doi: 10.12029/gc2017Z102

论文引用格式：庞健峰，丁孝忠，韩坤英，曾勇，陈安蜀，张艳玲，张庆合，姚冬生. 2017. 1∶100 万中华人民共和国地质图空间数据库 [J]. 中国地质，44(S1): 8−18.

数据集引用格式：庞健峰，丁孝忠，韩坤英，曾勇，陈安蜀，张艳玲，张庆合，姚冬生. 2017. 1∶100 万中华人民共和国地质图空间数据库 [DB]. 全球地质数据，DOI: 10.23650/data.H.2017.NGA105570.T1.64.1.

收稿日期：2017-07-24
改回日期：2017-08-01

项目：中国地质调查局地质大调查项目（1212011120115，1212010511501）资助。

1∶100 万中华人民共和国数字地质图空间数据库

庞健峰[1] 丁孝忠[1] 韩坤英[1] 曾勇[2] 陈安蜀[3]
张艳玲[4] 张庆合[5] 姚冬生[6]

（1. 中国地质科学院地质研究所，北京 100037；2. 中国地质调查局南京地质调查中心，江苏 南京 210016；3. 中国地质调查局天津地质调查中心，天津 300170；4. 吉林省区域地质矿产调查所，吉林 长春 130061；5. 中国石油化工股份有限公司石油勘探开发研究院，北京 100083；6. 四川省地质矿产勘查开发局，四川 成都 610081）

摘要：中华人民共和国 1∶100 万数字地质图数据库是根据统一标准和要求编制的专题数字地质图，以中华人民共和国 1∶50 万数字地质图数据库为数据源，在综合研究的基础上，充分吸收近年来地质调查 1∶25 万、1∶20 万、1∶5 万等区调工作新成果、新资料，应用地质编图新技术、新理论和新方法编制而成。以年代地层单位为主、辅以岩石地层的表示方法，侵入岩按“岩性加年代”表示方法，进一步提高了基础地质的研究程度。地质图数据库内容丰富，信息量大，数据量约为 1.2 GB，标示了岩石地层单位 5347 个图例，侵入体“岩性加时代”单位 1780 个图例，跨省区重要断裂 93 条，各省（市、自治区）内重要断层 558 条，同位素年龄数据 1545 个（组），有代表性的钻孔 382 个。所有地质体的面元及线元、同位素年龄和钻孔都建立了相应的属性，相邻图幅之间进行了接图处理，编写了编图说明书和元数据。数据库采用统一的线型库、符号库、色标库等，成图过程全部采用 MapGIS6.5 平台计算机辅助成图，成图精度高，质量好，符合设计要求，全国 64 幅图采用分 4 个片区的工作方法，最后统一编制而成。该数字地质图是目前中国资料最全、内容最新的 1∶100 万地质图，是中国第一份应用 GIS 技术的 1∶100 万数字地质图的最新成果，充分反映了中国地质构造特点和当前地质研究的新水平。

关键词：1∶100 万数字地质图；空间数据库；MapGIS
数据服务系统网址：http://dcc.cgs.gov.cn

1 引言

全国 1∶100 万地质图空间数据库建设工作，是充分利用了近年来已有的小比例尺数字地质图、数据库和地质大调查新成果，应用地理信息系统和地质制图等新技术和新方法，在进行全国综合基础地质图件编制与更新，建立和完善不同比例尺系列地质图的空间数据库的同时，建立全国 1∶100 万地质图空间数据库，填补中国 1∶100 万地质图

第一作者简介：庞健峰，男，1983 年生，助理研究员，主要从事区域地质编图与 GIS 应用研究；E-mail: pjf1712@163.com。
通讯作者简介：丁孝忠，男，1963 年生，研究员，从事区域地质与地质编图研究；xiaozhongding@sina.com。

空间数据库的空白，达到加快成图速度，缩短成图周期，实现信息资源共享的目的。按1∶100万地质图编制精度开展综合研究与数字地质图编制工作，在完成64幅按国际标准分幅的全国1∶100万数字地质图基础上，进行集成研究，最终建成了国家1∶100万地质图空间数据库。

国际上对小比例尺地质图件编制、更新和数据库建设工作非常重视。如俄罗斯现已开始第三轮1∶100万地质调查和国际分幅地质图图件编制与更新工作，其他独联体国家以及部分亚洲国家（蒙古、日本和韩国等）均进行了小比例尺地质编图和综合研究，编制了1∶100万或1∶250万或1∶500万地质图、构造图和矿产图等，蒙古已完成了1∶100万数字化地质图，日本也编制了小比例尺数字化地质图（李廷栋，2007; Asch, 2001; Bouysse et al., 2004），美国早在20世纪80年代末就已经初步完成这一工作，实现了资源共享。地理信息系统(GIS)的迅速发展和广泛应用，使小比例尺地质图件的编制、更新和空间数据库建设的周期大大缩短（韩坤英等，2005；万常选等，2009）。

中国幅员辽阔、地质条件复杂，东西部地区研究程度存在较大差别。1948年前后，我国曾编制过北京幅(J−50)等1∶100万国际分幅地质图14幅。1960—1966年，中国地质科学院地质研究所又指导全国各省（区）地质局编制了部分1∶100万国际分幅地质图等一套图件和1∶300万的全国一套图件等，在编制1∶100万国际分幅地质图及其他地质图方面，积累了丰富的经验。但从20世纪60年代起至今已有40多年的发展历史，系统编制我国国际分幅1∶100万地质图一直没有进行。所以，我国1∶100万国际分幅地质图亟待更新。1996—1999年由原国家计委和原地矿部共同立项，利用GIS技术建立了中华人民共和国1∶50万数字地质图空间数据库（张庆合等，2002）。因此，以全国1∶50万地质图数据库为基础，充分吸收1∶25万区域地质调查的新成果资料，特别是青藏高原地区1∶25万区域地质调查已全面完成（共计110幅），以及其他地区1∶5万、1∶25万区域地质调查和专题研究的新资料和新进展，按国际标准分幅开展全国1∶100万数字地质图编制工作，建立全国1∶100万地质图空间数据库，填补了我国1∶100万数字地质图和全国1∶100万地质图空间数据库的空白，健全国家小比例尺地质图空间数据库。全国1∶100万国际分幅数字地质图研究区范围为中华人民共和国陆域部分为主。经纬度范围为：东经72°~138°，北纬16°~56°，采用1∶100万地形图的分幅编号，图幅接合表及工作片区划分如图1所示。作为一套全国性、综合性研究成果，力争反映我国近年来国土资源大调查中所取得的地质调查、矿产勘查以及科研新成果，为我国的矿产资源战略研究、能源勘探、国土整治、环境保护、地质灾害防治和重大工程建设等提供基础地质图件。为地学教育、科研和野外地质调查提供有益的参考资料，也为国外科学家全面了解整个中国地质，共同研究地球、认识地球和保护地球，促进更加广泛地国际交流与合作，提供详细的基础信息资料（韩坤英等, 2005）。

1∶100万中国地质图空间数据库元数据简介如表1所示。

2 数据采集和处理过程

2.1 数据基础

全国1∶100万地质图编制以板块构造及地球动力学理论等为指导，以全国1∶50

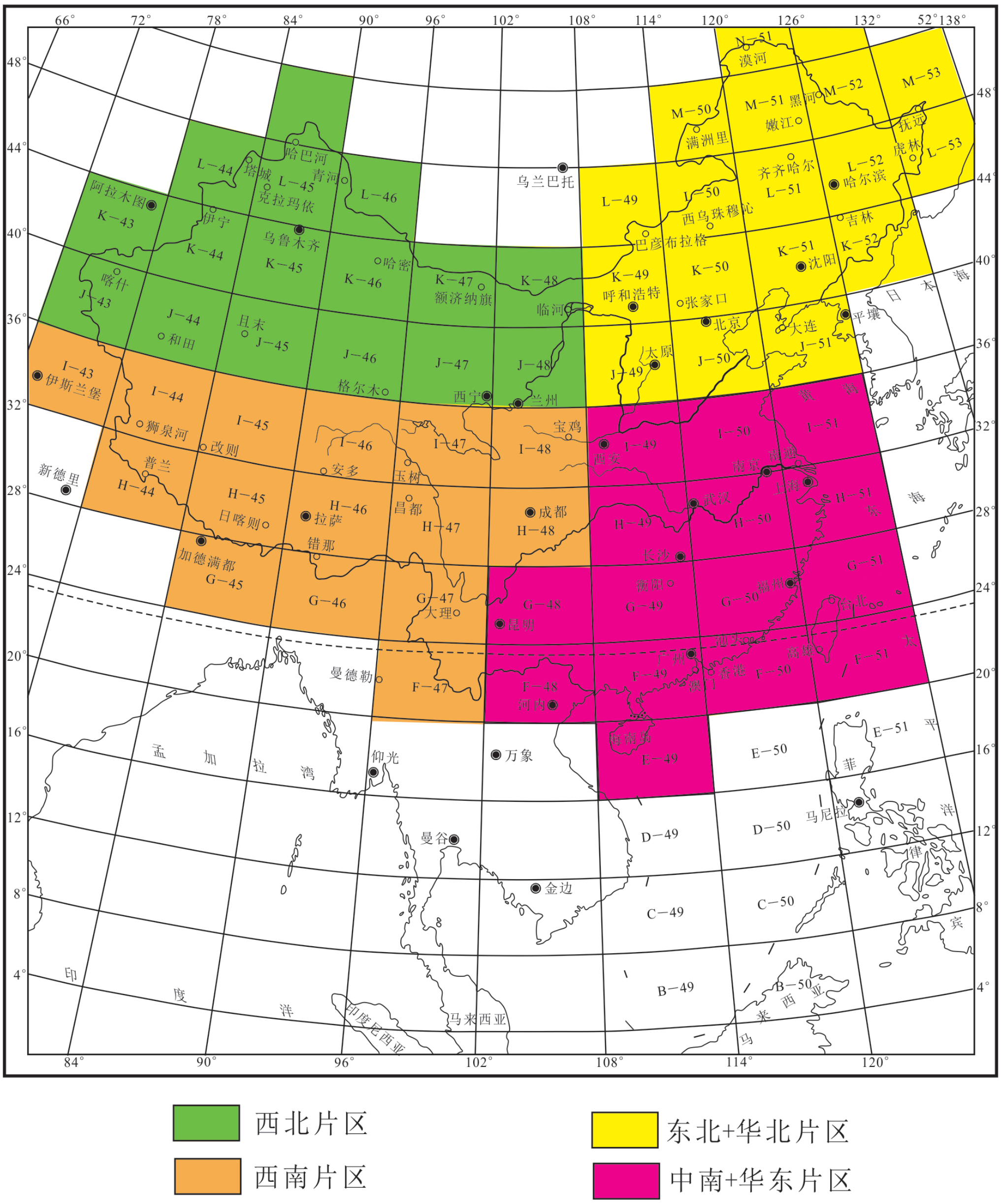

图 1　1∶100 万国际分幅地质图图幅接合表及片区划分

万地质图数据库为基础，充分吸收新完成的 1∶25 万区域地质调查新资料和研究成果，地理底图采用国家基础地理信息中心 2002 年版最新 1∶100 万国际分幅数字地形图，同时依据中华人民共和国民政部、国家测绘局 2004 年 6 月发布的 1∶100 万《中华人民共和国省级行政区域界线标准画法图集》的资料，2002—2005 年《中华人民共和国行政区划简册》中最新地理资料编制；地质资料截止 2006 年 12 月，部分至 2007 年底。应用已有的技术标准以及国内和国际上通用的计算机软件进行数据处理和管理（必要时开发研制了专用软件），按 1∶100 万比例尺地质图精度要求，建立全国 1∶100 万地质图空间数据库。同时为充分展示我国近年来的区域地质调查、矿产勘查和综合研究水平提供一份基础地质图件。

表 1　数据库（集）元数据简表

条目	描述
数据库（集）名称	1∶100 万中华人民共和国数字地质图空间数据库
数据作者	庞健峰，中国地质科学院地质研究所 丁孝忠，中国地质科学院地质研究所 韩坤英，中国地质科学院地质研究所 曾勇，中国地质调查局南京地质调查中心 陈安蜀，中国地质调查局天津地质调查中心 张艳玲，吉林省区域地质矿产调查所 张庆合，中国石油化工股份有限公司石油勘探开发研究院 姚冬生，四川省地质矿产勘查开发局
通讯作者	丁孝忠, E−mail: xiaozhongding@sina.com
数据时间范围	2002—2007 年
地理区域	全国 1∶100 万国际分幅数字地质图研究区范围为中华人民共和国陆域部分为主。经纬度范围为：东经 72°~138°，北纬 16°~56°，采用 1∶100 万地形图的分幅编号
数据格式	MapGIS
数据量	1.2 GB
数据服务系统网址	http://dcc.cgs.gov.cn
语种	中文
数据库（集）组成	该系统由国际分幅为 1∶100 万的地质图库，1∶100 万的地理底图库、属性库、色标库、线型库、花纹符号库等构成。地质图库由覆盖全国陆域面积的 64 个标准图幅组成，相当于 64 个子库，每幅图经差 6° 和纬差 4°。地质图内容以单一精度的地理坐标存储。地理数据库也有 64 个标准图幅，包括有 7 个专题层：境界、水系、居民地、交通、地貌、文化要素、地理网格。

2.2　数据处理过程

全国 1∶100 万数字地质图数据库及地质图的数据处理过程如下：

（1）首先应用 1∶50 万地质图数据库，检索出标准分幅的 1∶100 万地质图，在此基础上，结合最新资料，在综合研究的基础上，应用地球科学的新理论、新方法和新技术，以《全国岩石地层》为依据，进行归纳、合并；将图件补充新资料，按 1∶100 万地质图编图要求进行综合取舍后，扫描生成 TIF 文件。在 MapGIS 系统下进行线元矢量化编辑，生成 WL 文件；输入注记代号生成 WT 文件。通过投影转换、误差校正与 1∶100 万地理底图套合，再与 1∶100 万地质图进行拼接，校样输出，检查修改；在屏幕上修改、编缉、审查、输出，进行初审。拓扑造区，填色整饰，生成 WP 文件。由于每幅图编图的基本资料各异，故其编图流程也各有差异，主要工作流程见图 2。

（2）编写属性表。在 MapGIS6.5 平台上，输出属性表，应用其他的软件（如 Excel），进行属性的修改、补充，进行编码的转换等，然后打印输出属性表，人工检查属性内容，之后再与图形数据进行关联，彩喷输出。

（3）地质内容和地理底图进行严格套合，每幅图选取 35 个校正控制点，保证经纬

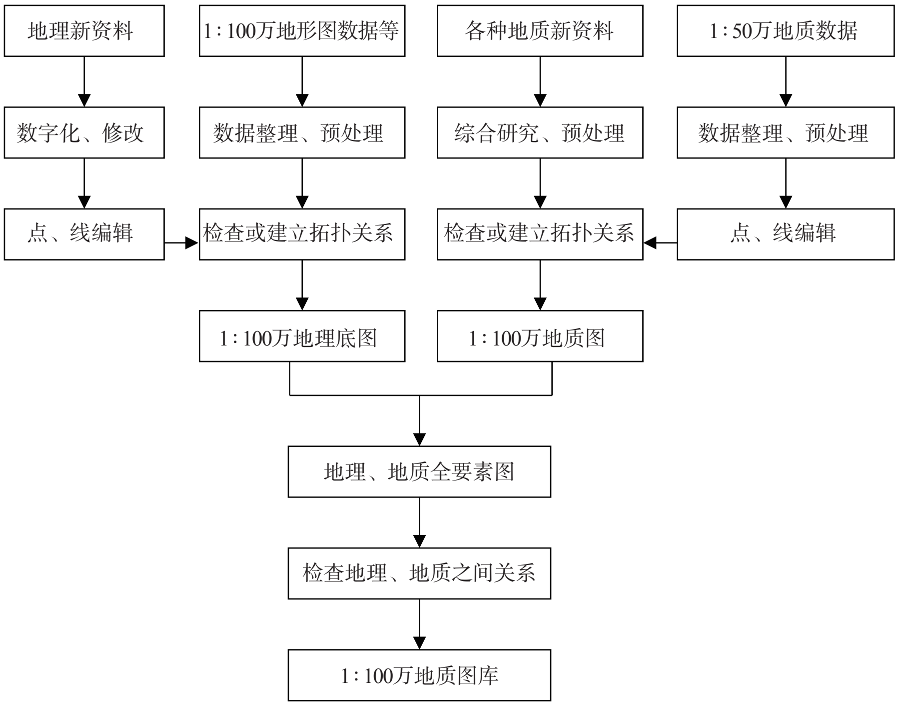

图 2　1：100 万地质图数据库主要工作流程图

网误差和图廓点误差小于或等于 0.1 mm。

（4）数据接边处理：对地质图数据库进行投影转换，转换成地理坐标系后，首先与项目办提供的理论框套合。其次再与邻幅接边处理。处理步骤：①地质内容衔接一致；②为了使地质图无缝入库，与邻幅地质界线衔接时，采用了每一条接边线进行抓线头处理，保证了地质界线无缝衔接。

（5）1：100 万地质图图外整饰采用统一要求，图例编排的位置、字体的大小采用统一规格，图例内容按照地层、侵入岩、火山岩、特殊地质体、第四纪成因类型及花纹、火山岩花纹、地质界线、构造界线的顺序进行编排。

（6）属性数据检查。项目组编写了属性检查软件，进行属性数据的检查，包括属性结构、属性类型、属性内容等，同时结合人工检查的方法，尽量将错误率降到最低。

（7）编写文字说明书及元数据，提交项目办，由项目办组织汇总、审查和修改。

3　数据内容描述

3.1　图层名称

地质图和地理底图图层主要按要素类型划分，以文件的形式存放。

3.2　地质图数据的命名方式

图幅号 + 地质面 .WP，图幅号 + 地质线 .WL，图幅号 + 地质点 .WT

3.3　地理图幅文件命名方式

L+ 图幅号 + 地理要素名 .WP

3.4 要素（实体）类型名称

实体类型名称：点、面、弧段；点实体：同位素、岩心钻孔、地质体注记、地质符号、地质花纹。

面实体：地层、侵入体等；弧段实体：断裂构造、整合、不整合、平行不整合、岩相界线等。

3.5 属性列表

1：100 万数字地质图数据库包括地质实体要素信息和地理要素信息，地质实体包含的属性有：地层面元属性表、地质界线属性表、断层线属性表、地质点元属性表。

地质体面元属性表主要是包括地层和侵入岩单位，它的属性结构如下：User ID 码（标识码）；TYPE（面元类型）分 6 类：1—地层、2—第四纪、3—火成岩、4—上新世以前火山岩、5—混合岩及变质深成侵入体、6—岩脉及时代不明岩体；COLOR NO（色标号）：填写色标号；FILL NO（填充图案号）；FILL COLOR（填充图案颜色号）；FILL HEIGHT（填充图案高度）；CODE1（地质年代代码）；CODE2（岩石名称代码）；SYMBOL（地质代号）；UNITNAME（包括岩石地层单位和侵入岩岩石名称）；DESCRIPTOR（地层或岩石描述）。

断层属性表：User ID 码（标识码）；TYPE（分类码）分 3 类：1—全国性重要断裂、2—省内重要断裂、3—一般断裂；LSTY1（线型码）；LSTY2（辅助线型码）；CODE1（断层编码）分 7 种：1—板块结合带、2—地壳拼接带、3—走滑断裂带、4—逆冲推覆断裂带、5—复合断裂带、6—性质不明断裂带、7—其他断裂带；CODE2（断层符号）：根据 GB958-99 编码填写；ATTR（线元性质）：按断层实际填写；NAME（名称）；DESCRIPTOR（断层描述）：对全国和省内重要断裂进行描述，内容有断裂性质及类型、产状、延伸方向及范围、地质构造意义等。

地质体边界线属性表：UserID 码（标识码）；TYPE（分类码）分 2 类：1—岩层界线、2—地质体构面界线；LSTY1（线型码）；LSTY2（辅助线型码）；CODE1：为空；CODE2（地质界线、地质体接触界线、地质体构面界线）：前两者根据 GB958–99 编码填写，后者按项目办提供的补充代码填写；ATTR（线元性质）；NAME（名称）；DESCRIPTOR：对相应的地质体边界进行描述。

地质体点元属性表：User ID 码（标识码）；TYPE（分类码）分 6 类：1—同位素年龄采样点、2—钻孔、3—火山口、4—重要化石采集地、5—地质公园、6—标准剖面；CODE1（点元代码）：前 3 位为 GB958-99 编码，后 3 位为顺序号，如同位素的代码为 802001 等；SYMBOL（点元符号编码）：各点元在 1：100 万系统库中的编号；LONGITUDE（点元位置的经度）；LATITUDE（点元位置的纬度）；DESCRIPTOR（描述）：对相应点元特征的描述。

地理要素信息包含有居民地属性表、铁路属性表、公路属性表、单线河属性表、面状水系属性表、文化要素属性表等。

4 数据库的组成

该系统由国际分幅为 1：100 万的地质图库，1：100 万的地理底图库、属性库、色

标库、线型库、花纹符号库等构成。地质图库由覆盖全国陆域面积的 64 个标准图幅组成，相当于 64 个子库，每幅图经差 6 度和纬差 4 度。地质图内容以单一精度的地理坐标存储。地理数据库也有 64 个标准图幅，包括有 7 个专题层：境界、水系、居民地、交通、地貌、文化要素、地理网格。

5 数据输出质量及准确度

按 1：100 万地质图的输出精度要求，1：1 等比例输出；或者按用户要求选择输出参数。

地质体精度方面，地质时代表示到世，地层单位表示到组（岩组），个别到段或群（岩群），侵入体表示到“岩性加年代”（代或世），断裂表示了跨省区的重要断裂和省内重要的断裂，一般断裂归类表示，每个地质体单位都建立相应的属性。

地质体图面表示精度，宽度≥ 0.8 mm 或面积≥ 2 mm^2；每个地质体单位都建立相应的属性。有些重要的地质体面积虽小，在图面上均予以夸大表示，如反映构造运动的榴辉岩等。同位素年龄测定在变质岩区采用 U–Pb 全岩等时线法和单颗粒锆石法，岩浆岩采用 Rb–Sr 全岩等时线法测定，精度能够满足要求。

地理内容主要表示了水系、居民地、道路等，图上表示了长度大于 10 mm 或面积大于 2 mm^2 的湖泊，居民地表示到乡、镇以上。在进行地质数据与地理数据套合时，每幅图选取 35 个控制点，四个图廓点误差在≤ 0.1 mm 之内，达到了精度的要求。

6 数据库质量保证措施

在数据库全部数据汇总之后，为了保证编图过程及地质体要素所赋属性内容、结构、编码等的完整、正确，项目组根据“编图细则”自主开发了“1：100 万地质图空间数据库数据自动检查系统”，进行数据内容的全面检查与修改。

检查数据的范围是否在规定的范围之内，检查接边属性是否正确，检查拓扑关系是否正确，数据入库后检查按图幅显示是否完整。针对每幅图生成图例，按图例、图层检查属性及面元颜色、填充图案是否正确。在建库过程中经过多层次、多环节的质量检查与监督，确保数据库中数据准确无误。

该数据集参加人员单位以及质量控制人员名单见表 2。

表 2 参加人员单位分工表

序号	图名	编号	参加单位	参加人员
1	三亚幅地质图	E–49	广西壮族自治区地质矿产勘查开发局	张忠伟、刘真
2	景洪幅地质图	F–47	四川省地质矿产勘查开发局 成都地质矿产研究所	姚冬生、张萍、马红嫚 秦德厚
3	凭祥幅地质图	F–48	广西壮族自治区地质矿产勘查开发局	张忠伟、刘真
4	广州幅地质图	F–49	广西壮族自治区地质矿产勘查开发局	张忠伟、刘真
5	香港幅地质图	F–50	广西壮族自治区地质矿产勘查开发局	张忠伟、刘真
6	高雄幅地质图	F–51	江西省地质矿产勘查开发局 南京地质矿产研究所	杨明桂、李艳红 曾勇

续表 2

序号	图名	编号	参加单位	参加人员
7	亚东幅地质图	G-45	四川省地质矿产勘查开发局	姚冬生、梁信之、罗建宁
			成都地质矿产研究所	王全海、王立全、颜仰基、凌小明
8	错那幅地质图	G-46	四川省地质矿产勘查开发局	姚冬生、梁信之
			成都地质矿产研究所	潘桂堂、颜仰基、耿全如、凌小明、马红嫚
9	大理幅地质图	G-47	四川省地质矿产勘查开发局	姚冬生、张萍、马红嫚
			成都地质矿产研究所	秦德厚
10	昆明幅地质图	G-48	四川省地质矿产勘查开发局	姚冬生、秦德厚、魏佳庸、张萍
11	衡阳幅地质图	G-49	广西壮族自治区地质矿产开发局	张忠伟、刘真
12	福州幅地质图	G-50	江西省地质矿产勘查开发局	杨明桂、李木香
			南京地质矿产研究所	曾勇
13	台北幅地质图	G-51	江西省地质矿产勘查开发局	杨明桂、李艳红
			南京地质矿产研究所	曾勇
14	普兰幅地质图	H-44	中国地质科学院地质研究所	刘训
15	日喀则幅地质图	H-45	四川省地质矿产勘查开发局	姚冬生、梁信之、罗建宁
			成都地质矿产研究所	王全海、王立全、颜仰基、凌小明
16	拉萨幅地质图	H-46	四川省地质矿产勘查开发局	姚冬生、梁信之
			成都地质矿产研究所	潘桂堂、颜仰基、耿全如、凌小明、马红嫚
17	昌都幅地质图	H-47	四川省地质矿产勘查开发局	姚冬生、王增、张萍、马红嫚
18	成都幅地质图	H-48	四川省地质矿产勘查开发局	姚冬生、胡明明、张萍
			中国地质科学院地质研究所	刘燕学
19	长沙幅地质图	H-49	江西省地质矿产勘查开发局	杨明桂、李艳红
			南京地质矿产研究所	曾勇
20	武汉幅地质图	H-50	江西省地质矿产勘查开发局	杨明桂、李艳红、李木香
			南京地质矿产研究所	曾勇
21	上海幅地质图	H-51	江西省地质矿产勘查开发局	杨明桂、李艳红、李木香
			南京地质矿产研究所	曾勇
22	乔戈里峰幅地质图	I-43	中国地质科学院地质研究所	刘训
23	噶尔幅地质图	I-44	中国地质科学院地质研究所	刘训
24	改则幅地质图	I-45	中国地质科学院地质研究所	傅德荣、刘训、韩坤英
25	安多幅地质图	I-46	中国地质科学院地质研究所	刘训
26	玉树幅地质图	I-47	中国地质科学院地质研究所	刘燕学

续表 2

序号	图名	编号	参加单位	参加人员
27	宝鸡幅地质图	I-48	中国地质科学院地质研究所	刘燕学
28	西安幅地质图	I-49	中国地质科学院地质研究所	刘燕学
29	南京幅地质图	I-50	江西省地质矿产勘查开发局	杨明桂、李木香
			南京地质矿产研究所	曾勇
30	南通幅地质图	I-51	江西省地质矿产勘查开发局	杨明桂、李木香
			南京地质矿产研究所	曾勇
31	喀什幅地质图	J-43	中国地质科学院地质研究所	刘训
32	和田幅地质图	J-44	青海省区域地质综合调查队	郑建康、王冬青、余景晖、彭玺、皮英楠
33	且末幅地质图	J-45	青海省区域地质综合调查队	郑建康、王冬青、余景晖、彭玺、皮英楠
34	格尔木幅地质图	J-46	青海省区域地质综合调查队	郑建康、王冬青、余景晖、彭玺、皮英楠
35	西宁幅地质图	J-47	青海省区域地质综合调查队	郑建康、王冬青、彭玺、余景晖、车莉
36	兰州幅地质图	J-48	青海省区域地质综合调查队	郑建康、王冬青、彭玺、余景晖、车莉
37	太原幅地质图	J-49	中国地质科学院地质研究所	闵隆瑞
38	北京幅地质图	J-50	中国地质科学院地质研究所	迟振卿
39	大连幅地质图	J-51	中国地质科学院地质研究所	迟振卿
40	吐尔尕特山口幅地质图	K-43	中国地质科学院地质研究所	丁孝忠、刘训、剧远景
41	伊宁幅地质图	K-44	中国地质科学院地质研究所	丁孝忠、刘训、剧远景
42	乌鲁木齐幅地质图	K-45	中国地质科学院地质研究所	丁孝忠、刘训、韩坤英
43	哈密幅地质图	K-46	中国地质科学院地质研究所	王永、丁孝忠
44	额济纳旗幅地质图	K-47	中国地质科学院地质研究所	王永、丁孝忠
45	巴彦淖尔幅地质图	K-48	中国地质科学院地质研究所	王永、丁孝忠
46	呼和浩特幅地质图	K-49	天津地质矿产研究所	陈安蜀、张宝华
			内蒙古自治区地质调查院	邵和明
47	张家口幅地质图	K-50	天津地质矿产研究所	陈安蜀、张宝华
			内蒙古自治区地质调查院	邵和明
48	沈阳幅地质图	K-51	吉林省区域地质矿产调查所	王友勤、张艳玲、王凯红
49	吉林幅地质图	K-52	吉林省区域地质矿产调查所	王友勤、张艳玲、胡红霞
50	塔城幅地质图	L-44	中国地质科学院地质研究所	王永、丁孝忠
51	克拉玛依幅地质图	L-45	中国地质科学院地质研究所	王永、丁孝忠
52	青河幅地质图	L-46	中国地质科学院地质研究所	王永、丁孝忠
53	巴彦乌拉幅地质图	L-49	天津地质矿产研究所	陈安蜀、张宝华
			内蒙古自治区地质调查院	邵和明

续表 2

序号	图名	编号	参加单位	参加人员
54	西乌珠穆沁旗幅地质图	L-50	天津地质矿产研究所	陈安蜀、张宝华
			内蒙古自治区地质调查院	邵和明
55	齐齐哈尔幅地质图	L-51	中国地质调查局实物地质资料中心	叶定衡、王桂兰
56	哈尔滨幅地质图	L-52	吉林省地质调查研究院	王友勤、张艳玲、王凯红、胡红霞
57	虎林幅地质图	L-53	吉林省地质调查研究院	王友勤、张艳玲
58	哈巴河幅地质图	M-45		
59	满洲里幅地质图	M-50	中国地质调查局实物地质资料中心	叶定衡、王桂兰、叶青培
60	嫩江幅地质图	M-51	国土资源部高咨研究中心，中国地质科学院地质研究所	李廷栋
			中国地质调查局实物地质资料中心	叶定衡、王桂兰
61	黑河幅地质图	M-52	吉林省地质调查研究院	王友勤、张艳玲、王凯红、胡红霞
62	抚远幅地质图	M-53	吉林省地质调查研究院	王友勤、张艳玲
63	漠河幅地质图	N-51	中国地质调查局实物地质资料中心	叶定衡、王桂兰
64	新民幅地质图	N-52	中国地质调查局实物地质资料中心	叶定衡、王桂兰

7　数据库应用前景

数据库有广泛的应用前景，可作为编制各种同比例尺专题图件的基础地质信息库，也可作为编制更小比例尺地质图的基础地质信息库，从而为我国各种小比例尺地质图及相应专题图编制的现代化提供了有力的支持，还可广泛地用于地质矿产调查、管理、规划与经济建设工作。总之，该项成果利用先进的 GIS 技术，应用地质编图新理论、新技术，建立了全国统一 1∶100 万数字地质图数据库，并编制了全国 1∶100 万数字地质图。项目起点高，设计思想先进，应用了先进的信息技术，内容丰富、查询检索方便、用途广泛、可操作性强，并建立了相应的元数据库，便于库的管理与信息共享。

8　结论

全国 1∶100 万地质图空间数据库建设项目，是以近年来我国区域地质调查和专题研究的新成果资料，以板块构造及地球动力学理论等为指导，应用地理信息系统和地质制图等新技术和新方法，按照国际标准分幅和 1∶100 万地质图编制精度，开展综合研究与数字地质图编制工作，在完成 64 幅国际分幅 1∶100 万数字地质图基础上，进行集成研究，最终建立了国家 1∶100 万地质图空间数据库，填补了我国 1∶100 万地质图空间数据库的空白，为充分展示我国近年来的区域地质调查、矿产勘查和综合研究水平提供一套基础性地质图件。地质资料截止 2006 年 12 月，部分至 2007 年底，研究区范围为中华人民共和国陆域部分。

这是我国首次全面系统地编制“全国 1∶100 万数字地质图”和建立“全国 1∶100 万地质图空间数据库”，完善了国家基本比例尺地质图数据库系统，为最大限度地满足

国家对区域地质信息集成的需求，扩大地质图数据库的功能，实现信息资源共享创造了条件。为实现基础性、公益性地质调查工作成果的社会共享奠定基础。

“全国 1：100 万地质图空间数据库”具有信息量大、数据库系统功能齐全、实用性强等特点。但是，数据库中仍然存在着许多问题和不足，需要在下一阶段工作中对数据库进行综合修改和完善，进一步补充新资料，建立数据库定期更新和维护机制。

致谢：《全国 1：100 万地质图空间数据库》是一项集成性成果，研究工作顺利开展是与全体项目组科技人员的辛勤劳动和共同努力分不开的，对来自中国地质科学院、中国地质调查局天津地质调查中心、中国地质调查局沈阳地质调查中心、中国地质调查局南京地质调查中心、中国地质调查局成都地质调查中心、中国地质调查局西安地质调查中心、中国地质调查局发展研究中心、江西省地质矿产勘查开发局、广西壮族自治区地质矿产勘查开发局、四川省地质矿产勘查开发局、青海省地质科学研究所、中国石油化工股份有限公司石油勘探开发研究院、吉林省区域地质矿产调查所、内蒙古自治区地质矿产勘查开发局、河北省区域地质矿产调查所、中国地质调查局实物地质资料中心的各位专家表示衷心感谢。本项目的实施，得到中国地质调查局科技外事部彭齐鸣原主任，卢民杰、刘凤山、肖桂义原处长的大力支持，在此深表谢意。同时感谢科学顾问组的各位专家，以及所有参加单位的支持和大力协作，陈克强、高振家和高林志研究员为本项目提供了岩石地层数据资料。感谢项目承担单位中国地质科学院地质研究所给予的一贯支持。

参考文献

Asch K. Under construction: the geological GIS of the 1∶5 000 000 international geological map of Europe and adjacent areas [J]. Episodes, 2001, 24(3): 201−204.

Bouysse P, Mendel V, Munschy M, et al. A new CGMW map: The structural map of the Indian Ocean: An attempt at ocean cartography[J]. Episodes, 2004, 26(2): 199−202.

韩坤英 , 丁孝忠 , 范本贤 , 马丽芳 , 剧远景 . 2005. MapGIS 在建立地质图数据库中的应用 [J]. 地球学报 , 26(6): 587−590.

韩坤英 , 丁孝忠 , 范本贤 , 耿树方 , 剧远景 . 2005. 基于 GIS 的区域地质编图方法 [J]. 中国地质 , 32(4): 713−717.

李廷栋 . 2007. 国际地质编图现状及发展趋势 [J]. 中国地质 , 34(2)：206−211.

张庆合 , 曹邦功 , 姜兰 . 2002. 1∶50 万地质图数据库的研建 [J]. 中国地质 , 29(2): 208−212.

万常选 , 廖国琼 , 吴京慧 , 刘喜平 . 2009. 数据库系统原理与设计 [M]. 北京：清华大学出版社 , 1−44. 587-590.

李廷栋 . 2007. 国际地质编图现状及发展趋势 [J]. 中国地质 , 34(2)：206−211.

张庆合 , 曹邦功 , 姜兰 . 2002. 1∶50 万地质图数据库的研建 [J]. 中国地质 , 29(2): 208−212.

（责任编辑　王学明　贾丽琼）

doi: 10.12029/gc2017Z102

Article Citation: Pang Jianfeng, Ding Xiaozhong, Han Kunying, Zeng Yong, Chen Anshu, Zhang Yanling, Zhang Qinghe, Yao Dong sheng. 2017.The national 1:1000000 geological map spatial database[J]. Geology in China, 44(S1): 10−23.
Dataset Citation: Pang Jianfeng, Ding Xiaozhong, Han Kunying, Zeng Yong, Chen Anshu, Zhang Yanling, Zhang Qinghe, Yao Dong sheng. 2017. The national 1:1000000 geological map spatial database [DB]. Global Geology Data, DOI:10.23650/data.H.2017.NGA105570.T1.64.1

Received: 24-07-2017
Accepted: 01-08-2017

Fund support: Supported by China Geological Survey Program (No. 1212010511501, 1212010511501).

The National 1:1000000 Geological Map Spatial Database

PANG Jianfeng [1], DING Xiaozhong[1], HAN Kunying[1], ZENG Yong[2], CHEN Anshu[3], ZHANG Yanling[4], ZHANG Qinghe[5], YAO Dongsheng[6]

(1. *The Institute of Geology,Chinese Academy of Geological Science, Beijing* 100037*, China;* 2. *Nanjing Geological Survey Center of NanjingChina Geological Survey, Nanjing* 210016*, Jiangsu, China;* 3. *Tianjin Geological Survey Center of China Geological Survey, Tianjin* 300170*, China;* 4. *Jilin Province Regional Geological and Mineral Survey, Changchun* 130061*, Jilin, China;* 5. *China Petroleum & Chemical Corporation Petroleum Exploration and Development Research Institute, Beijing* 100083*, China;* 6. *Sichuan Province Geology and Mineral Exploration and Development Bureau, Chengdu* 610081*, Sichuang, China*)

Abstract: The People's Republic of China 1:1000000 digital geological map database is based on uniform standards and requirements for the preparation of a thematic digital geological map. The geological map is based on comprehensive research, and fully absorbs the new achievements and new data of geological survey in recent years, making use of new technology, new theory and new methodology. Based on the chronology of the stratigraphic units and the representations of the rock strata, the intrusive rocks are further represented by the method of "lithology plus dating", which further improves the research degree of basic geology. The geological map database is rich in information with about 1.2 GB, having: rock stratigraphy units 5347 illustrations; intrusion "lithology plus era" unit 1780 cases; inter-provincial important fault 93; 558 important faults in the provinces (autonomous regions and municipalities); 1545 (group) of isotopic age data; and 382 representative holes. All the geometric elements of surface elements and line elements, isotopic age and drillings have established corresponding attributes, with adjacent maps between the map processing, map instructions and metadata are prepared. The database uses a unified linear library, symbol library, color library, the mapping process all using the MapGIS6.5 platform computer-aided map, plotting high precision, good quality, meeting design requirements to produce 64 national maps with four Area of the work of the method, the final unified system made. The digital geological map is the most complete and the latest 1:1000000 geological map in China, being the first result of China's first such digital geological map using GIS technology, which fully reflects the characteristics of China's geological structure and the current new level of geological research.

Keywords: 1:1000000 digital geological map; spatial database; MapGIS
Data service system URL: http://dcc.cgs.gov.cn

1 Introduction

The construction of the National 1:1000000 Geological Map Spatial Database has fully utilized the existing small−scale digital geological maps and databases, the new achievements of geological grand survey, the Geography Information System (GIS) and other new technology and methods in geological mapping. The Database is constructed

About the first author: PANG Jianfeng, male, born in 1983, assistant researcher, majors in Regional geological map compilation and application of GIS research; E−mail: pjf1712@163.com.

along with the compilation and update of national comprehensive basic geological maps and the construction and improving of spatial databases for the geological map series of different scales. It fills the gap for China in the 1:1000000 geological map spatial database and has achieved the aim of improving mapping speed, shortening mapping periods and realizing the sharing of information resources. As a basis for the National 1:1000000 Geological Map Spatial Database, the development of 64 sheets of international standard division range National 1:1000000 Digital Geological Map has been completed through integrated research and digital geological map compilation precision work.

Internationally great importance is attached to the compilation, update and database construction of small-scale geological maps. For example, Russia has started the third 1:1000000 geological survey and compilation and update of international standard sheet line geological maps. Other CIS countries and some Asian countries (e.g. Mongolia, Japan, South Korea) have conducted compilation and integrated research of small–scale geological maps, and made 1:1000000, 1:2.5000000 or 1:5000000 geological maps, tectonic maps and mineral deposit maps. Mongolia has completed the development of a 1:1000000 digital geological map and Japan has also developed a small–scale digital geological map (Asch, 2001, Bouysse et al., 2004, Li, 2007). The USA had completed this work and realized sharing of resources by the end of the 1980s. The rapid development and wide application of GIS greatly shortened the period for compilation, update and spatial database construction of small–scale geological maps (Han et al., 2005, Wan et al., 2009).

The geological conditions are complicated over the vast territory of China, and significant differences exists in the extent of geological research between East and West China. Around 1948, China made 14 sheets of international standard sheet line 1:1000000 geological maps including the Beijing sheet (J-50). From 1960 to 1966, the Geology Institute of the Chinese Academy of Geology guided the geological bureaus of all provinces and autonomous regions of China to compile a set of international standard division range 1:1000000 geological maps for some regions of China and a set of 1:3000000 national geological maps. Rich experience has been accumulated in compiling the international standard sheet line 1:1000000 and other geological maps. However, the systematic compilation of international standard sheet line National 1:1000000 Geological Maps had not been conducted since 1960s. So, it became urgent to update these maps. During 1996 to 1999, jointly initiated and approved by the former State Development and Planning Commission and the Ministry of Geology and Mineral Resources of China, the 1:500000 Digital Geological Map Spatial Database of PRC was constructed with GIS technology (Zhang et al., 2002). Therefore, the international standard sheet line National 1:1000000 Digital Geological Map has been compiled and the National 1:1000000 Geological Map Spatial Database constructed on the basis of the 1:500000 Geological Map Database of China, updating the achievements and development of the 1:250000 regional geological survey, especially that fully completed for the Qinghai—Tibetan Plateau region (110 sheets in total) combined with the 1:50000 and 1:250000 regional geological survey and thematic research. This digital map and spatial database have filled the gap for China and also improved the small–scale geological map spatial database of China. The scope of the international standard sheet line National 1:1000000 Digital Geological Map mainly covers the land area of PRC within 72°–138° East longitude and 16°–56° North latitude, numbered with the same sheet numbering as the 1:1000000 topographic maps. The sheet adjoining table and work area division are shown in Fig. 1. As a set of national integrated research achievements, the National 1:1000000 Digital Geological Map and associated Spatial Database reflect to the maximum extent the new achievements of Chinese geological survey, mineral exploration and scientific research made during the national land and resources grand survey in recent years. This survey provided basic geological maps for strategic research on mineral resources, energy exploration, territorial control, environmental protection, geological disaster prevention and major project construction. The maps are also a useful reference for geology teaching, scientific research and field geological investigation, and provide detailed basic information for foreign scientists to fully understand the geology of China, to study and protect the earth and facilitate international communication and cooperation (Han et al., 2005).

The metadata of the National 1:1000000 Geological Map Spatial Database is shown in Table 1.

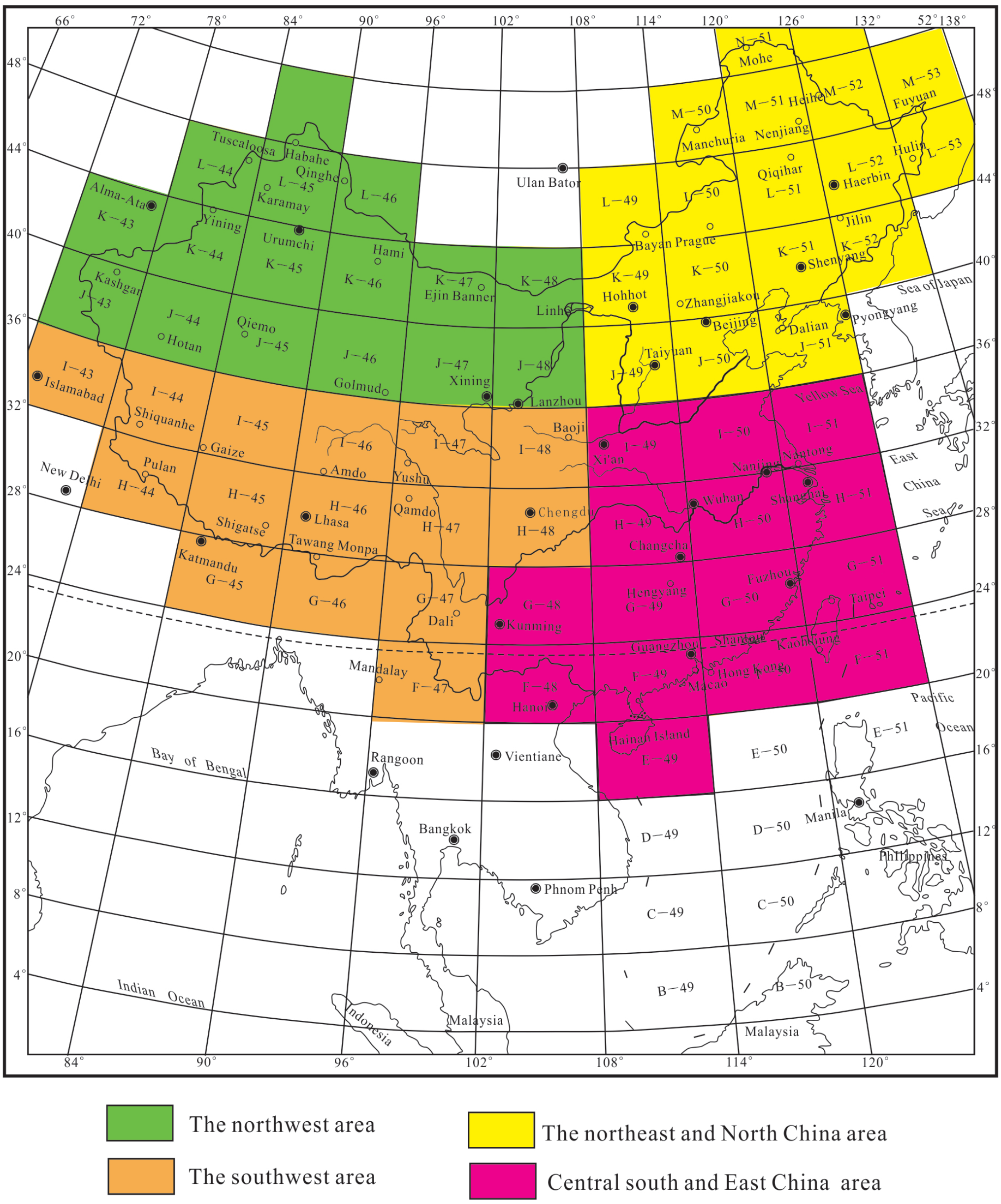

Fig. 1 Sheet index of 1:1000000 geological map of China and the division of working areas.

Table1 Metadata table of dataset(s)

Items	Description
Database (dataset) name	The National 1:1000000 Geological Map Spatial Database
Database authors	Pang Jianfeng, The Institute of Geology, Chinese Academy of Geological Science Ding Xiaozhong, The Institute of Geology, Chinese Academy of Geological Science Han Kunying, The Institute of Geology, Chinese Academy of Geological Science Zeng Yong, Nanjing Geological Survey Center of Nanjing, China Geological Survey Chen Anshu, Tianjin Geological Survey Center of China Geological Survey Zhang Yanling, Jilin Province Regional Geological and Mineral Survey Zhang Qinghe, China Petroleum & Chemical Corporation Petroleum Exploration and Development Research Institute Yao Dongsheng, Sichuan Province Geology and Mineral Exploration and Development Bureau
Corresponding Author	Ding Xiaozhong, E-mail: xiaozhongding@sina.com
Data acquisition time	From 2002 to 2007
Geographic area	The scope mainly covers the land area of PRC within 72°−138° E longitude and 16°−56° N latitude, numbered with the sheet numbers of the 1:1000000 topographic maps
Data format	MapGIS
Data size	1.2 GB
Data service system URL	http://dcc.cgs.gov.cn
Language	Chinese
Database (set) composite	This system consists of the international standard sheet line1:1000000 geological map database, the 1:1000000 geographical base map database, attribute database, color database, line database and pattern symbol database. The geological map database consists of 64 standard sheets covering the land area of China, equivalent to 64 sub-databases. Map sheets are divided by longitude difference 6 degrees and latitude difference 4 degrees. The content of geological map is stored in single precision geography coordinates. The geographic database has 64 standard sheets, including 7 thematic layers: boundary, water system, residential area, communication, topographic feature, cultural element and geographic grid

2 Data Collection and Processing

2.1 Data Basis

The National 1:1000000 Geological Map has been compiled under the guidance of the theories of plate tectonics and geodynamics, utilising the National 1:500000 Geological Map Database, updated information and research achievements of the recently completed 1:250000 regional geological survey, using the updated international standard sheet line National 1:1000000 Digital Topological Map (2002) released by the National Geomatics Center of China as the geographical base map, and also in accordance with the 1:1000000 Standard Map Atlas of Provincial Level Administrative Boundary of the

Peoples Republic of China released in June 2004 by the Ministry of Civil Affairs and the State Bureau of Surveying and Mappingas well as the updated geography information in the *Administrative Divisions of the People's Republic of China* (2002–2005). The geological information is up to date as of December 2006, except for some as of the end of 2007. Using the existing technical standards and domestic and international common software for data processing and management (dedicated software is developed when necessary), the National 1:1000000 Geological Map Spatial Database has been constructed with the precision required for 1:1000000 geological maps. Meanwhile, a basic geological map is provided to fully display the regional geological survey, mineral exploration and comprehensive research level of China in recent years.

2.2 Data Processing

The data processing flow of the 1:1000000 Digital Geological Map Database and the National 1:1000000 Geological Map is described below:

(1) First, retrieve the standard sheet line National 1:1000000 Geological Map from the 1:500000 Geological Map Database, then summarize and merge them on the basis of updated information, integrated research, new theory, new method and new technology of geoscience and lithostratigraphy of China, complementing and selecting updated mapping information according to the compilation requirements of the 1:1000000 Geological Map. Then scan them to generate TIF files. Vectorize line features in MapGIS system to generate WL files, and input note code to generate WT files. After that, match with the 1:1000000 geographical base map through projection conversion and error correction, then adjoin with the 1:1000000 Geological Map and output proof sheet. Inspect and modify the proof sheet, then modify, edit and review the map on a computer screen, then output and preliminarily review the map, create topological area, fill color and finish appearance to generate WP files. Due to differences in mapping basic information, each sheet of the map differs in mapping flow. The main work flow is shown in the following flow chart (Fig. 2).

(2) Prepare attributes lists. Output the attribute list in MapGIS6+.5, modify and complement attributes and convert code with other software (such as EXCEL), then print the attributes lists, inspect the content of the attributes lists manually, then associate them with mapping data and output with color ink-jet printer.

(3) Match the geological content strictly with the geographical base map by selecting 35 control points for each sheet of map to ensure the graticule error and contour point error is no more than 0.1 mm.

(4) Data neighbor processing: after projection conversion of the geological map database to geographic coordinate system, first match it with the theoretical frame provided by the Project Office, then process neighboring map with the adjacent sheets in the following steps: (a) ensure coherence in geological content; (b) in order to seamlessly input the geological map to the database, each adjoining line is processed by line end connection to ensure seamless connection of the geological boundary with the neighboring sheets.

(5) The outside appearance of the National 1:1000000 Geological Map conforms to uniform requirements. The legend layout location and font size meet uniform specifications. The content of the legend is prepared in the order of strata, igneous rock, volcanic rock, special geological entity, tectonic structural boundaries.

(6) Inspect attribute data. The Project Team developed a software to carry out inspection

of attribute data, including structure, type and content of attribute. Meanwhile, manual inspection is conducted to minimize error ratio.

(7) Prepare text description and metadata and submit them to the Project Office for summarizing, reviewing and revising.

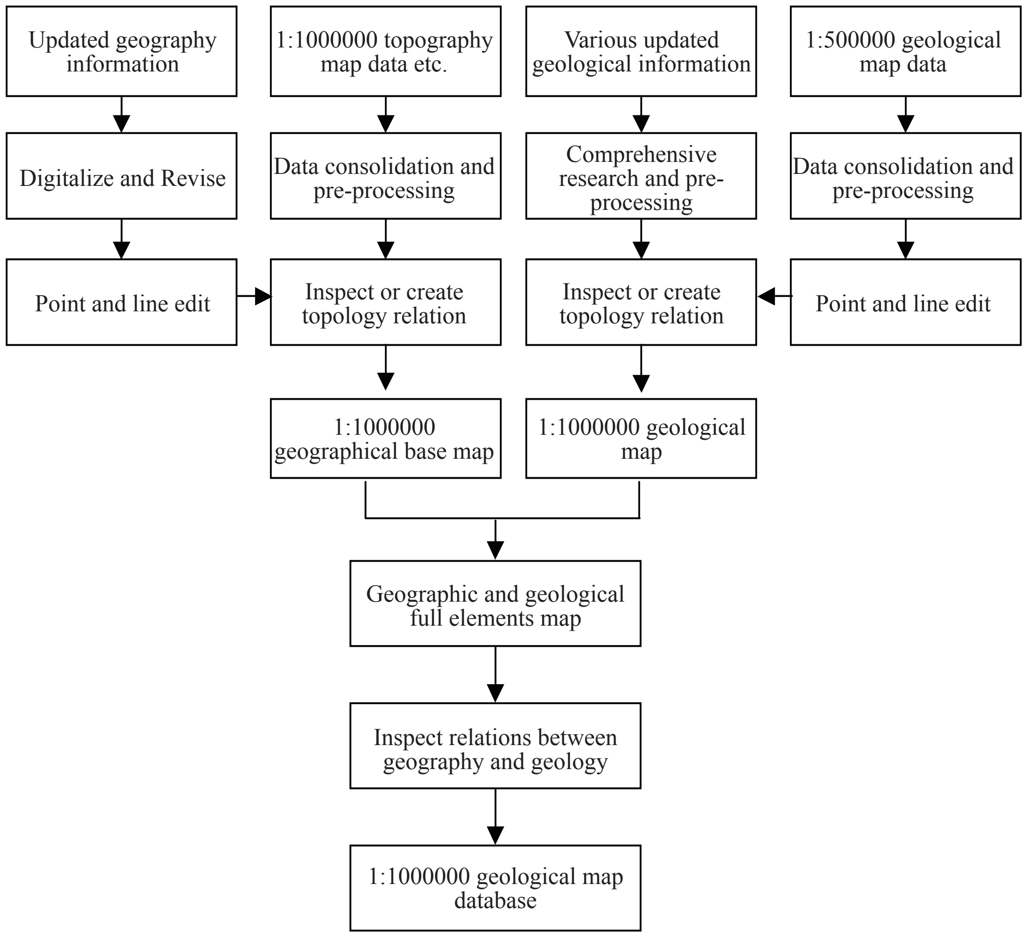

Fig. 2 Main route chart of the 1:1000000 geological map database.

3 Description of Data Content

3.1 Name of map layers

The layers of the geological map and geographical base map are mainly classified by the types of elements and stored in the form of files.

3.2 Naming of geological map data

Sheet number + geological polygon. WP, sheet number + geological line. WL, sheet number + geological point. WT.

3.3 Naming of geographic sheet file

L+ sheet number + name of geographic element.

3.4 Names of element (entity) types

Name of entity type: point, polygon, arch;

Point entities: isotopes, core drilling site, geological entity note, geological symbol, geological pattern;

Polygon entities: strata, intrusive mass;

Arc entities: fracture structure, conformity, unconformity, parallel unconformity and lithofacies boundary, etc.

3.5 Attributes lists

The 1:1000000 Digital Geological Map Database include geological entities element information and geography elements information. Attributes of geological entities include a strata polygon feature attributes list, geological boundary attributes list, fault attributes list, and geological point feature attribute list.

The geological entity polygon feature attributes list mainly includes strata and intrusive rock units. Its attribute structure is as follows: User ID (identification code); TYPE (types of polygon feature): 1−strata, 2−Quaternary, 3−igneous rock, 4−Pre-Pliocene volcanic rocks, 5−mixed rock and metamorphosed plutonite; COLORNO (color number): fill in the number of color; FILLNO (number of fill pattern); FILLCOLOR (color number of fill pattern); FILLHEIGHT (height of fill pattern) ; CODE1 (code of geological age) ; CODE2 (code of rock name) ; SYMBOL (geological code) ; UNITNAME (including rock strata unit and intrusive rock name) ; DESCRIPTOR (strata or rock description).

Fault attributes list: User ID (identification code); TYPE (type code): 1−national major fault, 2−provincial major fault, 3−common fault; LSTY1 (line type code); LSTY2 (auxiliary line type code); CODE1 (fault code): 1−plate junction zone, 2−crust suture zone, 3−strike-slip fault zone, 4−thrust nappe fault zone, 5−complex fault zone, 6−unidentified fault zone, 7−other fault zone; CODE2 (fault symbol): filled in with codes in GB958−99; ATTR (nature of line feature): filled in with actual fault; NAME (name); DESCRIPTOR (description of fault): describing the national and provincial major faults including the nature and type of faults, strata occurrence, fault strike and tectonic significance, etc.

Geological entity boundary attributes list: User ID (identification code); TYPE (type code): 4−strata boundary, 5−geological entity structural polygon boundary; LSTY1 (line type code); LSTY2 (auxiliary line type code); CODE1: blank; CODE2 (geological boundary, geological entity contact boundary, geological entity structural polygon boundary): the former two attributes are filled in with codes in GB958−99, the last is filled in with additional code provided by the Project Office; ATTR (nature of line feature); NAME (name); DESCRIPTOR: description of the corresponding geological entity boundary.

Geological entity point feature attributes list: User ID (identification code); TYPE (type code): 1−isotopic age sampling point, 2−drilling site, 3−grater, 4−important fossil collection site, 5−geological park, 6−standard section; CODE1 (point feature code), the first three digits are GB958-99 code, the late three digits are sequence number, e.g. code for isotope 802001; SYMBOL (code of point feature symbol): the number of point features in the 1:1000000 systematic database; LONGITUDE (longitude of location of point feature); LATITUDE (latitude of location of point feature); DESCRIPTOR (description): description of corresponding point features.

Geographic element information includes residence site attributes list, railway attributes list, road attributes list, single line stream attributes list, planar water system attributes list and cultural elements attributes list, etc.

4 Database Composition

This system consists of the international sheet line 1:1000000 geological map database, the 1:1000000 geographical base map database, attributes database, color database, line database and pattern symbol database. The geological map database consists of 64 standard sheets covering the land area of China, equivalent to 64 sub-databases. Map sheets are divided by longitude difference 6 degrees and latitude difference 4 degrees. The content of the geological map is stored in single precision geographic coordinates. The geographic database has 64 standard sheets, including 7 thematic layers: boundary, water system, residential area, communication, topographic feature, cultural element and geographic grid.

5 Data Output Quality and Accuracy

The 1:1000000 Geological Map is outputted in 1:1 equal proportion in accordance with the output precision requirements or in parameters as required by the customer.

As for precision of geological entities, geological ages are expressed in epoch, stratigraphic units are expressed in formation (formation complex), a few stratigraphic units are expressed in member or group (group complex), intrusive body is expressed in “lithologic age group”(era or epoch). A fault is expressed to national major fault and provincial major fault. Common faults are indicated by classes. Corresponding attributes are created for each geological unit.

Geological entities map expression precision: width≥0.8mmor area≥$2mm^2$; corresponding attributes are created for each geological entity unit. Some important geological entities, e.g. eclogite, which reflects tectonic movement, though with small area, are expressed exaggeratedly on the map. Isotopic dating applies the U−Pb whole rock isochron dating method and single zircon dating method in metamorphic rock areas and the Rb−Sr whole rock isochron dating method in magmatic rock areas. The dating precision can meet the requirements.

For geographic content, water system, residential area and road are expressed on the map. Lakes with length>10mm or area >$2mm^2$ are expressed on the map. Residential areas above township level are expressed on the map. To match the geological data and geographic data, 35 control points are chosen from each sheet and the error of the four map border points is within 0.1 mm and meet the requirement on precision.

6 Quality Assurance for the Database

After all data of the database are consolidated, in order to ensure the completeness and correctness of the mapping process and the attribute content, structure and code of the geological entity elements, the Project Team developed the “1:1000000 Geological Map Spatial Database Automatic Inspection System” according to the “Mapping Details”, to conduct comprehensive inspection and modification of the data.

The inspection covers the following items: the data scope, bordering attributes and topology relation are inspected for correctness; map sheet display after data has been imported to database is inspected for completeness; the attributes, color of polygon feature and fill pattern are inspected by legends and layers after the legend is generated for each map sheet. During database construction, multi–level and multi–link inspection and supervision are implemented to ensure the correctness of data in the database.

The list of staff members and quality control personnel is shown in Table 2.

Table 2 Participation in staff unit division table

Serial number	Map title	Number	Participating units	Participants
1	Geological map of Sanya	E–49	Guang Xi Bureau of Geology & Mineral Prospecting & Exploitation	Zhang Zhongwei, Liu Zhen
2	Geological map of Jinghong	F–47	Si Chuan Bureau of Geology & Mineral Resources	Yao Dongsheng, Zhang Ping,Ma Dongman
			Chengdu Institute of Geology and Mineral Resources	Qin Dehou
3	Geological map of Pinxiang	F–48	Guang Xi Bureau of Geology & Mineral Prospecting & Exploitation	Zhang Zhongwei, Liu Zhen
4	Geological map of Guangzhou	F–49	Guang Xi Bureau of Geology & Mineral Prospecting & Exploitation	Zhang Zhongwei, Liu Zhen
5	Geological map of Xianggang	F–50	Guang Xi Bureau of Geology & Mineral Prospecting & Exploitation	Zhang Zhongwei, Liu Zhen
6	Geological map of Gaoxiong	F–51	Jiang Xi Bureau of Geology & Mineral Prospecting & Exploitation	Yang Minggui, Li Yanhong
			Nanjing Institute of Geology and Mineral Resources	Zeng Yong
7	Geological map of Yadong	G–45	Si Chuan Bureau of Geology & Mineral Resources	Yao Dongsheng, Liang Xinzhi, Luo Jianning
			Chengdu Institute of Geology and Mineral Resources	Wang Haiquan, Wang Liquan, Yan Yangji, Ling Xiaoming
8	Geological map of Cuona	G–46	Si Chuan Bureau of Geology & Mineral Resources	Yao Dongshneg, Liang Xinzhi
			Chengdu Institute of Geology and Mineral Resources	Pan Guitang, Yan Yangji, GengQuanru, Ling Xiaoming, Ma Hongman
9	Geological map of Dali	G–47	Si Chuan Bureau of Geology & Mineral Resources	Yao Dongsheng, ZhangPing, Ma Dongman
			Chengdu Institute of Geology and Mineral Resources	Qin Dehou
10	Geological map of Kunming	G–48	Si Chuan Bureau of Geology & Mineral Resources	Yao Dongsheng, Qin Dehou, Wei Jiayong, Zhang Ping
11	Geological map of Hengyang	G–49	Guang Xi Bureau of Geology & Mineral Prospecting & Exploitation	Zhang Zhongwei, Liu Zhen

Continued from Table 2

Serial number	Map title	Number	Participating units	Participants
12	Geological map of Fuzhou	G−50	Jiang Xi Bureau of Geology & Mineral Prospecting & Exploitation	Yang Minggui, Li Muxiang
			Nanjing Institute of Geology and Mineral Resources	Zeng Yong
13	Geological map of Taibei	G−51	Jiang Xi Bureau of Geology & Mineral Prospecting & Exploitation	Yang Minggui, Li Yanhong
			Nanjing Institute of Geology and Mineral Resources	Zeng Yong
14	Geological map of Pulan	H−44	The Institute of Geology,Chinese Academy of Geological Science	Liu Xun
15	Geological map of Shigatse	H−45	Si Chuan Bureau of Geology & Mineral Resources	Yao Dongsheng, Liang Xinzhi, Luo Jianning
			Chengdu Institute of Geology and Mineral Resources	Wang Quanhai,Wang Liquan,Yan Yangji, Ling Xiaoming
16	Geological map of Lhasa	H−46	Si Chuan Bureau of Geology & Mineral Resources	Yao Dongsheng, Liang Xinzhi
			Chengdu Institute of Geology and Mineral Resources	PanGuitang, Yan Yangji, GengQuanru, Ling Xiaoming, Ma Hangman
17	Geological map of Changdu	H−47	Si Chuan Bureau of Geology & Mineral Resources	Yao Dongsheng, Wang Zeng, Zhang ping, Ma Hongman
18	Geological map of Chengdu	H−48	Si Chuan Bureau of Geology & Mineral Resources	Yao Dongsheng, Hu Mingming,Zhang Ping
			The Institute of Geology,Chinese Academy of Geological Science	Liu Yanxue
19	Geological map of Changsha	H−49	Jiang Xi Bureau of Geology & Mineral Prospecting & Exploitation	Yang Minggui, Li Yanhong
			Nanjing Institute of Geology and Mineral Resources	ZengYong
20	Geological map of Wuhan	H−50	Jiang Xi Bureau of Geology & Mineral Prospecting & Exploitation	Yang Minggui, Li Yanhong, Li Muxiang
			Nanjing Institute of Geology and Mineral Resources	ZengYong
21	Geological map of Shanghai	H−51	Jiang Xi Bureau of Geology & Mineral Prospecting & Exploitation	YangMinggui, Li Yanhong, Li Muxiang
			Nanjing Institute of Geology and Mineral Resources	ZengYong
22	Geological map of Chogori	I−43	The Institute of Geology,Chinese Academy of Geological Science	Liu Xun
23	Geological map of Gaer	I−44	The Institute of Geology,Chinese Academy of Geological Science	Liu Xun

Continued from Table 2

Serial number	Map title	Number	Participating units	Participants
24	Geological map of Gaize	I−45	The Institute of Geology,Chinese Academy of Geological Science	Fu Derong, Liu Xun, Han Kunying
25	Geological map of Anduo	I−46	The Institute of Geology,Chinese Academy of Geological Science	Liu Xun
26	Geological map of Yushu	I−47	The Institute of Geology,Chinese Academy of Geological Science	Liu Yanxue
27	Geological map of Baoji	I−48	The Institute of Geology,Chinese Academy of Geological Science	Liu Yanxue
28	Geological map of Xi'an	I−49	The Institute of Geology,Chinese Academy of Geological Science	Liu Yanxue
29	Geological map of Nanjing	I−50	Jiang Xi Bureau of Geology & Mineral Prospecting & Exploitation	Yang Minggui, Li Muxiang
			Nanjing Institute of Geology and Mineral Resources	Zeng Yong
30	Geological map of Nantong	I−51	Jiang Xi Bureau of Geology & Mineral Prospecting & Exploitation	Yang Minggui, Li Muxiang
			Nanjing Institute of Geology and Mineral Resources	Zeng Yong
31	Geological map of Kashgar	J−43	The Institute of Geology,Chinese Academy of Geological Science	Liu Yanxue
32	Geological map of Hotan Prefecture	J−44	Regional Geological Survey Team of Qinghai Province	Zheng Jiankang, Wang Dongqing, Yu Jinghui, Peng Xi,Pi Yingnan
33	Geological map of Qiemo	J−45	Regional Geological Survey Team of Qinghai Province	Zheng Jiankang, Wang Dongqing,Yu Jinghui,Peng Xi,Pi Yingnan
34	Geological map of Golmud	J−46	Regional Geological Survey Team of Qinghai Province	Zheng Jiankang,Wang Dongqing,Yu Yinghui,Peng Xi,Pi Yingnan
35	Geological map of Xining	J−47	Regional Geological Survey Team of Qinghai Province	Zheng Jiankang,Wang Dongqing,Yu Jinghui,Peng Xi,Che Li
36	Geological map of Lanzhou	J−48	Regional Geological Survey Team of Qinghai Province	Zheng Jiankang,Wang Dongqing,Yu Jinghui,Peng Xi,Che Li
37	Geological map of Taiyuan	J−49	The Institute of Geology,Chinese Academy of Geological Science	Min Longrui
38	Geological map of Beijing	J−50	The Institute of Geology,Chinese Academy of Geological Science	Chi Zhenqing
39	Geological map of Dalian	J−51	The Institute of Geology,Chinese Academy of Geological Science	Chi Zhenqing
40	Geological map of Moutain of turrigo	K−43	The Institute of Geology,Chinese Academy of Geological Science	Ding Xiaozhong,Liu Xun,JuYuanjing

Continued from Table 2

Serial number	Map title	Number	Participating units	Participants
41	Geological map of Yining	K−44	The Institute of Geology,Chinese Academy of Geological Science	Ding Xiaozhong,Liu Xun,JuYuanjing
42	Geological map of Urumchi	K−45	The Institute of Geology,Chinese Academy of Geological Science	Ding Xiaozhong,Liu Xun,Han Kunying
43	Geological map of Hami	K−46	The Institute of Geology,Chinese Academy of Geological Science	Wang Yong,Ding Xiaozhong
44	Geological map of Ejin Banner	K−47	The Institute of Geology,Chinese Academy of Geological Science	Wang Yong,Ding Xiaozhong
45	Geological map of Bayan Nur	K−48	The Institute of Geology,Chinese Academy of Geological Science	Wang Yong,Ding Xiaozhong
46	Geological map of Hohhot	K−49	Tianjin Institute of Geology and Mineral Resources	Chen Anshu,Zhang Baohua
			Geological Survey Institute of Inner Mongolia	Zhao Heming
47	Geological map of Zhangjiakou	K−50	Tianjin Institute of Geology and Mineral Resources	Chen Anshu,Zhang Baohua
			Geological Survey Institute of Inner Mongolia	Zhao Heming
48	Geological map of Shengyang	K−51	Jilin Province Regional Geology and Mineral Resources Survey	Wang Youqin,Zhang Yanling,Wang Kaihong
49	Geological map of Jiling	K−52	Jilin Province Regional Geology and Mineral Resources Survey	Wang Youqin,Zhang Yanling,Hu Hongxia
50	Geological map of Tacheng	L−44	The Institute of Geology,Chinese Academy of Geological Science	Wang Yong,Ding Xiaozhong
51	Geological map of Karamay	L−45	The Institute of Geology,Chinese Academy of Geological Science	Wang Yong,Ding Xiaozhong
52	Geological map of Qing Courty	L−46	The Institute of Geology,Chinese Academy of Geological Science	Wang Yong,Ding Xiaozhong
53	Geological map of Bayanwula	L−49	Tianjin Institute of Geology and Mineral Resources	Chen Anshu,Zhang Baohua
			Geological Survey Institute of Inner Mongolia	Zhao Heming
54	Geological map of West Ujimqin Banner	L−50	Tianjin Institute of Geology and Mineral Resources	Chen Anshu,Zhang Baohua
			Geological Survey Institute of Inner Mongolia	Zhao Heming
55	Geological map of Tsitsihar	L−51	Physical Geological Data Center of China Geological Survey	Ye Dingheng,Wang Guilan
56	Geological map of Harbin	L−52	Jilin Institute of Geological Survey	Wang Youqin,Zhang Yanling,Hu Hongxia
57	Geological map of Hulin	L−53	Jilin Institute of Geological Survey	Wang Youqin,Zhang Yanling,

Continued from Table 2

Serial number	Map title	Number	Participating units	Participants
58	Geological map of Habahe	M−45		
59	Geological map of NZH	M−50	Physical Geological Data Center of China Geological Survey	Ye Dingheng,Wang Guilan,Ye Qingpei
60	Geological map of Nen River	M−51	Consulting &Resaearch Center Ministry of Land & Resources,The Institute of Geology,Chinese Academy of Geological Science	Li Tingdong
			Physical Geological Data Center of China Geological Survey	Ye Dingheng, Wang Guilan
61	Geological map of Heihe	M−52	Jilin Institute of Geological Survey	Wang Youqin, Zhang Yanling, Wang Kaihong, Hu Hongxia
62	Geological map of Fuyuan	M−53	Jilin Institute of Geological Survey	Wang Youqin, Zhang Yanling
63	Geological map of Mohe	N−51	Physical Geological Data Center of China Geological Survey	Ye Dingheng, Wang Guilan
64	Geological map of Xinmin	N−52	Physical Geological Data Center of China Geological Survey	Ye Dingheng, Wang Guilan

7 Application Prospects of the Database

The database has prospects of wide application. It may be used as a basic geological information database for compiling thematic maps of various scales and geological maps of smaller scale, thus providing powerful support for modernizing the compilation of various small−scale geological maps and corresponding thematic maps. Besides, it can be widely applied in geological and mineral surveys, management, planning and economic construction.

8 Conclusion

The National 1:1000000 Geological Map Spatial Database Construction Project is implemented on the basis of the new achievements of geological survey and thematic research of China in recent years, underpinned by plate tectonics and geodynamics theories. The Geography Information System (GIS) is used for guidance, and new technology and methods of geological mapping are used in this project. As an outcome of integrated research and digital geological map compilation work conducted in accordance with international standard sheet line and the requirements on precision of 1:1000000 geological mapping, the project team successfully completed 64 sheets of international sheet line National 1:1000000 Digital Geological Map and the National 1:1000000 Geological Map Spatial Database. This achievement fills the gap for China in 1:1000000 Geological Map Spatial Database field and provides a set of basic geological maps for demonstrating the regional geological survey, mineral exploration and comprehensive research level of China in recent years. The geological information is updated as of December 2006, except for some updated as of the end of 2007. The research covers the land area of the People's Republic of China.

This is the first time for China to systematically compile a National 1:1000000 Digital Geological Map and construct the National 1:1000000 Geological Map Spatial Database. This map and database have improved the basic scale geological map database system of China, met the needs of China for integration of regional geological information to the maximum extent, expands the function of geological map database, creates conditions for sharing of information, and lays the foundation for public sharing of geological survey results of a basic and public welfare nature.

The National 1:1000000 Geological Map Spatial Database features mass information, complete database function and strong practicality. However, there are still problems and shortcomings in the database. Revision and improvement and addition of updated information to the database and establishment of regular update and maintenance mechanism are necessary in the next stage.

Acknowledgements: *The National 1:1000000 Geological Map Spatial Database* is an integrated achievement. The successful implementation of this project relies on the effort of all participating scientists and technicians. Peng Qiming, Director of Science, Technology and Foreign Affairs Department, Geological Survey of China, and section chiefs Lu Minjie, Liu Fengshan and Xiao Guiyi, all experts in the Scientific Advisory Group and all participating institutions provided great support to this project. Prof. Chen Kuqiang, Prof. Gao Zhenjia and Prof. Gao Linzhi provided lithostratigraphic data for this project. The Institute of Geology, Chinese Academy of Geological Sciences, the underwriter of the project, has consistently provided support for this project. We highly appreciate all of these efforts and support and express our sincere thanks to all of them.

Reference

Asch K. 2001. Under construction: the geological GIS of the 1:5000000 international geological map of Europe and adjacent areas [J]. Episodes, 24(3): 201−204.

Bouysse P, Mendel V, Munschy M, Segoufin J. 2004. A new CGMW map: The structural map of the Indian Ocean: An attempt at ocean cartography[J]. Episodes, 26(2): 199−202.

Han Kunying, Ding Xiaozhong, Fan Benxian, Geng Shufang, Ju Yuanjing. 2005. The application of MapGIS to the construction of geological map database [J]. Acta Geoscientica Sinica, 26(6): 587−590(in Chinese with English abstract).

Han Kunying, Ding Xiaozhong, Fan Benxian, Geng Shufang, Ju Yuanjing. 2005. Methods of regional geological map production based on GIS [J]. Geology in China, 32(4): 713−717(in Chinese with English abstract).

Li Tingdong. 2007. Status and development trend of geological map compilation in the world [J]. Geology in China, 34(2): 26−211(in Chinese with English abstract).

Zhang Qinghe, Cao Banggong, Jiang Lan. 2002. Development and construction of the 1:500 000 geological map database [J]. Geology in China, 29(2): 208−212 (in Chinese with English abstract).