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Analysis of soil structure effects based on geothermal deveplopment

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Abstract: With the deepening of people's understanding of new energy, geothermal has become more and more "hot." The abundant geothermal resources of Henan Province will be an important resource pillar for the future economic growth of the Central Plains[1]. However, the vigorous development and utilization of geothermal resources will largely affect the soil structure. Through the data analysis of Luoyang A area, the influence of temperature change on soil structure was studied by using control variables and single factor experiment. The results showed that: with the continuous development of geothermal resources in Luoyang A area, the total amount of microbes, organic carbon and total nitrogen in the soil would chang with the increase of temperature.Among them, the number of microorganisms growed faster with the increase of temperature and reached the highest value up to 40 °C .As the temperature continuing to rise ,the number of microbes growed slowly or on a downward trend.In order to avoid the influence of temperature changes on the soil structure, it is recommended to put insulation materials around the wellhead and the reservoir to prevent the lowest loss temperature from exceeding 30 °C or 3 wells alternating every other quarter[2].

1. Introduction

With the deepening of people's understanding of new energy, geothermal has become more and more "hot." Henan's abundant geothermal resources will be an important resource pillar for the future economic growth of the Central Plains. Its development and utilization will be one of the important measures for energy conservation and emission reduction, optimization of energy structure, reduction of air pollution and improvement of people's living standards. However, with the development and utilization of geothermal resources, the soil structure will be affected to a large extent. Luoyang A area belongs to the convective heat storage of the uplifted mountain, controlled by the Xin'an-Longmen-Ludian fault, and the thermal storage structure is a single structure thermal reservoir of the Ordovician karst fissures in the Paleozoic. The geothermal area of Luoyang A is distributed along the fault zone, with an area of about $10km^2$, a heat storage temperature of 94°C, a single well water inflow of $75m^3/h$, and a maximum unit water inflow of $15m^3/(h•m)$. At present, there are 3 geothermal wells in Area A, only 1 well is used, and the operation is good. The development and utilization of geothermal resources is mainly in the hot spring bath, the heating area is about $10000m^2$, and the single well water inflow is $50m^3/h$. This analysis is to analyze the influence of the operating

1temperature of the geothermal well on soil structure. The soil samples are taken from the geothermal well outlet and the reservoir to determine the total number of microorganisms, organic carbon and total nitrogen in the soil at different temperatures. Changes in potassium content [3][4] .

2. Test content and method

This experiment used control variable method and single factor experiment.

After collecting soil samples, the physical and chemical properties of the original soil such as the total number of microorganisms, organic carbon content, total nitrogen content, total phosphorus, and potassium content were determined.

Simulate soil temperature change: place the collected soil stored in the sealed bag in a constant temperature water bath, change the temperature of the constant temperature water bath, simulate the temperature gradient to 30℃, 40℃, 50℃, 90℃, soil samples in each Keep it for 4 days in temperature.

The total number of microorganisms, organic carbon, total nitrogen, total phosphorus and potassium at different temperatures were determined. details as follows:

2.1 Total number of microorganisms

10 gram of the collected soil was weighed into 90 ml of sterile water, shaken and allowed to stand for 20 minutes; inoculated with beef paste-peptone medium on a clean bench; cultured in a 37 ° C incubator for 48 hours; total bacterial community statistics were performed.

2.2 Determination of organic carbon

Adopting "HJ 615-2011 Determination of Soil Organic Carbon - Potassium Dichromate Oxidation - Spectrophotometric Method"Weigh 0.4gram of soil sample in a 50ml plug colorimetric tube; add 0.1g mercury sulfate and 5.00ml potassium dichromate solution, shake separately; then slowly add 7.5ml concentrated sulfuric acid and gently shake it; After the colorimetric tube is wrapped, it is placed in a high-pressure steam sterilization pot, digested for 45 min at 134 ° C, and cooled; the volume is adjusted to 50 ml with water, and allowed to stand for 8 hours; the absorbance is measured at 585 nm; Also do a blank experiment.

2.3 Determination of total nitrogen

Adopting determination of Total Nitrogen in Soil by Potassium Persulfate Oxidation weigh 0.5 gram soil sample in 25ml plug colorimetric tube, add 10ml alkaline potassium persulfate, shake well; put the plug color tube and put it into high pressure steam sterilization pot, 124 °C Dissolve in 30 min, cool; transfer the cooled soil digestion solution to a 500 ml Erlenmeyer flask, dilute to 500 ml with water; filter the filtrate after pressure filtration to adjust the pH to 7; transfer 2.5 ml of the filtrate to 25 ml of the plug color In the tube, dilute to the reticle; measure the absorbance at 220 nm and 275 nm respectively;Also do a blank experiment.

3. Test results

3.1 sampling point position

The sampling point locations are shown in figure 1 and figure 2.

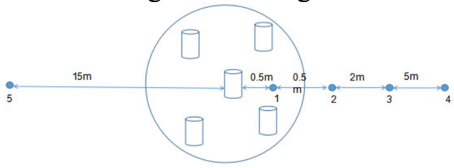

Figure 1. Reservoir sampling point plane position map in Luoyang A area

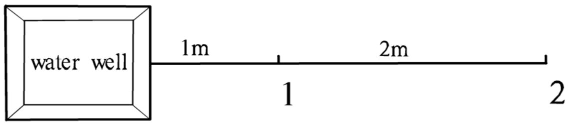

Figure 2. Water well sampling point plane position map in Luoyang A area

3.2 sampling depth and initial temperature

In the plot, samples were taken at different depths of the same point and at different distances from the reservoirs or water well in A area of Luoyang. The sampling point depth and initial temperature are shown in Table 1 and Table 2.

Table 1. Reservoir sampling depth and initial temperature record table in Luoyang A area pH: 5~6

Name	20cm(No.1)	50cm(No.1)	20cm(No.2)	50cm(No.2)
Initial temperature	32.6	53.1	31.5	51.8
Sampling time	September 16, 2017			

Table 2. Water well sampling depth and initial temperature record table in Luoyang A area pH: 5~6

Name	20cm(N	50cm(No	70cm(No.	20cm(No.2	50cm(No.	70cm(No.2
Initial temperatur	22.0	24.6	24.1	29	27.5	25.3
Sampling	September 16, 2017					

3.3 test results

3.3.1 Microbiological test results

The effects of reservoir temperature on microorganisms in Luoyang District A are shown in Table 3 and Figure 3. The effects of temperature on microbes near the water well in Luoyang District A are shown in Table 4 and Figure 4.

Table 3. Effect of reservoir temperature on microorganisms in Luoyang A area

Name	20cm(No.1	50cm(No.1)	20cm(No.2)	50cm(No.
Initial temperature（ ℃）	1400	1680	1360	872
30℃	936	1300	2408	970
40℃	1460	720	1430	820
50℃	648	1808	1464	773

Table 4. Effect of water well temperature on microorganisms in Luoyang A area

Name	20cm (No.1)	50cm (No.1)	70cm (No.1)	20cm (No.2)	50cm (No.2)	70cm (No.2)
Initial temperature	1520	1040	456	292	448	172
30℃	1740	1560	1874	453	570	359
40℃	3470	1720	2380	730	374	234
50℃	4400	1270	1500	720	780	193

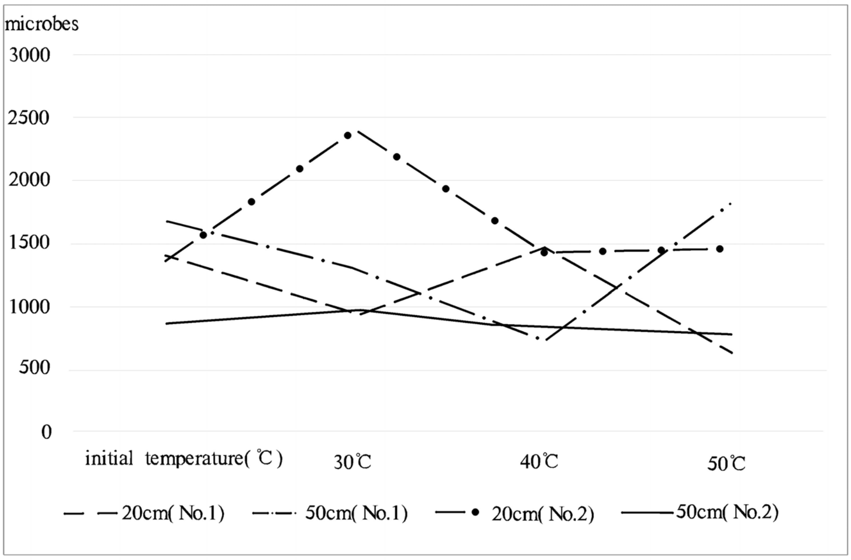

Figure 3. Total number of microorganisms changing treng with temperature of the reservoir

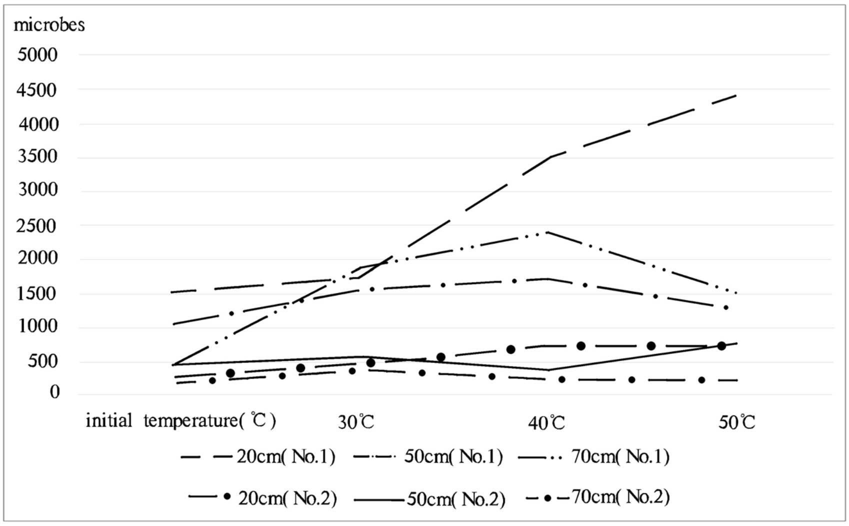

Figure 4. Total number of microbes changing treng with the temperature of the water well

Table 3, Table 4, Figure 3 and Figure 4 show that:

(1) When the initial temperature being less than 30 °C, the number of microorganisms increases rapidly with the increase of temperature. When the temperature reaching 40 °C, the number of microorganisms reaches the highest value. With the increasing of temperature, the number of microorganisms grows slowly or decreases.

(2) The closer to the reservoir or the water well, the more obvious the change of microorganisms is.

(3) When the initial temperature exceeding 30 °C, the change of microorganisms with temperature is slightly lower than that of the reservoir, and it changes slowly when it being far away from the reservoir.

This shows that: the continuous development of geothermal resources has a certain impact on soil microbes. The microorganisms in the soil are mainly bacteria. Among them, the amount of bacteria in the soil accounts for 70% to 90% of the total amount of microorganisms in the soil, and there are many kinds of bacteria, mainly heterotrophic bacteria, and a small amount of autotrophic bacteria [5]. The various types of fungi that are present in the surface soil are mostly semi-infected. The presence of many microorganisms in the soil has a positive effect on soil fertility and soil structure improvement. When the soil temperature is suitable, the humidity is appropriate, and the ventilation is good, many aerobic microorganisms in the soil proliferate and move, which promote the decomposition of humus in the soil and release a large amount of nutrients for the ground plants to absorb and use.Other fungi such as soil can Decomposition of lignin, cellulose and pectin plays a positive role in the natural circulation of other substances in the soil [6]. Humus in soil plays an important role in the normal growth of vegetation on the surface. Humus is a dark brown colloid. It is usually combined with other mineral particles in the soil. It is the main component of soil organic matter. It can improve soil fertility [7] [8].

The increase of soil temperature causes the soil microbial metabolic rate to increase and requires more oxygen, causing some microorganisms to be hindered or killed under the action of thermal potency. The function of other biological enzymes will be affected, causing problems in metabolism, leading to regional ecology and the destruction of balance.

3.3.2 Soil organic carbon test results

The effect of reservoir temperature change on soil organic carbon in Luoyang A area is shown in Figure 5. The influence of the temperature of the water well in Luoyang A area on soil organic carbon is shown in Figure 6.

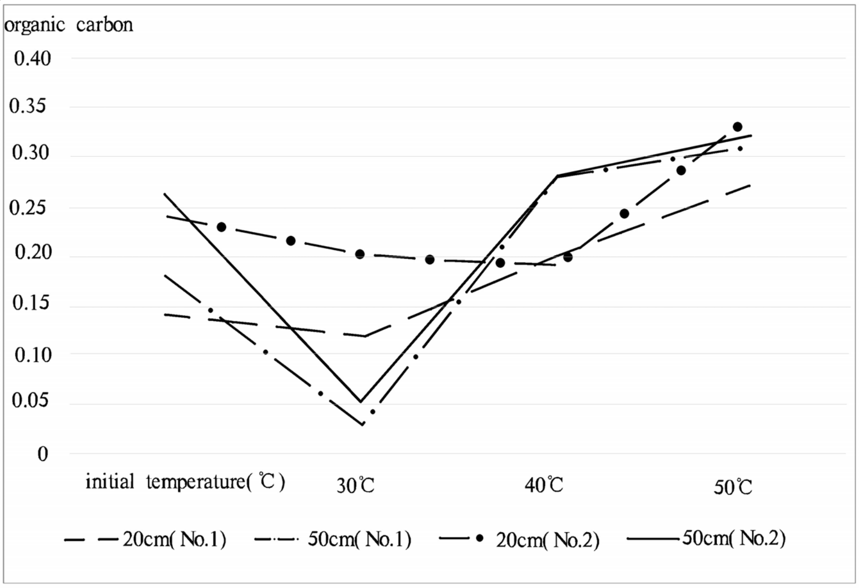

Figure 5. Trend of organic carbon content in soil with temperature of the reservoir in Luoyang A area

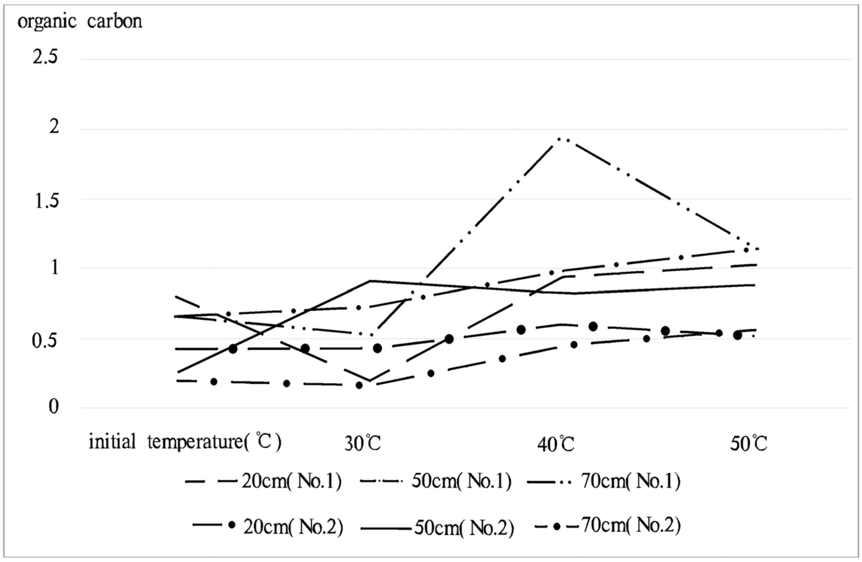

Figure 6. Trend of organic carbon content in soil with temperature of the water well in Luoyang A area

It can be seen from Figure 5 and Figure 6:

(1) The organic carbon content increases fastest between 30 °C and 40 °C. When the temperature reaching 40 °C, the organic carbon content reaches the maximum value. Then with the continuous increasing of temperature, the organic carbon content increases slowly or decreases.

(2) The closer to the reservoir or the water well, the more obvious the change is in organic carbon content .

4. Conclusion

From the above analysis, the following conclusions can be drawn:

(1) With the continuous development of geothermal resources in Luoyang A area, the total amount of microorganisms, organic carbon, total nitrogen, total phosphorus and potassium in the soil all changed with the increase of temperature.

(2) The number of microorganisms growed faster with the increase of temperature and reached the highest value up to 40 °C .As the temperature continuing to rise ,the number of microbes growed slowly or on a downward trend.

(3) The organic carbon content increases fastest between 30 °C and 40 °C. When the temperature reaching 40 °C, the organic carbon content reaches the maximum value. Then, with the continuous increase of temperature, the organic carbon content increases slowly or decrease. The closer to the reservoir or the water well, the more obvious the change is in organic carbon content.

(4) The total nitrogen content increased fastest between 30 °C and 40 °C. After 40 °C, the total nitrogen content increased slowly or decreased with the continuous increase of temperature.

Therefore, in order to avoid the influence of temperature changes on the soil structure, it is recommended to put insulation materials around the wellhead and the reservoir to prevent the lowest loss temperature from exceeding 30 °C or 3 water wells alternating every other quarter.

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