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粤港澳湾区 1∶50 000 斗门镇幅工程地质调查及岩土样品试验数据集

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摘要：本数据集依托 2017 年中国地质调查局“粤港澳湾区 1∶50 000 环境地质调查”项目，在充分收集以往地质资料的基础上，开展了粤港澳大湾区珠江口西岸的斗门镇幅 1∶50 000 工程地质调查工作，编制了 1∶50 000 工程地质图及说明书，并依据此次调查及采取的样品进行测试获取的数据建立了本数据集。本数据集包含调查与实验测试两大类 10 种数据类型，其中遥感野外检查验证数据 53 条，基础调查数据 168 条，野外地质综合调查数据 22 条，工程地质调查数据 77 条，地质灾害调查数据 23 条，钻孔基本情况数据 13 条，原位试验成果数据 583 条，岩石样品试验数据 36 条，土工试验数据 130 条，野外照片数据 669 幅，共计 1 774 条数据。本数据集对查清粤港澳大湾区珠江口西岸的工程地质条件，评价软土地面沉降、崩塌滑坡不稳定性斜坡等地质灾害具有数据支撑意义。

关键词：粤港澳湾区；斗门镇幅；工程地质调查；岩土样品试验；1∶50 000 数据集

数据服务系统网址：http://dcc.cgs.gov.cn

1　引言

斗门镇幅（图 1）位于广东省珠海市与江门市的交界部位，区内虎跳门水道与崖门水道共同汇入黄茅海，黄杨山与古兜山分列东西两侧，燕山期花岗岩侵入其中，西江断裂、崖门断裂等北西向断裂与五桂山北麓断裂等北东向断裂围截其中 (陈伟光等，2002)，五桂山断隆与灯笼沙断陷 (姚衍桃等，2008) 的存在造成了区内北西高、南东低的格局，构造的强烈发育、2 268.3 mm 的年均降雨量（梁颖，2018）与西部沿海高速 (S32)、格力工业园区等重大工程设施的修建造成工程地质问题频发，急需开展工程地质调查工作，并建立相应数据库。

斗门镇幅的工程地质调查和岩土样品试验工作由“泛珠三角地区地质环境综合调查”工程下属的二级项目“粤港澳湾区 1∶50 000 环境地质调查”进行，数据集来源于

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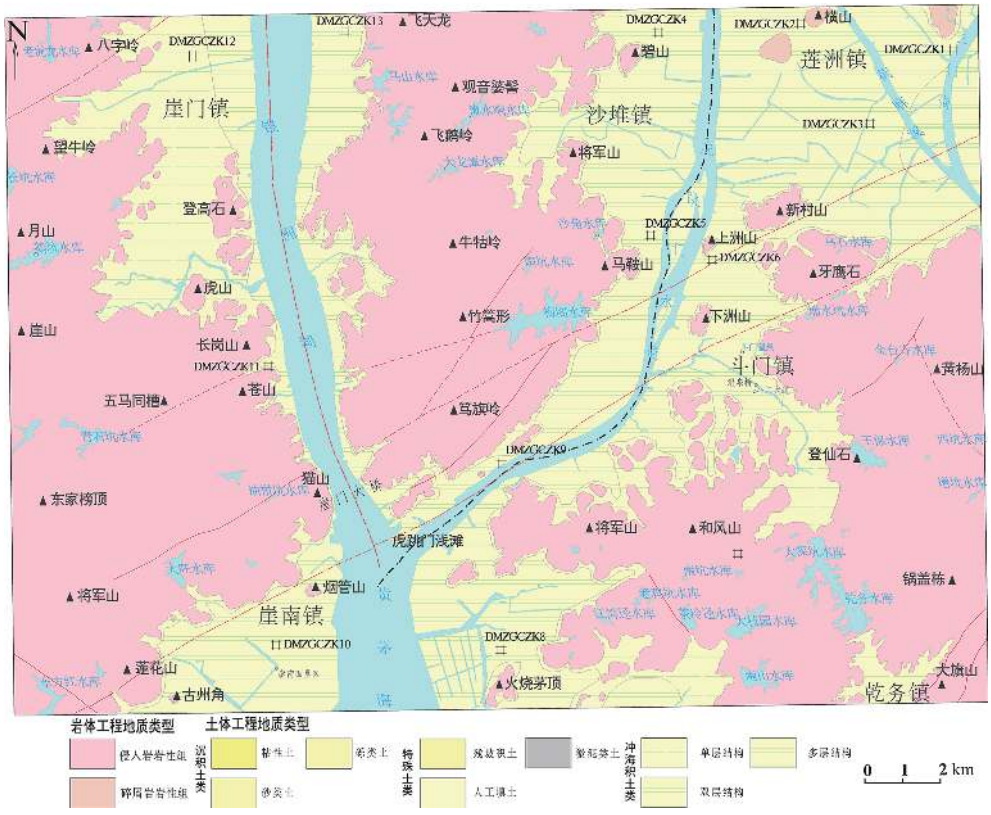

图 1　斗门镇幅工程地质简图

此。该项目于 2017 年开展粤港澳湾区斗门镇幅 1：50 000 工程地质调查，查明区内工程地质条件和侵入岩强烈风化所形成的崩塌、滑坡、不稳定斜坡等地质灾害、三角洲海积平原的软土地面沉降问题，并开展软土地面沉降专题调查评价，进行工程地质分区评价并提出对策与建议，为珠江口西岸土地资源优化利用、地下空间开发及防灾减灾提供依据。

本数据集涵盖遥感解译数据、地质环境调查数据、工程地质调查数据、钻孔数据、原位测试数据、岩土试验数据和野外照片等各类数据 (表 1)。其中地质环境调查数据包括野外地质综合调查点、地质灾害调查点等数据，工程地质调查数据以工程地质调查点为主，包含浅井调查点、岩石风化程度调查点等数据，原位试验数据与岩土试验数据来源于图幅内 13 个工程地质钻孔及其岩土样品的采集、送检，原位试验包括标贯、静力触探、十字板剪切，岩土样品测试内容主要包括抗压强度、含水量、比重、孔隙比、饱和度、凝聚力、内摩擦角、液性指数、塑性指数、压缩系数、压缩模量等，以获得岩土体的物理力学参数（孙巧银等，2018），为后期工程地质分区评价提供数据支撑。本数据集对于查清粤港澳大湾区珠江口西岸的工程地质条件及地面沉降、地质灾害等环境地质问题，提供了基础数据支持，同时为工程地质分区评价、土地资源优化利用、防灾减灾等提供了专业技术支撑。

2　数据采集和处理方法

本次工程地质调查工作针对侵入岩强烈风化所形成的崩塌、滑坡、不稳定斜坡等地质灾害、三角洲海积平原的软土地面沉降问题等采用资料收集、遥感解译、地面调查、工程地质钻探、原位试验、岩土样品试验等工作手段。

表 1　数据库 (集) 元数据简表

条目	描述
数据库(集)名称	粤港澳湾区1：50 000环境地质调查斗门镇幅工程地质调查及岩土样品试验数据集
数据库(集)作者	曾敏，中国地质调查局武汉地质调查中心 赵信文，中国地质调查局武汉地质调查中心 喻望，中国地质调查局武汉地质调查中心 顾涛，中国地质调查局武汉地质调查中心
数据时间范围	2017年
地理区域	粤港澳湾区1：50 000斗门镇幅(F49E011021)
数据格式	Excel
数据量	168.16 KB
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“粤港澳湾区1：50 000环境地质调查”(DD20160260)
语种	中文
数据库(集)组成	本数据集包含10种数据类型，其中遥感野外检查验证数据53条，基础调查数据168条，野外地质综合调查数据22条，工程地质调查数据77条，地质灾害调查数据23条，钻孔基本情况数据13条，原位试验成果数据583条，岩石样品试验数据36条，土工试验数据130条，野外照片数据669条，共计1 774条数据

2.1　遥感解译数据集

斗门镇幅遥感解译采用 ALOS 全色与多光谱融合数据，其多光谱空间分辨率为 10 m，全色波段空间分辨率为 2.5 m，所选数据成像时间是 2015 年 10 月 20 日，云量<10%。遥感解译数据集按照《遥感解译地质图制作规范 (1：250 000)》(DZ/T 0264–2014)、《区域环境地质勘查遥感技术规程 (1：50 000)》(DZ/T 0190–1997)、《遥感平面图制作规范》(GB 15968–1995)、《卫星遥感图像产品质量控制规范》(DZ/T 0143–1994) 等规程规范开展工作，经过数据源选择、影像数据预处理、初步判读、遥感解译、目视修改、野外验证、成果输出等环节而获得。

首先从空间角度及辐照角度对影像进行校正，使处理后的影像的象元尽量恢复原有的空间、辐照度特征。参考有关文献提及的各类典型地物的影像特征，并结合图幅的实际情况和项目的具体需求，确定合适的地物类别。初步判读提取典型地物影像图，并设计合适的路线进行野外踏勘，以建立各类地物的解译标志。遥感解译使用目视直接判断选择合适的窗口大小合并细碎图斑。然后，确定验证的典型区域范围，设计好合适的路线，进行野外验证并尽可能在实地进行初步修改。

2.2　工程地质调查

工程地质调查的主要内容是，调查区内地形地貌、地质构造、岩土体类型及其工程性质和不良地质作用等区域工程地质条件及其对人类活动的影响，划分工程地质岩组，提供各类岩组的主要物理力学参数；调查自然或人类活动及其相互作用引发的主要工程地质问题类型、强度、分布和发展演化规律，评价其对人类活动的影响；开展工程地质分区评价和人类活动适宜性评价，提出对策建议。

工程地质调查工作的主要目的如下：(1) 划分工程地质岩组，提供各类岩组的主要物理力学参数；(2) 为服务规划和重大工程建设，优化国土空间开发格局，提供区域性

工程地质依据，并针对存在的工程地质问题提出具体的对策建议；(3) 为地质灾害调查评价、监测预警和治理提供区域性工程地质资料。

在调查过程中，着重调查地貌分界线、地层界线、构造点、岩石露头、人工水体、人工填筑体 (填海造陆等)、大型深基坑、隧道桥梁等，采用描述、照相、素描图等方法记录地质地貌、工程地质等现象，并现场测试回弹仪岩石抗压强度等指标。最后将调查数据记录在野外调查记录卡片和表格上，并将所有数据资料导入数据集中。

2.3 工程地质钻探

工程地质钻探主要任务是查明地表以下地质结构、岩土体性状、厚度、埋藏深度、分布范围以及工程地质条件等，并通过采取钻孔内的岩土样品，并在钻孔内开展现场原位测试，以获取必要的工程地质参数。

工程地质钻探采用正循环回转取心钻进，粘性土 (包括淤泥、淤泥质土、粉质黏土、花斑状黏土等) 平均采取率均大于 90%，砂性土、砂砾岩、中微风化花岗岩等平均采取率均大于 80%，中粗砾、砾砂岩采取率均大于 60%，基岩风化破碎带、碎块状强风化花岗岩采取率均大于 45%。钻孔每钻进 50 m 测量孔斜及校正孔深一次，使其深度内孔斜小于 1°，孔深误差不大于 2‰，并以校正后的孔深为准。随钻探工作进度及时进行钻孔地质编录、标准贯入试验及岩土样品采集；钻孔竣工后，进行物探测井及静力触探、十字板剪切试验，并及时送样测试分析，最终整理分析各项数据建立数据集。

2.4 原位试验

标贯试验采用 63.5 kg 的重锤按照规定的落距 76 cm 自由下落，将标准规格的贯入器打入地层。测试前应先击入 15 cm，不记击数。以下每击入 10 cm，记录击数，共击入 30 cm。记录试验深度和标准贯入试验的试验锤击数 N。根据《岩土工程勘察规范》(GB 50021–2001)，当钻杆长度大于 3 m 时，锤击数按下式进行钻杆长度修正: $N=\alpha N'$，式中 N' 为标准贯入试验锤击数，α 为触探杆长度校正系数，如触探杆长分别为≤ 3 m、≤6 m、≤9 m、≤12 m、≤15 m、≤18 m、≤21 m 时，则 α 相应分别为 1、0.92、0.86、0.81、0.77、0.73、0.70。

按照《岩土工程勘察规范》(GB 50021–2001)、《建筑地基基础检测规范》(DBJ 15–60–2008) 等技术指标进行双桥静力触探试验。查明该场地各层土力学指标 *qc*、*fs* 值；并根据试验结果，对本场地进行地质力学分层，并绘制 *qc-h*、*fs-h*、*Rf-h* 曲线，计算各层土的静探参数平均值。

十字板剪切试验按照试验规程先进行原状土剪切试验，再进行重塑土剪切试验，计算原状土及重塑土的十字板抗剪强度及软土的灵敏度。

2.5 岩土样品试验

依据《岩土工程勘察规范》(GB 50021–2001)、《土工试验方法标准》(GB/T 50123–1999)，在钻孔取芯编录时采集岩土样品。钻孔一般采取原状土样；砂、砾、卵石层地区取扰动土样。采集完成后及时送至实验室进行测试。分析质量报告显示，检测方法准确，各项检测数据指标间关系合理，检测结果准确可靠。

3 数据样本描述

粤港澳湾区 1：50 000 环境地质调查斗门镇幅工程地质调查及岩土样品试验数据集

包含 10 种数据类型，分别为调查点基础数据表、野外照片数据表、野外地质综合调查表、遥感野外检查验证记录表、浅井记录表、岩石风化程度调查表、崩塌调查表、滑坡调查表、不稳定斜坡调查表、地面沉降调查表、钻孔基本情况表、工程地质静力触探试验记录表、工程地质十字板剪切试验记录表、工程地质标贯试验记录表、土工试验综合成果表、工程地质钻孔岩样试验表，共计 1 774 个数据属性表，数据类型与属性表对应关系见表 2。

表 2　数据库 (集) 数据类型—属性表对应关系

调查数据类型	属性表类型
遥感野外检查验证数据	遥感野外检查验证记录表
基础调查数据	调查点基础数据表
野外地质综合调查数据	野外地质综合调查表
工程地质调查数据	浅井记录表、岩石风化程度调查表
地质灾害调查数据	崩塌调查表、滑坡调查表、不稳定斜坡调查表、地面沉降调查表
钻孔基本情况数据	钻孔基本情况表
原位试验数据	工程地质静力触探试验记录表、工程地质十字板剪切试验记录表、工程地质标贯试验记录表
岩石样品试验数据	工程地质钻孔岩样试验表
土工试验数据	土工试验综合成果表
野外照片数据	野外照片数据表

3.1　遥感野外检查验证数据

遥感野外检查验证数据的数据属性表类型为遥感野外检查验证记录表，包含以下内容：统一编号、野外编号、经度、纬度、地面高程、地理位置、图幅编号、解译正确性、观测点遥感影像特征、遥感解译类别、实际验证类别、实地观测记录、备注等，如表 3 所示。

3.2　基础调查数据

基础调查数据的属性表为调查点基础数据表，包含如下内容： 统一编号、野外编号、经度、纬度、X 坐标、Y 坐标、地面高程、地理位置、图幅编号、调查点类型等，如表 4 所示。

3.3　野外地质综合调查数据

野外地质综合调查数据的属性表类型为野外地质综合调查表，包含以下内容:统一编号、野外编号、经度、纬度、地面高程、地理位置、调查点类型、取样情况、图幅编号、地貌部位、天气状况、地层倾向、地层倾角、照片编号、点间关系、地貌与地质、水文地质、环境地质、工程地质、访问及沿途、人工地质剖面示意图、调查点平面位置示意图、备注、项目名称、调查单位、调查人、调查时间、记录人、审核人、填表时间等，如表 5 所示。

3.4　工程地质野外调查数据

工程地质野外调查数据的属性表类型为浅井记录表、岩石风化程度调查表，其中浅井记录表包含以下内容：统一编号、野外编号、经度、纬度、地面高程、X 坐标、Y 坐

表 3　遥感野外检查验证记录表

字段名称	量纲	数据类型	实例
统一编号	–	字符型	11311479522144441401
野外编号	–	字符型	D1057
经度	°	浮点型	113114795
纬度	°	浮点型	22144414
地面高程	m	字符型	7
地理位置	–	字符型	广东省珠海市斗门区斗门镇深潭采石场
图幅编号	–	字符型	斗门镇幅F49E011021
解译正确性	–	字符型	正确
观测点遥感影像特征	–	字符型	图斑位于斗门镇斗门大道以东，温泉桥北东，形状不规则，颜色呈现浅灰褐色，表面纹理较光滑，可见挖痕和斑点，植被破损严重，无阴影覆盖
遥感解译类别	–	字符型	露天开挖场地
实际验证类别	–	字符型	露天开挖场地解译验证点
实地观测记录	–	字符型	实地验证调查点D1057，解译结果与实际情况大致相符
备注	–	字符型	KW06

表 4　调查点基础数据表

字段名称	量纲	数据类型	实例
统一编号	–	字符型	11305073022173290001
野外编号	–	字符型	D2095
经度	°	浮点型	113050730
纬度	°	浮点型	22173290
X坐标	–	浮点型	19714928
Y坐标	–	浮点型	2467671
地面高程	m	字符型	8
地理位置	–	字符型	广东省江门市新会区古井镇奇乐村南峰旗
图幅编号	–	字符型	斗门镇幅F49E011021
调查点类型	–	字符型	岩石风化调查点

标、图幅编号、地理位置、天气、气温、水位埋深、地形地貌、地质与环境地质、水文地质、生态与植被、取样情况、备注、浅井柱状剖面图、项目名称、调查单位、调查日期、调查人、记录人、审核人等；岩石风化程度调查表包含以下内容:统一编号、野外编号、经度、纬度、X 坐标、Y 坐标、地理位置、地面高程、图幅编号、天气、气温、调查方式、地形坡度、覆盖层厚度、照片编号、基岩时代、基岩岩性、空间分布、岩石强度划分、与构造关系、岩层倾向、岩层倾角、岩石风化程度划分、岩石风化层厚度、岩石风化层形态、岩石风化层性质、裂隙情况、剖面示意图、平面示意图、备注、项目名称、调查单位、调查日期、调查人、记录人、审核人等，如表 6 所示。

3.5　地质灾害调查数据

地质灾害调查数据的属性表类型为地面沉降调查表，其中地面沉降调查表包含统一编号、野外编号、地理位置、经度、纬度、地面沉降名称、地面高程、图幅编号、城市

表 5　野外地质综合调查表

字段名称	量纲	数据类型	实例
统一编号	–	字符型	11305563122183948O1
野外编号	–	字符型	D2092
经度	°	浮点型	113055631
纬度	°	浮点型	22183948
地面高程	m	浮点型	20
地理位置	–	字符型	广东省江门市新会区古井镇奇乐村马山水库
调查点类型	–	字符型	综合地质调查点
取样情况	–	字符型	现场取水样进行测试
图幅编号	–	字符型	斗门镇幅F49E011021
地貌部位	–	字符型	丘陵岗地
天气状况	–	字符型	阵雨转阴
地层倾向	–	浮点型	–
地层倾角	–	浮点型	–
照片编号	–	字符型	1035–1039
点间关系	–	字符型	点间多为低丘岗地地貌，山林遍布，植被茂密，环境较好
地貌与地质	–	字符型	点处为低丘岗地地貌，自然坡度约为15°～20°，地势稍有起伏，相对高差约为2～6 m，主要岩性为燕山期侏罗系($J_3^1n\gamma$)灰白、肉红中粗粒斑状黑云母二长花岗岩，中粗粒斑状结构，块状构造，强烈风化，顶部为全风化花岗岩，厚度约0～2 m，未见明显构造迹象
水文地质	–	字符型	周边多为全风化-强风化花岗岩，顶部多为全风化花岗岩，厚度约为0～2 m，为松散孔隙水，水量较大，水质一般，其下为强风化花岗岩，可见原岩结构，为风化网状裂隙水，水量较大，水质较好，经大气降水补给，地面径流及面流江入水库，排泄至下游
环境地质	–	字符型	因抽水作业，水位下降较大，水库库岸可见多处不稳定岸坡，极易发生垮塌和崩岸，另水库的下游即北西侧，二级水库及下游山塘都改为养殖场，农药化肥等农业污染可见
工程地质	–	字符型	点处周边顶部为全风化花岗岩，松散土状，厚约0～2 m，下部为强风化花岗岩，可见原岩结构，经过现场回弹仪测量抗压强度为12 MPa
访问及沿途	–	字符型	沿途访问马山水库管理站，水库堤坝曾经溃坝，后来重修，现用作古井镇饮用水源，供水量较大，水位较低
人工地质剖面示意图	–	长二进制数据	(图片)
调查点平面位置示意图	–	长二进制数据	(图片)
备注	–	字符型	无；
项目名称	–	字符型	粤港澳湾区1：50 000环境地质调查
调查单位	–	字符型	中国地质调查局武汉地质调查中心
调查日期	Y.M.D	字符型	2017-06-20
调查人	–	字符型	喻望，曾敏，高志斌
记录人	–	字符型	曾敏
审核人	–	字符型	赵信文

表 6　浅井记录表

字段名称	量纲	数据类型	实例
统一编号	–	字符型	11305099722194494 01
野外编号	–	字符型	D1160
经度	°	浮点型	113050997
纬度	°	浮点型	22194494
地面高程	m	浮点型	2
X坐标	–	浮点型	19714821
Y坐标	–	浮点型	2471780
图幅编号	–	字符型	斗门镇幅F49E011021
地理位置	–	字符型	广东省江门市新会区古井镇慈爱村老蔡围
天气	–	字符型	晴
气温	℃	浮点型	34
水文埋深	m	浮点型	0.4
地形地貌	–	字符型	三角洲平原地貌，地势较为平坦，相对高差约为1~3 m；
地质与环境地质	–	字符型	地表出露地层岩性为第四系全新统灯笼沙组(Q_4dl)黏土、淤泥、粉细砂等
水文地质	–	字符型	点位于崖门水道附近点处为花木厂钻孔揭露地层岩性为第四系全新统桂州组黏土，淤泥，淤泥质，砂层，为软土层
生态与植被	–	字符型	–
取样情况	–	字符型	未取样
备注	–	字符型	D1160
浅井柱状剖面图	–	长二进制数据	(图片)
项目名称	–	字符型	粤港澳湾区1：50 000环境地质调查
调查单位	–	字符型	中国地质调查局武汉地质调查中心
调查日期	Y.M.D	字符型	2017-06-17
调查人	–	字符型	顾涛
记录人	–	字符型	顾涛
审核人	–	字符型	赵信文

名称、天气、诱发因素、地貌特征、发展趋势、造成危害状况、防治措施、平面示意图、剖面示意图、备注、项目名称、调查单位、照片编号、调查日期、调查人、记录人、审核人等，如表 7 所示。

3.6　钻孔基本情况数据

钻孔基本情况数据的数据属性表类型为钻孔基本情况表，包含以下内容:统一编号、野外编号、经度、纬度、X 坐标、Y 坐标、地理位置、地面高程、图幅编号、孔口高程、钻机类型、钻孔类型、开孔日期、终孔日期、井斜、开孔直径、终孔直径、终孔深度、含水层初见水位、成井深度、静止水位、质量等级等，如表 8 所示。

3.7　原位试验成果数据

原位试验成果数据的属性表类型为工程地质静力触探试验记录表、工程地质十字板剪切试验记录表、工程地质标贯试验记录表，其中工程地质标贯试验记录表包含统一编

表 7　地面沉降调查表

字段名称	量纲	数据类型	实例
统一编号	–	字符型	1130258842219497601
野外编号	–	字符型	D2111
地理位置	–	字符型	广东省江门市新会区崖门镇南昌村
经度	°	浮点型	113025884
纬度	°	浮点型	22194976
地面沉降名称	–	字符型	南昌村沉降
地面高程	m	浮点型	–
图幅编号	–	字符型	斗门镇幅F49E011021
城市名称	–	字符型	广东省江门市
天气	–	字符型	阵雨转多云
诱发因素	–	字符型	周边南昌村内房屋较多，2001年9月铺设的水泥路面以及小型河桥梁等荷载，以及村内民井提水成为软土沉降
地貌特征	–	字符型	为山前平原地貌，地形无起伏，相对高差约为0～1 m，崖门水道的两侧，主要地层岩性为第四系全新统(Q_h)深灰色，灰黑色淤泥，淤泥质土，呈软塑状，工程地质力学性质较差
发展趋势	–	字符型	将持续沉降
造成危害状况	–	字符型	房屋墙体开裂，地面裂缝以及供电，供水管的局部挤压，断错，潜在威胁着本村300余户，500余人；
防治措施	–	字符型	局部墙体重新修补，部分砂浆已垮落，建议加强监测及房屋修补工作
平面示意图	–	长二进制数据	(图片)
剖面示意图	–	长二进制数据	(图片)
备注	–	字符型	矩形
项目名称	–	字符型	粤港澳湾区1：50 000环境地质调查
调查单位	–	字符型	中国地质调查局武汉地质调查中心
照片编号	–	字符型	1142–1152
调查日期	Y.M.D	字符型	2017-06-24
调查人	–	字符型	喻望，曾敏，高志斌
记录人	–	字符型	曾敏
审核人	–	字符型	赵信文

号、野外编号、经度、纬度、X 坐标、Y 坐标、地理位置、地面高程、图幅编号、钻孔ID、试验编号、杆长、修正击数、试验深度、实测击数、承载力基本值、起始深度、终止深度等，如表 9 所示。

3.8　岩石样品试验数据

岩石样品试验数据的属性表类型为工程地质钻孔岩样试验表，包含统一编号、样品编号、岩芯编号、岩性、测试编码、饱和抗压强度等，如表 10 所示。

3.9　土工试验数据

土工试验数据的属性表类型为土工试验综合成果表，包含统一编号、样品编号、土样深度、室内命名、含水率、比重、湿密度、干密度、孔隙比、饱和度、液限、塑限、

表 8　钻孔基本情况表

字段名称	量纲	数据类型	实例
统一编号	–	字符型	11314382022191946O1
野外编号	–	字符型	DMZGCZK1
经度	°	浮点型	113143820
纬度	°	浮点型	22191946
X坐标	–	浮点型	19731176
Y坐标	–	浮点型	2471239
地理位置	–	字符型	广东省珠海市斗门区西江清荷农村(江珠高速公路东北)
地面高程	m	浮点型	1.193
图幅编号	–	字符型	斗门镇幅F49E011021
孔口高程	m	浮点型	1.193
钻机类型	–	字符型	XY-100
钻孔类型	–	字符型	工程地质钻孔
开孔日期	Y.M.D	字符型	2017.10.08
终孔日期	Y.M.D	字符型	2017.10.11
井斜	°	浮点型	0
开孔直径	mm	浮点型	130
终孔直径	mm	浮点型	91
终孔深度	m	浮点型	74.15
含水层初见水位	m	浮点型	0.7
成井深度	m	浮点型	74.15
静止水位	m	浮点型	0.55
质量等级	–	字符型	良好

塑性指数、液性指数、凝聚力、内摩擦角、压缩系数、压缩模量、测试编码等，如表 11 所示。

3.10　野外照片数据

野外照片数据的属性表类型为野外照片数据表，包含统一编号、拍照时间、照片种类、拍照人、照片类型、照片说明、拍照参数、地质现象描述等，如表 12 所示。

4　数据质量控制

工作区内开展的所有工作手段均依照国家行业规范《工程地质调查规范 (1：50 000)》执行，所产生的数据表均依照规范附表执行，精度满足工程地质调查工作的规范要求。

工作区内的调查数据表 100% 开展自检和互检，调查数据表整理完成后完成了 30% 抽检，抽查结果显示的质量可信度满足工程地质调查工作的规范要求。

5　结论

粤港澳湾区 1：50 000 环境地质调查项目根据《工程地质调查规范 (1：25 000～1：50 000)》(DZ/T 0097–1994)、《工程地质调查技术要求 (1：50 000)》(试用稿) 开展

表 9　工程地质标贯试验记录表

字段名称	量纲	数据类型	实例
统一编号	–	字符型	1131438202219194601
野外编号	–	字符型	DMZGCZK1
经度	°	浮点型	113143820
纬度	°	浮点型	22191946
X坐标	–	浮点型	19731176
Y坐标	–	浮点型	2471239
地理位置	–	字符型	广东省珠海市斗门区西江清荷农村(江珠高速公路东北)
地面高程	m	浮点型	1.193
图幅编号	–	字符型	斗门镇幅F49E011021
钻孔ID	–	字符型	1
试验编号	–	字符型	1
杆长	m	浮点型	16.93
修正击数	–	浮点型	8.2
试验深度	m	浮点型	14.8
实测击数	–	浮点型	11
承载力基本值	MPa	浮点型	14.8
起始深度	m	浮点型	14.8
终止深度	m	浮点型	15.25

表 10　工程地质钻孔岩样试验表

字段名称	量纲	数据类型	实例
统一编号	–	字符型	1131217612219437401
样品编号	–	字符型	DMZGCZK2-1
岩芯编号	–	字符型	DMGCZK02岩芯
岩性	–	字符型	砂岩
测试编码	–	字符型	1452
饱和抗压强度	MPa	浮点型	43.3

珠江口西岸斗门镇 1：50 000 工程地质调查工作，在充分收集以往地质资料及调查成果的基础上，编制了 1：50 000 工程地质图及说明书，并依据此次调查获取的数据建立了工程地质调查成果数据集。本数据集包含 10 种数据类型，其中遥感野外检查验证数据 53 条，基础调查数据 168 条，野外地质综合调查数据 22 条，工程地质调查数据 77 条，地质灾害调查数据 23 条，钻孔基本情况数据 13 条，原位试验成果数据 583 条，岩石样品试验数据 36 条，土工试验数据 130 条，野外照片数据 669 条，共计 1 774 条数据。

粤港澳湾区 1：50 000 环境地质调查斗门镇幅工程地质调查及岩土样品试验数据集的建立，对查清粤港澳大湾区珠江口西岸工程地质条件提供了基础数据支撑，同时也对评价珠三角平原区软土地面沉降、崩塌滑坡不稳定性斜坡等地质灾害具有一定的指导意义。

本次 1：50 000 工程地质调查主要取得了两点认识：（1）基本查明了区内工程地

表 11　土工试验综合成果表

字段名称	量纲	数据类型	实例
统一编号	–	字符型	1131438202219194601
样品编号	–	字符型	DMZGCZK1-1
土样深度	m	浮点型	3.40−3.60
室内命名	–	字符型	淤泥质土
含水率	%	浮点型	45.3
比重	–	浮点型	2.64
湿密度	g/cm^3	浮点型	1.74
干密度	g/cm^3	浮点型	1.2
孔隙比	–	浮点型	1.2
饱和度	%	浮点型	99.3
液限	%	浮点型	43.9
塑限	%	浮点型	24.6
塑性指数	–	浮点型	19.3
液性指数	–	浮点型	1.07
凝聚力	kPa	浮点型	7.8
内摩擦角	°	浮点型	6
压缩系数	–	浮点型	0.87
压缩模量	–	浮点型	2.53
测试编码	–	字符型	委0011755(2016)0942

表 12　野外照片数据表

字段名称	量纲	数据类型	实例
统一编号	–	字符型	1130509972219449401
拍照时间	Y.M.D	字符型	2017-06-17
照片种类	–	字符型	彩色
拍照人	–	字符型	顾涛
照片类型	–	字符型	钻孔基本情况表
照片	–	长二进制数据	(图片)
照片说明	–	字符型	钻孔基本情况表D1160
拍照参数	–	字符型	自动
地质现象描述	–	字符型	点位于崖门水道附近点处为花木厂钻孔揭露地层岩性为第四系全新统桂州组黏土，淤泥，淤泥质，砂层，为软土层

质条件及各工程地质层的工程地质特征，将岩体工程地质单元划分为 2 个岩性组：侵入岩岩性组、碎屑岩岩性组；将土体类型划分为 3 类土：粘性土、砂类土、砾类土，特殊土类型划分为 3 类土：残坡积土、人工填土、淤泥类土，并对平原区土层结构的进行了单层、双层和多层的划分；（2）将全区划分为 5 个工程地质地段，进行了工程地质分区评价并提出对策与建议。侵入岩地段埋深浅处可作为天然地基基础持力层，中风化以深岩石可作为高层建筑天然地基或桩基持力层，高层建筑应避开断裂带；碎屑岩地段岩质一般较坚硬，可作为建筑天然地基或桩基持力层，靠近坡脚或在坡体上进行工程建设是注意人工边坡问题；一般沉积土地段工程地质条件较好，可作一般工民建天然地基持

力层；软土地段以淤泥、淤泥质黏土、淤泥质粉细砂等为主，饱和，流塑，天然含水率高，地基承载力特征值建议为 40 ~ 50 kPa，不能作为建筑物基础持力层；区内液化砂土地段分布极少。

致谢：广东省斗门镇幅 1：50 000 工程地质调查是一项区调工作，工程地质调查及岩土样品试验数据库是一项集体成果，野外一线地质工作人员付出了艰辛的努力。在整个调查过程中，更是得到了多位专家学者的指导，在此对各位专家和野外项目组所有人员致以诚挚的感谢。

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1∶50 000 Engineering Geological Survey and Geotechnical Test Dataset of the Doumen Map-Sheet in the Guangdong-Hong Kong-Macao Greater Bay Area

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Abstract: This dataset was created as a result of the “Environmental Geological Survey (1∶50 000) in the Guangdong-Hong Kong-Macao Greater Bay Area” project of the China Geological Survey in 2017. Based on previously collected geological information, we have carried out a 1∶50 000 engineering geological survey in Doumen on the west bank of the Pearl River Estuary in the Guangdong-Hong Kong-Macao Greater Bay Area and compiled the 1∶50 000 engineering geological map and specifications. This dataset was established based on the survey and analytical data of the samples. The dataset has 10 types of data in two categories: survey data and experimental test data, including 168 series of basic survey data, 53 series of data from field verification and remote sensing interpretation, 22 series of data from the integrated geological field survey, 77 series of data from the engineering geological survey, 23 series of data from the geological hazard survey, 13 series of data on the basic information of boreholes, 583 series of data from in-situ test results, 36 series of data from rock sample tests, 130 series of data from geotechnical tests and 669 series of data from field pictures, in total 1 774 series of data. This dataset will help us understand the engineering geological conditions of the west bank of the Pearl River Estuary in the Guangdong-Hong Kong-Macao Greater Bay Area and evaluate geological hazards such as soft ground subsidence, collapse, landslide and unstable slopes.

Key words: Guangdong-Hong Kong-Macao Greater Bay Area; Doumen map-sheet; engineering geological survey; rock sample tests; 1∶50 000 dataset

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

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1 Introduction

The Doumen map-sheet (Fig. 1) is located at the junction of Zhuhai and Jiangmen, Guangdong Province. In the Doumen district, the Hutiaomen Waterway and Yamen Waterway merge into the Huangmao Sea. The Huangyang Mountains and Gudou Mountains lie in the east and west sides of the Doumen region respectively. Yanshanian granites, NW faults like the Xijiang Fault and the Yamen Fault and NE faults including the Wuguishan Northern Piedmont Fault are found in this region (Chen WG et al., 2002). The existence of the Wuguishan Fault Uplift and Denglongsha Fault Depression (Yao YT et al., 2008) has resulted in higher terrains in the northwest and lower terrains in the southeast of the region. Frequent engineering geological problems have emerged because of the strong development of geological structures, an average annual rainfall of 2 268.3 mm (Liang Y, 2018) and the construction of major engineering facilities such as the Western Coastal Expressway (S32) and Green Industrial Park. Therefore, it is imperative to conduct an engineering geological survey and establish a corresponding database.

The dataset is derived from the engineering geological survey and rock sample tests, which were conducted in the subproject "Environmental Geological Survey (1∶50 000) in the Guangdong-Hong Kong-Macao Greater Bay Area" under the project "Comprehensive Geological and Environmental Survey in the Pan-Pearl River Delta Region". In 2017, we launched a 1∶50 000 engineering geological survey of the Doumen map-sheet in the Guangdong-Hong Kong-Macao Greater Bay Area to identify the engineering geological conditions in this area and geological hazards such as collapse, landslide and unstable slope

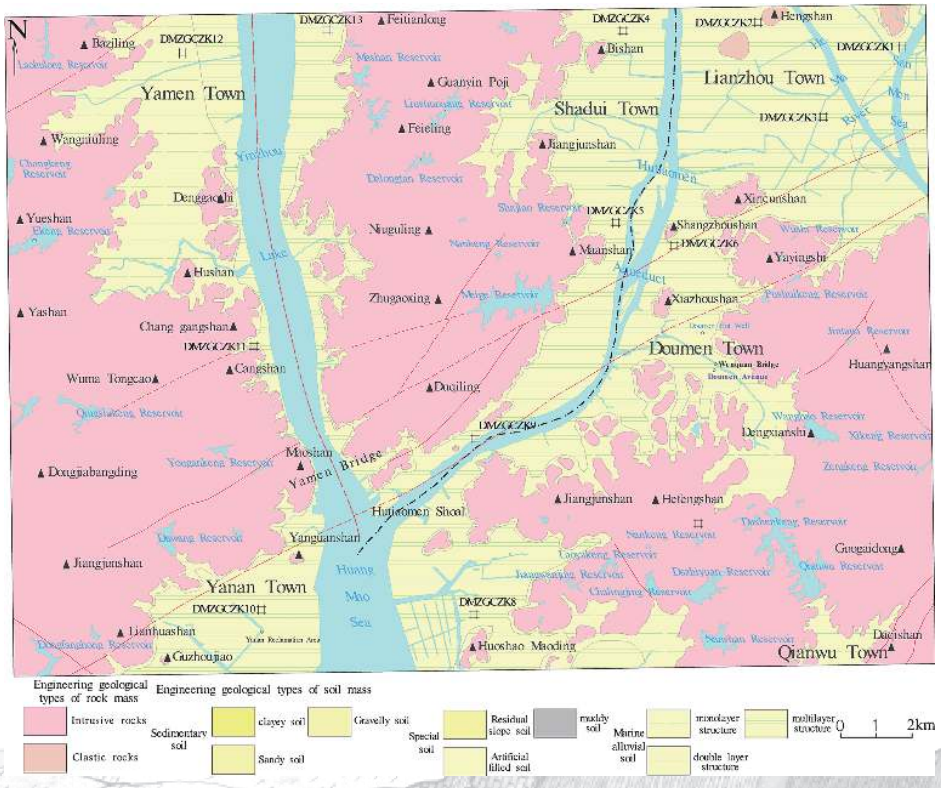

Fig. 1 The brief engineering geological map of the Doumen map-sheet

caused by strong weathering of intrusive rocks, as well as the problem of soft ground subsidence in the delta alluvial plain. In the survey, a special investigation and evaluation of soft ground subsidence was conducted, the evaluation and zoning of engineering geology was made and countermeasures and suggestions were proposed. All these efforts provide a basis for the optimized use of land resources, the development of underground space and the prevention and reduction of disasters on the west bank of the Pearl River Estuary.

The dataset covers a variety of data types, including those compiled from remote sensing interpretation, geological environmental survey, engineering geological survey, drilling, in-situ tests, geotechnical survey and photographs taken during the survey (Table 1). The geological environment survey data include those from integrated geological field and geological hazard survey points. Engineering geological survey data are mainly from engineering geological survey points, including shallow well survey points and survey points of weathering degree of rocks, etc. The in-situ test and geotechnical test data come from the collection of 13 engineering geological boreholes and their geotechnical samples in the map. The in-situ tests include the Standard Penetration Test (SPT), Cone Penetration Test (CPT) and Vane Shear Test (VST). The geotechnical sample tests include tests of compression strength, moisture content, specific gravity, void ratio, saturation, cohesion, angle of internal friction, liquidity

Table 1 Metadata Table of Database (Dataset)

Items	Description
Database (dataset) name	1∶50 000 Engineering Geological Survey and Geotechnical Test Dataset of the Doumen Map-Sheet in the Guangdong-Hong Kong-Macao Greater Bay Area
Database (dataset) authors	Zeng Min, Wuhan Center, China Geological Survey Zhao Xinwen, Wuhan Center, China Geological Survey Yu Wang, Wuhan Center, China Geological Survey Gu Tao, Wuhan Center, China Geological Survey
Data acquisition time	2017
Geographic area	1∶50 000 Geological Map of the Doumen map-sheet in the Guangdong-Hong Kong-Macao Greater Bay Area (F49E011021)
Data format	Excel
Data size	168.16 KB
Data service system URL	http://dcc.cgs.gov.cn
Fund project	China Geological Survey project titled “Environmental Geological Survey(1∶50 000) in the Guangdong-Hong Kong-Macao Greater Bay Area” (DD20160260)
Language	Chinese
Database (dataset) composition	The dataset has 10 types of data including 53 series of data from field verification and remote sensing interpretation, 168 series of basic survey data, 22 series of data from integrated geological field survey, 77 series of data from engineering geological survey, 23 series of data from geological hazard survey, 13 series of data on basic information of drilled boreholes, 583 series of data from results of in-situ tests, 36 series of data from rock sample tests, 130 series of data from geotechnical tests and 669 series of data from field pictures, in total 1 774 series of data.

index, plastic index, coefficient of compressibility and modulus of compressibility, etc. The purpose of this is to obtain physical and mechanical parameters of the rock-soil mass (Sun QY, 2018), thus providing data support for later evaluation and zoning of engineering geology. This dataset will help us understand the engineering geological conditions of the west bank of the Pearl River Estuary in the Guangdong-Hong Kong-Macao Greater Bay Area and evaluate geological hazards such as soft ground subsidence, collapse, landslide and unstable slopes. It can also provide specialized technical support for an engineering geological evaluation in different zones, the optimized use of land resources and the reduction and prevention of disasters.

2 Data Acquisition and Processing

This engineering geological survey focused on geological hazards caused by strong weathering of intrusive rocks such as collapse, landslide and unstable slopes, as well as soft ground subsidence in the delta alluvial plain. Many processes were implemented in the survey including data collection, remote sensing interpretation, ground survey, engineering geological drilling, in-situ tests and rock sample tests.

2.1 Remote-Sensing Interpretation Data

In the remote sensing interpretation of the Doumen map-sheet, the fusion data of ALOS PAN and multi-spectral images were used, with a multispectral spatial resolution of 10 m and a panchromatic band spatial resolution of 2.5 m. The selected data imaging time is October 20, 2015, with cloud cover <10%. The dataset of remote sensing interpretation is collected in accordance with *Standard for Production of Geological Map Interpreted with Remote Sensing Image* (1:250 000) (DZ/T 0264–2014), *Regional Environmental Geological Exploration of Remote Sensing Technology Procedures*(1∶50 000) (DZ/T 0190–1997), *Specification for Making Photo Plans of Remote Sensing Images* (GB 15968–1995), *Specification for Quality Control of Satellite Remote Sensing Image Products* (DZ/T 0143–1994) and other regulations. The dataset was obtained through several processes including data source selection, image data preprocessing, preliminary interpretation, remote sensing interpretation, visual modification, field verification and output of results.

First, spatial and irradiance corrections were made on the images, in order to restore as much of the original spatial and irradiance features in the processed images as possible. Appropriate feature categories were determined, combined with the actual situation of the map and the specific needs of the project, with reference to the image characteristics of various typical features mentioned in relevant literature. Through preliminary interpretation, the images of typical features were extracted and appropriate routes were designed for field reconnaissance to establish interpretation marks of various features. Remote sensing interpretation uses visual interpretation to directly select appropriate window sizes and merge the finely-divided patches. The following steps were to determine the typical area of verification, design the appropriate route, conduct field tests and in-situ preliminary

modifications.

2.2 Engineering Geological Survey Data

The main steps of the engineering geological survey were identifying the regional engineering geological conditions including the geological landforms, geological structure, types of rock-soil mass and their engineering properties and adverse geological effects; figuring out their impacts on human activities; dividing engineering geological formation and providing their main physical and mechanical parameters; investigating the types, intensity, distribution and evolution of major engineering geological problems caused by natural or human activities and their interactions; evaluating their impacts on human activities; carrying out evaluations of the suitability of engineering geological zoning and human activity and proposing countermeasures and suggestions.

The primary objectives of the engineering geological survey were as follows: (1) classifying engineering geological formations and providing their key physical and mechanical parameters; (2) optimizing the land space development pattern, providing a regional engineering geological basis for service planning and major project construction and proposing specific countermeasures and suggestions for existing engineering geological problems; (3) providing regional engineering geological information for the investigation, evaluation, monitoring, early warning and management of geological hazards.

During the survey, the focus was on investigating topographic border lines, strata boundaries, construct points, rock outcrops, artificial water bodies, artificial filling bodies (land reclamation, etc.), large-scale deep foundation pits, tunnels and bridges, etc.This was achieved by using descriptions, photos, sketches and other means to record phenomena such as geological landforms and engineering geology and measuring in-situ indicators, like the rock compressive strength of a rebound hammer. Finally, data was recorded in the field investigation logbook and sheets and then imported into the dataset.

2.3 Engineering Geological Drilling Data

The main task of engineering geological drilling was to identify the subsurface geological structure, rock-soil properties, thickness, burial depth, distribution range and engineering geological conditions, etc. In order to obtain the necessary engineering geological parameters, we carried out in-situ tests using the rock-soil samples from the boreholes.

Normal circulation core drilling was used in engineering geological drilling. For clayey soil (including sludge, mucky soil, silt clay, granophyric clay etc.), the mean core recovery rate is over 90%; for sandy soil, sand gravel stone, light weathered and middle weathered granite, the mean core recovery rate is over 80%; for coarse sand and sandstone with gravel, the mean core recovery rate is over 60%; for highly weathered zones in bedrocks and fractured zones, the rate is over 45%. The borehole was measured for deviation and corrected for depth every 50 m that was drilled, in order to maintain a borehole deviation below 1° over the depth and with a depth error of less than 2 ‰, subject to the corrected borehole depth. Geological recording for the borehole, SPT and geotechnical sample collection were performed while the

drilling was in progress. After the completion of the drilling, CPT and VST were conducted and the samples were promptly sent for testing. Finally, all data were analyzed and imported into the dataset.

2.4 In-situ Test Data

In the standard penetration test, a 63.5 kg weight was used to fall freely according to the prescribed falling distance of 76 cm and a standard-sized penetrator was driven into the soil. The number of blows recorded for the first 15 cm was not recorded. Then the sampler was further driven by 30 cm and the number of blows for each 10 cm was recorded. The depth and the number of blows in the standard penetration test (N) were recorded. According to the *Code for Investigation of Geotechnical Engineering* (GB 50021–2001), when the length of the drill rod is over 3 m, the number of blows should be corrected in accordance with the following formula: $N=\alpha N'$; where N' is the number of blows in the standard penetration test, α is the correction factor for the length of the rod. If the length of the rod is ≤3 m, ≤6 m, ≤9 m, ≤12 m, ≤15 m, ≤18 m and ≤21 m respectively, then α is 1, 0.92, 0.86, 0.81, 0.77, 0.73 and 0.70 accordingly.

The double bridge cone penetration tests were conducted in accordance with some technical standards including the *Code for the Investigation of Geotechnical Engineering* (GB 50021–2001) and *Code for the Inspection of Building Foundations* (DBJ 15–60–2008). The values of the mechanical indexes *qc* and *fs* were identified and the geomechanics was used to stratify the site, based on the tests results. Then the *qc-h, fs-h and Rf-h* curves were drawn and the average value of cone penetration parameters of each layer of soil was calculated.

In accordance with the test procedures of vane shear tests, the original soil sheer test was firstly performed, then the remolded soil sheer test was done, and finally the sheer strength of the original and remolded soil and the sensitivity of the soft soil were calculated.

2.5 Geotechnical Sample Test Data

According to the *Code for Investigation of Geotechnical Engineering* (GB 50021–2001), the geotechnical samples were collected while the drilling was in process. Generally, the original soil samples were taken in boreholes while the disturbed soil samples were taken in sand, gravel and pebble layers. After the collection, the samples were promptly sent to the laboratory for testing. According to the analytical report, the detection method is accurate, the relationship between the various test data indicators is reasonable and the test results are accurate and reliable.

3 Description of Data Samples

The "1∶50 000 Engineering Geological Survey and Geotechnical Test Dataset of the Doumen Map-sheet in the Guangdong-Hong Kong-Macao Greater Bay Area" has 10 types of data, including "Table of basic data of survey points", "Table of field pictures data", "Table of integrated geological field survey", "Table of field verification and remote sensing interpretation record", "Table of shallow well record", "Table of weathering degree of rocks

survey", "Table of collapse survey", "Table of landslide survey", "Table of unstable slope survey", "Table of ground subsidence survey", "Table of basic information of drilled boreholes", "Table of SPT record of engineering geology", "Table of CPT record of engineering geology", "Table of VST record of engineering geology", "Table of comprehensive results of geotechnical tests" and "Table of borehole rock sample tests of engineering geology", adding up to a total of 1 774 series of data. The correspondence between the data type and the properties table is shown in Table 2.

3.1 Field Verification and Remote Sensing Interpretation Data

The data from field verification and remote sensing interpretation are presented in the table of field verification and remote sensing interpretation record, which includes: Unified No., Field No., Longitude, Latitude, Surface elevation, Geographical location, Map No., Correctness of interpretation, Characteristics of remote sensing image of observation points, Type of remote sensing interpretation, Type of field verification, Record of field observation, Remark, etc. (Table 3)

3.2 Basic Survey Data

Basic survey data are presented in the table of basic data of survey points, which includes: Unified No., Field No., Longitude, Latitude, X coordinate, Y coordinate, Surface elevation, Geographic location, Map No., Type of survey point, etc. (Table 4)

3.3 Integrated Geological Field Survey Data

The data from the integrated geological field survey are presented in the table of integrated geological field survey, which includes: Unified No., Field No., Longitude, Latitude, Surface elevation, Geographical location, Type of survey point, Sampling, Map No., Topographic feature, Weather, Stratigraphic dip direction, Formation dip, Photo No., Relation

Table 2 Correspondence between the Data Types and Properties of the Database (Dataset)

Category of surveyed data	Category of data attribute tables
Data from field verification and remote sensing interpretation	Table of field verification and remote sensing interpretation record
Data from basic survey	Table of basic data of survey points
Data from integrated geological field survey	Table of integrated geological field survey
Data from engineering geological survey	Table of shallow well record, Table of weathering degree of rocks survey
Data from geological hazard survey	Table of collapse survey, Table of landslide survey, Table of unstable slope survey, Table of ground subsidence survey
Data on basic information of drilled boreholes	Table of basic information of drilled boreholes
Data from results of in-situ tests	Table of SPT record of engineering geology, Table of CPT record of engineering geology, Table of VST record of engineering geology
Data from rock sample tests	Table of borehole rock sample tests of engineering geology
Data from geotechnical tests	Table of comprehensive results of geotechnical tests
Data from field pictures	Table of field pictures data

Table 3 Table of Field Verification and Remote Sensing Interpretation Record

Field name	Dimension	Data category	Real example
Unified No.	–	Char	1131147952214441401
Field No.	–	Char	D1057
Longitude	°	Float	113114795
Latitude	°	Float	22144414
Surface elevation	m	Char	7
Geographical location	–	Char	Shentan Quarry, Doumen map-sheet, Doumen District, Zhuhai, Guangdong Province
Map No.	–	Char	Doumen Map-sheet F49E011021
Correctness of interpretation	–	Char	Correct
Characteristics of remote sensing image of observation points	–	Char	The map spot is located to the east of Doumen Avenue in the Doumen map-sheet and to the north-east of the Wenquan Bridge, with an irregular shape, light grayish brown color, smooth surface texture, visible digging marks and spots and serious vegetation damage. It has no shadow coverage.
Type of remote sensing interpretation	–	Char	Open Pit Excavation Site
Type of field verification	–	Char	Interpretation and Verification Points of Open Pit Excavation Site
Record of field observation	–	Char	In in-situ verification and investigation point (D1057), the interpretation result is generally consistent with the actual situation.
Remark	–	Char	KW06

Table 4 Table of Basic Data of Survey Points

Field name	Dimension	Data category	Real example
Unified No.	–	Char	1130507302217329001
Field No.	–	Char	D2095
Longitude	°	Float	113050730
Latitude	°	Float	22173290
X-coordinate	–	Float	19714928
Y-coordinate	–	Float	2467671
Surface elevation	m	Char	8
Geographic location	–	Char	Nanfeng Qi, Qile Village, Gujing Town, Xinhui District, Jiangmen, Guangdong Province
Map No.	–	Char	Doumen Map-sheet F49E011021
Type of survey point	–	Char	Weathering rock survey point

between Points, Landform and geology, Hydrogeology, Environmental geology, Engineering geology, Visit and en-route, Artificial geological profile sketch (image), Survey point plan (image), Remark, Project name, Investigation entity, Investigator, Date of investigation, Recorder, Approver, Date of filling, etc. (Table 5).

Table 5 Table of Integrated Geological Field Survey

Field name	Dimension	Data category	Real example
Unified No.	–	Char	1130556312218394801
Field No.	–	Char	D2092
Longitude	°	Float	113055631
Latitude	°	Float	22183948
Surface elevation	m	Float	20
Geographical location	–	Char	Mashan Reservoir, Qile, Gujing, Xinhui District, Jiangmen, Guangdong Province
Type of survey point	–	Char	Integrated Geological Field Survey Points
Sampling	–	Char	In-situ Water Sampling for Testing
Map No.	–	Char	Doumen Map-sheet F49E011021
Topographic feature	–	Char	Hilly Land
Weather	–	Char	Shower Turned Cloudy
Stratigraphic dip direction	–	Float	–
Formation dip	–	Float	–
Photo No.	–	Char	1035–1039
Relation between Points	–	Char	From point to point, the landform is mainly low hills, with dense forest and vegetation and a good environment.
Landform and geology	–	Char	The landform of the surveyed point is low hills with a natural slope of about 15°–20°. The terrain is slightly undulating and the relative height difference is about 2 to 6 m. The main lithology is gray and white, flesh red medium-coarse grained porphyritic biotite monzogranite of the Yanshanian Jurassic ($J_3^1n\gamma$) with medium-coarse grained porphyritic structure and block structure. It is strongly weathered. The top is fully weathered granite, with a thickness of about 0 to 2 m, showing no obvious structural signs.
Hydrogeology	–	Char	Most of the surrounding area is completely-strongly weathered granite and the top is mostly fully weathered granite, with a thickness of about 0 to 2 m. The water here belongs to loose pore water with large volume and average quality. The bottom is strongly weathered granite and the initial rock can be identified. The water there belongs to weathered crevice water with a large volume and good quality. Supplied by precipitation, it flows to the reservoir through surface runoff and surface flow, then the water is discharged downstream.
Environmental geology	–	Char	Due to the pumping operation, the water level has dropped significantly and many unstable bank slopes can be seen on the reservoir bank, which are prone to collapse. The area downstream of the reservoir (the northwest side of the reservoir), the secondary reservoir and the downstream mountain ponds had been converted to farms and agricultural pollution, such as pesticides and fertilizers, was found.

Continued table 5

Field name	Dimension	Data category	Real example
Engineering geology	–	Char	The surrounding area of the surveyed point is mostly completely decomposed granite with a loose soil shape and thickness of about 0 to 2 m. The lower part is strong-weathered granite and the initial rock can be identified. The compressive strength measured by the in-situ rebound tester is 12 MPa.
Visit and en-route	–	Char	Along the way, we visited the Mashan Reservoir Management Station. The dam of the reservoir once broke and was later rebuilt. It is now used as a drinking water source in Gujing. The water supply volume is large and the water level is relatively low.
Artificial geological profile sketch (image)	–	Long	(image)
Survey point plan(image)	–	Long	(image)
Remark	–	Char	N/A
Project name	–	Char	Environmental Geological Survey(1∶50 000) in the Guangdong-Hong Kong-Macao Greater Bay Area
Investigation entity	–	Char	Wuhan Centre of China Geological Survey
Date of investigation	Y.M.D	Char	June 20, 2017
Investigator	–	Char	Yu Wang, Zeng Min, Gao Zhibin
Recorder	–	Char	Zeng Min
Approver	–	Char	Zhao Xinwen

3.4 Engineering Geological Field Survey Data

The data from the engineering geological field survey are presented in the table of shallow well record and table of weathering degree of rocks survey. The table of shallow well record (Table 6) includes: Unified No., Field No., Longitude, Latitude, Surface elevation, X coordinate, Y coordinate, Map No., Geographical location, Weather, Temperature, Water level depth, Topographic feature, Geology and environmental geology, Hydrogeology, Ecology and vegetation, Sampling, Remark, Column profile of shallow well, Project name, Investigation entity, Date of investigation, Investigator, Recorder, Approver, etc. The table of weathering degree of rocks survey includes: Unified No., Field No., Longitude, Latitude, X coordinate, Y coordinate, Geographical location, Surface elevation, Map No., Weather, Temperature, Investigation method, Topographical gradient, Overburden thickness, Photo No., Age of bedrock, Lithology of bedrock, Spatial distribution, Classification of rock strength, Construction relation, Dip direction of rock formation, Dip angle of rock formation, Classification of weathering degree of rocks, Thickness of weathered rock layer, Morphology of weathered rock layer, Properties of weathered rock layer, Fissure, Plan sketch, Profile sketch, Remark, Project name, Investigation entity, Date of investigation, Investigator, Recorder, Approver, etc.

Table 6 Table of Shallow Well Record

Field name	Dimension	Data category	Real example
Unified No.	–	Char	1130509972219449401
Field No.	–	Char	D1160
Longitude	°	Float	113050997
Latitude	°	Float	22194494
Surface elevation	m	Float	2
X-coordinate	–	Float	19714821
Y-coordinate	–	Float	2471780
Map No.	–	Char	Doumen Map-sheet F49E011021
Geographical location	–	Char	Laocaiwei, Ci'ai, Gujing, Xinhui District, Jiangmen, Guangdong Province
Weather	–	Char	Clear
Temperature	℃	Float	34
Water level depth	m	Float	0.4
Topographic feature	–	Char	The landform is a delta plain with relatively flat terrain and a relative height difference of about 1 to 3 m
Geology and environmental geology	–	Char	The lithology of the strata exposed on the surface is clay, silt, fine sand, etc. of Quaternary Holocene Stratigraphy Denglongsha Fm (Q4dl)
Hydrogeology	–	Char	The surveyed point was near the Yamen waterway and exposed by the Huamuchang borehole. Its stratum lithology is clay, silt, mucky and sand layer of the Quaternary Holocene Guizhou Formation, which belongs to the soft soil layer.
Ecology and vegetation	–	Char	–
Sampling	–	Char	Unsampled
Remark	–	Char	D1160
Column profile of shallow well	–	Long	(image)
Project name	–	Char	Environmental Geological Survey (1∶50 000) in Guangdong-Hong Kong-Macao Greater Bay Area
Investigation entity	–	Char	Wuhan Centre of China Geological Survey
Date of investigation	Y.M.D	Char	June 17, 2017
Investigator	–	Char	Gu Tao
Recorder	–	Char	Gu Tao
Approver	–	Char	Zhao Xinwen

3.5 Geological Hazard Survey Data

The data from the geological hazard survey are presented in the table of ground subsidence survey, which includes: Unified No., Field No., Geographical location, Longitude, Latitude, Name of land subsidence, Surface elevation, Map No., Name of city, Weather, Inducing factor, Topographic feature, Development trend, Hazard, Prevention and treatment,

Plan sketch, Profile sketch, Remark, Project name, Investigation entity, Photo No., Date of investigation, Investigator, Recorder, Approver, etc. (Table 7)

Table 7 Table of Ground Subsidence Survey

Field name	Dimension	Data category	Real example
Unified No.	–	Char	1130258842219497601
Field No.	–	Char	D2111
Geographical location	–	Char	Nanchang, Yamen, Xinhui District, Jiangmen, Guangdong Province
Longitude	°	Float	113025884
Latitude	°	Float	22194976
Name of land subsidence	–	Char	Nanchang Subsidence
Surface elevation	m	Float	–
Map No.	–	Char	Doumen Map-sheet F49E011021
Name of city	–	Char	Jiangmen, Guangdong Province
Weather	–	Char	Shower turned cloudy
Inducing factor	–	Char	Around the surveyed point, there are many houses in Nanchang. Some loads including the cement pavement built in Sept. 2001, small bridges and the wells had become the inducing factors of soft soil subsidence.
Topographic feature	–	Char	The landform is a piedmont plain with flat terrain and a relative height difference of about 0 to 1 m. On both sides of the Yamen Waterway, the main stratum lithology is dark gray, grayish black silt, muddy soil of Quaternary Holocene (Q_h) with soft plastics shape and poor engineering geomechanical properties.
Development trend	–	Char	Will continue to subside
Hazard	–	Char	The hazards were house wall cracks, ground cracks, the local compression and fault of the power supply and water supply pipes, which potentially threatened more than 500 people of over 300 households in the village.
Prevention and treatment	–	Char	Some walls had been repaired again and some mortar had collapsed. It is suggested to strengthen monitoring and house repair work.
Plan sketch	–	Long	(image)
Profile sketch	–	Long	(image)
Remark	–	Char	Rectangle
Project name	–	Char	Environmental Geological Survey(1∶50 000) in the Guangdong-Hong Kong-Macao Greater Bay Area
Investigation entity	–	Char	Wuhan Centre of China Geological Survey
Photo No.	–	Char	1142–1152
Date of investigation	Y.M.D	Char	June 24, 2017
Investigator	–	Char	Yu Wang, Zeng Min, Gao Zhibin
Recorder	–	Char	Zeng Min
Approver	–	Char	Zhao Xinwen

3.6 Data on Basic Information of Drilled Boreholes

The data on the basic information of drilled boreholes are presented in the table of basic information of drilled boreholes, which includes: Unified No., Field No., Longitude, Latitude, X coordinate, Y coordinate, Geographical location, Surface elevation, Map No., Borehole head elevation, Drill rig type, Borehole type, Open hole date, End hole date, Borehole deviation, Open hole caliber, End hole caliber, Borehole final depth, Initial water level of aquifer, Well depth, Static water level, Quality grade, etc. (Table 8)

3.7 Data from Results of In-situ Tests

The data from results of in-situ tests are presented in the table of SPT record of engineering geology, the table of CPT record of engineering geology and the table of VST record of engineering geology, which includes: Unified No., Field No., Longitude, Latitude, X coordinate, Y coordinate, Geographical location, Surface elevation, Map No., Borehole ID, Test No., Rod length, Corrected number of blows, Test depth, Measured number of blows, Basic value of bearing capacity, Starting depth, End depth, etc. (Table 9)

Table 8 Table of Basic Information of Drilled Boreholes

Field name	Dimension	Data category	Real example
Unified No.	–	Char	1131438202219194601
Field No.	–	Char	DMZGCZK1
Longitude	°	Float	113143820
Latitude	°	Float	22191946
X-coordinate	–	Float	19731176
Y-coordinate	–	Float	2471239
Geographical location	–	Char	Xijiang Qinghe (Northeast of the Jiangzhu Expressway), Doumen District, Zhuhai, Guangdong Province
Surface elevation	m	Float	1.193
Map No.	–	Char	Doumen Map-sheet F49E011021
Borehole head elevation	m	Float	1.193
Drill rig type	–	Char	XY-100
Borehole type	–	Char	Engineering Geological Borehole
Open hole date	Y.M.D	Char	October 8, 2017
End hole date	Y.M.D	Char	October 11, 2017
Borehole deviation	°	Float	0
Open hole caliber	mm	Float	130
End hole caliber	mm	Float	91
End hole depth	m	Float	74.15
Initial water level of aquifer	m	Float	0.7
Well depth	m	Float	74.15
Static water level	m	Float	0.55
Quality grade	–	Char	Good

3.8 Data from Rock Sample Tests

The data from the rock sample tests are presented in the table of borehole rock sample tests of engineering geology, which includes: Unified No., Sample No., Core No., Lithology, Test code, Saturated compressive strength, etc. (Table 10)

3.9 Data from Geotechnical Tests

The data from the geotechnical tests are presented in the table of comprehensive results of geotechnical tests, which includes: Unified No., Sample No., Depth of soil sample, Lab name, Moisture content, Specific gravity, Wet density, Dry density, Void ratio, Saturation, Liquid limit, Plastic limit, Plasticity index, Liquidity index, Cohesion, Internal friction angle,

Table 9 Table of SPT Record of Engineering Geology

Field name	Dimension	Data category	Real example
Unified No.	–	Char	1131438202219194601
Field No.	–	Char	DMZGCZK1
Longitude	°	Float	113143820
Latitude	°	Float	22191946
X-coordinate	–	Float	19731176
Y-coordinate	–	Float	2471239
Geographical location	–	Char	Xijiang Qinghe (Northeast of the Jiangzhu Expressway), Doumen District, Zhuhai, Guangdong Province
Surface elevation	m	Float	1.193
Map No.	–	Char	Doumen Map-sheet F49E011021
Borehole ID	–	Char	1
Test No.	–	Char	1
Rod length	m	Float	16.93
Corrected number of blows	–	Float	8.2
Test depth	m	Float	14.8
Measured number of blows	–	Float	11
Basic value of bearing capacity	MPa	Float	14.8
Starting depth	m	Float	14.8
End depth	m	Float	15.25

Table 10 Table of Borehole Rock Sample Tests of Engineering Geology

Field name	Dimension	Data category	Real example
Unified No.	–	Char	1131217612219437401
Sample No.	–	Char	DMZGCZK2-1
Core No.	–	Char	DMGCZK02 Core
Lithology	–	Char	Sandstone
Test code	–	Char	1 452
Saturated compressive strength	MPa	Float	43.3

compressibility, compression modulus, Test code, etc. (Table 11)

3.10 Data from Field Pictures

The data from the field pictures are presented in the table of field pictures data, which includes: Unified No., Date of photography, Picture type, Photographer, Type of photo content, Description of photography, Parameter, Description of geological phenomenon, etc. (Table 12)

4 Data Quality Control

All work within the study area was done in accordance with the national *Specification for Engineering Geological Survey* (1∶50 000), and all datasheets were generated as per its attached sheet, with a degree of precision meeting its requirements.

All survey datasheets for the working area were 100% self-checked and mutually-checked and 30% of all collated datasheets were randomly inspected. Results from random inspections show that the data quality met the credibility requirement for an engineering geological survey.

5 Conclusion

In the project of the "Environmental Geological Survey (1∶50 000) in the Guangdong-Hong Kong-Macao Greater Bay Area", the 1∶50 000 engineering geological survey of the Doumen map-sheet on the west bank of the Pearl River Estuary was performed in accordance

Table 11 Table of Comprehensive Results of Geotechnical Tests

Field name	Dimension	Data category	Real example
Unified No.	–	Char	1131438202219194601
Sample No.	–	Char	DMZGCZK1-1
Depth of soil sample	m	Float	3.40–3.60
Lab name	–	Char	Silty soil
Moisture content	%	Float	45.3
Specific gravity	–	Float	2.64
Wet density	g/cm^3	Float	1.74
Dry density	g/cm^3	Float	1.2
Void ratio	–	Float	1.2
Saturation	%	Float	99.3
Liquid limit	%	Float	43.9
Plastic limit	%	Float	24.6
Plasticity index	–	Float	19.3
Liquidity index	–	Float	1.07
Cohesion	kPa	Float	7.8
Internal friction angle	°	Float	6
Compressibility	–	Float	0.87
Compression modulus	–	Float	2.53
Test code	–	Char	0011755(2016)0942

Table 12 Table of Field Pictures Data

Field name	Dimension	Data category	Real example
Unified No.	−	Char	1130509972219449401
Date of photography	Y.M.D	Char	June 17, 2017
Picture type	−	Char	Color
Photographer	−	Char	Gu Tao
Type of photo content	–	Char	Table of basic information of drilled boreholes
Photo	−	Long	(image)
Description of photography	–	Char	Table of basic information of drilled boreholes (D1160)
Parameter	−	Char	Auto
Description of geological phenomenon	−	Char	The surveyed point was near the Yamen waterway and exposed by the Huamuchang borehole. The stratum lithology is clay, silt, mucky and sand layer of the Quaternary Holocene Guizhou Formation, which belongs to the soft soil layer.

with the *Specification for Engineering Geological Survey* (1∶50 000) (DZ / T 0097–1994) and *Technical Requirements for Engineering Geological Survey* (1∶50 000) (*Trial Implementation*). Informed by past geological information and survey results, we compiled a 1∶50 000 engineering geological map and specifications and established a dataset based on the results of this engineering geological survey. The dataset has 10 types of data, including 168 series of basic survey data, 53 series of data from field verification and remote sensing interpretation, 22 series of data from integrated geological field survey, 77 series of data from the engineering geological survey, 23 series of data from the geological hazard survey, 13 series of data on the basic information of boreholes, 583 series of data from in-situ test results, 36 series of data from rock sample tests, 130 series of data from geotechnical tests and 669 series of data from field pictures, in total 1 774 series of data.

The creation of the "1∶50 000 Engineering Geological Survey and Geotechnical Test Dataset of the Doumen map-sheet in the Guangdong-Hong Kong-Macao Greater Bay Area" provides basic data to shed light on the engineering geological conditions of the west bank of the Pearl River Estuary in the Guangdong-Hong Kong-Macao Greater Bay Area and also holds significance for evaluating geological hazards such as soft ground subsidence, collapse, landslide and unstable slopes in the Pearl River Delta Plain.

Two perspectives are mainly gained from the 1∶50 000 engineering geological survey. (1) The engineering geological conditions and geological characteristics of each engineering geological layer in the area were generally identified, and the engineering geological units of the rock mass were divided into two lithological groups, i.e. intrusive lithology and clastic lithology. The soil types were classified into three types of soil, i.e. cohesive soil, sandy soil and gravel soil. The special soil types were sorted into three types of soil: residual slope, artificial soil filling and silt-like soil. The soil layer structure of the plain area includes single-layer, double-layer and multi-layer. (2) The whole survey area was divided into five

engineering geological lots, and the engineering geological zoning evaluation was carried out and countermeasures and suggestions were proposed. The shallow buried intrusive rocks can be used as a natural foundation support layer, and the middle weathered deep buried rocks can be used as a natural foundation or pile foundation support layer for high-rise buildings (high-rise buildings should avoid fault zones). The clastic rocks are generally hard, which can be used as a natural foundation or pile foundation holding layer of the buildings, and the artificial slope should be considered during the construction near the foot of the slope or on the slope. The engineering geological conditions of the common sedimentary soils are good enough, and it can be used as a natural foundation supporting layer for the construction of worker and civil buildings. The soft soils are mainly silt, silty clay, silty sand, etc., showing saturated, fluid plastic, high natural moisture content, and the characteristic value of the foundation bearing capacity of this lot is recommended to be 40–50 kPa, which could not be used as the supporting layer of the buildings. The liquefied sandy soils in the area is rarely distributed.

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