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2017 年银川盆地 1∶50 000 平罗站幅工程地质钻孔及取样土工试验数据集

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摘要：本数据集是作者 2017 年在银川盆地平罗站幅施工的 14 个工程地质钻孔岩心中采集的 234 个岩土样品，经过测试分析后所得的共 2 602 组测试数据。这些数据主要体现了土体的抗剪强度、压缩模量、颗粒成分等。图幅内第四系分布广泛，厚度大，为区内主要的工程地质岩组，且成因多样，从西到东主要包括：上更新统洪积层，岩性主要为砾石、砂砾石；全新统灵武组细砂土；全新统湖沼积层，岩性主要为淤泥、砂质粘土及粉砂；全新统风积层，岩性主要为土黄色中−细砂、粉砂。其中，全新统灵武组占据了图幅大部分区域，岩性主要为细砂、粉砂、砂质粘土等。钻孔揭示，银川平原区地层纵向上以河湖相细砂、粉砂为主，夹粉质粘土，局部钻孔含卵砾石层。样品测试数据分析显示，图幅区内碎石土、冲积砂土、粘性土具较高的抗剪强度，工程地质条件较好；而图幅西北部砂岩、泥岩由于中等到强风化程度，且有软弱夹层，工程地质条件较差。湖沼积成因的淤泥、砂质粘土及粉砂工程地质性质亦较差。本次图幅区内的工程地质钻探工作施工规范，测试分析均由具备国家资质的实验室承担，得到的数据质量可靠，真实反映了该区域内地层信息及岩土物理力学性质。

关键词：银川盆地；工程地质钻孔；土工试验；平罗站幅；1∶50 000 数据集
数据服务系统网址：http://dcc.cgs.gov.cn

1 引言

该图幅的钻探数据和采样数据的获取由国家地调项目“宁夏沿黄经济区综合地质调查”支持，该项目旨在通过野外调查，并借助工程地质钻探、水文钻探、静动力触探、物探等手段查明该图幅区的工程、水文、环境地质条件，进行工程地质区划，解决制约区内建设和发展的重大环境地质问题，为评价区内地质环境资源承载力、城市群的建

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设、发展、规划及重大工程建设提供地质资料和科学依据。样品采集和测试主要为岩土样，岩土样测试内容主要包括颗粒分析、含水量、剪切强度、液性指数、塑性指数压缩性等，以期获取岩土体的物理力学参数，为当地的工程建设提供数据支撑 (孙巧银等，2018)。

平罗站幅位于宁夏回族自治区石嘴山市中南部，是宁夏最富饶的地区之一。该图幅地处银川平原与贺兰山交界地带。在构造上归属为：华北陆块（$Ⅲ_5$）、鄂尔多斯地块（$Ⅲ_5^{1}$）、鄂尔多斯西缘中元古代—早古生带裂隙带（$Ⅲ_5^{1-1}$）中的贺兰山褶断带（$Ⅲ_5^{1-1-1}$）和银川断陷盆地（$Ⅲ_5^{1-1-2}$）交界地带。地势上，西部贺兰山山区山大沟深，地形高低不平，东部平原区地势平缓，西高东低。大体可分为两个地貌单元：西部为贺兰山低中山，东部为平原，平原区由西向东又可进一步分为洪积倾向平原和冲湖积平原。区内西部贺兰山区出露二叠、三叠系地层，东部大片区域被第四系覆盖，且厚度大，局部第四系厚度达 1 000 米。图幅内主要岩土类型包括：上更新统洪积砾石、砂砾石；全新统河湖相灵武组细砂，粉细砂、粘土质砂等；全新统湖沼积淤泥、砂质粘土及粉砂、全新统风积层中细砂、粉砂及全新统冲湖积细砂、粉砂、砂质粘土等，图幅内岩土类型分布见图 1。结合收集的资料、本次野外调查及钻孔数据资料，平原区纵向地层岩性可参考图 2。

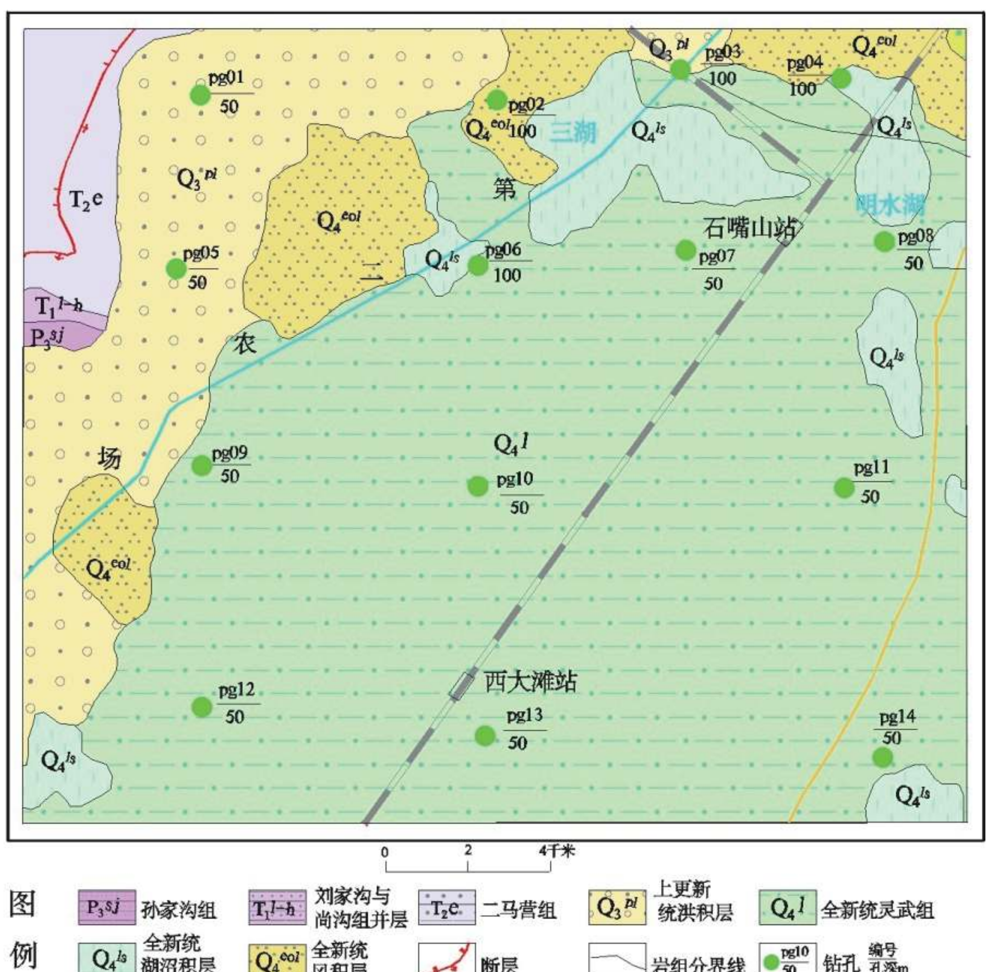

图 1　银川盆地平罗站幅地质简图及钻孔分布

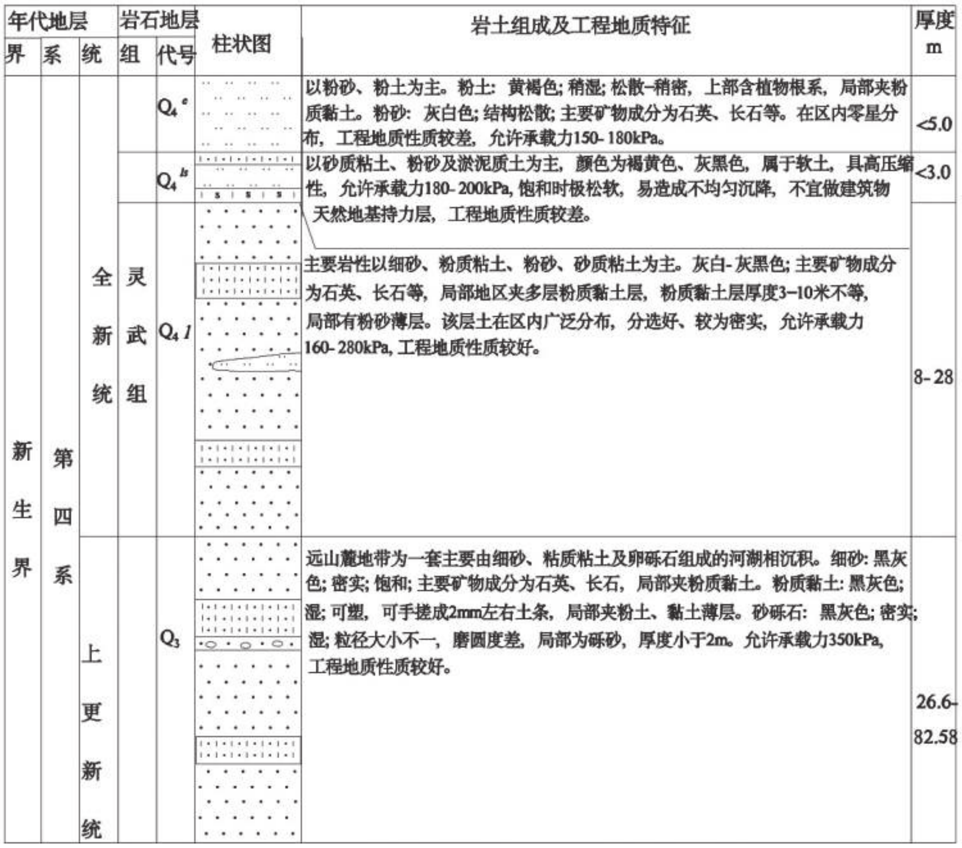

图 2　银川盆地平罗站幅钻孔柱状图

本次测试数据集元数据见表 1。

表 1　数据库（集）元数据简表

条目	描述
数据库（集）名称	2017年银川盆地1∶50 000平罗站幅工程地质钻孔及取样土工试验数据集
数据库（集）作者	孙巧银，中国地质调查局西安地质调查中心 李成柱，中国地质调查局西安地质调查中心 方　磊，宁夏回族自治区水文环境地质勘察院
数据时间范围	2017年
地理区域	银川盆地1∶50 000平罗站幅（J48E007018）
数据格式	*.xls
数据量	244KB
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“宁夏沿黄经济区综合地质调查”（DD20160263）
语种	中文
数据库（集）组成	本数据集共包含14个工程钻孔信息，其中扰动样品151个，原状样品83个，测试数据2 602组。包含如下测试指标：工程地质钻孔地层岩性信息、采样日期、钻探孔地理位置、孔口标高、采样层位、岩土类型、颗粒分析、液塑限、抗剪、压缩系数、压缩模量、含水量。

2　数据采集和处理方法

前人在该区域内开展了大量的区域地质调查与水文地质调查工作，项目的开展是在

收集前人的数据基础上进行的，但由于前人在工程地质方面的数据较少，本次的数据采集以本次的工程地质钻探为主，本次共进行了 14 孔工程地质钻探，土样采集 234 个。其中扰动样 151 个，原状样 83 个。本次工程地质钻孔布置的原则主要有 4 条：（1）重点考虑了石嘴山市的城市规划建设情况，重点布置在石嘴山市及其规划范围内，以一条东西向分布的工程地质剖面为工作布置重心；（2）本次钻孔布置基本以剖面的形式布置，为三维工程地质建模提供控制性钻孔；（3）本次钻孔布置尽可能填补前人钻孔空白区；（4）钻孔布置尽量避开湖泊、公路、居民区等不宜开展钻探工作的地区。工程钻孔部署前通过调查，重点考虑了急需解决的重大地质问题、环境地质问题，并综合考虑布孔的必要性以确定孔位，样品采集覆盖了每个岩层和不同的含水位层，由于星海湖附近经调查出现地下水降落漏斗，为查明地下水降落原因，故在此布置的工程钻孔相对较密。

钻探点位置信息采用 RTK 进行定位，记录平面坐标，孔口高程，采用西安 80 坐标系记录坐标。样品测试以室内测试为主，样品采集依据《中华人民共和国国家标准 GB50021−2001 岩土工程勘察规范》进行，并用样品箱进行密封保存，以保持土样的原状含水量。所有采集样品均送往宁夏回族自治区地质矿产中心实验室进行测试分析，并出具测试分析报告。

本数据集中的全部野外数据都是未经处理的原始数据；分析数据皆为实验室测试结果统计。

3 数据样本描述

岩土试验根据岩土类型的不同进行扰动样和原状样的采集和试验，区域内主要的岩土类型为圆砾、粉细砂、粉土和粉质粘土；圆砾、粉细砂由于其颗粒较分散的特性难以保持其原状性而只能采集其扰动样进行颗粒成分和液塑限分析；对粉土和粉质粘土则采取原状样，以分析含水量、抗剪强度、压缩系数、压缩模量、湿陷系数、颗粒成分和液塑限、塑性指数和液性指数分析为主。钻孔数据和实验数据显示，本图幅内平原区主要分布为冲积砂质土，以细砂和粉砂为主，分选较好，较为密实，允许承载力 160~280 kPa，工程地质条件较好；西北部局部区域内分布洪积碎石土，承载力较高，工程地质条件较好，满足一般的建筑物施工要求；图幅西北角出露在贺兰山边缘的砂岩、泥岩岩组，由于岩体破碎，表层风化严重，层状分布，属于软硬相间的岩体组合，其中存在软弱的泥岩夹层，降低其总体承载力，总体工程地质条件较差；图幅北部区域零星分布的湖沼积粘性土属于软土类，由于其高压缩性、低承载力和局部透镜体等不良特征，工程地质条件亦较差；零星分布的风积土，以粉砂为主，风积成因，分选较好，结构松散，工程地质条件亦较差（童国榜等，1998）。区内岩土工程地质性质见统计表 2。

表 2　图幅内岩土体类型及工程地质条件汇总表

岩土体类型		工程地质条件
岩体	砂岩、泥岩、砂质泥岩岩组	较差
土体	洪积碎石土	较好
	冲积砂土	较好
	风积砂土	较差
	湖沼积粘性土	较差

本样品数据包括三个 EXCEL 表格，数据根据扰动样和原状样分别统计汇总于 EXCEL 表格中，另有一个表格对工程钻孔信息进行了记录和说明。试验测试数据统计见表 3。图幅内主要岩土体物理力学性质参考表 4。

表 3　银川盆地 1∶50 000 平罗站幅土工试验测试数据统计表

序号	样品类型	主要测试内容	测试数据量（组）	单位	备注
1	原状样	含水量 W_o (%)	83	组	其中粉质粘土样59个，粉土24个。
2		天然密度 ρ_o (g/cm^3)	83	组	
3		干密度 ρ_d (g/cm^3)	83	组	
4		土粒比重 G_s	83	组	
5		液限 W_L (%)	82	组	
6		塑限 W_p (%)	82	组	
7		塑性指数 I_p	82	组	
8		液性指数 I_L	82	组	
9		饱和度(%)	83	组	
10		粘聚力 c (kPa)	83	组	
11		内摩擦角 φ (°)	83	组	
12		天然孔隙比 e_o	83	组	
13		孔隙比 e_i	408	组	
14		压缩系数 a_v	408	组	
15		压缩模量 E_s	408	组	
16		颗粒分析(%)	83	组	
17	扰动样	颗粒组成百分比(%)	151	组	其中粉质粘土样22个，粉土样16个。
18		液限 W_L (%)	38	组	
19		塑限 W_p (%)	38	组	
20		塑性指数 I_p	38	组	
21		液性指数 I_L	38	组	

表 4　图幅内主要岩土体物理力学参数参考表

岩土体	湿重度 γ (kN/m^3)	压缩模量 E_s (MPa)	黏聚力 c (KPa)	内摩擦角 φ (°)	压缩系数 $a_{1\sim2}$	允许承载力 f_a (kPa)
浅层粉细砂	19.5	10.0	0	30	–	160
粉土	17.0	5.0	10	21	0.30	180
粉质黏土	17.5	7.0	19	20	0.20	200
粉细砂	20.0	15.0	0	32	–	280
碎石土	22.0	–	0	38	–	350
强风化砂质泥岩	–	–	22	21	–	350
中风化砂质泥岩	–	–	25	24	–	450

4　数据质量控制和评估

4.1　工程地质钻探质量控制

工程地质钻探质量控制：总体上以把控区内地质分层、存在重大地质问题、不良地

质现象、工程建设布局等方面考虑布孔的必要性，勘探线按垂直主要构造线或沿地形地貌、岩性变化较大的方向呈“井”字型布控勘探孔位。钻孔的布置涵盖了不同的地貌区域、不同岩土体类型区、不良地质现象区等区域；钻孔密度为约 30 平方千米一个钻孔，取样按照每隔 2~3 m 采集一组土样。钻进前采用 RTK 对孔口高程进行了测量，钻孔孔径为 110 mm，钻井方法采取回转钻进法，全孔连续取心，钻进回次进尺根据岩土层情况限制回次进尺，严禁超管钻进。粘性土无岩心间隔不超过 1 m，其他不超过 2 m。松散地层中，潜水水位以上孔段，采用干钻。在砂层、卵砾石层、硬脆碎岩层和软碎岩层采样循环钻进。岩心采取率：对粘性土和完整岩体不低于 85%，砂类土不低于 70%，卵砾石类土不低于 60%，风化带和破碎带不低于 65%。每钻进 50 m 及终孔都按照相关规范要求完成了孔深、孔斜矫正（《中华人民共和国国家标准 GB50021–2001 岩土工程勘察规范》，2002 ）。钻进过程中，对水文地质进行了观测，记录最终稳定水位情况，部分钻孔因为泥浆影响没能确定准确稳定的水位，在工程钻孔信息中给出水位大概的层位。

4.2 岩心取样

采样根据不同土层、不同的实验目的选取不同的土样，采取土试样时，采用快速静力连续压入法，在粘性土和粉土取原状样，取样间隔为 2 m，厚度小于 2 m 但有意义的夹层也进行了取样，厚度大于 5 m 的土层间隔 3 m 取样。软土中用薄壁取土器进行压入取样，取样管内壁保持光滑，下放取土器前进行了清孔处理，孔底残留浮土厚度小于取土器废土段长度。采取土样时，尽量避免扰动，并保持土的原状性和天然湿度，采用专用的薄壁取土器进行取样，采取土样的数量根据实验需求的样品数进行采集。土样采集过程中，对原状样进行密封，以防水土散失，同时贴上标签标识取样编号、地点、深度、日期和土样层面方向等（《中华人民共和国国家标准 GB/T 50123–1999 土工试验方法标准》，1999 ）。

4.3 实验质量把控

在工程钻进、土样采集、实验测试过程中，所有的操作按照有关实验规程进行。在采集过程中尽量控制采样过程，以避免对其进行不必要的扰动，不因取样过程而导致样品污染，确保样品运输过程中的密封和完整，确保检测过程中未发生人为过失。严格按照有关规范进行试验，由有相应资质的专业人才在有资质的实验室规范操作，完成实验。

5 结论

本次数据集的钻孔布置涵盖了不同的地貌区域、不同岩土体类型区、不良地质现象区等区域，旨在为该图幅综合地质调查提供地层、水文等基本数据，了解该地区的工程、水文、环境地质问题，评价地质资源，为编制 1∶50 000 水文地质、工程地质等图件，查明图幅内的地质环境背景提供数据参考。综合野外调查、钻孔数据以及其它调查手段，基本查明了图幅内的地质环境特点。图幅内西北部靠近贺兰山区岩土类型主要为冲洪积卵砾石层，工程地质性质较差，且靠近贺兰山，根据野外调查数据与钻孔数据显示，该区域泥石流灾害比较发育，此处不宜建设居民楼；图幅东南部为平原区，地势平坦，主要工程地质岩组为全新统灵武组岩组，工程地质性质较好，适合各类工程建设，但地下水位埋深较浅，进行工民建时要处理好地基基础。

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Dataset of the 1∶50 000 Pingluo Station Map Sheet Area in the Yinchuan Basin in 2017 - Obtained from Geological Engineering Drilling, Borehole Sampling and Geotechnical Tests

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Abstract: This dataset contains 2 602 sets of test data on 234 rock and soil samples collected from the cores of 14 geological engineering boreholes that were drilled in the Pingluo Station map sheet area of Yinchuan Basin (also referred to as "the Area") in 2017. It primarily consists of information about the shear strength, compression modulus and grain composition of soil masses. In the Area, the geological structures of the Quaternary, which is formed by many causes and has a great thickness, compose the main geological engineering formation, since it is widely distributed. From west to east they include: diluvium of the Upper Pleistocene Series, in which gravels and sandy gravels are mainly distributed; fine sandy soil of the Lingwu Formation, Holocene Series; lacustrine sediment of the Holocene Series, throughout which sludge, sandy clay and silty sand are mainly distributed; aeolian deposits of the Holocene Series, in which khaki medium-fine sand and silty sand are mainly distributed. Among these geological structures, the Lingwu Formation of the Holocene Series covers most of the Area and mostly contains fine sand, silty sand and sandy clay. As revealed by the boreholes, vertically, the strata of the plain area of the Yinchuan Basin mainly consist of fine sand and silty sand of fluviatile-lacustrine facies that are interspersed with silty clay, whilst gravel-cobble layers are found in some boreholes. According to analysis of sample testing data, the gravel soil, alluvial sandy soil and cohesive soil in the Area are subject to good geological engineering conditions due to their high shear strength, while the sandstones and mudstones in

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the northwest suffer from poor geological engineering conditions since they are moderately or strongly weathered and interspersed with weak intercalations. In addition, the sludge, sandy clay and silty sand of lacustrine sedimentary origin also suffer from poor geological engineering conditions. The data obtained for the dataset are credible and can accurately reflect the strata information as well as the physical and mechanical properties of the rock and soil masses in the Area since the geological engineering drilling was conducted in a standardized manner and the tests and analysis were all performed by nationally-certified laboratories.

Key words: Yinchuan Basin; Geological engineering borehole; Geotechnical test; Pingluo Station map sheet; 1：50 000 dataset

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

1 Introduction

Data acquisition through drilling and sampling in the Pingluo Station map sheet area of the Yinchuan Basin (also referred to as ‘the Area’) was funded by a national geological survey project entitled “Comprehensive Geological Survey in the Economic Zone in Ningxia along the Yellow River”. The objective was to achieve detailed information on the engineering geology, hydrology and environmental geology in the Area through field survey and by means of geological engineering drilling, hydrogeological drilling, static and dynamic sounding tests and geophysical prospecting. The information was then used to determine the engineering geology zones and work out solutions to critical environmental geological problems that restrict construction and development of the Area, thus providing geological information and a scientific foundation for the assessment of the carrying capacity of the geological environmental resources, the construction, development and planning of urban clusters, as well as the construction of major projects in the Area. Rock and soil samples were collected and tested for grain composition analysis, water content, shear strength, liquidity index, plasticity index, compressibility, etc. The purpose is to obtain physical and mechanical parameters of the rock and soil masses and thus provide data support for local construction projects (Sun QY, et al.,2018).

The Area is located to the south of the central part of Shizuishan City, Ningxia Hui Autonomous Region, and is one of the most affluent areas in Ningxia. It is situated in the region between the Yinchuan Plain and the Helan Mountain range. Tectonically, it belongs to the intersection of the Helan Mountain fold-fault belt ($Ⅲ_5^{1\text{-}1\text{-}1}$) and the Yinchuan fault basin ($Ⅲ_5^{1\text{-}1\text{-}2}$), both of which lie in the fracture zone ($Ⅲ_5^{1\text{-}1}$) of the early Proterozoic and Paleozoic Era in the western margin of Ordos, Ordos block ($Ⅲ_5^{1}$), North China Craton ($Ⅲ_5$). In terms of topographical relief of the Area, in the western Helan Mountain area, an uneven topography exists, due to the presence of large mountains and deep valleys, while in the eastern plain area, a gentle topography exists, and it is high in the west and low in the east. In terms of landform of the Area, there are two major parts, i.e. low and medium mountains of the Helan Mountain range in the west and a plain in the east, which further consists of a diluvial plain and an alluvial-lacustrine plain from west to east. Strata of the Permian and Triassic are exposed in the western Helan Mountain area, while most of the east is covered by Quaternary strata with a great thickness in local areas of up to 1 000 meters. The main rocks and soils in the Area include diluvial gravels and sandy gravels of the Upper Pleistocene; lacustrine-facies fine sand, silty fine sand, clayey sand, etc. of the Lingwu Formation, Holocene Series; of lacustrine bog sludge, sandy clay and silty sand of the Holocene Series; fine sand and silty sand in the aeolian deposits of the Holocene Series; as well as fine sand, silty sand, sandy clay, etc., in the alluvial-lacustrine deposits of the Holocene Series(Fig.1). Based on the information collected and data from the field survey as well as data from boreholes, the horizontal lithology of the strata in the eastern plain area are collated as shown below in Fig. 2.

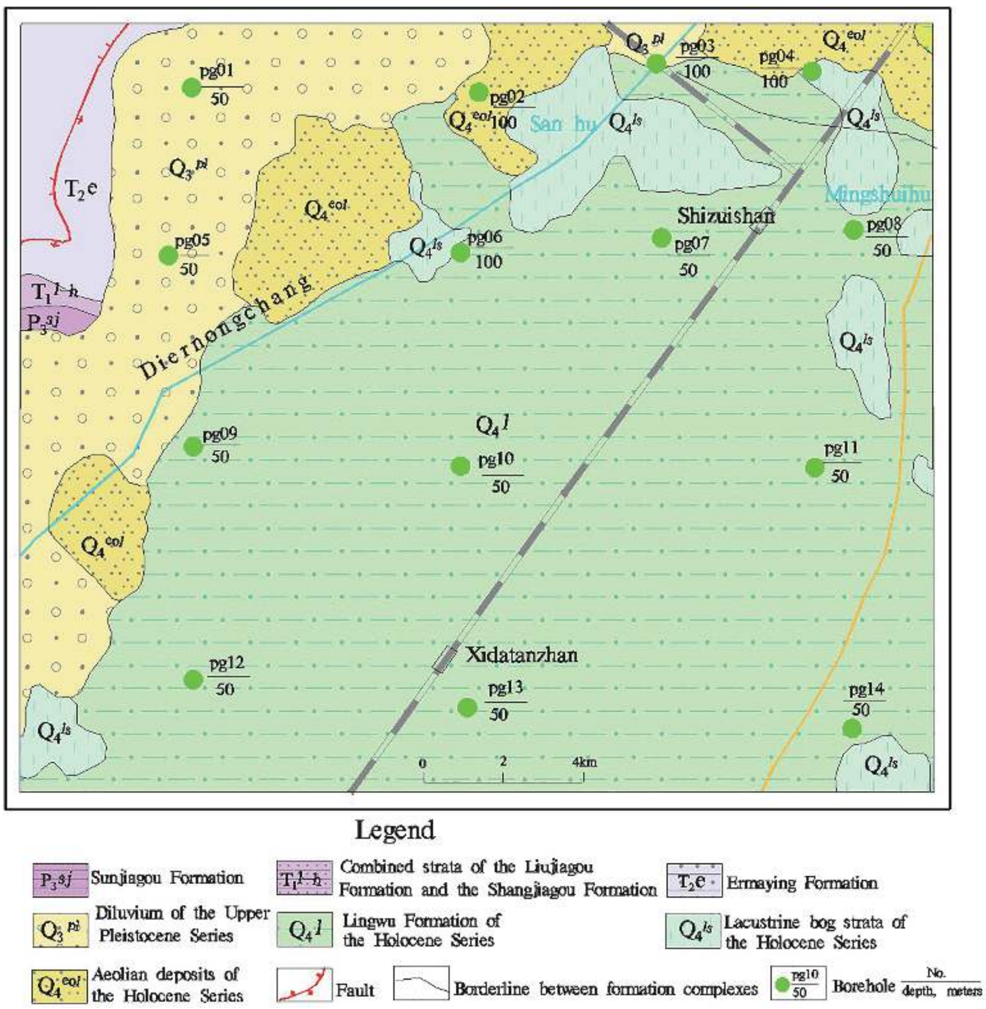

Fig. 1 Geological schematic diagram and borehole distribution of the Area

The metadata tested for the dataset is shown in Table 1.

Chronostratigraphy			Lithostratigraphy			Rock & soil composition and geological engineering characteristics	Thickness (m)
Erathem	System	Series	Formation	Code	Histogram		
Cenozoic Erathem	Quaternary System	Holocene Series		Q_4^e		Silty sand and silty soil are mainly distributed throughout the stratum. Silty soil: khaki, slightly humid, loose and a little dense, containing plant roots in the upper part, and locally interspersed with silty clay. Silty sand: grayish, loosely structured. The main minerals are quartz, feldspar, etc. This stratum is sporadically distributed throughout the Area. It suffers from poor geological engineering properties, with a permitted load-bearing capacity of only 150~180 kPa.	<5.0
				Q_4^{lS}		Sandy clay, silty sand and mucky soil are mainly distributed in the stratum. The sediments are khaki and/or dark-gray soft soil with high compressibility and a load-bearing capacity of 180~200 kPa. They are extremely loose and soft when saturated, and prone to cause uneven settlement. Therefore, they are not suitable to be treated as a natural load-bearing layer for the foundations of buildings', and are poor in terms of their geological engineering properties.	<3.0
			Lingwu Formation	Q_4L		Fine sand, silty clay, silty sand and sandy clay are mainly distributed throughout this stratum. They are grayish to dark gray. The main minerals are quartz and feldspar, locally interspersed with multiple layers of silty claywith a thickness of 3~10 m. There are thin silty sands locally. The oil of this stratum is widely distributed in the Area. The strata is dense and compact with similar grain size as well as good geological engineering properties. The permitted load-bearing capacity is 160~280 kPa.	8~28
		Upper Pleistocene Series		Q_3		The strata lie far away from the piedmont, sediments of fluviatile-lacustrine facies and mainly consist of fine sand, silty clay, gravels, and gravel-cobbles. Fine sand: dark gray; dense; saturated; main minerals include quartz and feldspar, locally interspersed with silty clay. Siltyclay: dark gray; wet; malleable and capable of being rubbed into 2 mm soil strips with hands, locally interbedded with thin silty soil and clay. Sandy gravels: dark gray; dense; wet; with different particle size and poor sphericity; there are local gravel sands with a thickness of less than 2m. The permitted load-bearing capacity of these strata is 350 kPa and thus it has good geological engineering properties.	26.6~82.58

Fig. 2 Borehole histogram of the Area

Table 1 Metadata Table of Database (Dataset)

Items	Description
Database (dataset) name	Dataset of the 1∶50 000 Pingluo Station Map Sheet Area in the Yinchuan Basin in 2017- Obtained from Geological Engineering Drilling, Borehole Sampling and Geotechnical Tests
Database (dataset) authors	Sun Qiaoyin, Xi'an Center, China Geological Survey Li Chengzhu, Xi'an Center, China Geological Survey Fang Lei, Research Institute of Hydrological and Environmental Geology of Ningxia Hui Autonomous Region
Data acquisition time	2017
Geographical area	1∶50 000 Pingluo Station map sheet area, Yinchuan Basin (J48E007018)
Data format	*.xls
Data size	244 KB
Data service system URL	http://dcc.cgs.gov.cn
Fund project	China Geological Survey Project "Comprehensive Geological Survey in the Economic Zone in Ningxia Along the Yellow River"(DD20160263).
Language	Chinese
Database (dataset) composition	The dataset consists of 2 602 sets of test data obtained from 151 disturbed samples and 83 undisturbed samples that were taken from 14 engineering boreholes. It includes the following test indicators: stratum lithology of geological engineering boreholes, sampling date, geographical location of boreholes, ground elevations of borehole locations, sampling position, rock and soil type, grain composition analysis, liquid-plastic limit, shear strength, compression coefficient, modulus of compressibility, and water content

2 Method for Data Acquisition and Processing

The dataset acquisition of the Area was based to a large extent on the previous survey of regional geology and hydrogeology in the Area. Geological engineering drilling was the focus since little geological engineering data was gathered in the previous survey. 14 geological engineering boreholes were drilled and 234 soil samples collected, including 151 disturbed samples and 83 undisturbed samples. The following four principles were followed in the deployment of geological engineering boreholes. (1) With Shizuishan City's urban planning and construction as the primary consideration, the boreholes were mainly deployed in Shizuishan City and its planning range, especially along a geological engineering profile in a west-east direction; (2) The boreholes were deployed along a profile in order to provide control boreholes for 3D geological engineering modeling; (3) The boreholes were deployed to fill gaps in previous drilling as much as possible; (4) The boreholes were deployed away from areas that are unsuitable for drilling such as lakes, roads and residential areas, wherever possible. The deployment of boreholes was based on the investigation of the geological engineering characteristics of the Area, the consideration of critical geological and environmental geological problems requiring urgent solutions, and comprehensive consideration of the necessity of borehole arrangement. The samples were collected from all rock strata at different water levels. Boreholes were deployed fairly intensively near Xinghai Lake so as to find out the reasons why funnel-shaped drawdown often takes place in the groundwater in the area.

The drilling positions were determined by the use of IRTK and the Xi'an Coordinate System of 1980 was adopted to record the plane coordinates and ground elevation of the borehole locations. Samples were mainly tested indoors, and collected in accordance with GB 50021−2001 *Code for Investigation of Geotechnical Engineering*, a national standard of the People's Republic of China, and sealed and stored in sample boxes to retain the *in situ* water content of the soil samples. All samples were tested and analyzed by the laboratory of the Geological and Mineral Center of the Ningxia Hui Autonomous Region, which then issued testing and analysis reports.

All field data contained in this dataset are raw and unprocessed and all data analyzed comes from statistical results of lab testing.

3 Description of Data Samples

Disturbed or undisturbed samples were acquired and tested according to the different types of rocks and soils in order to conduct geotechnical tests. The main types of rocks and soils in the area included rounded gravels, silty fine sand, silty soil, and silty clay. For the rounded gravels and silty fine sand, only disturbed samples could be collected for analysis of the grain composition and liquid-plastic limits, since their *in situ* state was hard to maintain due to their dispersed particles. As for the silty soil and silty clay, undisturbed samples were collected and then their water content, shear strength, compression coefficient, compression modulus, coefficient of collapsibility, grain composition, liquid-plastic limit, plastic index, and liquid index were primarily analyzed. The following information was obtained from the borehole data and test data: In the plain area of the Area, alluvial sandy soil, including fine sand and silty sand are predominantly distributed. They are dense and have a similar grain size, as well as a good geological engineering condition, with a permitted load-bearing capacity of 160~280 kPa. Diluvial gravel soil is primarily distributed in some northwestern parts of the Area, which consequently have good geological engineering conditions with a high load-bearing capacity, which meets the construction requirements for general buildings. In the northwest corner of the Area, formation complexes of sandstone and mudstone are exposed on the margins of the Helan Mountain range. The rock masses are disintegrated, strongly weathered on the surface, and distributed in layers. There are soft and hard intercalated beds in the formation complexes with interspersed weak mudstone intercalations, with the result that this area has a low load-bearing capacity and a poor geological engineering condition in general. Lacustrine cohesive soil and aeolian soil are sporadically distributed in the northern part of the Area. The lacustrine cohesive soil is soft in texture and is characterized by adverse properties, such as high compression, low load-bearing capacity and local lenses. Therefore, it suffers from a poor geological engineering condition. The aeolian soil, mainly including silty sand, has a similar grain size, loose structure and a poor geological engineering condition (Tong GB et al., 1998). The geotechnical geological properties of the Area are shown in Table 2.

Table 2 Summary of Types and Geological Engineering Conditions of Rock and Soil Masses in the Area

	Type of rock and soil mass	Geological engineering condition
Rock mass	Sandstone, mudstone and sandy mudstone	Poor
Soil mass	Diluvial gravel soil	Good
	Alluvial sandy soil	Good
	Aeolian sandy soil	Poor
	Lacustrine bog cohesive soil	Poor

This dataset includes three Excel files. Two files summarize the data obtained from disturbed samples and undisturbed soil samples respectively, while the last one records the information on the engineering geology of the boreholes with appropriate notes. See Table 3 for statistics of test data and Table 4 for physical and mechanical properties of the main rock-soil masses in the Area.

Table 3 Statistics of Geotechnical Test Data of the Area

No.	Sample type	Test item	Quantity of test data (set)	Unit	Remarks
1	Undisturbed samples	Water content, W_o (%)	83	Set	Including 59 sets of silty clay samples and 24 sets of silty soil samples
2		Natural density, ρ_o (g/cm^3)	83	Set	
3		Dry density, ρ_d (g/cm^3)	83	Set	
4		Specific gravity of soil particle, G_s	83	Set	
5		Liquid limit, W_L(%)	82	Set	
6		Plastic limit, W_p(%)	82	Set	

Continued table 3

No.	Sample type	Test item	Quantity of test data (set)	Unit	Remarks
7	Undisturbed samples	Plasticity index, l_p	82	Set	Including 59 sets of silty clay samples and 24 sets of silty soil samples
8		Liquidity index, l_L	82	Set	
9		Degree of saturation, (%)	83	Set	
10		Cohesive force, c (kPa)	83	Set	
11		Internal friction angle, φ (°)	83	Set	
12		Natural void ratio, e_o	83	Set	
13		Void ratio, e_i	408	Set	
14		Compression coefficient, a_v	408	Set	
15		Compression modulus, E_s	408	Set	
16		Analysis of grain composition, (%)	83	Set	
17	Disturbed samples	Grain composition, (%)	151	Set	Including 22 sets of silty clay samples and 16 sets of silty soil samples
18		Liquid limit, W_L(%)	38	Set	
19		Plastic limit, W_p(%)	38	Set	
20		Plasticity index, l_p	38	Set	
21		Liquidity index, l_L	38	Set	

Table 4 Physical and Mechanical Properties of the Main Rock and Soil Masses in the Area

Rock and soil mass	Moist unit weight γ (kN/m^3)	Compression modulus E_s (MPa)	Cohesive force c (KPa)	Internal friction angle φ (°)	Compression coefficient a_{1-2}	Permitted load-bearing capacity f_a (kPa)
Shallow silty fine sand	19.5	10.0	0	30	/	160
Silty soil	17.0	5.0	10	21	0.30	180
Silty clay	17.5	7.0	19	20	0.20	200
Silty fine sand	20.0	15.0	0	32	/	280
Gravel soil	22.0	/	0	38	/	350
Strongly weathered sandy mudstone	/	/	22	21	/	350
Moderately-weathered sandy mudstone	/	/	25	24	/	450

4 Data Quality Control and Assessment

4.1 Quality Control of Geological Engineering Drilling Exploration

In general, the aspects such as geological stratification, existing critical geological problems, adverse geological phenomena and layout of project construction in the Area were considered when determining the necessity of drilling. Boreholes were arranged perpendicularly to the main structural lines or in the direction where the topography or landform and lithology change significantly, with exploratory lines of a ‘#’ pattern formed. The boreholes were deployed in the areas with different landforms, different types of rock and soil masses, different geological phenomena, etc. The density of the boreholes was about 30 km^2 and a set of samples were taken every 2~3 m.

Prior to drilling, the ground elevation of the borehole locations was measured with IRTK. The boreholes were drilled at a diameter of 110 mm using the rotary drilling method and by way of full-hole continuous coring. The drilling roundtrip and drilling footage depended on the conditions of the rock and soil formations, and no over-pipe drilling was allowed. The non-core spacing was not more than 1 m for cohesive soil and not more than 2 m for other types of soil. In loose strata, the section above the phreatic water level was drilled at circulation break. Drilling in a circulative way was adopted in sand, gravels and cobbles, rigid-brittle-fragmentary rocks and the soft-fragmentary rocks. The core recovery rate was no less than 85% for clay and intact rock masses, 70% for sandy soil, 60% for gravel soil and 65% for weathered zones and fractured zones. The borehole depth and deviation were corrected every 50 m of drilling and at the bottom of the borehole (GB50021−2001 *Code for Investigation of Geotechnical Engineering*, 2002). In the process of drilling, the hydrogeological condition was observed and the final stable water level was recorded. For some boreholes, however, only the rough estimate of the water level was given in the engineering borehole information, because the precise stable water level could not be determined, due to the presence of mud.

4.2 Sampling of Cores

Different soil samples were taken for different soil layers and test purposes. During soil sampling, the quick static-force continuous press-in method was used. For cohesive soil and silty soil, undisturbed soil samples were taken at an interval of 2 m. Samples were also taken from distinct interlayers with a thickness of less than 2 m. For soil layers with a thickness of greater than 5 m, samples were taken at an interval of 3 m. For soft soil, thin-walled samplers were pressed in to take samples, with the inner wall of the sampling tube kept smooth. Before the sampler was pressed into the soil, the borehole was cleaned to ensure that the thickness of the soil left at the bottom of the borehole was less than the length of the waste soil section of the sampler. During soil sampling, disturbances were avoided wherever possible, in order to keep the soil undisturbed and maintain its natural humidity. A dedicated thin-walled sampler was used. The quantity of soil samples to be taken was dependent on the demand of the tests. During soil sampling, undisturbed soil samples were sealed to prevent loss of soil and water and affixed with labels to specify the sample number, sampling location, depth and date, as well as soil formation and direction (GB−T 50123−1999 *Standard for Geotechnical Test Methods*, 1999).

4.3 Quality Control of Experiments

All operations complied with applicable test procedures during engineering drilling, soil sampling and testing. During soil sampling, due care was taken to avoid any unnecessary disturbances and to prevent polluting of the samples. During transportation, the samples were kept sealed. During testing, human faults were prevented. All tests were performed by qualified professional personnel in strict accordance with the regulations.

5 Conclusion

The boreholes involved in this dataset were deployed in the areas with different landforms, different types of rock and soil masses, different geological phenomena, etc. The purpose is to provide basic data on strata and hydrology for comprehensive geological investigation of the Area, understand the problems regarding engineering, hydrology and environmental geology and therefore assess geological resources and provide data references for the determination of the geological environmental background in the Area. In this way, the 1∶50 000 hydrogeological and geological engineering maps can be prepared. The characteristics of the geological environments in the Area were fundamentally derived from field survey, borehole data and other methods of survey. In the northwest of the Area, near the Helan Mountain range, alluvial-diluvial gravel-cobble strata are mostly distributed and the geological engineering condition is poor. Furthermore, it is not advisable to construct any residential buildings here, since this area is close to the Helan Mountain range, and as indicated by the data from the field survey and boreholes, catastrophic debris flows are well-developed in the area. In the southeastern part of the Area, the flat plain area, the Lingwu Formation of the Holocene Series forms the main formation complex with good geological engineering properties. Therefore, it is suitable for various projects in this area to be constructed. However, due to the shallow groundwater in this area, considerable effort must be expended in order to lay foundations fit for both industrial and civil purposes.

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