doi: 10.12029/gc2018Z207

论文引用格式：孙巧银，方磊，王化齐. 2018. 银川盆地 1∶50 000 芦花台幅工程地质钻孔及取样土工试验数据集[J]. 中国地质，45(S2):56−61.
数据集引用格式：孙巧银; 方磊; 王化齐. 银川盆地 1∶50 000 芦花台幅工程地质钻孔及取样土工试验数据集[V1]. 中国地质调查局西安地质调查中心;宁夏回族自治区水文地质与环境地质勘察院[创建机构]，2016. 全国地质资料馆[传播机构]，2018−12−31. 10.23650/data.D.2018.P12; http://geodb.ngac.org.cn/geologicalDataJournal/rest/manuscript/manuscriptDetail/22a49d0d24395a58bd999fab6ca2a330

收稿日期：2018-03-15
改回日期：2018-10-15

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）资助。

银川盆地 1∶50 000 芦花台幅工程地质钻孔及取样土工试验数据集

孙巧银[1]　方磊[2]　王化齐[1]

(1. 中国地质调查局西安地质调查中心，陕西 西安，710054;
2. 宁夏回族自治区水文地质与环境地质勘察院，宁夏 银川 750021)

摘要：本数据集包含了 2016 年从银川盆地 1∶50 000 芦花台图幅区内采集的 14 个工程钻孔的数据信息，293 个岩土样品共 1 996 组测试数据。主要测试土体抗剪强度、压缩模量、颗粒成分等。图幅区内出露的地层主要为第四系。经钻孔揭露，纵向上岩土类型从地表至深部依次为砂砾石土、粉细砂、粉土和粉质粘土等；横向上，西部以洪积成因的砂砾石为主，东部以冲积和风积成因的粉细砂为主；整体上表现出由西向东地层时代变新，岩性颗粒由粗变细的总体特征。样品测试显示，图幅区内砂砾石、粘性土具有较高的抗剪强度，工程地质特性较好；而图幅东部区域的风成粉细砂土因胶结差，结构较分散，易出现砂土液化现象而呈现出较差的工程地质特性。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。本数据集的数据和分析结论，可以为研究银川盆地的地质演化及在该区开展工程建设规划提供参考。

关键词：银川盆地；岩土测试；工程地质；芦花台幅；1∶50 000
数据服务系统网址：http://dcc.cgs.gov.cn

1　引言

工程地质钻探是获取地层岩性资料的重要方法，可以获得岩层的厚度、类别信息，并通过钻孔取样、试验测试和现场力学实验获取岩土体物理力学性质参数，为工程设计提供依据；对岩土进行岩土测试分析，了解其力学特性，帮助了解有关特殊工程建设所要求的专门工程地质问题，如抗震、滑坡、地基沉陷等问题，为工业及民用建筑勘察地基、选择厂址，机场、公路、铁路交通线路勘察，水库坝基建设、水源地建设、地下空间开发利用等提供工程地质参数。

第一作者简介：孙巧银，女，1975 年生，工程师，硕士，从事城市地质调查与研究工作；E-mail：360141152@qq.com。

银川盆地芦花台图幅内的工程地质条件相对简单，区内地势平坦，构造活动不强烈，区内不良地质现象主要表现为盐渍土和局部地区砂土液化，主要岩土类型为第四系冲积–洪积层和冲积–湖积层砾石类、砂质土和粉质粘土。芦花台图幅内的钻探数据和采样数据的获取是由国家地质调查项目“宁夏沿黄经济区综合地质调查项目”支持；该项目旨在通过野外调查，借助工程地质钻探和水文钻探、静动力触探、物探等手段查明图幅区内的工程地质、水文地质、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、城市群的建设、发展、规划，以及重大工程建设提供地质资料参考。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。

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	银川盆地1∶50 000芦花台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 方磊，宁夏回族自治区水文环境地质勘察院 王化齐，中国地质调查局西安地质调查中心
数据时间范围	2016年
地理区域	银川盆地1∶50 000芦花台幅（J48E009017）
数据格式	*.xls
数据量	312 KB
数据服务系统网址	http://dcc.cgs.gov.cn
基金项目	国家地质调查项目“宁夏沿黄经济区综合地质调查”（项目编号：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231个，原状样品62个，测试数据1 996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

图幅位于银川平原中部，贺兰山山前地带，根据地貌成因及形态，可分为堆积–剥蚀区、堆积区和风积区。堆积–剥蚀区分布在图幅中西部大部分地方，主要包括山前老洪积扇、新洪积扇、冲–洪积平原和扇前洪积洼地。堆积区主要分布在图幅的东部，多由河湖堆积形成，呈近南北向延伸，地面低平。风积区主要分布在南梁台子及贺兰山农牧场一带，形成图幅区内固定–半固定草丛沙丘；沙丘之间为平铺沙地，地形较平坦。

本次共进行了 14 孔工程地质钻探，土样采集 293 个。工程钻孔部署前通过调查，了解图幅的工程地质特性，在此基础上重点考虑了急需解决的重要地质问题、环境地质问题，并综合考虑地貌单元的差异以及以经济建设为目的的布孔必要性以确定孔位，样品采集覆盖了每个岩层和不同的水位层。工程钻孔分布见图 1。

钻探点位置信息采用 IRTK 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《中国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。

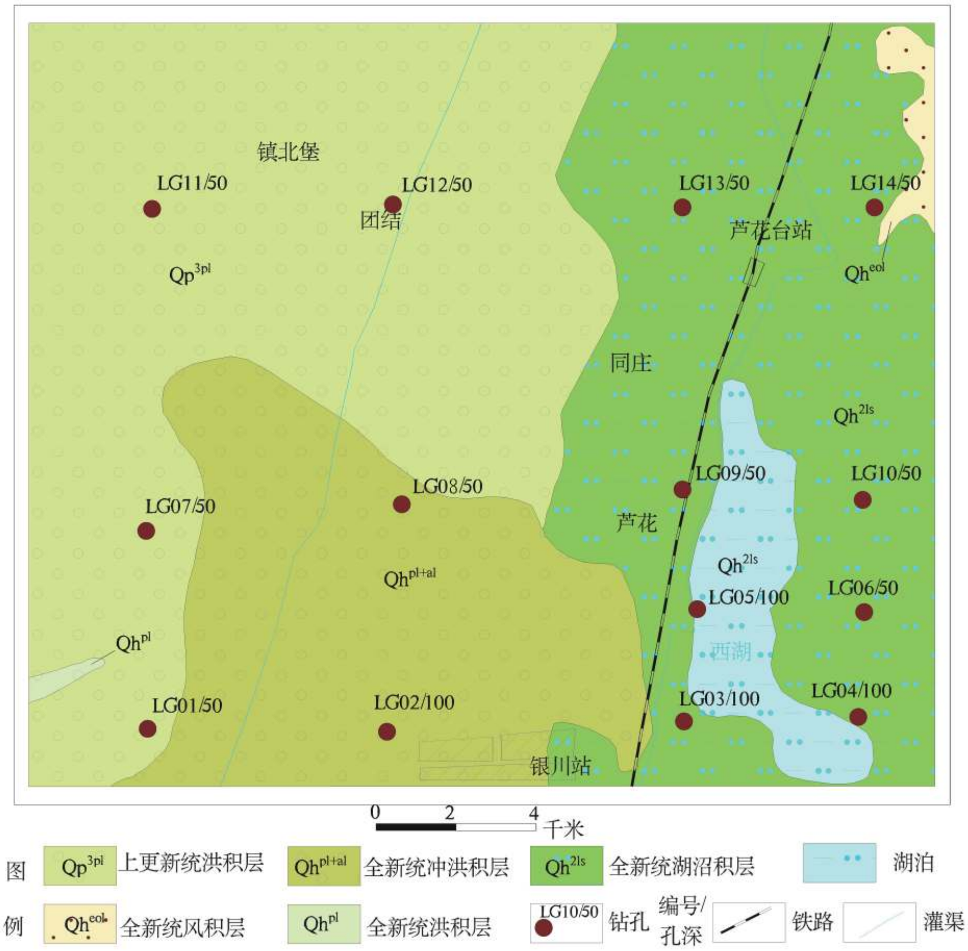

图 1 银川盆地芦花台幅地质简图及工程钻孔分布

3 数据样本描述

钻孔揭示第四系地层在图幅范围内广泛分布，大部分在地表有出露。图幅西部堆积了洪积碎石土层，分选差，磨圆度差，大于 20 mm 的粒径占 70% 以上，中密到密实，承载力较高，工程地质条件较好。图幅中南部为冲积–洪积层，地表堆积全新统洪积物，较为松散，存在砂土液化不良工程地质现象，工程地质条件较差。地表以下 100 m 内堆积上更新统冲积–洪积层，岩性以粉细砂为主，含砾石，夹有粘性土和粉土，土体较密实，工程地质条件良好 (童国榜，1998)。图幅东部，湖泊湿地密布，地下水浅埋，且排泄不畅。地层主要为冲积–湖积层，上部为粘性土，存在砂土液化和盐渍土等不良工程地质现象，工程地质条件较差；下部以粉细砂为主，夹有粉土和粘性土，饱和密实，工程地质条件较好。区内岩土工程地质性质见统计表 2。

表 2　银川盆地 1：50 000 芦花台幅岩土体类型及工程地质性质汇总表

岩土体类型		工程地质性质
土体	洪积碎石土	较好
	冲洪积砂土	较好
	风积砂土	较差
	湖沼积砂土	较差

岩土试验根据岩土类型的不同，做了扰动样和原状样的采集和试验。区域内主要的岩土类型为砾石、粉细砂、粉土和粉质粘土 (童国榜，1998)。砾石、粉细砂由于其颗粒较分散从而难以保持其原状性，以采集其扰动样进行颗粒成分分析为主。对粉土和粉质粘土采原状样，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、颗粒成分和液限/塑限、塑性指数和液性指数分析为主 (土工试验规程，1999)。

本数据集包括三个 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 芦花台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 (%)	62	组	其中粉质粘土40组，粉土22组
2		天然密度ρ_o (g/cm^3)	62	组	
3		干密度 ρ_d (g/cm^3)	62	组	
4		土粒比重G_s	62	组	
5		液限W_L (%)	61	组	
6		塑限W_p (%)	61	组	
7		塑性指数I_p	61	组	
8		液性指数I_L	61	组	
9		饱和度(%)	62	组	
10		粘聚力c (kPa)	62	组	
11		内摩擦角φ (°)	62	组	
12		天然孔隙比e_o	62	组	
13		孔隙比 e_i	289	组	
14		压缩系数a_v	289	组	
15		压缩模量E_s	289	组	
16		颗粒分析(%)	62	组	
17	扰动样	颗粒组成百分比(%)	231	组	其中粉质粘土2组，粉土22组
18		液限W_L (%)	24	组	
19		塑限W_p (%)	24	组	
20		塑性指数I_p	24	组	
21		液性指数I_L	24	组	

表 4　银川盆地 1：50 000 芦花台幅主要岩土体物理力学性质参考表

编号	土体类型	含水量(%)	密度(g/cm^3)	孔隙比	压缩模量 Es_{1-2} (MPa^{-1})	内聚力(kPa)	内摩擦角	承载力(kPa)
		最小值~最大值	最小值~最大值	最小值~最大值	最小值~最大值	最小值~最大值	最小值~最大值	最小值~最大值
		平均值	平均值	平均值	平均值	平均值	平均值	平均值
1	粉质粘土	16.3~36.7	1.83~2.12	0.551~0.999	5.52~10.26	14~36	10~20	100~270
		23.9	2.00	0.683	8.67	24.2	15.3	175
2	粘土	23.5~27.0	2.01~2.07	0.659~0.714	6.49~8.20	31~44	11~15	220~250
		25.6	2.04	0.689	7.3	35.7	12.6	235
3	粉土	17.7~26.5	1.74~2.10	0.535~0.794	9.9~13.99	6~17	19~22	160~280
		18.4	2.00	0.672	12.25	12.7	20.3	220
4	粉细砂	19.6~23.3	1.99~2.02	0.587~0.654	11.63~14.18	6~9	21~21	140~250
		21.9	2.00	0.631	12.48	7.3	21	180
5	粉砂	饱和密实，标贯击数大于50击						340
6	细砂	饱和密实，标贯击数大于50击						340

4　数据质量控制和评估

4.1　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和岩性变化较大的方向呈“井”字型布控勘探孔。钻孔前采用IRTK对孔口标高进行了测量，钻孔孔径选择127 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而定，严禁超管钻进；粘性土无岩心的间隔不超过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−碎和软−碎岩层采样循环钻进。岩心采取率情况：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以及终孔时，都进行了孔深、孔斜矫正 (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　取样要求

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；对于厚度小于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。采取土样的数量应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、取样地点、取样深度、取样日期、土样层面方向等。

4.3 实验质量把控

本数据集从工程钻孔、土样采集、试验测试均进行了质量控制，所有的操作要按照有关实验规程进行操作, 具有适用型、规范性、准确性 (游国庆，2018)。在采集过程中尽量控制采样过程，避免对其进行不必要的扰动，并确保不发生样品污染，确保样品在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《中国人民共和国国家标准 GB−T50123−1999 土工试验方法标准》进行试验，实验由有相应资质的专业人员进行规范操作。

5 结论

本数据集汇总了 2016 年从银川盆地芦花台图幅区内采集的 14 个工程钻孔的数据信息，293 个岩土样品共 1 996 组测试数据。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；钻孔施工操作规范，记录详实，真实反映了该时段内银川盆地芦花台幅内岩土体特性，具有一定的代表性。钻孔数据信息揭露了图幅区内地层层序及岩土体类型，可以为银川盆地的三维地质模型的建设提供地质数据信息，满足宁夏沿黄经济区综合地质调查项目的目标任务需求。样品采集、测试过程严格按照《中国人民共和国国家标准 GB−T50123−1999 土工试验方法标准》进行操作，测试结果质量可靠。岩土测试结果给出了图幅区内各岩土类型的物理力学参数，结合图幅内的地面调查以及其他调查手段，可以对图幅区域进行进一步的工程地质分区，评价区内工程地质条件，为银川盆地的不同类型的工程建设规划提供参考。

参考文献

童国榜, 石英, 郑宏瑞, 张静, 林防, 何庆林, 宋祥华, 刘振西, 乔光东, 张纪祥, 羊向东, 张文卿. 1998. 银川盆地第四纪地层学研究[J]. 地层学杂志, 22(1).

游国庆, 易荣龙, 耿树方, 陈炳蔚, 庞健峰, 杨志新, 李佳林. 2018. 中国南部及邻区能源资源成矿区带数据集[J]. 中国地质, 45(S1): 66−75.

中国人民共和国国家标准 GB50021−2001 岩土工程勘察规范[S]. 2002. 北京: 中国建筑工业出版社.

中国人民共和国国家标准 GB−T50123−1999 土工试验方法标准[S]. 1999. 北京: 中国计划出版社.

中华人民共和国行业标准 SL237−1999 土工试验规程[S]. 1999. 北京: 中国水利水电出版社.

Received: 03-15-2018
Accepted: 10-15-2018

Fund Project:
CGS's geological survey project titled "Comprehensive Geological Survey in the Economic Zone in Ningxia Along the Yellow River" (DD20160263)

doi: 10.12029/gc2018Z207

Article Citation: Sun Qiaoyin, Fang Lei, Wang Huaqi. 2018. Luhuatai in the Yinchuan Basin for the 1∶50 000 Map: Dataset from Engineering Geology Boreholes, Samples and Geotechnical Tests[J]. Geology in China, 45(S2):75−82.

Dataset Citation: Sun Qiaoyin; Fang Lei; Wang Huaqi. Luhuatai in the Yinchuan Basin for the 1∶50 000 Map: Dataset from Engineering Geology Boreholes, Samples and Geotechnical Tests[V1]. Xi'an Center, China Geological Survey; Institute of Hydrological and Environmental Geology of the Ningxia Hui Autonomous Region[producer], 2016. National Geological Archives of China[distributor], 2018−12−31. 10.23650/data.D.2018.P12; http://geodb.ngac.org.cn/geologicalDataJournal/rest/manuscript/manuscriptDetail/b1bc6759264d593e81e616c0380a51f8

Luhuatai in the Yinchuan Basin for the 1∶50 000 Map: Dataset from Engineering Geology Boreholes, Samples and Geotechnical Tests

SUN Qiaoyin [1], FANG Lei [2], WANG Huaqi [1]

(1. *Xi'an Center, China Geological Survey, Xi'an* 710054, *China*; 2. *Institute of Hydrological and Environmental Geology of the Ningxia Hui Autonomous Region, Yinchuan*, 750021, *China*)

Abstract: This dataset contains 1 996 sets of test data, obtained from 293 rock and soil samples collected from 14 engineering boreholes drilled in Luhuatai, Yinchuan Basin, in 2016. The test items include the shear strength, modulus of compressibility and grain composition of the soil mass. The exposed strata in Luhuatai is predominantly Quaternary. The boreholes reveal that, vertically, the rocks/soils are sandy gravel, fine silty sand, silty soil and silty clay, respectively, from the surface downwards; and horizontally, the western area is dominated by diluvial sand while the eastern area is mainly alluvial and eolian fine silty sand. Generally, the characteristic of the area is that the rock tends to young with finer lithological particles from west to east. The sample tests indicate that the sand and cohesive soil in Luhuatai possess high shear strength and ideal engineering geology characteristics. However, the eolian fine silty sand in the eastern area exhibits poor engineering-geological characteristics because it is prone to liquefaction of sandy soil due to poor cementation and a dispersed structure. The engineering geology drilling in Luhuatai is performed according to related specifications, where tests and analysis are all performed by nationally-certified laboratories. Therefore, the data obtained is reliable and can truly reflect the strata information and the physical and mechanical properties of the rocks and soil in Luhuatai. The data and conclusions contained in the dataset can be used as a reference for the study of the geological evolution of the Yinchuan Basin and for project construction and planning in Luhuatai.

Key words: Yinchuan Basin; Geotechnical testing; Engineering geology; Luhuatai map-sheet; 1∶50 000

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

About the first author: SUN Qiaoyin, female, born in 1975, engineer, master, engages in urban geological survey and research; E-mail: 360141152@qq.com.

1 Introduction

Engineering geology drilling is an important method of obtaining stratum lithology information, such as the thickness and type of the stratum. In addition, through borehole sampling, tests and field mechanical experiments, the parameters for the physical and mechanical properties of the rock/soil can be obtained, thus providing a basis for project design. Furthermore, geotechnical testing and analysis of rock and soil can be used to provide information on mechanical properties and engineering geology problems encountered in the construction of special projects, such as earthquake, landslide and foundation settlement, thus providing engineering geology parameters needed for survey and siting of industrial and civil buildings, survey of routes of airports, highways and railways, construction of reservoir dams and water sources, as well as the development and utilization of underground spaces.

Luhuatai in the Yinchuan Basin has relatively simple engineering geology conditions since the terrain is flat, tectonic activity is minimal, and the adverse geological phenomena are mainly salty soil and local sand liquefaction. The rock/soil is mostly Quaternary alluvial-diluvial and alluvial-lacustrine gravels, sandy soil and silty clay. The data acquisition from drilling and sampling in Luhuatai was funded by the national geological survey project entitled "Comprehensive Geological Survey in the Economical Zone in Ningxia along the Yellow River". The purpose is to obtain detailed information on the engineering geological, hydrogeological and environmental geological conditions in Luhuatai through field investigation, by means of engineering geology drilling, hydrogeological drilling, static and dynamic sounding tests and geophysical exploration. The information is then used to determine the engineering geology zones of Luhuatai and work out solutions to critical environmental geological problems restricting construction and development of Luhuatai, thus providing a reference for assessment of the geological environment, for the construction, development and planning of city clusters, and for the construction of major projects in Luhuatai. Soil samples are collected and tested for analysis of grain composition, water content, shear strength, liquidity index, plasticity index and compressibility. The purpose is to obtain physical and mechanical parameters of the soil mass, and thus provide data support for local project construction.

The metadata of the dataset from the test is shown in Table 1.

Table 1 Metadata Table of the Database (Dataset)

Items	Description
Database (dataset) name	Luhuatai in Yinchuan Basin for the 1：50 000 Map: Dataset from Engineering Geology Boreholes, Samples and Geotechnical Tests
Database(dataset) authors	Sun Qiaoyin, Xi'an Center, China Geological Survey Fang Lei, Hydrological and Environmental Geology Research Institute of the Ningxia Hui Autonomous Region Wang Huaqi, Xi'an Center, China Geological Survey
Data acquisition time	2016
Geographic area	Luhuatai for the 1：50 000 geological map in Yinchuan Basin (J48E009017)
Data format	*.xls
Data size	312 KB

Continued table 1

Items	Description
Data service system URL	http://dcc.cgs.gov.cn
Fund project	CGS's geological survey project titled "Comprehensive Geological Survey in the Economic Zone in Ningxia Along the Yellow River" (DD20160263)
Language	Chinese
Database (dataset) composite	The dataset consists of 1, 996 sets of test data obtained from 231 disturbed samples and 62 undisturbed soil samples, which are taken from 14 engineering boreholes. It includes the following test indicators: stratum lithology of engineering geology boreholes, sampling date, geographical location of boreholes, ground elevations of borehole locations, sampling layer, rock-soil type, grain composition, liquid-plastic limit, shear strength, compression factor, modulus of compressibility and water content.

2 Methods for Data Acquisition and Processing

Luhuatai, located in the middle of the Yinchuan Plain and the piedmont area of Helan Mountain, can be divided into an accumulation-denudation zone, an accumulation zone and an eolian zone, according to the landform origin and topography. The accumulation-denudation zone is distributed over most of the western area, mainly consisting of piedmont old diluvial fan, neo-diluvial fan, alluvial-diluvial plain and pre-fan diluvial depression. The accumulation zone is primarily distributed over the eastern area, mostly resulting from the accumulations of rivers and lakes and stretching in a north-south direction. The ground in this zone is low and flat. The eolian zone is mainly distributed over the Nanliangtaizi farm and ranch area of Helan Mountain composed of the fixed and semi-fixed dunes within Luhuatai with the flat sandy land between the dunes.

For the purposes of the test, 14 engineering boreholes were drilled and 293 soil samples taken. Before deployment of engineering boreholes, the positions of the boreholes were determined based on the investigation of the engineering-geological characteristics of Luhuatai, the consideration of critical geological and environmental geological problems requiring urgent solutions, and comprehensive consideration of the differences between landform units and the necessity of borehole arrangement for economic construction. The samples were collected from all rock strata at different water levels. See Fig. 1 for borehole distribution.

The drilling positions were determined by use of IRTK and the Xi'an 80 Coordinate System was adopted to record the plane coordinates and ground elevation of the borehole locations. Samples were mainly tested indoors, collected in accordance with the *National standard of the People's Republic of China GB 50021-2001 Code for Investigation of Geotechnical Engineering*, and sealed and stored in sample boxes to keep the water content in the soil undisturbed. All samples were tested and analyzed by the laboratory of the Geological and Mineral Center of the Ningxia Hui Autonomous Region which then issued the testing and analysis reports.

All field data contained in this dataset is raw unprocessed data; all analyzed data comes from laboratory testing results.

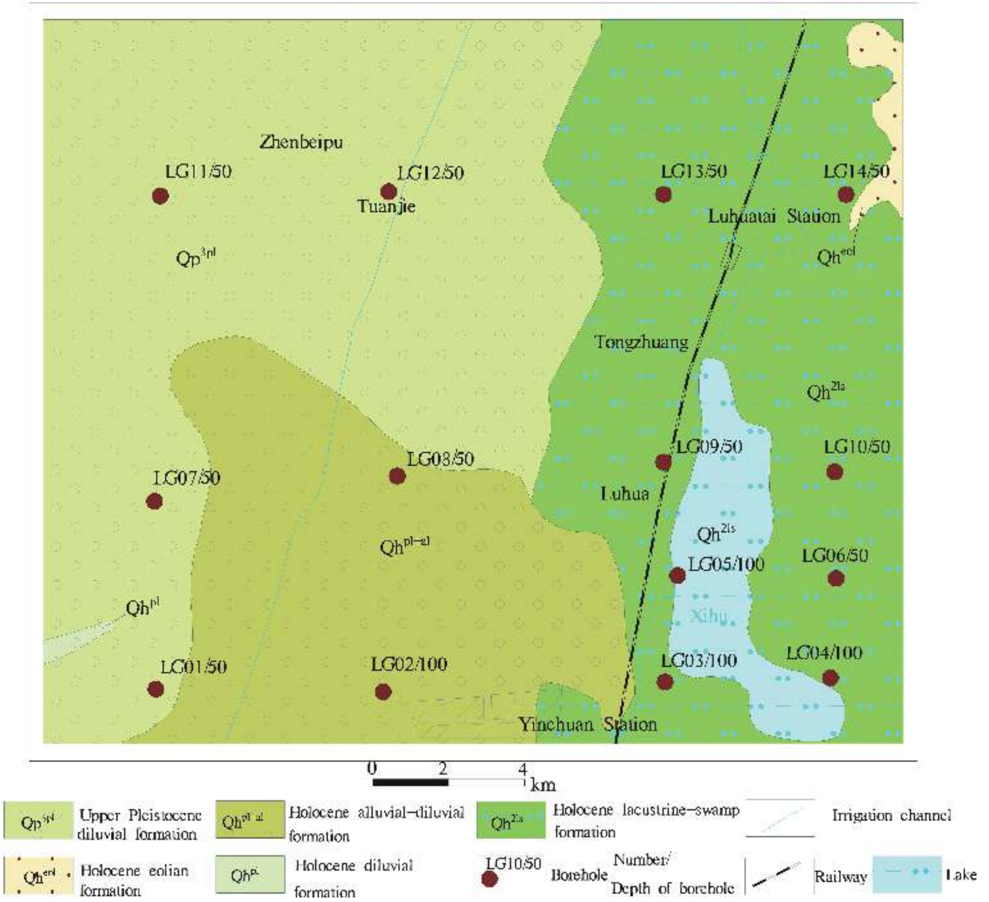

Fig. 1 Diagram of Geology and Engineering Borehole Distribution in Luhuatai, Yinchuan Basin

3 Description of Data Samples

The boreholes reveal that Quaternary strata are widely distributed in Luhuatai and are mostly exposed. In the western area of Luhuatai, there is an accumulation of diluvial detrital soil. The soil is poor in sorting and psephicity, moderately dense or dense, has a high bearing capacity, and grains greater than 20 mm in size account for more than 70% of the total, thus forming excellent engineering geology conditions. In the south central area of Luhuatai, the alluvial-diluvial formation is distributed. Here, Holocene diluvium accumulates on the surface, the structure is fairly loose, sand liquefaction occurs, thus forming poor engineering geology conditions. From the surface to a depth of 100 m below, upper Holocene alluvial-diluvial formation accumulates that is dominant in fine silty sand, contains gravel, and is entrained with cohesive soil and silty soil. The soil is pretty dense and the engineering geology conditions are excellent (Tong GB, 1998). In the eastern area of Luhuatai, lakes and wetlands are densely distributed, with a low groundwater level depth and poor discharge conditions. The strata are mainly alluvial-lacustrine formation. The upper part is composed of cohesive soil and has such adverse engineering geology phenomena as sand liquefaction and salty soil, creating poor engineering geology conditions. The lower part is dominant in fine silty sand and entrained with silty soil and cohesive soil which are saturated and dense, thus forming excellent engineering geology conditions. The engineering geology nature of the soil mass within Luhuatai is shown in Table 2.

Table 2 Summary of Type and Engineering Geology Condition of Soil Mass in Luhuatai in the Yinchuan Basin for the 1：50 000 Map

	Type of soil mass	Engineering geology condition
Soil mass	Diluvial detritus soil	Good
	Alluvial-diluvial sandy soil	Good
	Eolian sandy soil	Poor
	Lacustrine-swamp sandy soil	Poor

For geotechnical tests, disturbed and undisturbed soil samples are collected and tested, depending on the type of rock and soil. The rock and soil in Luhuatai are mainly gravel, fine silty sand, silty soil and silty clay (Tong GB, 1998). Gravel and fine silty sand are taken for disturbed samples since their grains are too dispersed to keep them undisturbed. These samples are mainly used for analysis of the grain composition. Silty soil and silty clay are taken for undisturbed soil samples. These samples are mainly used for analysis of water content, shear strength, coefficient of compressibility, modulus of compressibility, collapsible coefficient, grain composition and liquid/plastic limit, plasticity index and liquidity index (*Procedure for Geotechnical Test*, 1999).

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 engineering geology boreholes with necessary notes. See Table 3 for statistics of the test data and Table 4 for physical and mechanical properties of the main rock-soil bodies in Luhuatai.

Table 3 Statistics of Geotechnical Test Data of Luhuatai, Yinchuan Basin

Serial number	Sample type	Test item	Number of tested data (set)	Unit	Remarks
1	Undisturbed soil sample	Water content, W_o (%)	62	set	Including 40 sets of data from silty clay samples and 22 from silty soil samples
2		Natural density, ρ_o (g/cm^3)	62	set	
3		Dry density, ρ_d (g/cm^3)	62	set	
4		Specific gravity of soil particle, G_s	62	set	
5		Liquid limit, W_L(%)	61	set	
6		Plastic limit, W_p(%)	61	set	
7		Plasticity index, l_p	61	set	
8		Liquidity index, l_L	61	set	
9		Saturation, (%)	62	set	
10		Cohesive force, c (kPa)	62	set	
11		Angle of internal friction, φ (°)	62	set	
12		Natural void ratio, e_o	62	set	
13		Void ratio, e_i	289	set	
14		Coefficient of compressibility, a_v	289	set	
15		Modulus of compressibility, E_s	289	set	
16		Grain analysis, (%)	62	set	

Continued table 3

Serial number	Sample type	Test item	Number of tested data (set)	Unit	Remarks
17	Disturbed sample	Grain composition (%)	231	set	Including 2 sets of data from silty clay samples and 22 from silty soil samples
18		Liquid limit, W_L(%)	24	set	
19		Plastic limit, W_p(%)	24	set	
20		Plasticity index, I_p	24	set	
21		Liquidity index, I_L	24	set	

Table 4 Physical and Mechanical Properties of the Main Rock-Soil Bodies in Luhuatai in the Yinchuan Basin for the 1∶50 000 Map

Serial Number	Type of rock-soil mass	Water content (%)	Density (g/cm^3)	Void ratio	Modulus of compressibility, Es_{1-2} (MPa^{-1})	Cohesive force (kPa)	Angle of internal friction	Bearing capacity (kPa)
		Min.-max. Mean	Min.-max. Mean	Min.-max. Mean	Min.-max. Mean	Min.-max. Mean	Min.-max. Mean	Min.-max. Mean
1	Silty clay	16.3-36.7 23.9	1.83-2.12 2.00	0.551-0.999 0.683	5.52-10.26 8.67	14-36 24.2	10-20 15.3	100-270 175
2	Cohesive soil	23.5-27.0 25.6	2.01-2.07 2.04	0.659-0.714 0.689	6.49-8.20 7.3	31-44 35.7	11-15 12.6	220-250 235
3	Silty soil	17.7-26.5 18.4	1.74-2.10 2.00	0.535-0.794 0.672	9.9-13.99 12.25	6-17 12.7	19-22 20.3	160-280 220
4	Fine silty sand	19.6-23.3 21.9	1.99-2.02 2.00	0.587-0.654 0.631	11.63-14.18 12.48	6-9 7.3	21-21 21	140-250 180
5	Silty sand	Saturated and dense, standard penetration test blowcount is greater than 50						340
6	Fine sand	Saturated and dense, standard penetration test blowcount is greater than 50						340

4 Data Quality Control and Assessment

4.1 Quality Control of Engineering Geology Drilling

In general, aspects such as geological stratification, existing critical geological problems, adverse geological phenomena and layout of project construction in Luhuatai, are considered when determining the necessity of drilling. Exploratory boreholes are arranged perpendicular to the main structural lines or in the direction where the topography or landform and lithology changes significantly. Prior to drilling, the ground elevation of the borehole locations was measured with IRTK. The boreholes are drilled at a diameter of 127 mm using the rotary drilling method and by way of full-hole continuous coring. The drilling roundtrip and drilling footage depend on the conditions of the rock and soil formations, and no over-pipe drilling is allowed. The non-core spacing is no more than 1 m for cohesive soil and 2 m for other types of soil. In a loose layer, the section above the phreatic water level is drilled at circulation break, while in a sand layer, the gravel section, the rigid-brittle-fragmentary section and the soft-fragmentary rock section are drilled in a circulatory way. The core recovery rate is no less than

85% for clay and a body of intact rock, 70% for sandy soil, 60% for gravel soil and 65% for weathered zone and fracture zone. The borehole depth and deviation are corrected every 50 m and at the bottom of each borehole (*Code for Investigation of Geotechnical Engineering*, 2002). In the process of drilling, the hydrogeological condition is observed and the final stable water level is recorded. For some boreholes, however, only the rough water level is given in the engineering borehole information, because the precise stable water level cannot be determined, due to the presence of mud.

4.2 Sampling Requirements

Different soil samples were taken for different soil layers and test purposes. During soil sampling, the quick static-force continuous press-in method is used. For cohesive soil and silt, undisturbed soil samples are taken at intervals of 2 m. Samples are also taken from meaningful interlayers with a thickness less than 2 m. For soil layers with a thickness of greater than 5 m, samples are taken at intervals of 3 m. For soft soil, a thin-walled sampler is pressed in to take samples with the inner wall of the sampling tube kept smooth. Before the sampler is pressed into the soil, the borehole should be cleaned, to ensure that the thickness of soil left at the bottom of the borehole is smaller than the length of the waste soil section of the sampler. In soil sampling, disturbance is avoided wherever possible, in order to keep the soil undisturbed and maintain its natural humidity. A dedicated thin-walled sampler is used. The quantity of soil samples to be taken is dependent on what the tests require. During soil sampling, undisturbed soil samples were sealed to prevent soil and water from changing and affixed with labels to specify the sample number, sampling location, depth and date, as well as soil layer and direction.

4.3 Test Quality Control

Quality control is performed throughout the whole process of dataset preparation, from engineering drilling to soil sampling and testing. All operations are suitable, standardized and correct as specified in the relevant procedures (You GQ, 2018). During soil sampling, due care is taken to avoid any unnecessary disturbance and prevent pollution of the samples. During transportation, the samples are kept sealed and intact. During testing, human faults were prevented. All tests were performed by qualified professional personnel in strict accordance with the *National standard of the People's Republic of China GB-T 50123-1999 Standard for Geotechnical Test Methods*.

5 Conclusions

The dataset contains 1 996 sets of test data from 293 soil samples taken from 14 engineering boreholes drilled in Luhuatai, Yinchuan Basin. The arrangement of boreholes covers different landforms, different types of soil mass, and areas with adverse geological phenomena. The drilling operations were performed according to the relevant procedures and were recorded in detail. Therefore, the data is representative to a certain extent and can truthfully reflect the characteristics of the soil mass in Luhuatai, Yinchuan Basin, during that period. The sequence of strata and the types of soil mass in Luhuatai were obtained from the information and data of the boreholes, providing geological data and information used to establish a 3D geological model of the Yinchuan Basin and meeting the mission and need of the comprehensive geological survey in the economical zone in Ningxia along the Yellow River. Sampling and testing were carried out in strict accordance with the *National standard of the People's Republic of China GB-T 50123-1999 Standard for Geotechnical Test Methods*, thus ensuring the quality and reliability of the test results. The geotechnical testing results contain physical and mechanical parameters of various types of soil mass in Luhuatai, which, in combination with ground survey and other survey methods in Luhuatai, will provide a reference for further engineering geology zoning of Luhuatai, the assessment of engineering geology conditions of Luhuatai, and construction and planning of different types of projects in the Yinchuan Basin.

References

Tong Guobang, Shi Ying, Zheng Hongrui, Zhang Jing, Lin Fang, He Qinglin, Song Xianghua, Liu Zhenxi, Qiao Guangdong, Zhang Jixiang, Yang Xiangdong, Zhang Wenqing. 1998. Quarternary Stratigraphy in Yinchuan Basin[J]. Journal of Stratigraphy, 22(1): 42−51 (in Chinese with English abstract).

You Guoqing, Yi Ronglong, Gengshufang, Chen Bingwei, Pang jianfeng, Yang Zhixin, Li Jialin. 2018. Dataset of Metallogenic Provinces and Belts of Energy Resources in Southern China and Adjacent Areas[J]. Geology in China, 45(S1): 98−110.

National standard of the People's Republic of China GB50021−2001) Code for investigation of geotechnical engineering [s].2002. Beijing: China Architecture & Building Press (in Chinese)

National standard of the People's Republic of China(GB−T50123−1999) Standard for soil test method [s].1999. Beijing: China Planning Press (in Chinese).

People's Republic of China industry standard SL237−1999 Specification of soil test [s].1999. Beijing: China Water & Power Press (in Chinese).