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项目：内蒙古自治区阿拉善左旗腾格里工业园区供水水文地质详查项目 (2010-3-SK3) 资助。

内蒙古自治区阿拉善左旗腾格里工业园区供水水文地质详查数据集

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摘要： 2011 年内蒙古自治区阿拉善左旗腾格里工业园区供水水文地质详查数据集是对内蒙古自治区地质调查院承担的“内蒙古自治区阿拉善左旗腾格里工业园区供水水文地质详查”项目提供的钻孔抽水试验成果（12 个钻孔点）、地下水水化学成果（40 个水样）、岩土样试验成果（102 个岩土样）、地下水位统测（35 个测试点）四组数据整理而得。其中，钻孔抽水试验成果数据主要包括水位埋深、静止水位标高、水位降深、涌水量、渗透系数、导水系数、矿化度等；地下水水化学成果数据主要包括游离 CO_2、H_2SiO_3、溶解性固体、总硬度、总碱度、Ph 值等；岩土样试验成果数据主要包括给水度、含盐量、颗粒组成等；地下水位统测主要包括取水层位、含水层顶底板埋深、水位埋深、水位标高、水利性质等内容。通过校核和验证，所有结果均在误差范围之内。对于地表水资源贫乏地区，围绕该地区对水资源的需求，以选择供水水源地为勘查目的，为科学合理的利用地下水资源提供依据，保证经济和生态环境的可持续发展。为了更好地利用这些数据，采用国内规范的数据处理方法和原则，对试验数据进行整理和质量控制。

关键词： 水文地质；数据集；水化学；岩土；抽水试验；地下水位

数据服务系统网址： http://dcc.cgs.gov.cn

1　引言

腾格里工业园位于阿拉善左旗南部，托管腾格里镇，行政隶属阿拉善左旗（金玉山等，2005）。北距盟旗驻地巴彦浩特 180 km，东距银川市 220 km，西距兰州市 330 km，南距中卫市 20 km，黄河在中卫市由西向东通过，京藏铁路经中卫市东西向展布。园区距黄河直线距离 13 km，离“包—兰”铁路迎水货运编组站及 110 国道 10 km，距中卫市旅游支线飞机场 15 km，是阿拉善左旗的“南大门”。资源禀赋较好，境内芒硝、盐、铁、煤、石膏、硅石、陶土、石墨等矿产资源储量丰富，已探明原盐 2000 万 t，芒硝 2400 万 t。勘查区是在普查基础上圈定的富水地段，是充分考虑当地地理条件和水文地质条件后选定的，东西长 20 km，南北宽 20 km，总面积 400 km^2，交通位置图见图 1。工作区位于工业园区规划范围内，其地理坐标为（北京 54）：东经：104° 51′ 09″ ~105° 04′ 45″，

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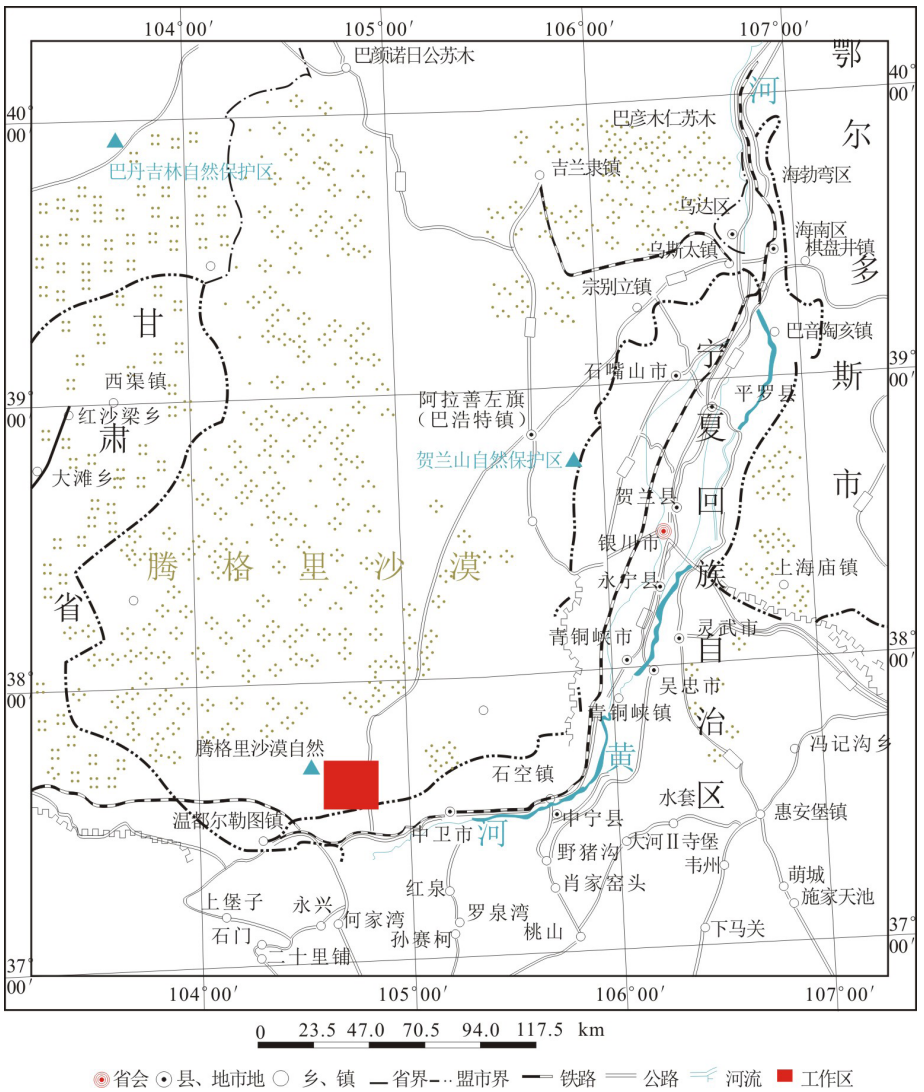

图 1　交通位置图

北纬：37° 32′ 39″ ~37° 43′ 28″ 。

腾格里地区蕴藏着丰富的矿产资源，是阿拉善盟重要的化工基地和旅游区，开发潜力巨大，加快其资源开发步伐，对促进阿拉善左旗经济发展具有重要意义（欧阳慧等，2008 ）。但水资源短缺已成为制约当地经济进一步发展的瓶颈。由于地表水资源贫乏，地下水成为园区生活和生产的唯一水源（喻晓林等，2007 ）。因此，腾格里工业经济的发展规模，很大程度上取决于地下水资源量的多寡。在园区建设和发展过程中，盲目无序开采地下水，致使地下水位出现了持续下降和水质不断恶化的问题。腾格里工业园区做为阿拉善盟“十二五”重点发展的大型工业基地，工业园 2015 年需水量估计可达 60000 m^3/d，为了科学合理的利用地下水资源，保证当地经济和生态环境持续稳定健康的发展，选择相对富水地段进一步开展详查工作。

内蒙古自治区阿拉善左旗腾格里工业园区供水水文地质详查数据集的基本信息简介见表 1。它包括数据集的中（英）名称、数据论文作者、数据采集时间、地理区域、数据量、数据格式、数据出版地址、基金项目、数据库（集）组成等。

表 1　数据库（集）元数据简表

条目	描述
数据库（集）名称	内蒙古自治区阿拉善左旗腾格里工业园区供水水文地质详查数据集
数据作者	侯建军，王宇，郑泉，蒙奎文，刘忠辉
语种	中文
数据时间范围	2011 年 1—12 月
地理区域	地理范围包括东经：104° 51′ 09″～105° 04′ 45″ 北纬：37° 32′ 39″～37° 43′ 28″
数据量	219 kB
数据格式	.xlsx
数据服务系统网址	http://dcc.cgs.gov.cn
基金项目	内蒙古自治区阿拉善左旗腾格里工业园区供水水文地质详查（2010-3-SK3）
数据库（集）组成	数据集由 4 部分数据组成，分别为内蒙古自治区阿拉善左旗腾格里工业园区供水水文地质详查钻孔抽水试验成果数据 .xlsx、内蒙古自治区阿拉善左旗腾格里工业园区供水水文地质详查地下水水化学成果数据 .xlsx、内蒙古自治区阿拉善左旗腾格里工业园区供水水文地质详查岩土样试验成果数据 .xlsx、内蒙古自治区阿拉善左旗腾格里工业园区供水水文地质详查地下水位统测数据 .xlsx

2　数据采集和处理方法

在 1∶10 万水文地质调查基础上，进行了补充水文地质调查，调查采用 1∶50000 地形图作为底图，手持 GPS 进行实地定点，对所有新施工的机民井进行了详细的记录和描述，对普查阶段调查的地质地貌界线进行了验证，对有偏差的地质地貌界线进行了修正，各类观测点均符合规范要求。对现状开采量进行了调查和统计计算，调查成果满足相应详查阶段的精度要求。

2.1　地下水动态长期观测

在不同地质、地貌单元布置地下水动态长期观测点 15 个（勘探孔 5 个），其中第Ⅱ含水岩组 10 个，第Ⅲ含水岩组 5 个。观测频率为 6 次 / 月，即每月的 5、10、15、20、25、30 日进行观测。

2.2　地下水水位统测

2011 年 5 月 27—30 日和 2012 年 5 月 27—30 日枯水期，进行了两次水位统测，每个统测点均进行了水位、水温、含水层岩性及时代的记录，体现了统测的等时性，真实地反映了地下水的流场。

2.3　岩（土）、水样的采集与分析

在勘探孔中采集岩（土）样 103 件，主要分析项目为含盐量、给水度及颗粒分析定名，化验结果与实际定名及邻区资料基本吻合，质量可靠。在勘探孔、代表性井（泉）和地表水体中共采取了水质全分析样 40 件，所有样品均采取新鲜水样，对于不稳定项目在取样现场及时加入保护剂，保护剂添加种类、方法及数量均符合化验单位要求。分

析项目为：K^+、Na^+、Ca^{2+}、Mg^{2+}、NH_4^+、全 Fe、OH^-、Cl^-、SO_4^{2-}、HCO_3^-、CO_3^{2-}、NO_3^-、NO_2^-、可溶性 SiO_2、耗氧量、矿化度、PH 值、总硬度、永久硬度、暂时硬度、负硬度、总碱度、游离 CO_2 等。

2.4 抽水试验

本次采取稳定流抽水试验，每个试段均进行了三个落程，并按反向抽水进行，而且满足 *S*1=*S*3、*S*2=*S*3、*S*3 大于 1 m，稳定延续时间：S3 大于 24 h，S1、S2 大于 8 h；孔组非稳定流抽水试验，现场绘制了水位下降与时间 [s(或 $\Delta h2$)−lg*t*] 关系曲线，抽水试验的延续时间一般大于 72 h。稳定流和非稳定流抽水试验的动水位和出水量观测时间、恢复水位观测时间，均按非稳定流观测时间进行观测；群孔干扰抽水试验，XK6、XK6-1、XK7 进行孔组非稳定流和干扰抽水试验。孔组非稳定流试验采用一个主孔抽水，观测孔和另一主孔同时进行观测，以了解干扰抽水时的水位削减值，抽水延续时间大于 72 h。干扰抽水试验采用两个主孔同时抽水，观测孔进行观测，以了解群孔抽水时的水量削减系数，抽水延续时间大于 168 h。

3 数据样本描述

2011 年内蒙古自治区阿拉善左旗腾格里工业园区供水水文地质详查数据集为 Excel 表格型数据，包含 4 个 Excel 数据文件，分别为“内蒙古自治区阿拉善左旗腾格里工业园区供水水文地质详查钻孔抽水试验成果数据 .xlsx”、“内蒙古自治区阿拉善左旗腾格里工业园区供水水文地质详查地下水水化学成果数据 .xlsx”、“内蒙古自治区阿拉善左旗腾格里工业园区供水水文地质详查岩土样试验成果数据 .xlsx”和“内蒙古自治区阿拉善左旗腾格里工业园区供水水文地质详查地下水位统测数据 .xlsx”。其中，“内蒙古自治区阿拉善左旗腾格里工业园区供水水文地质详查钻孔抽水试验成果数据 .xlsx”将第Ⅱ和第Ⅲ含水岩组做为上下试段，分别进行了单孔稳定流和孔组非稳定流抽水试验，调整后单孔稳定流抽水试验由原来 15 个试段调整为 17 个试段；孔组非稳定流抽水试验由原来 12 个试段调整为 8 个试段，记录信息包含孔号、试段、试段位制、孔深、抽水方法、渗透系数、导水系数等内容（表 2）。“内蒙古自治区阿拉善左旗腾格里工业园区供水水文地质详查地下水水化学成果数据 .xlsx”包含了 K^+、Na^+、Ca^{2+}、Mg^{2+}、NH^{4+}、全 Fe、OH^-、Cl^-、SO_4^{2-}、HCO_3^-、CO_3^{2-}、NO_3^-、NO_2^-、可溶性 SiO_2、耗氧量、矿化度、PH 值、总硬度、永久硬度、暂时硬度、负硬度、总碱度、游离 CO_2 等数据（表 3）。“内蒙古自治区阿拉善左旗腾格里工业园区供水水文地质详查岩土样试验成果数据 .xlsx”主要包含含盐量、给水度、颗粒分析定名、颗粒组成等内容（表 4）。“内蒙古自治区阿拉善左旗腾格里工业园区供水水文地质详查地下水位统测数据 .xlsx”主要包括地理位置、水位、含水层岩性、水力性质等内容（表 5）。

表 2 内蒙古自治区阿拉善左旗腾格里工业园区供水水文地质详查钻孔抽水试验成果数据集例表

字段名称	实例		
孔号	XK1		
试段	Ⅰ	Ⅱ	全
试段位置 /m	59.5~125	136~204.5	59.5~204.5

续表 2

字段名称		实例		
孔号		XK1		
孔深 /m		219		
坐标		*x*:4173741 *y*:18497331		
地面高程 /m		1315.75		
含水层顶板埋深 /m		59.5	136	59.5
含水层厚度 /m		36.5	29.4	65.9
含水层岩性		含卵石泥质砂砾岩、泥质砂岩	含卵石泥质砂砾岩	含卵石泥质砂砾岩、泥质砂岩
地下水类型		承压水		
抽水方法		非稳定流抽水	稳定流抽水试验	稳定流抽水试验
水位埋深 /m	主孔	33.905	38.095	33.905
	观测孔	33.84		34.15
静止水位标高 /m	主孔	1281.845	1277.655	1281.845
	观测孔			
水位降深 /m	主孔	5.63	17.33	8.54
	观测孔	0.6		
涌水量 /(m^3/d)		615.84	485.4	1135.92
单位涌水量 /(m^3/d· m)		109.3854352	28.00923254	133.0117096
渗透系数 /(m/d)		15.8	1.405	2.92
导水系数 /(m^2/d)		577.9	41.32	192.48
弹性释水系数		6.28×10^{-5}		
导压系数 /(m^2/d)		9.2×10^{6}		
水温 /℃		12	13	12
矿化度 /(g/L)		2.918	2.465	
氟离子含量 /(mg/L)		1.05	2.21	
水化学类型		CL55 · S37–Na54 · Mg31	CL64 · S29–Na64	
抽水日期 /（年 . 月 . 日）		2011.10.29	2011.10.19	2011.10.9
抽水延续时间 (h)		72	40	40
水位恢复时间 (h)		33	75	60

表 3　内蒙古自治区阿拉善左旗腾格里工业园区供水水文地质详查地下水水化学成果数据集例表

字段名称			实例		
序号			1		
野外编号			S76		
每升水中含量	mg	mmol	mmol%	每升水中含量	mg· L^{-1}
K^+	5.90	0.15	2.80	Li	

续表 3

字段名称	实例				
Na^{+}	50.22	2.18	40.90	Sr	
Ca^{2+}	33.07	1.65	31.00	Zn	未检出
Mg^{2+}	16.41	1.35	25.30	Br	
Fe^{2+}	0.00	0.00	0.00	I	
Fe^{3+}	0.00	0.00	0.00	Se	
NH^{4+}	0.00	0.00	0.00	游离 CO_2	3.30
合计	105.60	5.33	100.00	H_2SiO_3	16.67
Pb	未检出			溶解性总固体	323.22
Mn	< 0.05			总硬度	150.14
Cd	未检出			暂时硬度	121.11
Hg	0.00			负硬度	0.00
Cr^{6+}	0.02			永久硬度	29.03
Cu	未检出			总碱度	121.11
As	0.00			总酸度	
Al				PH 值	7.82
Cl^{-}	39.00	1.10	20.80	CODMn (以 O_2 计)	2.84
SO_4^{2-}	56.68	1.18	22.30	侵蚀性 CO_2	
HCO_3^{-}	147.66	2.42	45.70	酚 (以苯酚计)	
CO_3^{2-}	0.00	0.00	0.00	氰 (以 CN^{-} 计)	
NO_3^{-}	34.72	0.56	10.60	色度	无
NO_2^{-}	0.01	0.00	0.00	浑浊度	透明
合 计	278.63	5.29	100.00		
水化学类型	$HCO_3 \cdot SO_4 \cdot CL^{-}Na \cdot Ca \cdot Mg$				

表 4　内蒙古自治区阿拉善左旗腾格里工业园区供水水文地质详查岩土样试验成果数据集例表

字段名称	实例
编号	1
孔号及样号	XK1−1
取样深度 /m	0.0~1.5
取样长度 /m	1.50
室内定名	粉砂
给水度 / μ	0.16
渗透系数 K/（cm/s）	4.5×10^{-2}
含盐量 (毫克 / 百克土)	119.73
液限　ωL/%	
塑限　ωp/%	

续表 4

字段名称		实例
颗粒组成 /%	塑性指数 IP	
	> 20 mm	
	> 2 mm	
	> 0.5 mm	
	> 0.25 mm	
	> 0.075	76.50
	> 0.005	23.50

表 5　内蒙古自治区阿拉善左旗腾格里工业园区供水水文地质详查地下水位统测数据集例表

字段名称		实例	
统一编号		TC1	
编号野外		S45	
坐标		4158909.3	18503010.9
地理位置		沙漠研究院	
地面标高 /m		1277.96	
井深 /m		120	
井口标高 /m		1278.56	
取水层位		Ⅱ含水组	
含水层	岩性	泥质细砂岩	
	顶板埋深 /m	30	
	底板埋深 /m	120	
	厚度 /m	90	
2011.5.28 统测	水位埋深 /m	9.2	
	水位标高 /m	1268.764	
2012.5.28 统测	水位埋深 /m	9.13	
	水位标高 /m	1268.83	
水力性质		承压水	

4　数据质量控制和评估

原始观测数据和实验室分析数据的质量控制过程包括对数据的检查整理、单个数据点的检查，对异常数据进行修正、剔除。

进行抽水试验时，钻孔抽水延续时间满足水文地质参数计算要求，抽水曲线正常，获取的各项数据真实可靠，符合工作区实际情况。水文地质参数采用多种方法进行计算，并相互验证与对比。结合水文地质条件对计算的参数进行选择，所求参数能满足地下水资源计算与评价的要求。每孔抽水试验结束后，按照《供水水文地质勘察规范》(GB

50027−2001，2001）、《供水管井技术规范》（GB 50296−1999，1999）八项标准进行验收，合格率 100%，优良率 83%。抽水试验虽然施工质量有很好的保证，但也存在一些问题，如个别钻孔洗孔效果较差、降深偏小、稳定延续时间不够等。针对 XK5 号孔组降深太小，XK6、XK6−1、XK7 干扰孔洗孔效果不理想等，按照野外检查意见均进行了重新抽水试验。

水样分析时，对分析结果进行阴阳离子平衡校核和总量平衡验证。阴阳离子平衡校核是根据阴离子物质的量浓度总和 $\sum a$ 与阳离子物质的量浓度总和 $\sum c$ 的最大允许误差 $|R| \leqslant 3\%$（$\sum a + \sum c > 5$ mmol/L）；总量平衡验证是根据可溶性固体总量与各离子含量的总和减去重碳酸根离子含量之半的误差小于 ±5%。通过校核和验证，所有结果均在误差范围之内，说明本次化验结果正确，成果可靠。

5 结论

2011 年内蒙古自治区阿拉善左旗腾格里工业园区供水水文地质详查数据集共包含四组数据，分别为钻孔抽水试验成果数据（12 个孔位）、水化学成果数据（40 个测试样品，每个样品 13 个测试项）、岩土样试验成果数据（102 个测试样品，）、地下水位统测数据（35 个测试样品）。该数据集为地下水资源的科学利用以及生态环境的可持续发展提供依据。

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Dataset of Detailed Hydrogeological Investigation for Water Supply in Tengri Industrial Park, Alxa Left Banner, Inner Mongolia Autonomous Region

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Abstract: This dataset is provided by the 'Detailed prospecting of water supply hydrogeology in Alashan League in Inner Mongolia' from the Geological Survey Institute of Inner Mongolia. It contains data of water pumping tests (12 drilling points), ground water chemical (40 water samples), rock sample tests (102 rock samples) and simultaneous measurement of groundwater level (35 test points). Data of borehole pumping test includes Aquifer lithology, Water depth, Static water level elevation, water level drop depth, gushing water, permeability coefficient, pressure coefficient, Water temperature, mineralization degree, etc. Data of groundwater hydrochemical results include main ion content, Soluble CO_2, Free CO_2, H_2SiO_3, Soluble total solids, total hardness, Total alkalinity, pH, etc. Data of rock and soil samples results include specific yield, permeability coefficient K, particle composition, etc. Data of simultaneous measurement of groundwater level include ground elevation, well depth, wellhead elevation, water level, aquifer, etc. According to the requirements for water resources, the data can provide evidence for developing groundwater resources, ensuring sustainable development of the economy and ecological environment. We take the domestic standards data processing method and principles to ensure observational data quality.
Keywords: hydrogeology; dataset; water chemistry; geotechnical; pumping test; groundwater level
Data service system URL: http://dcc.cgs.gov.cn

1 Introduction

Tengri Industrial Park is located to the south of Alxa Left Banner, and is managed by Tengri Town, although administratively it belongs to Alxa Left Banner (Jin et al., 2005). The park is 180 km south of Bayanhot (the government seat of Alxa Left Banner and of Alxa League), 220 km west of Yinchuan City, 330 km east of Lanzhou City, and 20 km north of Zhongwei City, the Yellow River passes through Zhongwei City from west to east, the Beijing-Tibet Railway crosses Zhongwei City in an east-west direction. The park is a linear distance of 13 km from the Yellow River, 10 km from the Yingshui railway marshalling yard of the Baotou—Lanzhou Railway and from China National Highway 110, 15 km from the regional airport for tourism of Zhongwei City, and it is the 'South Gate' of Alxa Left Banner. Within the perimeter, the resource endowments are relatively good, and there are rich reserves of such mineral resources as mirabilite, salt, iron, coal,

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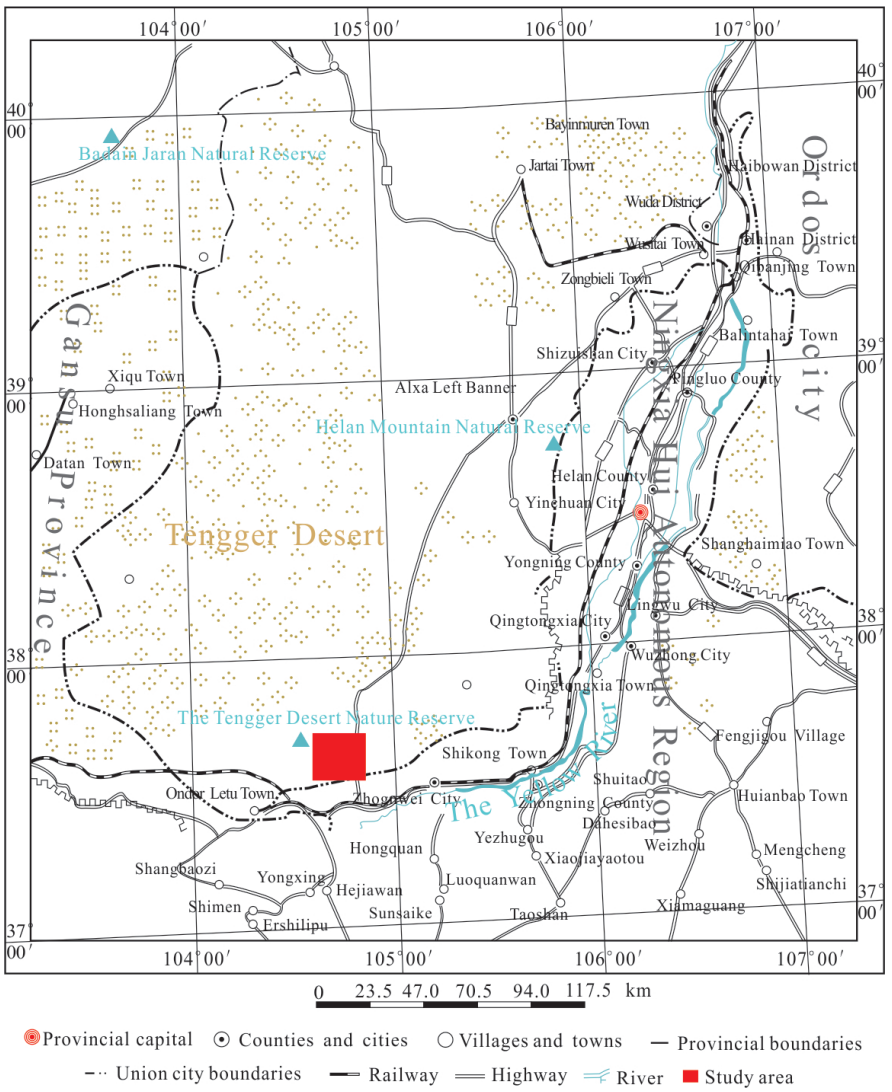

Fig.1 The drawing of traffic routes

gypsum, silica, pottery clay, and graphite, with proven crude salt and mirabilite reserves of 2,000 $\times 10^4$ tons, and 2,400 $\times 10^4$ tons, respectively. The exploration area is a water-enriched section, delimited on the basis of general investigation, and selected with the local geographical and hydrogeological conditions being fully taken into account. It has a length of 20 km in the east-west direction, a width of 20 km in the south-north direction, and a total area of 400 km^2, and its location map is shown in Fig. 1. The work area lies within the industrial park planning range, and its geographical coordinates are (Beijing 54):East longitude: 104°51′09″—105°04′45″, North latitude: 37°32′39″—37°43′28″.

The Tengri area contains rich mineral resources, and it is an important chemical industrial base and tourism area of Alxa League, with huge exploitation potential; accelerating the exploitation of resources here is of primary significance for promoting economic development in Alxa Left Banner (Ouyang et al., 2008). However, shortage of water resources has become a bottleneck restricting further development of the local economy. Owing to scarce surface water resources, groundwater becomes the only water source for living and production in the park (Yu et al., 2007). Therefore, the industrial and economic development scale in Tengri greatly depends on the quantity of groundwater

resources. During the construction and development of the park, random, opportunistic and chaotic exploitation of the groundwater has caused problems of continuous decline in groundwater level and constant degradation of water quality. Tengri Industrial Park, as a large industrial base developed primarily by Alxa League during the Twelfth Five-Year Plan, has a water demand estimated to reach 60,000 m^3/d in 2015. In order to scientifically and reasonably utilize the groundwater resources to ensure a sustainable, stable and healthy development of the local economy and ecological environment, a section relatively rich in water resources was selected for further detailed investigation.

The brief introduction to the basic information on the dataset of detailed hydrogeological investigation for water supply in Tengri Industrial Park, Alxa Left Banner, Inner Mongolia Autonomous Region is shown in Table 1. The table includes dataset name, the authors of the data paper, data acquisition date, geographic area, data size, data format, foundation projects, and database (set) composition.

Table 1 Metadata table of dataset(s)

Items	Description
Database (dataset) name	Dataset of Detailed Hydrogeological Investigation for Water Supply in Tengri Industrial Park, Alxa Left Banner, Inner Mongolia Autonomous Region
Database author	Hou Jianjun, Wang Yu, Zheng Quan, Meng Kuiwen, Liu Zhonghui
Language	Chinese
Data acquisition time	Jan.—Dec., 2011
Geographic area	East longitude: 104°51′09″—105°04′45″ North latitude: 37°32′39″—37°43′28″
Data size	219 kB
Data format	.xlsx
Data service system URL	http://dcc.cgs.gov.cn/
Foundation items	Hydrogeological Survey of Tengri Industrial Park in Alashan Zuoqi, Inner Mongolia Autonomous Region (2010−3−SK3)
Database (set) composition	The dataset comprises 4 sections of data, which are 'Data of borehole pumping test results in detailed hydrogeological investigation for water supply in Tengri Industrial Park, Alxa Left Banner, Inner Mongolia Autonomous Region.xlsx', 'Data of hydrochemical results of groundwater in detailed hydrogeological investigation for water supply in Tengri Industrial Park, Alxa Left Banner, Inner Mongolia Autonomous Region.xlsx', 'Data of test results of rock and soil samples in detailed hydrogeological investigation for water supply in Tengri Industrial Park, Alxa Left Banner, Inner Mongolia Autonomous Region.xlsx', and 'Data of simultaneous measurement of groundwater level in detailed hydrogeological investigation for water supply in Tengri Industrial Park, Alxa Left Banner, Inner Mongolia Autonomous Region.xlsx', respectively

2 Data acquisition and processing methods

On the basis of a 1:100000 scale hydrogeological investigation, a supplementary

hydrogeological investigation was conducted; a 1:50000 topographic map was used as the base map in the investigation, and field positioning was conducted with handheld GPS devices; all newly-constructed production wells and domestic wells were recorded and described in detail, the geological and geomorphic boundaries investigated at the general investigation stage were verified, and the geological and geomorphic boundaries with deviations were corrected; all of the various observation points met the specification requirements. Investigations and statistical calculations were performed for the existing mining quantities, and the investigation results met the requirements for accuracy at the corresponding investigation stage.

2.1 Long−term observation of groundwater regime

Fifteen long-term observation points (5 exploration holes) for the groundwater regime were arranged in different geological and geomorphic units, including 10 in aquifer group II, and 5 in aquifer group III. The observation frequency was 6 times/month, in other words, the observation was conducted on the 5^{th}, 10^{th}, 15^{th}, 20^{th}, 25^{th}, and 30^{th} of each month.

2.2 Simultaneous measurement of groundwater level

In the dry seasons May 27−30, 2011 and May 27−30, 2012, two periods of simultaneous measurement of groundwater level were conducted, and the water level, the water temperature and the aquifer lithology and age were recorded for each simultaneous measurement point, showing the isochroneity of the simultaneous measurement, and truly reflecting the groundwater flow field.

2.3 Collection and analysis of rock (soil) and water samples

One hundred and three (103) rock (soil) samples were collected from the exploration holes, and the main analysis items were salinity, specific yield, and grain analysis and naming; the test results basically agree with the actual naming and the data obtained in the adjacent areas, so the quality is reliable. Forty (40) samples for complete water quality analysis were collected from the exploration holes, representative wells (fountains) and surface waters, and all samples were fresh water samples; protective agents were added for unstable items at the sampling sites, and the varieties and quantities of added protective agents and the adding methods for protective agents met the testing body's requirements. The analysed items included K^+, Na^+, Ca^{2+}, Mg^{2+}, NH^{4+}, total Fe, OH^-, Cl^-, SO_4^{2-}, HCO_3^-, CO_3^{2-}, NO_3^-, NO_2^-, soluble SiO_2, oxygen consumption, degree of mineralization, pH value, total hardness, permanent hardness, temporary hardness, negative hardness, total alkalinity, and free CO_2, etc.

2.4 Pumping test

A steady−flow pumping test was conducted, three drop heights were employed for each test section, the pumping was conducted repeatedly, and the following conditions were met: *S1* = *S3*, *S2* = *S3*, and *S3* >1 m; the duration of steady state: >24 h for S3, and >8 h for S1 and S2; in the borehole-group unsteady−flow pumping test, the relationship curve of water level declined over time [s(or Δh2)-lgt] was plotted on the site, and the pumping test duration was generally over 72 h. In both steady−flow and unsteady−flow pumping

tests, the dynamic water level and specific yield observation time and the recovery water level observation time followed the observation times in the unsteady-flow test; in the interfering pumping test of well-groups, XK6, XK6-1, and XK7 were used for borehole-group unsteady-flow and interfering pumping tests. In the borehole-group unsteady-flow test, one main borehole was used for pumping, and the observation borehole and another main borehole were simultaneously used for observation, to understand the water-level drawdown value in the interfering pumping; the pumping duration was over 72 h. In the interfering pumping test, two main boreholes were used for simultaneous pumping, and the observation borehole was used for observation, to understand the water quantity drawdown coefficient in the pumping from the well-group; the pumping duration was over 168 h.

3 Description of data samples

The dataset of detailed hydrogeological investigation for water supply in Tengri Industrial Park, Alxa Left Banner, Inner Mongolia Autonomous Region in 2011 is Excel sheet-type data, comprising 4 Excel data files, which are 'Data of borehole pumping test results in detailed hydrogeological investigation for water supply in Tengri Industrial Park, Alxa Left Banner, Inner Mongolia Autonomous Region.xlsx', 'Data of hydrochemical results of groundwater in detailed hydrogeological investigation for water supply in Tengri Industrial Park, Alxa Left Banner, Inner Mongolia Autonomous Region.xlsx', 'Data of test results of rock and soil samples in detailed hydrogeological investigation for water supply in Tengri Industrial Park, Alxa Left Banner, Inner Mongolia Autonomous Region.xlsx', and 'Data of simultaneous measurement of groundwater level in detailed hydrogeological investigation for water supply in Tengri Industrial Park, Alxa Left Banner, Inner Mongolia Autonomous Region.xlsx', respectively. For 'Data of borehole pumping test results in detailed hydrogeological investigation for water supply in Tengri Industrial Park, Alxa Left Banner, Inner Mongolia Autonomous Region.xlsx', single-borehole steady-flow and borehole-group unsteady-flow pumping tests were conducted, with aquifer groups II and III as upper and lower test segments, respectively; after adjustment, 15 test segments were adjusted to 17 in the single-borehole steady-flow pumping test, and 12 test segments were adjusted to 8 in the borehole-group unsteady-flow pumping test; the recorded information includes such parameters as borehole number, test segment, test segment location, borehole depth, pumping method, permeability coefficient, and transmissivity (Table 2). 'Data of hydrochemical results of groundwater in detailed hydrogeological investigation for water supply in Tengri Industrial Park, Alxa Left Banner, Inner Mongolia Autonomous Region.xlsx' contains such data as K+, Na^{+}, Ca^{2+}, Mg^{2+}, NH^{4+}, total Fe, OH^{-}, Cl^{-}, SO_4^{2-}, HCO_3^{-}, CO_3^{2-}, NO_3^{-}, NO_2^{-}, soluble SiO_2, oxygen consumption, degree of mineralization, pH value, total hardness, permanent hardness, temporary hardness, negative hardness, total alkalinity, and free CO_2 (Table 3). 'Data of test results of rock and soil samples in detailed hydrogeological investigation for water supply in Tengri Industrial Park, Alxa Left Banner, Inner Mongolia Autonomous Region.xlsx' mainly contains such parameters as salinity, specific yield, grain analysis and naming, and grain composition (Table 4). 'Data of simultaneous measurement of groundwater level in detailed hydrogeological investigation for water supply in Tengri Industrial Park, Alxa Left Banner, Inner Mongolia Autonomous Region.xlsx' mainly includes such parameters as geographical location, water level, aquifer lithology, and hydraulic properties (Table 5).

Table 2 Pumping test data of detailed hydrogeology survey in Alashan League, Inner Mongolia

Field Name		Example		
Hole number		XK1		
Test section		Ⅰ	Ⅱ	全
Test position		59.5~125	136~204.5	59.5~204.5
Hole depth /m		219		
coordinate		x:4173741 y:18497331		
Ground elevation /m		1315.75		
Depth of aquifer roof /m		59.5	136	59.5
Thickness of aquifer /m		36.5	29.4	65.9
Aquifer lithology		Containing pebble mud and gravel, shaly sandstone	Containing pebble gravel and conglomerate	Containing pebble mud and gravel, shaly sandstone
Groundwater type		Confined water		
Pumping method		Unsteady flow pumping	Steady flow pumping test	Steady flow pumping test
Water depth /m	Main hole	33.905	38.095	33.905
	Observation hole	33.84		34.15
Static water level elevation /m	Main hole	1281.845	1277.655	1281.845
	Observation hole			
Water level drop depth /m	Main hole	5.63	17.33	8.54
	Observation hole	0.6		
Gushing water /(m^3/d)		615.84	485.4	1135.92
Unit water inflow /(m^3/d·m)		109.3854352	28.00923254	133.0117096
Permeability coefficient /(m/d)		15.8	1.405	2.92
Water conductivity /(m^2/d)		577.9	41.32	192.48
Elastic release coefficient		$6.28x10^{-5}$		
Pressure coefficient /(m^2/d)		$9.2x10^6$		
Water temperature /(℃)		12	13	12
Mineralization degree /(g/L)		2.918	2.465	
Fluoride ion content /(mg/L)		1.05	2.21	
Water chemistry type		CL55·S37−Na54·Mg31	CL64·S29−Na64	
Pumping date /(year month day)		2011.10.29	2011.10.19	2011.10.9
Pumping duration /h		72	40	40
Water level recovery time /h		33	75	60

Table 3 Ground water chemical analysis of detailed hydrogeology survey in Alashan League, Inner Mongolia

Field name	Example				
Number	1				
Field number	S76				
Per liter of water content	mg	mmol	mmol%	Per liter of water content	$mg \cdot L^{-1}$
K^+	5.90	0.15	2.80	Li	
Na^+	50.22	2.18	40.90	Sr	
Ca^{2+}	33.07	1.65	31.00	Zn	not detected
Mg^{2+}	16.41	1.35	25.30	Br	
Fe^{2+}	0.00	0.00	0.00	I	
Fe^{3+}	0.00	0.00	0.00	Se	
NH^{4+}	0.00	0.00	0.00	Free CO_2	3.30
total	105.60	5.33	100.00	H_2SiO_3	16.67
Pb	未检出			Soluble total solids	323.22
Mn	< 0.05			total hardness	150.14
Cd	未检出			Temporary hardness	121.11
Hg	0.00			Negative hardness	0.00
Cr^{6+}	0.02			Permanent hardness	29.03
Cu	未检出			Total alkalinity	121.11
As	0.00			Total acidity	
Al				PH	7.82
Cl^-	39.00	1.10	20.80	CODMn (in terms of O_2)	2.84
SO_4^{2-}	56.68	1.18	22.30	Aggressive CO_2	
HCO_3^-	147.66	2.42	45.70	Phenol (based on phenol)	
CO_3^{2-}	0.00	0.00	0.00	Cyanide (by CN)	
NO_3^-	34.72	0.56	10.60	Chroma	no
NO_2^-	0.01	0.00	0.00	Turbidity	Transparent
total	278.63	5.29	100.00		
Water chemistry type	$HCO_3 \cdot SO_4 \cdot CL \cdot Na \cdot Ca \cdot Mg$				

Table 4 Rock and soil test of detailed hydrogeology survey in Alashan League, Inner Mongolia

Field name		example
number		1
Hole number and sample number		XK1-1
Sampling depth /m		0.0-1.5
Sampling length /m		1.50
Indoors		silt
Specific yield /μ		0.16
Permeability coefficient K /(cm/s)		4.5×10^{-2}
Salinity (mg / kg)		119.73
Liquid limit ωL/%		
Plastic limit ωp/%		
Plasticity index IP		
Particle composition	> 20mm	
	> 2mm	
	> 0.5mm	
	> 0.25mm	
	> 0.075	76.50
	> 0.005	23.50

Table 5 Simultaneous observation of groundwater level for detailed hydrogeology survey in Alashan League, Inner Mongolia

Field name		example	
Uniform numbers		TC1	
Field number		S45	
Coordinate		4158909.3	18503010.9
Geographic area		Desert Research Institute	
Ground elevation /m		1277.96	
Well depth /m		120	
Wellhead elevation /m		1278.56	
Water level		Ⅱ Water group	
Aquifer	Lithology	Mud, fine sandstone	
	Roof depth /m	30	
	Floor depth /m	120	
	Thickness /m	90	
2011.5.28 Statistics	Water depth /m	9.2	
	Water level elevation /m	1268.764	
2012.5.28 Statistics	Water depth /m	9.13	
	Water level elevation /m	1268.83	
Hydraulic properties		Confined water	

4 Data quality control and evaluation

The quality control process for raw observation data and laboratory analysis data included checking and collation of data, checking of single data points, and correction and elimination of abnormal data.

In each pumping test, the borehole pumping duration met the hydrogeological parameter calculation requirements, the pumping curve was normal, and the obtained data of various items were true and reliable and conformed to the actual situations in the work area. The hydrogeological parameter values were calculated using multiple methods, and were verified and compared mutually between different methods. The calculated parameter values were selected based on the hydrogeological conditions, and that the obtained parameter values could meet the requirements for calculation and evaluation of groundwater resources. After the pumping test of each borehole was over, acceptance inspection was performed according to eight criteria in the Standard for Hydrogeological Investigation of Water-supply (GB 50027−2001, 2001) and the Technical Standard for Water-supply Well (GB 50296−1999, 1999); the pass rate was 100%, and the excellence rate was 83%. Although the construction quality was very well ensured for pumping tests, there were some problems existing, e.g., relatively poor flushing effect, too small drawdown, and insufficient stable duration, in some boreholes. As the drawdown was too small in borehole group XK5, there was an unsatisfactory flushing effect in inference boreholes XK6, XK6−1 and XK7, and so on, pumping re-test was conducted for all of these boreholes based on the field check comments.

In analysis of water samples, anion-cation balance checking and total quantity balance verification were conducted for the analysis results. The anion-cation balance checking was based on the maximum allowable error of the sum of amount-of-substance concentrations of anions $\sum a$ and the sum of amount-of-substance concentrations of cations $\sum c$, $|R| \leqslant 3\%$ ($\sum a + \sum c > 5$ mmol/L); total quantity balance verification was based on the fact that the error of the sum of total soluble solid and contents of all ions minus a half of the content of bicarbonate ion was less than ±5%. The checking and verification show that all results are within the error range, indicating that the results in the tests this time are correct, and the achievements are reliable.

5 Conclusions

The dataset of detailed hydrogeological investigations of the water supply in Tengri Industrial Park, Alxa Left Banner, Inner Mongolia Autonomous Region in 2011, comprises 4 sets of data, which are data of borehole pumping test results (12 boreholes), data of hydrochemical results (40 test samples, each with 13 test items), data of test results of rock and soil samples (102 test samples), and data of simultaneous measurement of groundwater level (35 test samples), respectively. This dataset provides a basis for the scientific utilization of groundwater resources, and the sustainable development of the ecological environment.

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