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河北省 1∶50 000 沙流河幅第四系钻孔数据库

陈圆圆　卜令　专少鹏　杨瑞　赵华平　季虹　陈超　陈宏强
(河北省区域地质调查院，河北 廊坊 065000)

摘要: 河北省 1∶50 000 沙流河幅是京津冀平原地区地质调查的重点图幅之一，晚新生代地层是图幅的主要调查对象，第四系钻孔数据库是地质调查核心成果的体现。本次工作利用钻孔施工和测试成果数据，结合收集的钻孔资料，建立了第四系钻孔数据库，主要包括 1 个钻孔基本信息图层、5 个钻孔编录数据库、5 个钻孔设计数据库及 5 张钻孔柱状图。本文从数据来源、数据处理方法、数据属性结构及数据质量控制等方面进行了归纳总结，以呈现基于数字地质调查系统的第四系钻孔数据库成果和建库实例。本数据库为唐山地区城市三维地质模型的建立提供了基础数据，服务于京津冀协同发展，同时也为平原区地质调查中钻孔数据的处理及建库提供了参考。

关键词: 河北；1∶50 000；沙流河幅；第四系钻孔；数据库；地质调查工程
数据服务系统网址: http://dcc.cgs.gov.cn

1　引言

钻孔是具有狭小地表面积和一定深度的三维柱状体，平面上可通过点状实体存储表示。对于获得地下地层、构造、含水量等信息来说，钻探无疑是最有效的手段。钻孔数据是钻探工作的主要成果，称得上是最直接、最可靠的地下空间信息源 (唐丙寅，2015)。第四系钻孔数据则是解析城市三维地质结构的重要依据 (何静等，2019)，因此在平原区地质调查中，第四系钻孔数据库的建设至关重要。

河北省 1∶50 000 沙流河幅 (J50E001016) 为"燕山–太行成矿带丰宁和天镇地区地质矿产调查项目"2016 年工作图幅之一，位于河北省东部，行政区划隶属唐山市玉田县管辖，为京津冀地区重要工业基地。图幅内主要包括 2 个地貌单元：北部低山丘陵区，高程一般在 100 ~ 400 m；南部华北平原区，高程为 2 ~ 50 m。区内水系较发育，均属于古滦河水系和燕山山前水系，形成本区冲洪积平原。调查区前期钻探工作主要是煤炭地质勘查和水文地质勘查，对查明基岩埋深和第四纪地层划分具有重要作用。本次工作中对前期钻孔资料进行了系统收集，认真分析不同钻孔的可利用程度，通过分析判

第一作者简介：陈圆圆，女，1988 年生，硕士，工程师，从事矿产地质调查及数据库建设工作；E-mail：517371457@qq.com。

别，根据不同钻孔地层划分的详细程度、分布特征，选择分布均匀、划分详细的钻孔作为主要参考资料。本次调查工作在沙流河图幅内施工第四系钻孔 1 眼 (PZK10)，收集钻孔 4 眼 (BK1、BK17、玉 3、丰 1)，构成图幅内东西向钻孔联合剖面 (图 1)，为研究第四纪地层结构、构建三维模型提供了重要资料支撑 (朱良峰等，2004；周毅等，2016)。河北省 1：50 000 沙流河幅第四系钻孔数据库（陈圆圆等，2020）依据《数字地质调查系统操作指南》(李超龄，2011）建立，按规定的文件目录进行存储，其元数据情况如表 1 所示，数据库结构目录如图 2 所示。

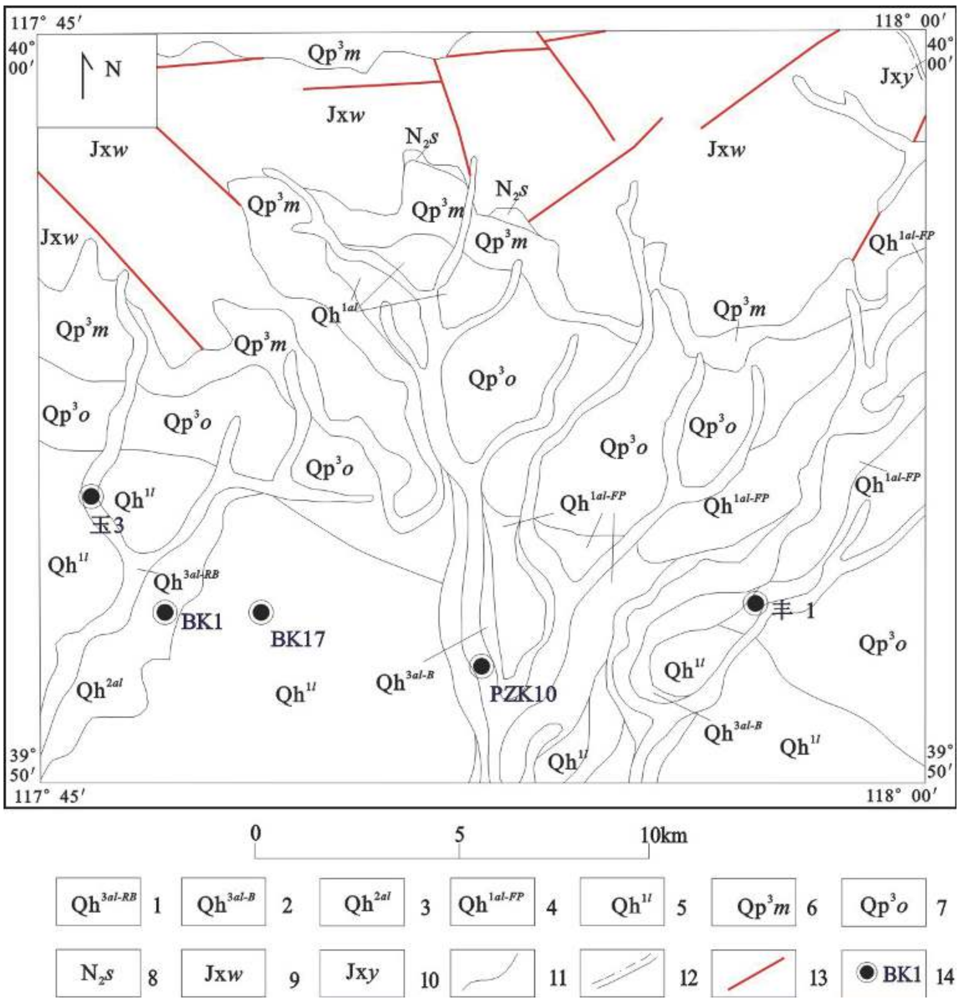

图 1　河北省 1：50 000 沙流河幅第四系钻孔数据库钻孔位置分布图

1—全新世晚期冲积物，河床亚相；2—全新世晚期冲积物，堤岸亚相；3—全新世中期冲积物；4—全新世早期冲积物，河漫亚相；5—全新世早期湖积物；6—晚更新世马兰组；7—晚更新世欧庄组；8—上新世石匣组；9—蓟县纪雾迷山组；10—蓟县纪杨庄组；11—整合界线；12—平行不整合界线；13—断层；14—钻孔位置及编号

2　数据采集和处理方法

2.1　数据采集

河北省 1：50 000 沙流河幅钻孔数据主要通过资料收集及钻探实测获得。收集资料包括钻孔岩心编录、分层数据、测井数据及钻孔报告等，数据格式为.doc、.xls 或.jpg。本图幅内收集钻孔为玉 3、丰 1、BK1、BK17，基本信息如表 2 所示。

表 1 数据库 (集) 元数据简表

条目	描述
数据库(集)名称	河北省1：50 000沙流河幅第四系钻孔数据库
数据库(集)作者	陈圆圆，河北省区域地质调查院 杨 瑞，河北省区域地质调查院 赵华平，河北省区域地质调查院 卜 令，河北省区域地质调查院 陈宏强，河北省区域地质调查院
数据时间范围	2017—2018年
地理区域	东经 117°45′～118°00′，北纬39°50′～40°00′
数据格式	.mpj,.mdb,.tif
数据量	249 MB
数据服务系统网址	http://dcc.cgs.gov.cn
基金项目	河北1：50 000沙流河幅(J50E001016)、左家坞幅(J50E001017)、鸦鸿桥幅(J50E002016)、丰润幅(J50E002017)区域地质调查(项目编号：DD20160042-4)
语种	中文
数据库(集)组成	该数据库包括5个钻孔，收集钻孔(BK1、BK17、玉3、丰1)数据中包括钻孔柱状图(.mpj文件)及数据库(.mdb文件)，施工钻孔(PZK10)数据中包括钻孔柱状图(.mpj文件)、岩心照片(.tif文件)及数据库(.mdb文件)，分别按照数字地质调查数据库建设标准以文件夹形式分别存储于不同级别目录中

本次调查施工钻孔为 PZK10，孔深 301 m，揭穿新生代地层。钻孔施工中采用机械岩心钻，钻探口径为 108 mm。采用 PVC 管作为岩心箱，完成岩心取样及保存工作。钻孔终孔后进行了综合测井。野外测井工作使用重庆地质仪器厂生产的 JGS-1 型综合数字测井设备，利用电位差计的自动补偿原理间接测量电位差；激电测井使用重庆地质仪器厂生产的 DZD–6A 多功能直流电法 (激电) 仪。对钻孔进行了视电阻率、自然电位、自然伽马、井温、激电和井斜的综合测井。技术指标参照《煤田地球物理测井规范》(DZ/T0080–1993) 以及《水文测井工作规范》(DZ/T0181–1997) 执行。每天野外测量收工后将采集的数据资料从仪器输出到数据资料存储硬盘中，检查所采集的数据文件、野外记录、测点坐标及点号等信息是否有错漏，确认无误后存盘待后期处理。

2.2 数据处理过程

将收集到的钻孔资料及野外钻孔施工数据进行整理，依据《数字地质调查系统操作指南》(李超龄，2011) 要求，进行第四系钻孔数据库建设工作。主要应用数字填图系统 (DGSS2014 版)、MapGIS 6.7、Excel 2007、Access 2007、CorelDrawX4 等软件进行数据处理。

2.2.1 钻孔基本信息录入

在数字填图系统 (DGSS) 第四系钻孔模块中，点击“新增钻孔”，在图幅内相应位置点下钻孔点，弹出钻孔基本信息对话框，依次录入勘探线号 (本幅内为 KT2 或 KT3)、工程编号 (本次以钻孔编号命名)、工程名称、钻孔类别、坐标位置、比例尺等信息，系统将依据勘探线号、工程编号生成相应的文件夹用于存储钻孔数据。此时钻孔位置为手工点击位置，必须点击“重投影”，系统将根据输入的测量坐标准确定位钻孔点。钻孔点文件存储于 ZKFOUR.WT 文件中，点击“编辑钻孔”，可编辑各钻孔基本信息，录入完成后保存点文件。

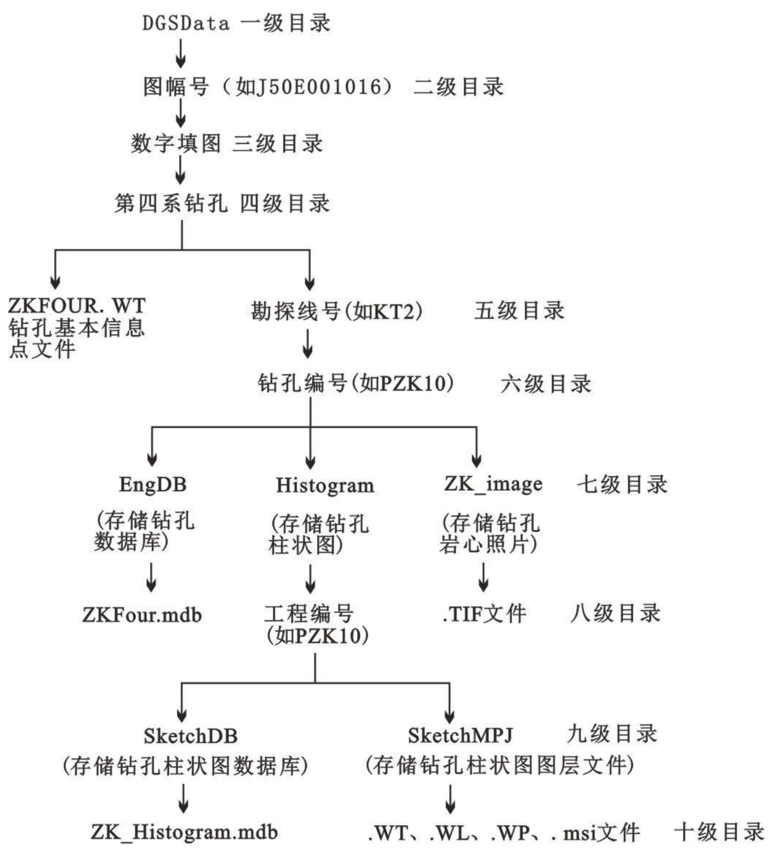

图 2　第四系钻孔数据库目录结构图

表 2　河北省 1：50 000 沙流河幅钻孔数据库钻孔基本信息

序号	钻孔编号	层位	厚度/m	施工单位	来源
1	PZK10	Q、N	301	河北省区域地质调查院	钻探实测
2	玉3	Q、N	405.46	河北地矿局水文工程地质大队	资料收集
		Jx	1.0		
3	丰1	Q、N	212.8	河北地矿局水文工程地质大队	
		Jx	1.9		
4	BK17	Q、N	200	河北建设勘察研究院有限公司	
		Jx	1		
5	BK1	Q、N	69	河北建设勘察研究院有限公司	
		Jx	192		

2.2.2　钻孔数据库录入

钻孔基本信息录入完成后，点击 DGSS 第四系钻孔菜单下“钻孔数据库”，选择需录入的钻孔点，系统弹出数据录入界面，主要包括回次库、分层库、采样库、水文库、冲洗库、弯曲库、测井点、测井线、室内分层等组成部分。首先录入回次库及分层库，再根据钻孔数据情况分别录入其它库。对于收集钻孔，受资料限制，本次仅录入了分层数据。对于实测钻孔 PZK10，分别进行了回次数据、分层数据、采样数据、测井数据、室内分层数据及测试成果数据录入。当数据量小时，可在系统界面窗口中逐个添加，当数据量较大时采用外部数据导入方式。数据库信息存储于 ZKFour.mdb 中，将各类属性

表导出为 Excel 格式，对照各属性字段录入完成后，导入 ZKFour.mdb 中。本次钻孔测试成果资料包括古地磁测试、色度、磁化率及粒度分析结果，也需录入钻孔数据库中。在 ZKFour.mdb 中添加新表，表名及字段名参考数据库整体规则，如古地磁测试结果表 (ZK_GDC)，根据测试结果编辑相应的数据结构，采用外部数据导入方式进行录入。

2.2.3 钻孔柱状图绘制

在 DGSS 第四系钻孔菜单下点击“打开钻孔柱状图”，选择钻孔对应的勘探线号及工程编号，选择“创建”，输入柱状图名称 (本次输入了钻孔编号)，确定后系统转入柱状图工程下。点击“钻孔柱状图设计”，弹出柱状图设计数据库。在“组成”表中设置图名、图眉及正文字体参数；在“标尺表”中设置标尺字体参数；在“栏目”表中勾选需要的栏目，以 PZK10 为例，勾选了界、系、统、回次号、起始孔深、终止孔深、进尺、回次岩心长度、回次采取率、层号、孔深、层厚、柱状图、地质描述、照片，并设置相应格式参数；在“分组表”中确定柱状图主体分组情况；在“从属表”中设计各个分组文本标注的参数。设计信息存储于 ZK_Histogram.mdb 中，可将各类属性表导出为 Excel 格式，数据录入完成后导入原数据库文件中。参数设置完成后，点击“表头”则自动生成相应的表头内容，点击“柱状图”，则依据分层数据生成岩心柱状图及地质描述。

将野外采集的岩心照片按回次分别整理编号，在 CorelDrawX4 中将照片按孔深由浅到深依次排序，保证照片清晰有序。处理完成后导出为.TIF 格式保存于 ZK_Image 文件夹内，放置于相应的钻孔文件目录下。在钻孔柱状图工程内，通过输入点→图像→设置图像高度、宽度→添加图像，可将.TIF 照片放入相应的位置，需注意当.TIF 文件索引目录改变时，系统将无法找到该文件。也可将照片转换为.msi 格式，通过影像校正放到工程中。

柱状图主体框架基本完成后，补充岩性柱花纹、测井曲线、地质年代信息，对图面进行整饰。

3 数据样本描述

河北省 1：50 000 沙流河幅第四系钻孔数据库是 1：50 000 沙流河幅区域地质调查数据库的重要组成部分，数据库内容主要包括钻孔基本信息图层、钻孔编录数据库、钻孔柱状图数据库。

3.1 钻孔基本信息图层

钻孔基本信息存放于第四系钻孔文件夹下 ZKFOUR.WT 点文件中，具体路径为：DGSData\J50E001016\数字填图\第四系钻孔\ZKFOUR.WT。图层属性如表 3 所示。

3.2 钻孔编录数据库

钻孔编录数据存储于 Access(ZKFour.mdb) 格式数据库中，具体路径为：DGSData\J50E001016\数字填图\第四系钻孔\勘探线号\钻孔编号\EngDB\ZKFour.mdb。数据库主要由钻孔采样、钻孔回次、分层数据、测井数据、岩心照片、测试成果数据等属性表组成，各属性表具体内容如表 4 所示。

表 3　钻孔基本信息图层属性表

序号	数据项名称	标准代码	数据类型	量纲	实例
1	工作区或矿区名称	KCANB_NAME	字符型		亮甲店
2	勘探线号	KTX_CODE	字符型		KT2
3	矿区编号	KCANB_CODE	字符型		J50E001016
4	钻孔编号	ENG_NO	字符型		PZK10
5	工程名称	SECNAME	字符型		河北1∶50 000沙流河幅、左家坞幅、鸦鸿桥幅、丰润幅区域地质调查
6	剖面编号	SECT_CODE	字符型		PM1
7	钻孔档案编号	DENG_CODE	字符型		ZKD01
8	钻孔类别	ENG_TYPE	字符型		基准孔
9	开孔X	COORD_X	数值型	m	574317.9
10	开孔Y	COORD_Y	数值型	m	4414908
11	开孔H	COORD_H	数值型	m	17
12	测量开孔X	COORD_X1	数值型	m	574317.9
13	测量开孔Y	COORD_Y1	数值型	m	4414908
14	测量开孔H	COORD_H1	数值型	m	17
15	开孔日期	STA_DATE	日期型		20170526
16	终孔日期	END_DATE	日期型		20170630
17	设计方位角	DE_AZIMUTH	数值型	°	90
18	设计倾角	DE_DIP_ANG	数值型	°	0
19	设计孔深	DE_DEPTH	数值型	m	300
20	实际方位角	PR_AZIMUTH	数值型	°	90
21	实际倾角	PR_DIP_ANG	数值型	°	0
22	实际孔深	PR_DEPTH	数值型	m	300
23	终孔X	E_COORD_X	数值型	m	574317.9
24	终孔Y	E_COORD_Y	数值型	m	4414908
25	终孔H	E_COORD_Z	数值型	m	–283
26	测量终孔X	E_COORD_X1	数值型	m	574317.9
27	测量终孔Y	E_COORD_Y1	数值型	m	4414908
28	测量终孔H	E_COORD_Z1	数值型	m	–283
29	比例尺	SCALE	数值型		100(比例尺分母)
30	施工质量	CONS_QL	字符型		优
31	编录质量	RECO_QL	字符型		优
32	施工单位	CONS_UNIT	字符型		河北省地矿局第五地质大队
33	编录单位	RECO_UNIT	字符型		河北省区域地质调查院
34	探矿技术员	PROSPECTOR	字符型		王伟
35	地质编录员	GEOLOGIST	字符型		陈宏强
36	水文编录员	HYDRO_IST	字符型		李峰
37	质量检查员	QL_TESTER	字符型		陈超

表 4 钻孔编录数据库属性表

数据库名	属性表名	要素内容	主要属性内容
ZKFour.mdb	ZK_BSample	标本采样记录	工作区或矿区编号(KCANB_CODE)、勘探线号(KTX_CODE)、工程编号(ENG_CODE)、剖面编号(SECT_CODE)、井深位置(POSITION)、分层号(LAYCODE)、标本编号(B_CODE)、标本类别(TYPE)、采样人(SAMPLING)、分析要求(ANALYSE)、备注(REMARK)、岩矿心编号回次自(F_CIR)、岩矿心编号总块数自(F_BLOCKS)、岩矿心编号本块数自(F_BLOCK_N)、岩矿心编号回次至(TO_CIR)、岩矿心编号总块数至(TO_BLOCKS)、岩矿心编号本块数至(TO_BLOCK_N)、岩矿心直径(ROCKDIAMETER)、重量(WEIGHT)、袋数(BAGS)、岩石名称(ROCKNAME)、采样日期(SAMDATE)、采取率(SAMRAO)
	ZK_Circle	钻孔回次数据	工作区或矿区编号(KCANB_CODE)、勘探线号(KTX_CODE)、工程编号(ENG_NO)、剖面编号(SECT_CODE)、回次序号(CIRCLE_N)、回次位置自(CIRCLE_FROM)、回次位置至(CIRCLE_TO)、岩心长(ROCK_L)、残留岩心(REMAIN_L)、进尺(DIG_L)、采取率(RATIO)、日期(CIRCLE_DATE)、备注(REMARK)、总块数(TOLBLK)
	ZK_CurveP	钻孔测井曲线点记录	工作区或矿区编号(KCANB_CODE)、勘探线号(KTX_CODE)、工程编号(ENG_CODE)、剖面编号(SECT_CODE)、测井日期(LOG_DATE)、测井曲线名称(LOG_NAME)、测井数据深度(LOG_DEPTH)、测井数据值(LOG_VALUE)
	ZK_Image	岩心编录照片记录	起始深度(HeiFrom)、终止深度(HeiTo)、照片文件路径(ImgName)
	ZK_Slayer	钻孔分层数据	工作区或矿区编号(KCANB_CODE)、勘探线号(KTX_CODE)、工程编号(ENG_CODE)、剖面编号(SECT_CODE)、分层号(LAYCODE)、上分层止孔深(SLAYER_FROM)、换层深度(SLAYER_TO)、回次岩心长(LAY_CIR_L)、分层岩心长(LAY_L)、进尺(DIG_L)、采取率(RATIO)、换层井深(CHANGE_L)、岩矿心编号回次自(F_CIR)、岩矿心编号总块数自(F_BLOCKS)、岩矿心编号本块数自(F_BLOCK_N)、岩矿心编号回次至(TO_CIR)、岩矿心编号总块数至(TO_BLOCKS)、岩矿心编号本块数至(TO_BLOCK_N)、接触关系(CONTACT)、分层回次号(现)(TEXTURECODE)、分层回次号(保留)(TEXTURENAME)、标志面孔深(HOLEDEPTH)、标志面名称(HOLENAME)、轴心夹角(HOLEPM)、标志层代码(HOLECODE)
	ZK_NewLayer	室内分层数据	工作区或矿区编号(KCANB_CODE)、勘探线号(KTX_CODE)、工程编号(ENG_CODE)、剖面编号(SECT_CODE)、新分层号(NEWLAYCODE)、分层号自(LAYCODE_FROM)、分层号至(LAYCODE_TO)、新层深度自(NEWLAY_FROM)、新层深度至(NEWLAY_TO)
	ZK_GDC	古地磁测试数据	样品编号(SAM_CODE)、深度(DEPTH)、磁倾角(MAGNETIC_DIP)
	ZK_SD	色度测试数据	样品编号(SAM_CODE)、深度(DEPTH)、明暗度(L)、红绿色(a)、黄蓝色(b)

续表 4

数据库名	属性表名	要素内容	主要属性内容
	ZK_CHL	磁化率测试数据	样品编号(SAM_CODE)、低频(LOW_FREQUENCY)、高频(HIGH_FREQUENCY)、重量(WEIGHT)、质量磁化率(MASS_SUSCEPTIBILITY)
	ZK_LD	粒度分析数据	样品编号(SAM_CODE)、中值粒径(MEDIAN_DIAMETER)、平均粒径(AVERAGE_DIAMETER)、标准偏差(STANDARD_DEVIATION)、偏态(SKEWNESS)、峰态(KURTOSIS)、砂含量(SAND_CONTENT)、粉砂含量(SILT_CONTENT)、黏土含量(CLAY_CONTENT)

3.3 钻孔柱状图数据库

钻孔柱状图以.mpj 工程文件存储，具体路径为：DGSData\J50E001016\数字填图\第四系钻孔\勘探线号\钻孔编号\Histogram\钻孔编号 (柱状图)\ SketchMPJ\ ZK_Histogram.mpj。工程文件中包含组成钻孔柱状图的点、线、面图层，部分图层由数字填图系统自动生成，如图框线、地质描述内容等，部分内容需后期编辑，如岩心照片、测井曲线等。具体分层情况如表 5 所示。

表 5　钻孔柱状图图层分层信息

图层名称	图层内容	图层名称	图层内容
TKBASELIN.WL	主体图框线	柱状图.WP	岩性柱状图区
TKBASEPNT.WT	图名、图眉、栏目、分层厚度标注	柱状图.WL	岩性柱状图线
GEODESLIN.WL	地质分层线	柱状图.WT	岩性柱状图花纹
GEODESPNT.WL	地质描述内容	测井曲线.WL	测井曲线
时代.WL	地质年代分界线	测井曲线.WT	测井曲线标注
时代.WT	地质年代标注	岩心照片.TIF	岩心照片

同时柱状图中还包括一个 ZK_Histogram.mdb 文件，具体路径为：DGSData\J50E001016\数字填图\第四系钻孔\勘探线号\钻孔编号\Histogram\钻孔编号\SketchDB\ZK_Histogram.mdb，用于存储钻孔柱状图设计数据，包括图名、图眉、标尺、栏目、地质描述字体大小等，具体属性内容如表 6 所示。

4 数据质量控制和评估

在数据库建设过程中，数据的采集、处理及应用环节均要进行质量控制与检查 (左群超等，2013)。本次建库中，收集的钻孔资料来源于全国地质资料馆或各钻孔施工单位，均已完成质量验收及资料归档工作。实测钻孔由具有相应钻探资质的施工队伍进行，均进行实时动态测量 RTK 定位，全孔取心、照相、编录。粘性土岩心采取率在 90% 以上，砂土类大于 80%，砂砾石大于 60%，达到设计要求。钻进过程中按照技术要求进行岩心取样、保管工作；施工人员针对工作区地质条件，采用优质泥浆护壁钻孔法，确保了钻孔稳定，使钻探施工安全顺利进行；合理控制钻进参数、回次进尺，保证了岩心采取率；采取了合理的质量保证措施，确保了钻探取心过程中的各项数据准确。测井设备性能稳定可靠，测井井深误差小于 0.2%，保证了解释的准确程度。质量检查工作量不少于有效工作总量的 5%～10%，技术指标参照《煤田地球物理测井规范》

表 6 钻孔柱状图设计数据库属性表

数据库名	属性表名	要素内容	主要属性内容
ZK_Histogram.mdb	ZKHis_Whole	柱状图组成	类型(TYPENAME)、字体高度(HEIGHT)、字体宽度(WIDTH)、字体间隔(SPACE)、字体角度(ANGLE)、中文字体(IFNT)、西文字体(CHNT)、字形(IFNX)、排列方式(HVPL)、颜色(CLR)
	ZKHis_Ruler	标尺表	名称(RULERNAME)、类型(RULERTYPE)、最小值(MINVAL)、最大值(MAXVAL)、最小单位(MINUNIT)、最小标注(MINLABUNIT)、小数位数(MINLABNUM)及相关字体参数
	ZKHis_Group	分组表	分组名称(GROUPNAME)、内容表(DB_TBL)、ID字段(FLD_ID)、开始字段(FLD_FROM)、结束字段(FLD_TO)、拉胡子(GROUPFLEX)
	ZKHis_HeadComp	从属表	名称(HEADNAME)、别名(HEADALIAS)、从属(PARENTID)、表高(TBLHEIGHT)、字体高度(HEIGHT)、字体高度(WIDTH)、字体间隔(SPACE)、字体角度(ANGLE)、中文(IFNT)、西文(CHNT)、字形(IFNX)、排列(HVPL)、颜色(CLR)
	ZKHis_Column	柱状图栏目	名称(COLNAME)、别名(COLALIAS)、单位(COLUNIT)、标尺(COLRULER)、从属(HEADID)、栏宽(COLWID)、内容表(DB_TBL)、内容字段(FLD_VAL)、高度字段(FLD_HEI)、分类(CLASSNO)、分组(GROUPNO)及相关字体参数

(DZ/T0080–1993) 以及《水文测井工作规范》(DZ/T0181–1997) 执行。在采集端进行数据录入时，逐一核实检查，保证了原始数据的真实性及可靠性。

数据处理过程中，由相关地质专家对各类钻孔数据的合理性及科学性进行认定，建库人员对图形矢量化质量、图形校正质量、属性编辑质量、图面整饰质量、投影变换质量等方面进行检查 (宗刚军，2009)。本次建库采用 DGSS 系统默认的系统库，所有图层采用统一的坐标投影参数，利用标准图框及坐标识别保证钻孔点投影在正确的位置上。检查钻孔基本信息及数据库录入数据有无明显错漏、数据结构及字段设置是否合理。检查钻孔柱状图中各项要素对应关系是否准确、岩石花纹填充是否符合规定、岩心照片顺序有无错乱。同时对图面整体美观性及完整性进行检查，发现问题及时调整。此外还需定期进行自检、互检及抽检工作，保证数据的准确性。

5 数据价值

钻孔是平原区区域地质调查的核心内容和成果，其数据库更是规范化管理的体现，对平原区城市建设具有重要意义。本数据库为唐山地区城市三维地质模型的建立提供了基础数据，服务于京津冀协同发展，同时也为平原区地质调查中钻孔数据的处理及建库提供了范例。

6 结论

河北省 1：50 000 沙流河幅第四系钻孔数据库的数据类型包括.mdb 数据库文件、.tif 文件、.mpj 工程文件及相关点线面文件，由 1 个钻孔基本信息图层、5 个钻孔编

录数据库、5 个钻孔设计数据库及 5 张钻孔柱状图组成。该数据库的建立将为河北省唐山地区城市三维地质模型的建立提供基础数据，同时也为平原区地质调查中钻孔数据的处理及建库提供参考。

致谢：本数据库是一项集体成果，野外一线项目组人员付出了辛勤的努力。在数据库建立过程中，得到了天津地质调查中心、河北省区域地质调查院多个专家的指导，在此一并表示最诚挚的感谢。

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Quaternary borehole database for 1∶50 000 Shaliu River Map-sheet of Hebei Province, China

CHEN Yuanyuan, BU Ling, ZHUAN Shaopeng, YANG Rui, ZHAO Huaping, JI Hong, CHEN Chao, CHEN Hongqiang

(*Hebei Institute of Regional Geological Survey*, *Langfang* 065000, *China*)

Abstract: The 1∶50 000 Shaliu River Map-sheet of Hebei Province is one of the key map-sheets for geological surveys of Beijing-Tianjin-Hebei plain Region, and the Late Cenozoic in the mapping area was mainly surveyed, with Quaternary borehole database reflecting the core achievement of the geological survey. By taking advantage of borehole construction and test data, as well as combining the collected borehole data, Quaternary borehole database was thus built, which mainly includes one basic data layers for borehole, five borehole catalog databases, five borehole design databases and five borehole histograms. Data source, data processing method, data attribute structure and data quality control are summarized in this paper, so as to present the practice of Quaternary borehole databases on the basis of *Digital Geological Survey System* (DGSS). The database provides a 3D geologic model of Tangshan urban area with basic data, serving coordinated development of Beijing-Tianjin-Hebei Region, which could also be referenced by borehole data processing and database construction in the geological survey of the other plain areas.

Key words: Hebei province; 1∶50 000; Shaliu river map-sheet; quaternary borehole; database; geological survey engineering

Data service system URL: http://dcc.cgs.gov.cn

1 Introudction

Borehole refers to a 3D column that is characterized by narrow surface area and certain depth, which could be flatly expressed by point entity. Drilling is undoubtedly the most effective method for getting subsurface stratum, structure, water content and other information. Borehole data is a major output for drilling work, which could be described as the most

About the first author: CHEN Yuanyuan, female, born in 1988, engineer, master, is engaged in mineral and geological survey and database construction; E-mail: 517371457@qq.com.

immediate and reliable information source for underground space (Tang BY, 2015). Quaternary borehole data is an important basis for analyzing 3D urban geologic structure (He J et al., 2019), database construction of which is thus of great importance for the geological survey in the plain area.

The 1∶50 000 Shaliu River Map-sheet (J50E001016) of Hebei Province is one of the working map-sheets derived from *Geology and mineral survey project of Fengning and Tianzhen area in the Yanshan-Taihangshan metallogenic belt* in 2016; it is located in eastern Hebei Province, and administrative division of which is under the jurisdiction of Yutian County, Tangshan City; it is an important industrial base of the Beijing-Tianjin-Hebei Region. It mainly includes two geomorphic units: low hilly area in the north, generally with a height of 100 m to 400 m; North China plain area in the south, generally with a height of 2 m to 50 m. Water systems in the area are quite developed, which belong to the ancient Luan River system and piedmont water system of Yan Mountain, resulting in the alluvial plain of the area. Early drilling in the survey area was mainly through geological surveys of coal and hydrology, which was of great importance for figuring out burial depth of the bed rocks and division of the Quaternary. Early drilling data were systematically gathered in the work, and availability of different boreholes was carefully analyzed; through analysis, division and distribution characteristics of strata in different boreholes, the boreholes that are uniformly distributed and divided in detail are selected as main references. One Quaternary borehole (PZK10) drilled in this survey, four collecting boreholes (BK1, BK17, YU3 and FENG1) are integrated in Shaliu River map-sheet, constituting a E-W combined borehole profile (Fig. 1) in the map-sheet, which have provided important information to study the Quaternary structure, as well as 3D models (Zhu LF et al., 2004; Zhou Y et al., 2016). The Quaternary borehole database of the 1∶50 000 Shaliu River Map-sheet of Hebei Province (also referred to as the Database) (Chen YY et al., 2020) was created in line with *Instructions for Digital Geological Survey System* (Li CY, 2011), and stored in a specified file directory. Table 1 is the metadata of the Database, and the database directory structure is shown in Fig. 2.

2 Data Acquisition and Processing Method

2.1 Data Acquisition

Borehole data of the 1∶50 000 Shaliu River Map-sheet of Hebei Province was mainly gained via data collection and actual measurement of drilling. The collected data includes a core catalog of borehole, stratified data, logging data and a drilling report. The data format is .doc, .xls or .jpg. Boreholes collected in the mapsheet are YU3, FENG1, BK1 and BK17, the basic information of which is shown in Table 2.

The drilling borehole in the survey is PZK10, with a depth of 301 m, penetrating the Cenozoic. Mechanical core drilling was employed in borehole construction, the caliber of which was 108 mm. PVC pipes were used as core boxes, so as to conduct core sampling and preservation. Comprehensive logging was conducted after borehole drilling was finished.

JGS-1 comprehensive digital logging equipments manufactured by Chongqing Geological Instrument Factory were used in filed logging, and potential difference was indirectly measured by making use of automatic compensating principle of the potentiometer; an induced polarization (IP) logging, DZD –6A multifunctional direct current (IP) apparatus, also manufactured by Chongqing Geological Instrument Factory, were used. Comprehensive logging of boreholes in aspects of apparent resistivity, natural potential, natural gamma, borehole temperature, IP and borehole deviation was conducted. For technical indexes, *Specifications for Geophysical Logging of Coal* (DZ/T0080–1993) and *Working Specification for Hydrogeological Logging* (DZ/T0181–1997) were followed. After field measurement was finished each day, the collected data and information were be transferred from apparatus to digital storage hard disk, to check whether the collected data files, field record, point coordinate of the measurement point, dot mark and other information were correct and not missed. After it was checked correctly, it would then be stored for later processing.

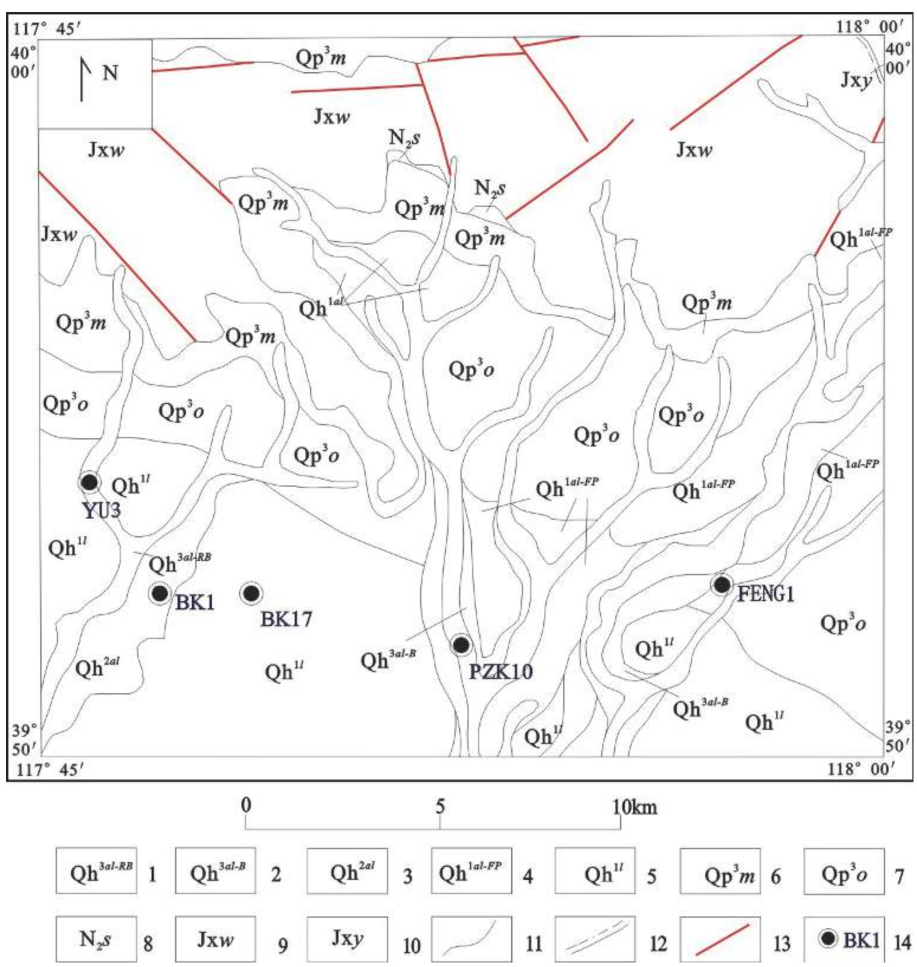

Fig. 1 Borehole location map of the 1：50 000 Shaliu river map-sheet of Hebei province

1—Late Holocene sediments, river bed subfacies; 2—Late Holocene sediments, river bank subfacies; 3—Mid Holocene sediments; 4—Early Holocene sediments, fluviatile floodplain subfacies; 5—Early Holocene lacustrine deposits; 6—Late Pleistocene Malan Formation; 7—Late Pleistocene Ouzhuang Formation; 8—Pliocene Shixia Formation; 9—Jixianian Wumishan Formation; 10—Jixianian Yangzhuang Formation; 11—conformity boundary; 12—parallel unconformity boundary; 13—fault; 14—location and number of boreholes

Table 1 Metadata Table of Database (Dataset)

Items	Description
Database (dataset) name	Quaternary borehole database of the 1∶50 000 Shaliu River Map-sheet, Hebei Province, China
Database (dataset) authors	ChenYuanyuan, Hebei Institute of Regional Geological Survey Yang Rui, Hebei Institute of Regional Geological Survey Zhao Huaping, Hebei Institute of Regional Geological Survey Bu Ling, Hebei Institute of Regional Geological Survey Chen Hongqiang, Hebei Institute of Regional Geological Survey
Data acquisition time	2017—2018
Geographic area	E 117°45′–118°00′, N 39°50′–40°00′
Data format	.mpj,.mdb,.tif
Data size	249 MB
Data service system URL	http://dcc.cgs.gov.cn
Fund project	The regional geological survey on 1∶50 000 Shaliu River Map-sheet (J50E001016), Zuojiawu Map-sheet (J50E001017), Yahongqiao Map-sheet (J50E00 2016) and Fengrun Map-sheet (J50E00 2017) of Hebei Province (project No.: DD20160042-4)
Language	Chinese
Database (dataset) composition	The database includes 5 boreholes. The collecting borehole (BK1, BK17, YU3 and FENG1) data includes borehole histograms (.mpj) and database (.mdb); the drilled borehole (PZK10) data includes borehole histograms (.mpj), core pictures (.tif) and database (.mdb). The data are respectively stored in different level of catalogs as files according to database construction standard of DGSS

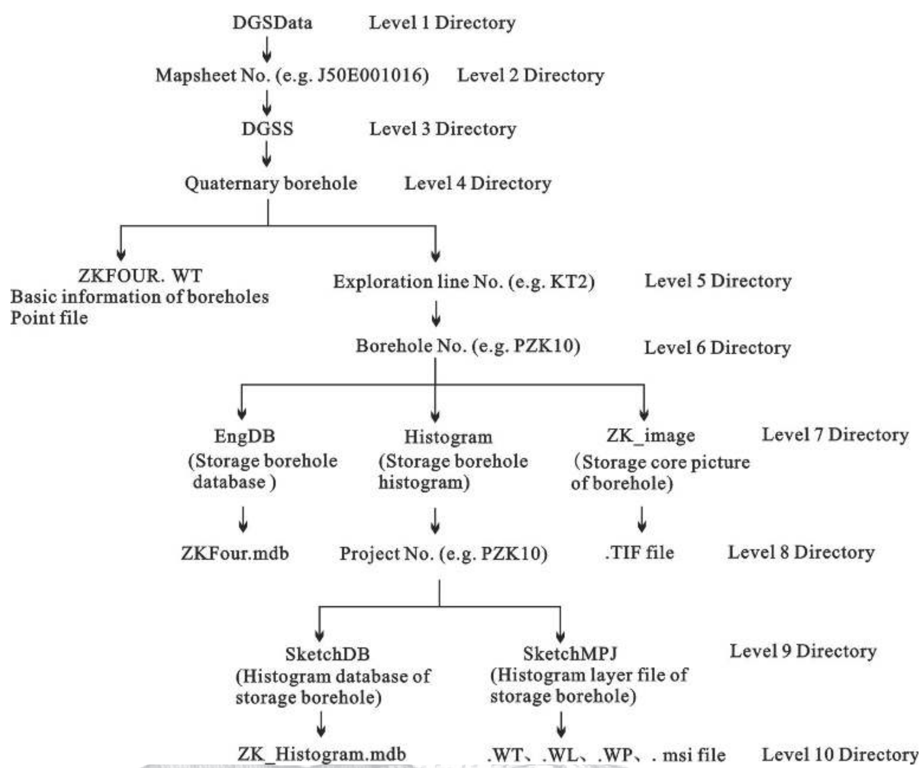

Fig. 2 Database directory structure diagram of quaternary borehole

Table 2 Basic information of borehole in the quaternary borehole database of the 1∶50 000 Shaliu river map-sheet of Hebei province

No.	Borehole No.	Layer	Depth/m	The drilling	Data source
1	PZK10	Q, N	301	Hebei Institute of Regional Geological Survey	Actual measurement of drilling
2	YU3	Q, N	405.46	Hydrological and Engineering Geological Brigade, Hebei Bureau of Geology and Mineral Resources Exploration	Collection
		Jx	1.0		
3	FENG1	Q, N	212.8	Hydrological and Engineering Geological Brigade, Hebei Bureau of Geology and Mineral Resources Exploration	Collection
		Jx	1.9		
4	BK17	Q, N	200	Hebei Research Institute of Construction & Geotechnical Investigation Co., Ltd	Collection
		Jx	1		
5	BK1	Q, N	69	Hebei Research Institute of Construction & Geotechnical Investigation Co., Ltd	Collection
		Jx	192		

Note: Q–Quaternary; N–Neogene; Jx–Jixian System

2.2 Data Processing

Through collating the collected borehole data and actual measurement data from field drilling, and following the requirements of *Instructions for Digital Geological Survey System* (Li CL, 2011), the Quaternary borehole database was created. *Digital Geological Survey System* (DGSS 2014), MapGIS 6.7, Excel 2007, Access 2007, CorelDrawX4 and other softwares were mainly used for data processing.

2.2.1 Input of Basic Borehole Data

Clicked "add borehole" in Quaternary borehole module of the DGSS, and then clicked borehole point in corresponding position in the mapsheet, and dialog box of basic information of the borehole would then pops up, and then input exploration line number (KT2 or KT3 in this mapsheet), project number (named by borehole number), project name, type of borehole, coordinate position, plotting scale and other data. The system generated corresponding files according to exploration line number and project number to store borehole data. Borehole position at that time was a manually clicked position, and "re-projection" must be clicked, so the system could accurately locate borehole point according to the inputted measuring coordinate. Borehole point file was stored in the ZKFOUR.WT file. Clicked "edit borehole", and basic data of each borehole could be edited, after which was inputted, clicked to save the point file.

2.2.2 Input of Borehole Database

After basic data of the borehole was input, clicked "borehole database" under the DGSS Quaternary borehole menu, to select borehole points required to be input, and then the data entry interface popped up, which showed circle library, layering library, sampling library, hydrology library, washout library, curving library, logging point, logging line, inner layering and other constituent parts. Circle library and layering library were firstly input, and other libraries were then respectively input according to borehole data. For collecting borehole, due to the lack of sone data, only layering data were input this time. For actual measuring borehole PZK10, circle data, layering data, sampling data, logging data, inner layering data and measuring data were respectively input. If there was a small amount of data, each of them could be added one by one in the window of the system interface; for large amount of data, external data entry should be used. Database information was stored in ZKFour.mdb. Exported each kind of attribute tables as Excel format, and input each property field into them. When finished, imported the attribute tables into ZKFour.mdb. The drilling testing outputs in the work include paleomagnetism, chromaticity, magnetic susceptibility and grading analysis, which should also be input into the database. Added new table into ZKFour.mdb, and table name and field name should follow the rules of the database, e.g. table of paleomagnetism testing (ZK_GDC). Edited corresponding data structure according to the testing result, and the external data importing method for input was used.

2.2.3 Drawing of Borehole Histogram

Clicked “open borehole histogram” under the DGSS Quaternary borehole menu, selected exploration line number and project number of the borehole, selected “create”, and input histogram name (borehole number was actually input). After clicked “yes”, the system was shifted to histogram project. Clicked “borehole histogram design” and borehole histogram design database popped up. Set figure name, figure header and text type parameters in the “constitute” table; set typeface parameters of ruler in the “ruler table”; selected required columns in the “column”, including erathem, system, series, circle number, depth of initial hole, depth of end hole, footage, length of circle core, circle recovery percentage, layer number, borehole depth, thickness of stratum, histogram, geological description and picture for PZK10, and their parameters were respectively set; confirmed the groups of the histogram in the “grouping table”; designed parameters of labels of each grouping text in the “subordinate table”. The design information was stored in ZK_Histogram.mdb. Each kind of attribute tables could be exported as Excel format, and input the data into them. When finished, import the attribute tables into the ZK_Histogram.mdb. After the parameter set was completed, clicked “header” and the header content would be generated automatically; clicked “histogram” and core histogram as well as geological description could be generated layer by layer.

Collated and numbered core pictures collected outdoors according to the circle respectively, and the pictures were prioritized from shallow depth to deep depth in CorelDrawX4, so as to ensure clearness and orderliness. After it was completed, exported the file as.TIF format, stored it into the ZK_Image file, and saved it in the borehole file catalog. The.TIF pictures could be stored at the corresponding positions in the borehole histogram project folder, by input point→picture→set height and width of the picture→add picture in turn. Note that when index catalog of.TIF file is changed, the system could not find the file any more. The pictures could also be converted into.msi format and add them into project folder via image correction.

When the main frame of histograms was basically completed, replenished and embellished pattern of lithologic column, logging curving and geochronological data.

3 Description of Data Sample

The Quaternary borehole database of the 1∶50 000 Shaliu River Map-sheet of Hebei Province is a key constituent part of the regional geological survey database of 1∶50 000 Shaliu River Mapsheet, mainly including basic information on layer of boreholes, catalog database of boreholes, and borehole histogram database.

3.1 Basic Information Layer of Boreholes

Basic information of boreholes is stored in point file ZKFOUR.WT, whose access path is: DGSData\J50E001016\DGSS\Quaternary borehole\ ZKFOUR.WT. The layer properties are shown in Table 3.

Table 3 Layer attribute table for basic information of boreholes

NO.	Data item	Standard code	Data type	Dimension	Example
1	Name of working area or mining area	KCANB_ NAME	character		Liangjiadian
2	Exploration line No.	KTX_CODE	character		KT2
3	Mining No.	KCANB_ CODE	character		J50E001016
4	Borehole No.	ENG_NO	character		PZK10
5	Project name	SECNAME	character		Regional geological survey for 1∶50 000 Shaliu River Mapsheet, Zuojiawu Mapsheet, Yahongqiao Mapsheet, Fengrun Mapsheet of Hebei Province
6	Section No.	SECT_CODE	character		PM1
7	Borehole file No.	DENG_CODE	character		ZKD01
8	Type of borehole	ENG_TYPE	character type		Basic hole
9	Open hole X	COORD_X	Numeric	m	574317.9
10	Open hole Y	COORD_Y	Numeric	m	4414908
11	Open hole H	COORD_H	Numeric	m	17
12	Measured open hole X	COORD_X1	Numeric	m	574317.9
13	Measured open hole Y	COORD_Y1	Numeric	m	4414908
14	Measured open hole H	COORD_H1	Numeric	m	17
15	Start date of drilling	STA_DATE	Date		20170526
16	End date of drilling	END_DATE	Date		20170630
17	Designed azimuth	DE_AZIMUTH	Numeric	°	90
18	Designed dip angle	DE_DIP_ANG	Numeric	°	0
19	Designed borehole depth	DE_DEPTH	Numeric	m	300
20	Actual azimuth	PR_AZIMUTH	Numeric	°	90

Continued table 3

NO.	Data item	Standard code	Data type	Dimension	Example
21	Actual dip angle	PR_DIP_ANG	Numeric	°	0
22	Actual borehole depth	PR_DEPTH	Numeric	m	300
23	End hole X	E_COORD_X	Numeric	m	574317.9
24	End hole Y	E_COORD_Y	Numeric	m	4414908
25	End hole H	E_COORD_Z	Numeric	m	–283
26	Measured end hole X	E_COORD_X1	Numeric	m	574317.9
27	Measured end hole Y	E_COORD_Y1	Numeric	m	4414908
28	Measured end hole H	E_COORD_Z1	Numeric	m	–283
29	Scale	SCALE	Numeric		100 (scale denominator)
30	Construction quality	CONS_QL	character		Excellent
31	Cataloging quality	RECO_QL	character		Excellent
32	Construction unit	CONS_UNIT	character		5th Geological Brigade, Hebei Bureau of Geology and Mineral Resources Exploration
33	Cataloging unit	RECO_UNIT	character		Hebei Institute of Regional Geological Survey
34	Prospector	PROSPECTOR	character		Wang Wei
35	Geologist	GEOLOGIST	character		Chen Hongqiang
36	Hydrological geologist	HYDRO_IST	character		Li Feng
37	Quality tester	QL_TESTER	character		Chen Chao

3.2 Borehole Catalog Subdatabase

The borehole catalog database is stored in the ZKFour.mdb, whose access path is: DGSData\J50E001016\DGSS\Quaternary borehole\Exploration line No.\Borehole No.\EngDB\ZKFour.mdb. The database is composed of tables of borehole sampling, borehole circle, layering data, logging data, core picture, testing data and other attributes. The details of each attribute table are shown in Table 4.

Table 4 Attribute table of borehole catalog database

Database	Attribute table	Elements	Main properties
ZKFour.mdb	ZK_BSample	Sampling record of specimen	No. of working area or mining area (KCANB_CODE), Exploration line No. (KTX_CODE), Project No. (ENG_CODE), Section No. (SECT_CODE), Borehole depth position (POSITION), Layering code (LAYCODE), Specimen code (B_CODE), Specimen type (TYPE), Sampling person (SAMPLING), Analysing requirement (ANALYSE), Remark (REMARK), Circle of rock core No. from (F_CIR), Total blocks of rock core No. from (F_BLOCKS), Block number of rock core No. from (F_BLOCK_N), Circle of rock core No. to (TO_CIR), Total blocks of rock core No. to (TO_BLOCKS), Block number of rock core No. to (TO_BLOCK_N), Diameter of rock core (ROCKDIAMETER), Weight (WEIGHT), Bags (BAGS), Rock name (ROCKNAME), Sampling date (SAMDATE), Sampling rate (SAMRATO)

Continued table 4

Database	Attribute table	Elements	Main properties
	ZK_ Circle	Borehole circle data	No. of working area or mining area (KCANB_CODE), Exploration line No. (KTX_CODE), Project No. (ENG_NO), Section No. (SECT_CODE), Circle No. (CIRCLE_N), Circle position from (CIRCLE_FROM), Circle position to (CIRCLE_TO), Core length (ROCK_L), Remaining core (REMAIN_L), Footage (DIG_L), Sampling rate (RATIO), Date (CIRCLE_DATE), Remark (REMARK), Total blocks (TOLBLK)
	ZK_ CurveP	Curve point record of borehole logging	No. of working area or mining area (KCANB_CODE), Exploration line No. (KTX_CODE), Project No. (ENG_CODE), Section No. (SECT_CODE), Logging date (LOG_DATE), Name of logging curve (LOG_NAME), Depth of logging (LOG_DEPTH), Value of logging data (LOG_VALUE)
	ZK_ Image	Record of core catalog picture	Initial depth (HeiFrom), Ending depth (HeiTo), File path of picture (ImgName)
	ZK_ Slayer	Borehole layering data	No. of working area or mining area (KCANB_CODE), Exploration line No. (KTX_CODE), Project No. (ENG_CODE), Section No. (SECT_CODE), Layering No. (LAYCODE), Ending hole depth of the upper layer (SLAYER_FROM), Boundary depth (SLAYER_TO), Circle core length (LAY_CIR_L), Layering core length (LAY_L), Footage (DIG_L), Sampling rate (RATIO), Boundary borehole depth (CHANGE_L), Circle of core No. from (F_CIR), Total blocks of core No. from (F_BLOCKS), Block number of core No. from (F_BLOCK_N), Circle of core No. to (TO_CIR), Total blocks of core No. to (TO_BLOCKS), Block number of core No. to (TO_BLOCK_N), Contact relation (CONTACT), Layering circle code (now) (TEXTURECODE), Layering circle name(reserved) (TEXTURENAME), Borehole depth of mark layer (HOLEDEPTH), Name of mark layer (HOLENAME), Pivot angle (HOLEPM), Code of mark layer (HOLECODE)
	ZK_NewLayer	Indoor layering data	No. of working area or mining area (KCANB_CODE), Exploration line No. (KTX_CODE), Project No. (ENG_CODE), Section No. (SECT_CODE), New layer No. (NEWLAYCODE), Layer No. from (LAYCODE_FROM), Layer No. to (LAYCODE_TO), New layer depth from (NEWLAY_FROM), New layer depth to (NEWLAY_TO)
	ZK_GDC	Paleomagnetism data	Sample No. (SAM_CODE), Depth (DEPTH), Magnetic dip (MAGNETIC_DIP)
	ZK_SD	Chroma data	Sample No. (SAM_CODE), Depth (DEPTH), Lightness (L), Red-green (a), Yellow-blue (b)
	ZK_CHL	Magnetic susceptibility data	Sample No. (SAM_CODE), Low frequency (LOW_FREQUENCY), High frequency (HIGH_FREQUENCY), Weight (WEIGHT), Mass Magnetisability (MASS_SUSCEPTIBILITY)

Continued table 4

Database	Attribute table	Elements	Main properties
	ZK_LD	Grading analysis data	Sample No. (SAM_CODE), Median diameter (MEDIAN_DIAMETER), Average grain diameter (AVERAGE_DIAMETER), Standard deviation (STANDARD_DEVIATION), Skewness (SKEWNESS), Kurtosis (KURTOSIS), Sand content (SAND_CONTENT), Silt content (SILT_CONTENT), Clay content (CLAY_CONTENT)

3.3 Borehole Histogram Subdatabase

The borehole histogram is saved as .mpj project files, whose access path is: DGSData\J50E001016\DGSS\Quaternary borehole\exploration line No.\borehole No.\Histogram\borehole No. (histogram)\ SketchMPJ\ ZK_Histogram.mpj. The project folder includes point, line and polygon layers of the borehole histogram, as well as other layers which automatically generated by the DGSS, e.g. box line, geological description. Some other contents were to be edited later, e.g. core picture, logging curve, etc. The borehole histogram layers are shown in Table 5.

The histogram also includes a ZK_Histogram.mdb file, whose access path is: DGSData\J50E001016\DGSS\Quaternary borehole\exploration line No.\borehole No.\Histogram\borehole No.\SketchDB\ZK_Histogram.mdb, which is used for storing design data of the borehole histogram, including picture name, picture header, ruler, column, font size of geological description, etc., and their details are shown in Table 6.

4 Quality Control and Assessment of Data

The data acquisition, processing and application should all be quality-controlled during the database construction (Zuo QC et al., 2013). Borehole data collected in the construction come from National Geological Archives of China or the drilling units. The measured boreholes were constructed by construction teams with corresponding qualifications, and dynamic measurement of RTK position, whole borehole coring, photographing, and cataloging were conducted in real time. Recovery factor of cohesive soils was above 90%, that of sandy soils was above 80% and that of sand gravels was above 60%, and all met the design

Table 5 Basic information of borehole histogram layers

Layer name	Layer description	Layer name	Layer description
TKBASELIN.WL	Line of main picture frame	Column.WP	Lithological column polygon
TKBASEPNT.WT	Picture name, Picture header, Column, Layer depth	Column.WL	Lithological column line
GEODESLIN.WL	Geological stratification line	Column.WT	Lithological column pattern
GEODESPNT.WL	Geological description	Logging curve.WL	Logging curve line
Age.WL	Geological age division line	Logging curcve.WT	Logging curve label
Age.WT	Geological age	Core picture.TIF	Core picture

Table 6 Attribute table of borehole histogram design database

Database	Attribute table	Elements	Main properties
ZK_Histogram.mdb	ZKHis_Whole	Constitution of histogram	Type (TYPENAME), Font height (HEIGHT), font width (WIDTH), Font space (SPACE), Font angle (ANGLE), Chinese language font (IFNT), Western language font (CHNT), Character pattern (IFNX), Arrangement mode (HVPL), Color (CLR)
	ZKHis_Ruler	Ruler table	Name (RULERNAME), Type (RULERTYPE), Minimum value (MINVAL), Maximum value (MAXVAL), Minimum unit (MINUNIT), Minimum label (MINLABUNIT), Decimal digits (MINLABNUM) and Relevant font parameters
	ZKHis_Group	Group table	Group name (GROUPNAME), Table of content (DB_TBL), ID field (FLD_ID), Initial field (FLD_FROM), Ending field (FLD_TO), Group flex (GROUPFLEX)
	ZKHis_HeadComp	Subordinate table	Name (HEADNAME), Alias (HEADALIAS), Subordination (PARENTID), Table height (TBLHEIGHT), Font height (HEIGHT), Font width (WIDTH), Font space (SPACE), Font angle (ANGLE), Chinese language (IFNT), Western language (CHNT), Character pattern (IFNX), Arrangement mode (HVPL), Color (CLR)
	ZKHis_Column	Histogram column	Name (COLNAME), Alias (COLALIAS), Unit (COLUNIT), Ruler (COLRULER), Subordination (HEADID), Column width (COLWID), Table of content (DB_TBL), Content field (FLD_VAL), Height field (FLD_HEI), Classification (CLASSNO), Group (GROUPNO) and relevant font parameters

requirements. Core sampling and preservation were conducted according to technical requirements in the drilling. Based on the geological conditions of the working area, the constructors adopted high quality slurry hole-boring method, to ensure the drilling stability, and thus to make sure the drilling construction was operated safely and smoothly. Due to a reasonably controlled drilling parameter and footage per circle, the recovery factor was qualified. The rational quality control measures were also made to ensure accuracy of data in the process of drill coring. For stable and reliable logging equipment, the error of logging depth was less than 0.2%, and data accuracy could thus be ensured. Besides, the quality inspection working was no less than 5% to 10% of the effective working, with technical index referring to *Specifications for Geophysical Logging of Coal* (DZ/T0080–1993) and *Working Specification for Hydrogeological Logging* (DZ/T0181–1997). All the data were checked one by one during the input process, and authenticity and reliability of the original data was thus ensured.

During data processing, accuracy of each kind of borehole data was affirmed by peer experts, and database builders checked qualities of figure vectorization, correction, attribute editing, drawing finishing, and projection transformation (Zong GJ, 2009). The default database of the DGSS system was used, and all layers used uniform coordinate projection parameters. By using standard drawing frame and coordinate identification, it could be ensured that the projection of the drilling point is in the correct position. Boreholes data of the database were checked, so as to confirm whether there were obvious mistakes or omissions, whether data structure and field setting was reasonable. Each elements, pattern filling and core picture sequence in the borehole histogram were also checked to ensure their correspondence and correction. Besides, aesthetic and integrity of the borehole histograms was checked, to find problems and dispose of them in time. Furthermore, self-inspection, mutual-inspection and sampling inspection were conducted at regular intervals, thus to ensure accuracy of data.

5 Data Value

Borehole data are the key content and achievement of regional geological surveys of plain areas, the database of which is the embodiment of standardized management, being of great significance to city construction of the plain area. The database provides basic data for the 3D urban geological modeling of Tangshan area, and serve the coordinated development of the Beijing-Tianjing-Heibei region, and also provides a good example to data processing and database construction of borehole in the future geological surveys on the plain area.

6 Conclusion

The Quaternary borehole database of the 1∶50 000 Shaliu River Map-sheet of Hebei Province was created in line with *Instructions for Digital Geological Survey System*, and stored in a specified file directory, which is composed by one basic information layer of borehole, five borehole catalog subdatabases, five borehole design subdatabases and five borehole histograms, with data types of .mdb database file, .tif file, .mpj project folder and point, line and polygon files. The database provides basic data to establishment of a 3D urban geological model of Tangshan area, Hebei Province, which could also be referenced by data processing and database construction of borehole in the future geological surveys on the plain area.

Acknowledgements: *The Quaternary borehole database of the 1∶50 000 Shaliu River Map-sheet of Hebei Province* is a collective achievement, for which the field team members have made many industrious efforts. During project implementation and database building process, the experts from Tianjin Center, China Geological Survey and Hebei Institute of Regional Geological Survey, gave lots of guidance, and the sincere thanks were expressed here.

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