地质图数据库建库和编图，在数据组织时将国内国外两部分数据分开存放。

4　数据库主要功能和构成

4.1　数据库主要功能

（1）数据库检索功能：①可按任意地质内容、任意空间范围及属性内容检索；②地理底图可按地理内容检索。

（2）自动输出成图功能：①自动形成颜色、花纹；自动绘制地质体符号 ; ②自动形

成图例图式；③可按不同地质内容、不同行政区、任意空间范围要求自动成图；④可按任意成图比例尺要求绘制地质图，但精度为 1∶250 万比例尺。

4.2 数据库构成

全国 1∶250 万数字地质图数据库以 MapGIS 和 ARC/INFO 两种数据格式建立，除了主数据库以外由下列子数据库构成：

（1）地理底图数据库及地理内容属性库，包括行政区、行政区界线、居民地、公路、铁路、河流、湖泊、海洋要素、地貌等 9 类 33 种内容。

（2）地质内容属性库：包括地层、侵入岩、火山岩、变质岩、特殊岩类、断层、同位素年龄、火山口、钻孔等 10 类内容。

（3）色标库、线型库、花纹库、符号库、图例库。

4.3 地质图构成

（1）地层：表示年代地层编图单位 4521 个。

显生宙地层以年代地层单位表示，尽量划分到统，由 1∶50 万数字地质图中岩石地层单位归并而成。早前寒武系划分了表壳岩和深成侵入岩。第四系以年代加成因类型表示，表示成因单位 473 个。对大面积第四纪覆盖区，表示了代表性钻孔 367 个。

（2）侵入岩：表示侵入岩编图单位 2286 个，按五大主要岩类以年代加岩性表示。代表性岩体表示了同位素年龄数据 1452 个，表示晶洞花岗岩 180 个。

（3）山岩以地层单位表示，东部中生代和西部古生代火山岩叠加花纹表示，火山口单独表示。

（4）特殊岩类：表示兰闪片岩带 33 处、榴辉岩 124 处、蛇绿混杂岩带 74 处，科马提岩 1 处。

（5）断裂构造按性质、规模表示，规模较大的 1、2 类断层 756 条。

（6）古人类遗址 3 处。

（7）地理底图内容：包括行政区 2 种、行政区界线 4 种，居民地 7 种，公路 4 种，铁路 1 种，河流 3 种，湖泊 4 种，海洋要素 3 种，地貌 4 种。

5 数据质量控制和评估

在项目实施过程中，各课题组始终把质量放在首位。笔者主要从两方面加强质量控制：第一、保证原始数据质量，即保证地理，地质内容的质量，必须准确客观反映实际情况并符合各类技术标准要求。为了确保原始数据的质量，主要通过专家审查、咨询研讨的途径加以控制。地理底图数据库建库过程中，除按一般技术标准采集数据以外，多次听取地质编图人员的意见，按编图要求不断补充或删节地理内容。使地理底图数据满足地质编图要求。地质编图过程中，除了按一般要求缩编归并 1∶50 万数字地质图内容以外，在编图过程中广泛听取国内权威专家意见，处理地质内容中的争议及疑难问题，做到了地质图内容都有资料依据，客观、真实地反映地质特征。第二、保证数据采集、数据处理过程中的质量。笔者采取的措施是从 1∶50 万数字地质图编图到数据库建设，地质图回放绘制全过程中凡是能用计算机处理的，尽量避免人工处理。实践证明这是确保数据处理质量的根本途径。对于必须由人工处理的工作，例如：属性表填制录入，以

及某些数据的处理，则加强自检和抽检。通过以上措施保证了数据库质量。

5.1 地理底图数据库质量

（1）地理底图内容质量：按1∶250万标准对水系、海洋要素、政区、居民地、交通、地貌、文化要素、地理格网、北回归线等内容进行了数据提取，根据地质编图要求尽量收集了1997年以后新建国道、省道、高速公路的有关资料，行政区划变更的有关资料以及各种标准、代码等属性信息。

（2）从数学基础、位置精度、属性数据精度、逻辑相容性、回放图等方面均显示数据质量符合要求。

（3）选择小范围进行了1∶50万地理底图数据和1∶250万原图套合比较，地理要素走势一致，位置准确，相关性强。

（4）国界线采用1∶50万数字地质图数据库的界线。

5.2 地质编图质量

（1）地质内容质量：经过片区组、综合组四轮两级检查，两轮专家审查，先后修改了千余处图面错误，修改了数百处内容。每次检查都有处理记录。地质内容都有资料依据，对有争议的问题广泛听取专家意见，采用多数人接受的意见表达。地质内容客观、真实，反映了我国的地质特征。

（2）建立了图历簿，详细记录了编图过程及技术处理内容，以备检查质量。

（3）空间数据质量情况：由于1∶250万数字地质图的数据是在1∶50万数字地质图数据基础上应用专用软件在计算机上归并而成，因此质量可靠。

（4）地质体符号、颜色、花纹、图例是由计算机统一生成，质量可靠。

（5）属性数据挂接质量，已用专门检查软件统一检查，因此差错基本上已消除。

（6）属性表内容填写及录入，由于是手工操作，经过自检、抽检，消除了部份差错，但是错别字、漏字等各类错误还存在不少，有待进一步仔细检查改正。

（7）由于1∶250万数字地质图从数据提取、归并、投影转换、接边、拓扑关系建立、地质图编辑、绘制基本上都是通过计算机完成，因此数据处理及录入总体质量是可靠的。

6 数据价值

1999年中国地质调查局组织并承担完成了中华人民共和国1∶50万数字地质图数据库以后，国土资源部领导批示在《中华人民共和国1∶50万数字地质图数据库》的基础上继续延伸，全面规划，建设各种比例尺的数字地质图数据库系列，为实现国土资源规划、管理、保护和合理利用提供基础资料。为此，中国地质调查局把建设1∶250万数字地质图数据库纳入了计划。根据国土资源部担负的对土地、矿产、海洋等自然资源的规划、管理、保护和合理利用的需要，尤其是服务于新一轮地质大调查以及结合党中央和国务院西部大开发的战略决策的需要，国土资源部急需编制整套的各种比例尺的系列地质图及地质图数据库。编制全国1∶250万数字地质图空间数据库就是其中的重要部分。该数据库的完成，填补了国土资源部1∶250万比例尺数字地质图空间数据库方面的空白。对显示和提高我国大陆地质研究程度，总结和体现我国地质的总体特征，为经济建设、国土资源管理、地质调查研究等方面提供基础地质资料，具有重要意义。

7 数据使用方法和建议

“数字地理底图”是以提供数字式的基础地理内容为目标，即提供基础的地理控制信息，用于专题信息的定位，表现其与周围地理环境的关系和分布规律。因此，在内容的选取方面和表示详细程度上与地形图有一定差异。数字图克服了模拟图的缺点，可快捷地实现投影变换、随意确定比例尺、任意选择显示范围、选取内容及内容的表达方式等。

1：250 万数字地理底图数据库是根据地质部门建立 1：250 万数字地质图空间数据库和地质出图的需要，以 1：50 万数字地理底图数据库数据和 1：250 万《中华人民共和国全图》为基本数据源，结合其他需要添加的数据，经过适当的选取、编辑、综合处理及数据更新而形成的数字地理底图数据库。

8 结论

中华人民共和国 1：250 万数字地质图空间数据库以板块构造及地球动力学理论为指导，以已有的数字化资料为基础，充分利用已有的技术标准编制相应地质图。该数据库除主数据库外，还有地理底图数据库及地理内容属性库，地质内容属性库、色标库、线型库、花纹库、符号库、图例库等构成。具有可按地质内容、行政区、任意空间范围及地理内容进行检索和自动输出成图、自动绘制地质体符号、自动形成图例等功能。中华人民共和国 1：250 万数字地质图空间数据库的建成为经济建设、国土资源管理、地质调查研究等方面提供基础地质资料，具有重要意义。

致谢：在编图过程中，得到李廷栋院士、任纪舜院士、常印佛院士、沈其韩院士和殷鸿福院士多次审查指导，也得到张洪涛、周家寰、李裕伟、陈平、陆松年、侯鸿飞、肖庆辉和洪大卫等专家的指导和帮助；马大铨、武铁山专家参加了前期的编制；同时，得到中国地质调查局发展研究中心、中石化勘探开发研究院、各省（区、市）地质调查院（所）的大力协助和国土资源部咨询研究中心以及中国地质调查局有关处室的全面支持；各省、区地矿局前总工程师或副总工程师和部分区域地质调查队总工程师参与了图件的认真审查，并提出了宝贵的修改意见。

本图从起步到完成，项目的数据库课题组同志与地质图课题组始终密切配合，国家基础地理信息中心地理底图课题组及时提供编图需要的地理底图数据。罗海晏缩编了图面角图，马丽芳提供了参考图件。因此，这是一份跨部门、众多单位和上百位专家和参加编图工作者集体辛勤劳动的成果。在此，对以上院士、专家、各单位领导及参加或支持工作的人员表示衷心的感谢！

参考文献

陈克强 . 2011. 地质图的产生、发展和使用 [J]. 自然杂志 , 33(4):222−231.

高秉璋 , 洪大卫 , 郑基俭 , 等 .1991. 花岗岩类区 1：5 万区域地质填图方法指南 [M] . 北京 : 中国地质大学出版社 .

Goodchild M F, Kemp K K. 1991. Introduction to GIS[M] .NCGIA Core Curri culum.

王勇毅 . 2000. GIS 与地质图制作 [J]. 地质与勘探 , 36(1)：44−47.

张艳玲 , 石玉丽 , 王凯红 , 等 . 2004. 建立东北地区 1：250 万地质图数据库几点新突破 [J]. 吉林地质，23(4)：144−149.

（责任编辑　王学明　齐钒宇）

doi: 10.12029/gc2017Z103

Article Citation: Ye Tianzhu, Huang Chongke, Deng Zhiqi. 2017. Spatial database of 1:2500000 digital geologic map of People's Republic of China[J]. Geology in China, 44(S1):24−31.
Dataset Citation: Ye Tianzhu, Huang Chongke, Deng Zhiqi. 2017. Spatial database of 1:2500000 digital geologic map of People's Republic of China [DB]. Global Geology Data, DOI:10.23650/data.H2017.NGA121474.k.1.1

Received: 22-07-2017
Accepted: 09-08-2017

Fund support: Supported by China Geologic Survey Project of Spatial database of 1:2,500,000 digital geologic map of People's Republic of China (No. 200183101).

Spatial Database of 1:2500000 Digital Geologic Map of People's Republic of China

YE Tianzhu[1], HUANG Chongke[2], DENG Zhiqi[1]

(*1. Development and Research Center of China Geologic Survey, Beijing* 100037*, China; 2. Consulting & Research Center Ministry of Land & Resources, Beijing* 100035*, China*)

Abstract: The People's Republic of China 1:2500000 digital geologic map space database was completed in 2001, after a two-year project. In addition to the main database, the database is composed of a geo-map database and geographic content attribute library, geologic content attribute library, color library, linear library, pattern library, symbol library and legend library. It includes the geologic content, administrative areas, arbitrary space and geographical content of the search and automatic output mapping, automatic drawing of geologic symbols, automatic legend and other functions. Database content includes: the People's Republic of China 1:2500000 vector geologic map 1, consisting of 0.7 GB of data. The 1:2500000 scale digital geologic map of the spatial database makes up for the gaps in the field. It is of great significance to show and improve the degree of geologic research in mainland China, to summarize and reflect the overall characteristics of China's geology, and to provide basic geologic data for economic construction, land and resources management, geologic survey and so on.

Keywords: 1:2500000 digital geologic map; space database; MapGIS; ARC/INFO
Data service system URL:http://dcc.cgs.gov.cn

1 Introduction

The graphical displays are produced by computer assisted mapping or digital mapping, using an electronic computer. In 1963, the American scholar Howard T. Fisher first realized the idea of computer mapping and le the development of the earliest mapping program SYMAP at Harvard University. Subsequently, a lot of computer mapping systems have been developed all over the world (Goodchild et al., 1991). GIS is also closely related to digital mapping. The world pre-Cambrian mineralization belt atlas compiled by Wang Yongyi in the first half of 1998 sets a successful example of computer-generated digital mapping and GIS geologic mapping. This project is an international mapping plan made by SCWMM of CWGM, mainly covering China, North Korea, South Korea, Mongolia, Nepal, Vietnam and northern India, etc., comprising a 1:1000000 master map and 1:2500000 accessory map. The diagram adopts MAPCAD to finish input vectorization and editing, and then uses the famous GIS software ARC/INFO to construct the geographic information system in which the mineral attribute employs the existing mineral resource

About the first author: YE Tianzhu, male, born in 1964, professor, supervisor of doctor candidate, mainly engages in the study of mineral resource exploration and evaluation and research; E−mail: ytz999@126.com.

database (Wang Yongyi, 2000).

From 1999 to 2003, research into the digital geologic mapping method led to some breakthrough achievements. Digital geologic mapping applies computer technology to save the digital geologic map factors into the computer in the form of electronic documents, facilitating the edition, utilization, maintenance and updating of geologic maps. For the regional geologic survey, GIS (geographic information system), GPS (global positioning system) and RS (remote sensing) technologies are used to digitize and save all the geologic observations acquired from field surveys. Through innovation, the digital mapping device (five new devices for digital mapping) is manufactured with independent intellectual property rights in China, realizing the whole-process digital geologic mapping (Gao Bingzhang et al., 1991; Chen Keqiang, 2011).

The development of the 1:2500000 digital geologic map database not only meets the demand of land and resource surveys and national economic construction, but also fills a blank of 1:2500000 digital geologic map spatial database and 1:2500000 geologic map in China (Zhang Yanling et al., 2004). This paper introduces the development process of the 1:2500000 digital geologic map spatial database in China in terms of database construction and architecture, which provides basic data for economic construction, land and mineral management, and geologic surveys, etc.

Table 1 Metadata table of dataset(s)

Items	Description
Database (dataset) name	Spatial Database of 1:2500000 Digital Geologic Map of People's Republic of China
Database authors	Ye Tianzhu, Development and Research Center of China Geological Survey Huang Chongke, Consulting & Research Center Ministry of Land & Resources Deng Zhiqi, Development and Research Center of China Geological Survey
Language	Chinese
Data acquisition time	2001–2002
Geographic area	Countrywide
Data format	MapGIS, ARC/INFO
Data size	334 MB
Data service system URL	http://dcc.cgs.gov.cn
Foundation item	CGS geologic survey project "1:2500000 digital geologic map spatial database (People's Republic of China)" (200183101)
Database (dataset) composition	1:2500000 digital geologic map spatial database, total data size 0.7 GB, comprising the relevant sub-base, such as attribute, legend, line type, symbol and geographical base map.

2 Data acquisition and base-construction flow

The flow chart showing the progress of 1:2500000 digital geologic map space database construction is shown in Fig. 1.

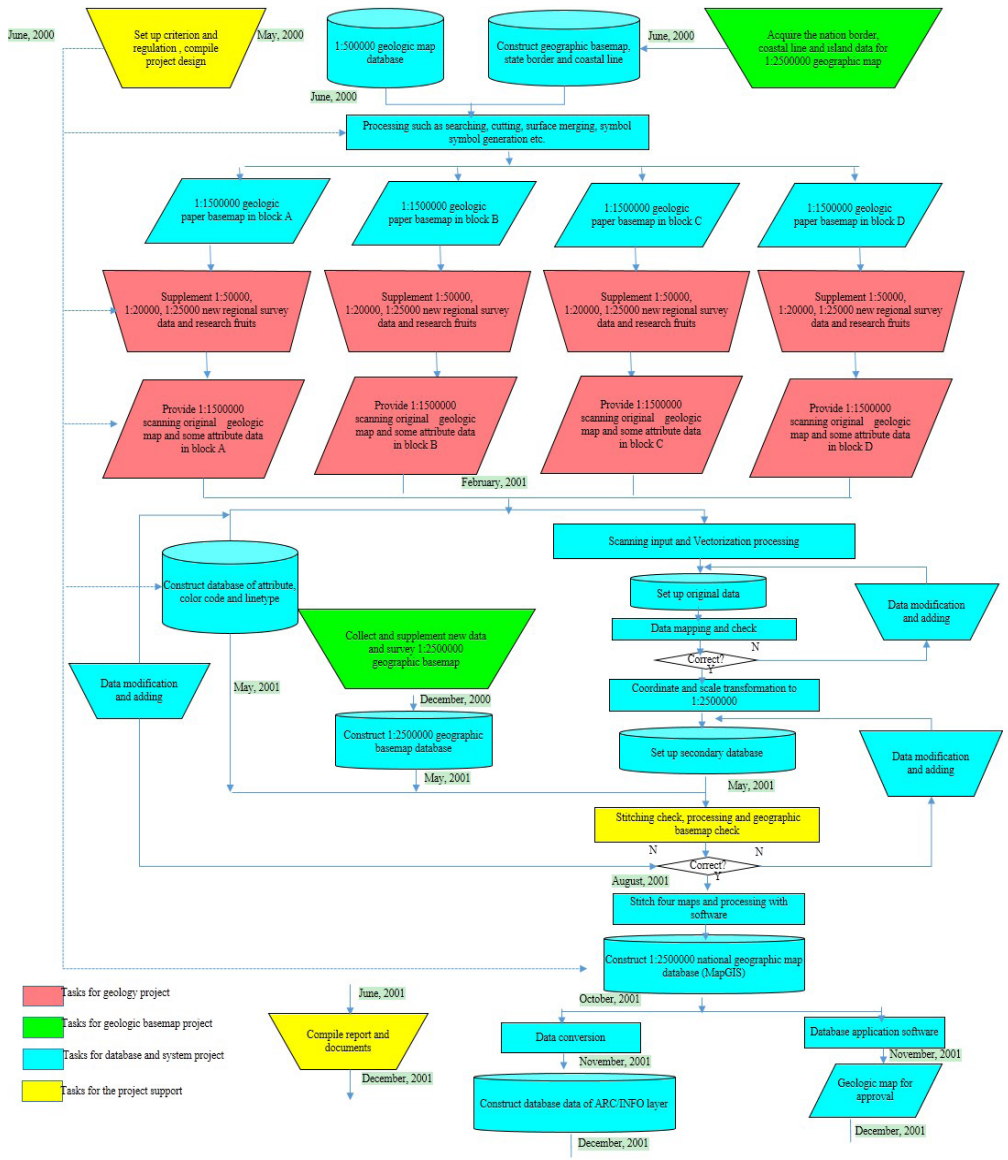

Fig. 1 Flow chart showing the progress of 1:2500000 digital geologic map space database construction

3 Data source

In order to ensure the consistency of geologic information and geographic basemap information of the 1:2500000 digital geologic map database extracted from 1:500000 digital geologic map database, the domestic part of the 1:2500000 digital geologic map database mainly adopts the 1:500000 digital geologic map database, yet the oversea part adopts the 1:2500000 *Map of The People's Republic of China*. Meanwhile, the Provincial Map of China compiled by the National Geomatics Center of China is used to update some domestic national roads, highways, and administrative divisions in order to keep the geographic basemap database as up-to-date as possible. The data source for database construction comes from the 1:500000 digital geographic basemap database and 1:2500000 *Map of The People's Republic of China*. The 1:500000 digital geographic basemap database was completed in December, 1999 with place names and administration division

codes current as at the end of 1999. Information on existing railways, highways and some administration borders were up-to-date as at the end of 1996. The geographic coordinate system is used to construct the database with the degree as its representative unit, without selection for overseas data. The 1:2500000 *Map of The People's Republic of China* was compiled by the National Administration of Surveying, Mapping and Geoinformation, and published by China Map Press and Xi'an Map Press in July, 1997. It is a nine-paper hanging topographic map with the projection of orthomorphic equilateral conical, and central meridian 110°, standard parallel 25° and 47°.

To improve the real-time renewal of the 1:2500000 digital geographic basemap database, the data acquisition renewed some administration divisions, newly-constructed railways and highways of the Provincial Map of China compiled by the National Geomatics Center of China, which was published in June, 2000.

From the data size and easy utilization, the 1:2500000 digital geographic basemap database is stored with the format of ARC/INFO COVERAGE. Considering the domestic data from the 1:500000 digital geographic basemap database, the data layering and naming should aim to stay as consistent with the 1:500000 digital geographic basemap database as possible. This part of the data is mainly used to construct the 1:2500000 digital map database, thus the topological relation and complete attribute data are set up. The overseas data are from the 1:2500000 *Map of The People's Republic of China*, which acts as background data, which is saved as point and line textures added by corresponding codes, facilitating data edition during the drawing production. For convenience during 1:2500000 digital map database construction and compiling, the domestic and overseas data are separately stored during data organization.

4 Major function and constitution of database

4.1 Major function of database

(1) Search function of database: ① search any geologic content, any spatial range and attribute content; ② search geographic content for the geologic basemap.

(2) Automatically output the map: ① automatically generate the color and pattern; automatically plot the geologic symbol; ② automatically generate the legend and format; ③ automatically map for different geologic content, different administration zones and any spatial range; ④ plot the geologic map at any scale with the precision of 1:2500000.

4.2 Database constitution

The 1:2500000 digital geologic map database of China is set up with two formats (MapGIS and ARC/INFO), and contains the following sub-databases within the main database:

(1) Geologic basemap database and geographic content attribute base, including nine types and 33 sorts, such as administration zone, administration border, residence, road, railway, river, lake, marine factor and landscape;

(2) Geologic content attribute base: including 10 sorts, such as strata, intrusive rock, volcanic rock, metamorphic rock, other rock, fault, isotope age, crater, and drilling pore;

(3) Color code base, line type base, pattern base, symbol base and legend base.

4.3 Geologic map constitution

(1) Strata: 4521 compiling units representing chronologic strata.

The Phanerozoic is represented by chronostratigraphic units and divided into series as far as possible, and merged with lithostratigraphic units in the 1:500000 digital geologic map. The pre-Cambrian develops supracrustal rock and plutonic intrusive rock according to the division. The Quaternary is represented by chronologic and genetic types, including 473 genetic units, and is inferred from 367 drilling holes;

(2) Intrusive rock: 2286 compiling units, represented by chronologic strata of five major distinct lithologies, including 1452 units representing isotope age and 180 units representing miarolitic granite;

(3) Volcanic rock: represented by stratigraphic units, the eastern Mesozoic and western Paleozoic volcanic rock represented by stack pattern, and craters individually represented;

(4) Other rocks: 33 sites of glaucophane schist bands, 124 sites of eclogite, 74 sites of ophiolitic mélange bands, and one site of komatiite;

(5) The faulting structure is represented by property and scale, 756 large faults of type 1 and 2.

(6) Three sites of ancient human ruins;

(7) Contents of geographic basemap: two types of administration zone; four types of administration border, seven types of residence, four types of road, one type of railway, three types of river, four types of lake, three types of marine feature, and four types of landscape.

5 Data quality control and assessment

The project team always gives priority to quality during implementation. Quality control is strengthened from two aspects: (1) Ensuring original data quality, namely the geographic and geologic contents, to accurately reflect the real condition and meet the demand of all the technical standards. The original data quality is mainly controlled through expert review and consulting discussion. During the construction of the geographic basemap database, data acquisition takes the advice of geologic graphic designers for many features except the general standard, and constantly data are supplemented or deleted to meet the geologic mapping requirements. During the geologic mapping, except incorporation into the 1:500000 digital geologic map as a general requirement, mapping widely takes the advice of domestic leading experts to solve any controversies and difficult problemsto truly reflect the geology. (2) Ensuring quality during data acquisition and processing. This is achieved by computer processing rather than artificial processing as much as possible from the 1:500000 mapping to database construction to geologic map playback plotting. The practice proves that this is a fundamental way to ensure the data processing quality. For the processing that must be artificially done, such as attribute entering and some data processing, self-review and random inspection should be conducted. All of the above measures are taken to guarantee the database quality.

5.1 Geographic basemap database quality

(1) Quality of geographic basemap content: extract data for water systems, marine features, administrative regions, residences, communication, landscapes, cultural factors, geographic grids, Tropic of Cancer, as 1:2500000 standard, collect the data related to new state roads, provincial roads, highways after 1997 as much as possible and the related data

of administrative division change as well as the attribute information, such as standard and code etc.

(2) The data meets the quality requirements from the aspect of a mathematical foundation, location precision, attribute data precision, logical compatibility, playback map and so on.

(3) The 1:500000 geographic basemap data is compared with the 1:2500000 original map, showing consistent trends of geographic factors, accurate locations and strong relativity.

(4) The nation border adopts the 1:500000 digital geologic map database.

5.2 Geologic mapping quality

(1) Quality of geologic content: through four rounds and two grades (section team and integrated team) of review as well as two rounds of expert review, more than 1000 map errors are corrected and hundreds of contents are revised. Each review results in processing records. The geologic contents are based on the data, and the expert advice is widely collected for controversial issues, finally the advice offered by the most people is taken. The geologic content is objective and true, showing the geology of China.

(2) Set up the mapping recorded file that records the mapping process and technical processing in detail in case of data review.

(3) Spatial data quality: Because the data of 1:2500000 digital geologic map is incorporated on the computer with professional software from the 1:500000 digital geologic map, it is reliable.

(4) The geologic body symbol, color, pattern and legend are generated by computer, and the quality is reliable.

(5) The hooking quality of attribute data has been checked by professional software, thus the error is basically eliminated.

(6) The attribute content writing and entering eliminates some mistakes after self-review and random inspection, but there are still some mistakes such as mispronounced words and hiatuses due to artificial operation, which awaits further check and correction.

(7) The 1:2500000 digital geologic mapping is completed by computer, including data extraction, incorporation, projection transformation, data access, topological relationship establishment, geologic map edition and plotting, thus the data processing and entering is generally reliable with a good quality.

6 Data value

After CGS organized and undertook the construction of the 1:500000 digital geologic map database of People's Republic of China in 1999, the head of the Ministry of land and resources orders continuation of the work, construct digital geologic map database series of different scales and provide basis data for land and mineral plan, management, conservation and rational utilization. Therefore, CGS brings the construction of 1:2500000 digital geologic map database into the plan. The Ministry of land and resources requires the natural resource (land, mineral and sea etc.) plan, management, conservation and rational utilization, especially serving the new round geologic survey and strategic decision of Western Development proposed by the Party Central Committee and State Council, the ministry strives for the entire set of geologic map as well as databases of different scales.

One important part is the 1:2500000 digital geologic map spatial database, which fills a gap in Chinese records. The map improves onshore geologic research in China, summarizes the general geology in China, and provides basic data for economic construction, land and resource management, and geologic surveys, etc.

7 Data usage and suggestion

The "digital geographic basemap" aims at providing the fundamental geographic content of a digital type, namely basic geographic control information for the positioning of subject information, showing the relation and distribution rule with the surrounding environment. Therefore, there is some difference from the topographic map in terms of content selection and representing degree. The digital map overcomes the shortcoming of the simulation map, and quickly realizes the projection transformation, random determination of scale, any election of display range and content as well as expression way, etc.

The 1:2500000 digital basemap database is under the request of the geologic department and based on the 1:500000 digital geographic basemap database and 1:2500000 *Map of The People's Republic of China*, in combination with other supplementary data, and undergoes the appropriate selection, edition, composite processing and data updates to form the digital geographic basemap database.

8 Conclusion

The 1:2500000 digital geologic map spatial database of People's Republic of China is guided by plate tectonics and geodynamics theory, based on the available digital data and technical standards to plot the geologic map. Besides the main database, the database comprises the geographic basemap database and geographic content attribute base that constitutes the geologic attribute base, color code base, line type base, pattern base, symbol base, and legend base, etc. The database has functions for searching the geologic content, administrative divisions, any spatial range and geography, can output maps automaticall, automatically plot geologic symbols, and automatically generate a range of scales, etc. The construction of the 1:2500000 digital geologic map spatial database of People's Republic of China provides fundamental data for economic development, land and resource management and geologic surveys, etc., thus is of vital importance.

Acknowledgements: We are grateful for the guidance and reviews from Academician Li Tingdong, Academician Ren Jishun, Academician Chang Yinfo, Academician Shen Qihan and Academician Yin Hongfu. We also thank Zhang Hongtao, Zhou Jiahuan, Li Yuwei, Chen Ping, Lu Songnian, HouHongfei, Xiao Qinghui, Hong Dawei and other experts for their help; Ma Daquan and Wu Tieshan participated in the early stages of compiling; meanwhile, we received great assistance from DRC of CGS, SINOPEC petroleum E&D research institute, and geology survey institutes of all the provinces (autonomous regions, municipalities), as well as overall support from Consulting research center of Ministry of land and Resource and related departments of CGS. The former or vice general engineer from the Bureau of Geology and Mineral Resources of all the provinces (autonomous regions, municipalities) and engineers from some regional survey units diligently reviewed the diagrams and offered valuable comments (see the attached table).

From start to finish, the database team always closely cooperated with the geologic map

team, and the geographic basemap team of National Geomatics Center of China provided the necessary geographic basemap data. Luo Haiyan helped to revise the plot angle diagram, and Ma Lifang contributed the referable diagrams. Therefore, the achievements resulted from the collective hard work of nearly 100 experts and mapping participants across the department from many organizations. We hereby express sincere thanks to the above academicians, experts, heads from each organization, and all the participants.

References

Chen Keqiang. 2011. Emergence, development and usage of geologic maps[J]. Chinese Journal of Nature, 33(4):222−231(in Chinese).

Gao Binzhang, Hong Dawei, Fang Zongbin.1991. A Guide to 1:50000 Regional Geological Mapping Method for Granite[M]. Beijing: China University of Geosciences Press (in Chinese).

Goodchild M F, Kemp K K. 1991. Introduction to GIS[M] .NCGIA Core Curri culum.

Wang Yongyi.2000.Computer generated geologic map applied to mineral resoureces assessment[J]. Geology and Prospecting, 36(1):44−47 (in Chinese).

Zhang Yanling, Shi Yuli, Wang Kaihong, Li Haiyu, Hu Hongxia.2004. Some new breakthroughs in establishing database of geological map of 1: 2500000 of Northeast China [J].Jilin Geology 23(4):144−149(in Chinese).