Hydrochemical Characteristics of the Geothermal Reservoirs in Xiong'an New Area

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ABSTRACT

Xiong'an New Area is a state-level new area in China. Established in April 2017, The construction of the area is described as part of the "millennium strategy". This area is rich in geothermal energy, including high quality carbonate and sandstone geothermal reservoirs. Almost all of the geothermal reservoirs in this area are liquid-dominated convective systems. The bedrock is divided by seven main tectonic units. We did lots of water quality sample and analysis, and got some series of results. It is hoped that, these results will make a headway for the study and management of this newborn area.

1. INTRODUCTION

In Xiong'an New Area, geothermal energy plays an important role before it was established. Xiong'an New Area consists of Xiongxian, Rongcheng and Anxincounties.The principal use of geothermal energy in this area is for space heating. The low-temperature geothermal systems, with a reservoir temperature below 100°C, are located in several tectonic units.

In this work, almost half of the geothermal wells in the whole Xiong'an New Area were sampled, trying to find the correlation between hydrochemical characteristics and stratas and tectonic units, so as to provide background values for further geothermal research.These results will make a headway for the study and management of this newborn area.

2. THE XIONG'AN NEW AREA

2.1 General

Xiong'an New Area is a state-level new area in China. Established in April 2017.The construction of the area is described as part of the "millennium strategy". This area is rich in geothermal energy, including high quality carbonate and sandstone geothermal reservoirs. Almost all of the geothermal reservoirs in this area are liquid-dominated convective systems. Xiong'an New Area is located in the middle of Heibei province. It is 120 km south of Beijing. The starting area is 192 km2，and the whole region is expected to 1770 km2 in the future.Up to May 2019，160 Automatic monitoring equipments for temperature and production were set. And 55 for pressure.

At present, the geothermal utilization in Xiong'an New Area are district heating, bathing , agriculture and aquaculture, etc. It made good economic and social benefits by using this clean energy. It reduced emissions of carbon, dust and sulfur dioxide, which is conducive to the protection of the atmosphere and ecological environment.About 251 geothermal Wells are mainly used for heating, accounting for 73% of the total number.Geothermal water contains many trace elements which are beneficial to human body and can be used as mineral water with medical value.About 9 wells are mainly used for heating and bathing, accounting for 3% of the total number of geothermal wells.The utilizations in agriculture and aquaculture are greenhouse, fish, shrimp and snails breeding.There are about 3 geothermal wells mainly used for agriculture and aquaculture, mainly concentrated in Xiongxian area, accounting for only 1% of the total number of geothermal wells.

2.2 Strata and tectonic units in Xiong'an New Area

 Strata and tectonic units analysis are the basis of studying geothermal system. only in the clear understanding of strata and tectonic units, we could understand the mechanism for the geothermal system. Different tectonic units may affect the hot water, in turn, in the case of area study is not deep, the differences in geothermal water quality analysis can confirm or correct people`s understanding of tectonic units.The strata in Xiong'an New Area from new to old are listed as followed:

2.1.1 Cenozoic

①Quaternary

Widely distributed in this area, the lithology is mainly composed of various sand layers, silty soils, silty clays and clays.Quaternary sediments are generally 440-560m thick and the genetic types are mainly alluvial, diluvial and lacustrine.

②Neogene

It mainly includes Minghuazhenian of Neogene(Nm for short) and Guantaoian of Neogene(Ng for short).Nm is distributed throughout the region.Ng is mainly distributed in the east of Anxin county and Xiongxian county, and the strata missing in the west of Rongcheng county and Xiongxiancounty.The thickness of the Nm is about 1000m, and the Ng is about 800m.

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③Paleogene

It is less distributed in this area. Only in the range of Baxian depression, there is deposition, but not in the range of Niutuo uplift, the main lithology is sandstone and silt stone.

2.2.2 Mesozoic

Mainly continental sedimentary, sporadic distribution.

2.2.3 Paleozoic

Paleozoic strata in the area mainly include Ordovician and Cambrian, which are less distributed in Xiongxian county, and widely distributed in Rongcheng county and Anxin county. The main lithology is dolomitic limestone, limestone, limestone dolomite and mudstone, which are in parallel unconformable contact with Qingbaikouian in the upper neoproterozoic.

2.2.4 Proterozoic

The Proterozoic strata in this area mainly include the Qingbaikouian of Neoproteroznic, Jixianian and Changchengian of Mesoproterozoic.Among them, Wumishanian of Jixianian strata(Jxw for short) is the main fissure karst thermal reservoir in this area.The lithology of the Jxw strata is mainly composed of silt-white to gray fine and cryptocrystalline chert nodules and bands and argillaceous band dolomites (mostly medium-thick layers), with a total thickness of 1045-2620m and a mixture of amaranth, gray-green mudstone and gray and grayish-brown argillaceous dolomites.TheChangchengian strata is a potential thermal reservoir here. The upper part is light gray dolomite argillaceous dolomite, while the lower part is dark gray dolomite argillaceous dolomite and siliceous dolomite.The bottom is a black sandy shale with a total thickness of 262-966m.

2.2.5 Archean

The upper part of the upper Archaean was composed of thick metamorphic granulite, biotite plagiogneiss and thick marble, while the lower part was composed of biotite metamorphic granulite, biotite plagiogneiss, amphibolite and magnetite.The lower archean is mainly granulite, amphibolite, biotite anorthosgneiss, biotite metamorphic granulite and so on.The burial depth in the area is generally more than 3,500m.

Up to May 2019，There are 343 geothermal wells in Xiong'an New Area,which includes 184 producing wells, 77 reinjection wells,16 exploration wells and 66 abandoned wells.The major used reservoirs are Jxw and Ng. There are 237 geothermal well of Jxw, and 6 geothermal well of Jxw and Changchengian. There are 83 geothermal well of Ng and 6 geothermal well of Ng and Ordovician. There are 9 wells of Nm and 2 wells of Nm and Ng.

2.3 Tectonic units

Tectonic units of Xiong`an new area is summarized as follows:

Basic tectonic units：Sino Korean paraplatform.In the long geological history period from middle to upper proterozoic to late Permian, the tectonic movement developed successively through Lvliang, Caledonian, hercynian-indosinian tectonic movements.After Mesozoic Jurassic to the early Cenozoic tertiary paleocene strong Yanshan movement, the stability of China and the DPRK on platform development a series of north east, north and east-west extensional faults, accompanied by frequent magmatic activity, resulting in the platform, platform around the Taihang mountains and Yanshan mountain uplift, the platform internal settlement, formed in the Jurassic and lower cretaceous basin of continental clastic sediments, established the prototype of the geological structure in north China.

Second level tectonic units：North China fault depression.It is the northern part of the large Cenozoic fault depression spanning HeBei, ShanDong, HeNan and AnHuiprovinces.Since entering tertiary, faulting, forming numerous small faulted basin, the largest accumulation of Eocene, Oligocene thickness can reach above 5000 m, accompanied by a large number of spot qualitative basalt eruption, according to nature of continental rift basin, late tertiary to quaternary, under the restriction of boundary faults, in the continuous smooth settlement.The small basins in the early stage were connected as a whole and the magmatic activity was weakened correspondingly.

Third level tectonic units：Hebei central platform depression:Which Located in the northwest of the north China fault depression, it is bounded by faults on the north, west and south sides, and bounded by the missing line of the paleogene in the east.The bedrock in this area is a buried anticlinal structure, and its axis is roughly in GuAn, GaoYang and GaoCheng. It is mainly composed of Jixianian strata, and the east and west wings are Paleozoic.In the Eogene, there was a large depression in the former two flanking parts, while the nuclear part was relatively stable with no deposition or thin deposition.Xiong'an New Area contains seven IV level tectonic units.

Fourth level tectonic units：Xushui depression, Rongcheng uplift, Niutuo uplift, Baxian depression, Baoding depression, Gaoyang uplift and Raoyangdepression.The fourth levels of structural units in the zone are described as follows in the table:

Second and Third Level tectonic units

Fourth level tectonic units

Partition specification：①Xushui depression, ②Rongcheng uplift, ③Niutuo uplift, ④Baxian depression, ⑤ Baoding depression, ⑥Gaoyang uplift ,⑦Raoyang depression
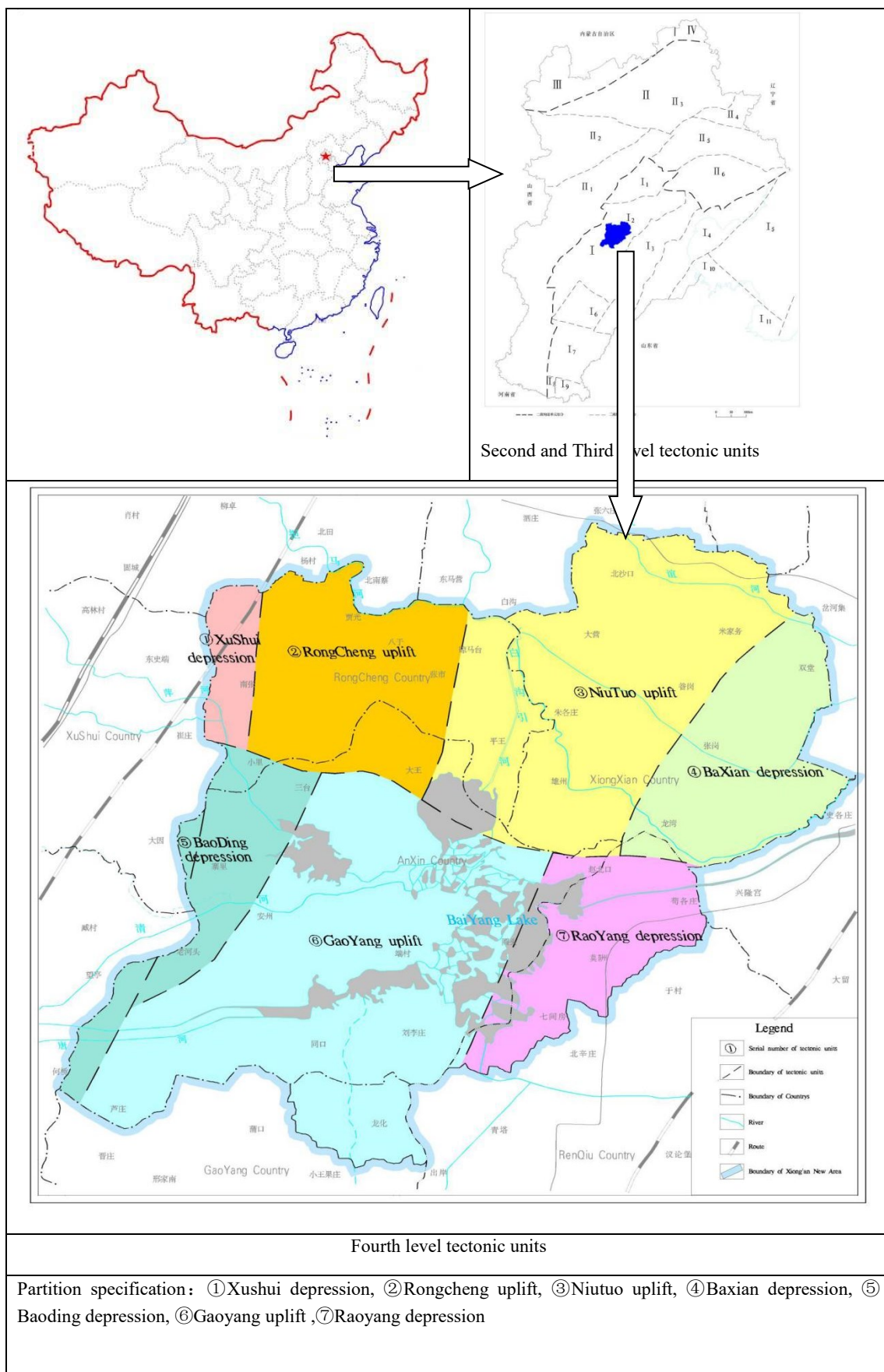
Figure 1: Tectonic units in Xiong'an New Area

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①Xushui depression

This tectonic unit includes the western part of Rongchengcounty, covering an area of 45km2. Currently, there are no geothermal wells in the area.

②Rongcheng uplift

It includes most of Rongcheng county and northern Anxin county, with an area of 222km2. The Ng is missing, and the buried depth of the Jxw is about 800-1000m. At present, there are 49 geothermal wells, and 47 of them pumping from Jxw. And they are the target monitoring layer of the area.The central temperature of the reservoir is about 100℃.According to the statistics of the geothermal wells here, the water temperature of the wellhead is 50～55℃, and the water yield is 60～120m3/h.

③NiuTuo uplift

It includes the eastern part of Rongchengcounty, the northeast corner of Anxin county, and most of the central and northern part of Xiongxian county, covering an area of 432km2. The buried depth of Ng is 1000-1400m, and the buried depth of Jxw is 800-1500m.At present, there are 196 geothermal wells, and 168 of them pumped from Jxw. And 17 of them pumped from Ng.The monitoring focuses on the Jxw and Ng.The central temperature of the reservoir is about 90~100℃.，According to the statistics of geothermal wells here, the wellhead water temperature is 70～83℃, and the water production is 60～150m3/h.

④Baxian depression

It covers the southeast of Xiongxiancounty, covering an area of 195km2. At present, it has 14 geothermal Wells, and 12 of them pumped from Ng .The buried depth of Ng is 1300-1800m, and strata thickness is 250-450m. The monitoring focuses on the Ng.

⑤ Baoding depression

It covers an area of 138km2, including the southwest corner of Rongchengcounty and the west of Anxin county. Currently, it has 8 geothermal wells, and half of them pumped from Ng.The buried depth of Ng is 1200-1350m, and the strata thickness is 200-250m. The monitoring focuses on the Ng.

⑥Gaoyang uplift

Including most of Anxincounty, covering an area of 581km2, there are currently 45 geothermal wells, and 29 of them pumped from Ng.The buried depth of Ng is 1200-1400m and the strata thickness is around 300m. This monitoring focuses on Ng.

⑦Raoyang depression

It mainly includes the east of Anxincounty, covering an area of 169km2. Currently, it has 8 geothermal wells, and 7 of them pumped from Ng.The buried depth of Ng is 1400-1800m, and the strata thickness is about 350-400m. The monitoring focus is Ng.

3. TESTING DATA AND HYDROCHEMICAL CHARACTERISTICS

3.1 Test data

In this work, we took 150 samples of geothermal water quality from seven tectonic units, mainly from sandstone and carbonate reservoirs. After screening and removal of extreme values, 110 representative samples remained.

The testing projects includes:

K^+,Na^+,Ca^{2+},Mg^{2+},HCO_3^-,Cl^-,SO_4^{2-},F^-,NO_3^-,SiO_3^{2-},Totalsalinity,PH,NH_4^+,Fe^{2+},Fe^{3+},CO_3^{2-},CO_2,Li^+,Sr^{2+},Bromide,monoiodideZn2+,Se1+,Cu2+,As3+,Hg2+,Cd2+,H3BO3,Ag+,Ba2+,Cr,Pb,Co3+,V2+,Mo,Mn4+,Ni4+,Al3+,Volatile phenol, Cyanide, Nitrite, Oxygen consumption, Chroma , Total alkalinity,

 Total acidity,etc.

The statistical results of main ionic concentration are as follows:

Table 1:Ionic concentration in Jxw in Rongchenguplift(mg/L)

Geothermal reservoir	Series of well	K^+	Na^+	Ca^{2+}	Mg^{2+}	HCO_3^-	Cl^-	SO_4^{2-}	F^-	NO_3^-	SiO_3^{2-}	Total salinity	PH
Jxw	A006	43.8	856.4	65.1	26.0	660.6	1065.2	37.8	7.5	0.0	62.4	2810.4	7.3
	A008	47.3	864.9	65.9	26.9	673.0	1079.3	38.9	7.7	0.9	53.7	2846.2	7.7
	A010	55.2	915.6	64.3	20.7	663.7	1157.1	38.5	7.8	0.0	79.0	2983.8	7.2
	R010	51.7	804.8	73.8	27.9	682.3	1100.5	0.6	8.3	0.9	48.9	2788.5	6.9
	R012	49.2	782.6	69.8	28.9	688.5	1079.3	2.4	8.2	0.8	50.3	2748.5	7.2
	R015	52.9	806.3	69.0	30.8	679.2	1079.3	0.5	8.0	1.0	49.6	2765.1	7.2
	R016	43.7	739.0	61.1	26.5	651.3	959.1	31.1	6.9	0.8	43.1	2552.7	7.1
	R026	48.0	850.3	77.0	30.8	716.4	1107.6	42.1	7.2	0.0	44.7	2913.7	7.1
	R031	47.5	864.9	74.6	36.6	719.5	1121.8	41.5	7.2	0.0	45.9	2948.9	7.6
	R032	60.1	837.6	77.8	34.2	753.7	1150.0	0.4	7.9	1.0	40.2	2953.5	7.5
	R035	54.0	882.4	77.0	36.6	759.9	1150.0	43.1	7.1	0.0	42.4	3042.7	7.1
	R037	60.8	854.4	73.7	34.0	583.3	1174.2	0.7	7.9	0.8	42.7	2822.9	7.1
	R043	34.4	604.9	62.7	30.8	567.6	761.0	10.0	4.8	2.1	43.2	2111.6	7.6
	R046	55.0	904.7	66.7	30.3	694.7	1128.8	41.9	7.4	0.9	57.6	2974.7	7.5
	R050	56.2	888.3	69.0	27.9	700.9	1171.3	41.5	7.3	0.9	60.8	3010.2	7.4
	R051	54.7	913.5	67.5	26.5	688.5	1171.3	41.2	7.8	0.0	68.4	3023.6	7.4
	R051-Q	60.0	892.9	64.9	27.7	662.5	1134.4	1.8	1.0	0.0	56.3	2888.6	6.8
Average		53.3	879.0	132.9	69.5	679.2	1093.6	187.0	10.0	1.0	52.3	2834.4	7.3

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Table 2 Ionic concentration in Jxw and $\overline{Ng}$ in Niutuouplift(mg/L)

Geothermal reservoir	Series of well	K^+	Na^+	Ca^{2+}	Mg^{2+}	HCO^{3-}	Cl^-	SO_4^{2-}	F^-	NO^{3-}	SiO_3^{2-}	Total salinity	PH
Jxw	A037	40.4	793.1	42.9	12.5	558.3	1001.5	35.4	6.1	0.9	88.1	2558.7	7.8
	R001	54.1	915.3	69.0	30.3	697.8	1157.1	40.6	7.7	0.0	28.6	2994.0	7.5
	R047	58.3	916.2	63.5	25.5	669.9	1185.4	15.8	8.0	0.0	67.3	2994.3	7.5
	R049	48.9	875.8	63.5	26.5	697.8	1093.5	28.3	7.6	0.0	51.3	2881.2	7.4
	R049-Q	53.7	861.2	60.9	26.7	671.4	1106.3	8.3	1.0	0.0	47.0	2825.7	6.7
	R055	62.6	881.2	65.1	23.6	682.3	1178.3	40.9	7.4	0.0	49.9	2979.7	7.5
	X003	62.8	1046.7	47.6	26.5	502.4	1355.2	1.8	10.7	0.9	71.0	3109.2	7.7
	X005	59.6	968.0	48.9	23.8	472.4	1415.2	1.0	1.4	0.0	63.4	3039.1	7.6
	X006	62.9	950.8	48.1	22.4	469.4	1352.0	0.9	1.4	0.0	63.8	2956.9	7.5
	X013	64.2	910.4	46.8	23.6	493.1	1376.4	0.3	11.6	0.7	70.3	2981.2	7.8
	X013-Q	59.8	957.3	49.7	26.2	466.4	1359.0	1.3	1.3	0.0	62.5	2969.1	7.7
	X014-Q	60.1	957.4	47.3	24.3	469.4	1345.0	1.0	1.4	0.0	60.0	2951.9	7.7
	X037	56.2	870.5	52.4	30.8	533.5	1348.1	0.5	9.7	0.7	55.2	2944.7	7.7
	X047	51.3	819.3	54.8	28.9	666.8	1100.5	0.6	9.1	0.6	42.2	2764.3	7.3
	X062	60.7	913.3	66.7	22.6	688.5	1178.3	1.1	10.4	0.8	60.5	2989.0	7.1
	X063	65.7	862.2	58.7	32.7	707.1	1192.5	0.6	9.3	0.8	61.7	2977.3	7.3
	X067	62.8	909.5	61.1	25.0	679.2	1192.5	0.5	10.0	0.8	55.7	2984.4	7.5
	X075	60.0	897.9	63.5	26.0	679.2	1192.5	1.5	9.9	0.8	54.0	2972.8	7.3
	X079	60.7	858.5	63.5	21.2	651.3	1150.0	1.0	9.0	0.6	61.6	2863.2	6.9
	X080	63.6	834.2	62.7	21.7	651.3	1185.4	0.6	8.6	0.7	67.0	2880.2	7.3
	X090	65.2	855.3	61.1	18.8	663.7	1206.6	0.6	8.6	0.9	63.9	2929.9	7.7
	X091	65.3	839.8	61.1	25.0	669.9	1178.3	1.4	8.9	0.7	71.2	2905.2	7.6
	X093	69.3	859.2	62.7	22.1	673.0	1171.3	1.6	8.8	0.7	66.7	2920.0	7.3
	X101	62.8	802.8	65.1	22.6	676.1	1157.1	0.8	8.8	0.7	58.9	2842.0	6.6
	X104	62.0	828.1	65.9	24.1	688.5	1185.4	1.0	8.8	0.7	56.3	2907.7	7.4
	X109	61.4	843.7	61.9	20.2	657.5	1185.4	1.6	8.7	0.8	72.0	2896.6	6.7
	X111	62.9	852.2	60.3	23.6	663.7	1171.3	1.2	8.5	0.8	74.7	2901.8	7.0
	X115	63.1	864.8	65.9	23.6	688.5	1192.5	0.5	8.8	0.7	61.0	2955.3	6.9
	X116	60.5	887.9	57.9	23.6	673.0	1185.4	1.6	9.5	0.8	60.9	2947.2	6.7
	X116-Q	61.0	872.9	60.1	22.8	644.7	1148.4	1.3	1.2	0.0	57.2	2856.4	6.7
	X120	62.1	888.2	64.9	24.8	534.5	1195.5	0.6	8.8	0.8	67.9	2832.5	7.3
	X122	61.3	859.2	66.7	22.6	679.2	1185.4	0.7	8.9	0.8	65.9	2935.5	7.2
	X127	61.4	907.4	64.3	20.7	666.8	1192.5	2.7	10.1	0.7	64.5	2976.2	7.5
	X127	63.1	896.6	60.9	21.9	647.7	1176.5	1.5	1.1	0.0	57.1	2913.1	7.1
	X128	58.8	904.0	63.5	20.2	669.9	1185.4	0.6	9.7	0.7	62.2	2960.7	7.4
	X130	62.3	873.4	57.9	20.7	645.1	1185.4	1.6	9.5	0.6	71.8	2911.7	7.5
	X131	57.7	809.7	55.6	20.2	638.9	1086.4	3.8	8.5	0.0	65.1	2730.9	7.3
	X131-Q	53.2	799.1	56.1	18.5	618.0	1057.2	3.6	1.0	0.0	56.9	2650.4	7.1
	X133	61.2	866.6	61.9	25.0	669.9	1178.3	1.4	8.9	0.8	69.8	2927.9	7.2
	X134	64.3	855.8	61.1	21.7	666.8	1178.3	0.9	8.9	0.7	70.5	2912.9	7.6
	X147	63.3	863.5	61.1	25.5	648.2	1192.5	1.9	9.4	0.7	73.3	2922.4	7.6
	X151	53.8	892.3	54.8	18.8	635.8	1114.7	1.5	9.5	0.6	63.3	2830.4	7.4

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		K⁺	Na⁺	Ca²⁺	Mg²⁺	HCO₃⁻	Cl⁻	SO₄²⁻	F⁻	NO₃⁻	SiO₃²⁻	Total salinity	PH
	X160	62.5	862.1	56.3	29.4	651.3	1178.3	0.3	9.2	0.7	65.5	2900.5	7.7
	X161-A	62.2	842.0	57.1	23.6	638.9	1171.3	0.4	9.8	0.6	67.7	2858.1	7.7
	X161-B	61.6	868.2	57.1	25.5	651.3	1164.2	0.7	9.7	0.7	65.4	2889.4	7.8
	X164	65.9	871.3	59.5	24.1	685.4	1192.5	2.8	8.9	0.8	76.1	2969.7	7.9
	X165	61.9	856.3	60.3	21.7	669.9	1192.5	2.9	8.7	0.8	75.8	2933.2	7.6
	X169	62.7	872.7	59.5	22.6	657.5	1171.3	0.6	9.5	0.7	69.0	2910.1	7.5
	X189	66.9	894.5	58.7	20.7	415.6	1234.9	1.1	9.5	0.8	73.0	2758.9	7.7
	X195	62.0	876.2	57.9	16.8	626.5	1192.5	2.3	9.7	0.6	76.5	2903.5	7.8
Average		60.6	877.3	59.1	23.4	630.5	1193.4	4.5	7.8	0.5	63.6	2906.1	7.4
Ng	X008	3.7	611.2	12.7	2.4	331.9	718.6	0.1	3.1	0.6	34.2	1713.6	8.2
	X033	3.9	635.7	13.5	2.9	344.3	824.7	0.2	3.1	0.6	31.2	1858.8	8.3
	X034	7.5	1273.1	45.2	7.2	257.4	1765.4	0.2	2.3	0.7	34.0	3388.3	8.2
	X043	9.1	1660.0	63.5	9.6	223.3	2472.7	1.2	1.5	0.8	34.8	4468.5	7.9
	X051	3.4	707.0	9.5	3.8	387.7	817.6	0.2	2.7	0.6	31.7	1966.1	8.3
	X058	3.4	683.1	10.3	2.4	431.1	768.1	0.9	2.8	0.6	32.0	1933.4	8.3
	X108	2.8	547.8	7.1	2.9	437.3	513.5	2.9	2.7	0.0	30.7	1549.8	8.3
Average		4.8	874.0	23.1	4.5	344.7	1125.8	0.8	2.6	0.5	32.6	2411.2	8.2

Table 3 Ionic concentration in Ng in Baxiandepression(mg/L)

Geothermal reservoir	Series of well	K⁺	Na⁺	Ca²⁺	Mg²⁺	HCO₃⁻	Cl⁻	SO₄²⁻	F⁻	NO₃⁻	SiO₃²⁻	Total salinity	PH
Ng	X050	3.7	737.4	14.3	2.4	369.1	888.4	0.4	3.8	0.0	36.7	2050.7	8.2
	X055	4.9	711.0	19.2	7.3	305.1	918.9	10.3	3.4	0.6	39.0	2015.5	8.3
	X065-Q	3.5	509.4	5.6	0.5	433.8	509.6	12.2	0.4	0.8	32.6	1512.4	8.4
	X066	3.8	560.5	6.3	0.5	462.1	520.6	12.1	5.4	0.0	45.2	1624.4	8.4
	X078	2.8	534.4	6.3	1.4	471.4	464.0	24.4	3.5	0.6	36.1	1552.0	8.4
	X172	3.8	601.5	7.9	0.5	421.8	577.1	15.1	3.9	0.0	43.4	1689.5	8.5
	X176	1.7	390.0	4.0	1.4	508.6	246.1	68.1	3.6	0.0	45.1	1276.6	8.4
	X176-Q	1.9	380.4	4.0	1.0	481.3	240.1	49.8	0.3	0.0	26.4	1187.8	8.4
	X182	3.3	589.1	7.9	1.4	431.1	591.3	17.3	3.9	0.6	37.8	1678.2	8.2
Average		3.3	557.1	8.4	1.8	431.6	550.7	23.3	3.1	0.3	38.0	1620.8	8.4

Table 4 Ionic concentrationin Ngin Baoding depression(mg/L)

Geothermal reservoir	Series of well	K^+	Na^+	Ca^{2+}	Mg^{2+}	HCO_3^-	Cl^-	SO_4^{2-}	F^-	NO_3^-	SiO_3^{2-}	Total salinity	PH
Ng	A044	1.5	466.8	15.1	2.9	369.1	513.5	37.0	1.4	0.9	28.1	1442.0	8.4
	A046-C	1.3	372.2	9.5	2.9	412.5	288.6	56.0	1.7	0.0	29.8	1179.8	8.4
	A046-Q	1.3	377.7	7.9	1.9	415.6	290.0	54.9	1.7	0.0	30.0	1183.3	8.3
	A060	1.7	271.5	4.8	0.5	320.9	115.1	82.0	2.2	0.0	7.4	854.0	8.9
Average		1.4	372.1	9.3	2.0	379.5	301.8	57.5	1.8	0.2	23.8	1164.8	8.5

Table 5 Ionic concentrationin Ng and Jxwin Gaoyang depression(mg/L)

Geothermal reservoir	Series of well	K^+	Na^+	Ca^{2+}	Mg^{2+}	HCO_3^-	Cl^-	SO_4^{2-}	F^-	NO_3^-	SiO_3^{2-}	Total salinity	PH
Ng	A013	1.9	366.3	6.3	1.9	443.5	294.2	26.3	1.7	0.9	31.8	1176.7	8.3
	A015	3.7	535.6	11.9	7.2	412.5	640.8	28.8	1.1	0.0	30.3	1671.0	8.3
	A016	3.6	550.5	11.9	5.3	418.7	647.9	28.2	1.1	0.9	31.7	1695.5	8.2
	A017	2.6	471.1	8.7	2.4	372.2	548.9	5.3	1.5	0.0	29.6	1444.6	8.3
	A018	3.3	490.5	8.7	2.9	462.1	499.3	30.5	1.2	0.9	32.2	1524.3	8.0
	A024	1.7	348.7	5.6	2.4	449.7	223.5	41.8	2.0	0.9	0.0	1094.6	8.4
	A025	1.3	191.9	23.0	14.4	300.8	130.1	48.5	0.9	0.9	20.6	733.9	8.3
	A026	2.2	379.0	7.1	2.9	434.2	326.8	29.8	1.7	0.9	28.7	1215.8	8.3
	A027	2.0	388.3	7.9	1.9	431.1	326.8	30.0	1.7	0.9	29.0	1222.1	8.3
	A031	2.5	477.2	8.7	3.4	409.4	506.4	40.7	1.9	0.9	27.0	1487.2	8.4
	A033	4.0	748.7	17.5	4.3	397.0	923.7	26.2	1.5	0.9	26.1	2147.0	8.2
	A039-C	1.3	278.8	3.2	2.4	446.6	87.7	70.6	2.7	0.0	37.4	943.4	8.5
	A056	1.3	303.7	4.0	2.4	452.8	144.3	72.9	3.3	0.0	36.7	1025.1	8.4
	A056-Q	2.3	283.2	5.6	1.5	460.5	139.0	71.4	3.4	0.0	28.8	991.9	8.2
	A062	1.9	344.9	5.6	1.0	471.4	188.1	72.6	3.5	0.9	45.5	1134.0	8.3
	A062-Q	2.5	358.5	4.8	1.0	442.7	210.6	69.6	3.7	0.0	36.8	1139.2	8.4
Average		2.4	407.3	8.8	3.6	425.3	364.9	43.3	2.1	0.6	29.5	1290.4	8.3
Jxw	A038	51.7	859.5	51.6	16.8	607.9	1143.0	34.5	7.1	1.1	83.9	2837.7	7.6
Average		51.7	859.5	51.6	16.8	607.9	1143.0	34.5	7.1	1.1	83.9	2837.7	7.6

Table 6 Ionic concentrationin Ngin Raoyang depression(mg/L)

Geothermal reservoir	Series of well	K⁺	Na⁺	Ca²⁺	Mg²⁺	HCO³⁻	Cl⁻	SO₄²⁻	F⁻	NO³⁻	SiO₃²⁻	Total salinity	PH
Ng	A041-Q	5.2	683.9	15.1	5.3	350.5	838.8	5.7	2.9	1.2	39.7	1942.1	8.2
	A043-C	3.5	684.5	11.1	1.9	297.7	845.9	5.5	2.6	0.0	38.6	1888.6	8.3
	RQ001	1.3	356.4	5.6	1.0	326.8	289.2	63.9	3.1	0.0	21.9	1084.6	8.5
	X183	3.4	601.7	10.3	3.4	384.6	612.5	25.5	3.5	0.5	35.8	1691.2	8.4
	X184	5.9	840.5	19.8	1.4	350.5	1164.2	0.5	3.2	0.6	41.5	2427.7	8.3
	X186	6.2	875.1	22.2	3.8	307.0	1298.6	1.4	3.0	0.7	46.6	2556.9	8.2
Average		4.2	673.7	14.0	2.8	336.2	841.5	17.1	3.0	0.5	37.3	1931.9	8.3

Table 7 Average of ionic concentration between different tectonic units(mg/L)

Geothermal reservoir	Series of well	K⁺	Na⁺	Ca²⁺	Mg²⁺	HCO³⁻	Cl⁻	SO₄²⁻	F⁻	NO³⁻	SiO₃²⁻	Total salinity	PH
Rongcheng uplift	Jxw	53.3	879.0	132.9	69.5	679.2	1093.6	187.0	10.0	1.0	52.3	2834.4	7.3
Niutuo uplift	Jxw	60.6	877.3	59.1	23.4	630.5	1193.4	4.5	7.8	0.5	63.6	2906.1	7.4
	Ng	4.8	874.0	23.1	4.5	344.7	1125.8	0.8	2.6	0.5	32.6	2411.2	8.2
Baxian depression	Ng	3.3	557.1	8.4	1.8	431.6	550.7	23.3	3.1	0.3	38.0	1620.8	8.4
Baoding depression	Ng	1.4	372.1	9.3	2.0	379.5	301.8	57.5	1.8	0.2	23.8	1164.8	8.5
Gaoyang uplift	Ng	2.4	407.3	8.8	3.6	425.3	364.9	43.3	2.1	0.6	29.5	1290.4	8.3
	Jxw	51.69	859.5	51.6	16.8	607.9	1143.0	34.5	7.12	1.05	83.9	2837.7	7.6
Raoyang depression	Ng	4.2	673.7	14.0	2.8	336.2	841.5	17.1	3.0	0.5	37.3	1931.9	8.3

3.2 Hydrochemical characteristics

The major sandstone geothermal reservoir is Ng in this area.Ng geothermal reservoir is not controlled by the Fourth level tectonic units.The lithology of Ng geothermal reservoir in this area is mainly fluvial fine sand rock and sand conglomerate, which is a semi-closed hydrogeological environment. Through sample analysis, hydrochemical type here is:HCO3·Cl-Na or Cl·HCO3-Na.Total salinity of geothermal water is generally between 1200-2400 mg/L.

The major carbonate geothermal reservoir is Jxw in this area. Dolomite is mainly lithology. It is marine sedimentary environment. Although controlled by the tectonic units, there is no obvious difference in the hydrochemical characteristics of the three uplift tectonic units sampled. Through sample analysis, hydrochemical type here is:Cl·HCO3-Na.Total salinity of geothermal water is generally between 2800-2800 mg/L.

Generally, the hydrochemical characteristics of carbonate geothermal reservoir is characterized by high total salinity and neutral PH value, and the hydrochemical characteristics of sandstone geothermal reservoir is characterized by low total salinity and weak alkaline PH value.The difference of hydrochemical characteristics in three carbonate geothermal reservoir is not obvious.

4. DISCUSSION AND CONCLUSIONS

The results of the hydrochemical characteristics and strata and tectonic units described in this report show that the background of the Xiong`An New Area. In the future, this field would provide more thermal water than is being extracted at present.these results will make a headway for the study and management of this newborn area.

The main conclusions of this work are summarized as follows:

- The Xiong'an New Area is rich in geothermal energy, including high quality carbonate and sandstone geothermal reservoirs. Which is located in Hebei province, about 120 km north of Beijing. The construction here means a lot to China, It is described as part of the "millennium strategy".

Wu

- Strata and tectonic units are complex in this area.Wumishanian of Jixianianstrata(Jxw) is the main bedrock reservoir in this area. And Guantaoian of Neogene(Ng) is the main sandstone reservoir here. The bedrock is controlled by seven tectonic units.

- Up to May 2019，There are 343 geothermal wells in Xiong'an New Area.The major used reservoirs are Jxw and Ng. About half of them were sampled, and After screening and removal of extreme values, 110 representative samples remained.

- The hydrochemical characteristics of carbonate geothermal reservoir is characterized by high total salinity and neutral PH value, and the hydrochemical characteristics of sandstone geothermal reservoir is characterized by low total salinity and weak alkaline PH value. The difference of hydrochemical characteristics in three carbonate geothermal reservoir is not obvious.

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