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Problems and Control of Drinking Groundwater Quality in the ChangBai Mountainous Region of China

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Abstract*—According to climate, vegetation, geomorphology, the degree of the Kaschin-Beck disease and geology, hydrogeology, soil, the degree of original environmental transform as well as the difference of the disease, etc., the authors divided the east of Jilin province into three ecological environmental zones (A,B,C), compares the situation among three zones, then draws conclusions as follows: Kaschin-Beck disease of Changbai mountainous region grows in the ecological environment of magnanimous elements, trace elements deficiency obviously: Na, S are the most deficient magnanimous elements, Sr, V, Co, Zn, Se are the most deficient trace elements.

Keywords-ChangBai Mountainous; Drinking Groundwater;Kaschin-Beck Disease

I. INTRODUCTION

Safe and good quality drinking water is the basis for good human health [1]. Clean drinking water is fundamental to the health and welfare of the world people [2]. Water provides essential elements [3,4,5],but when elements deficiency obviously it may become the source of undesirable substances dangerous to human health. The aim of this study is to verify the hypothesis that drinking water quality has a close relation to Kaschin-Beck disease.

Changbai mountainous is one of the major mountainous of Kaschin-Beck disease prevailing area in China. The total area of the mountain amounts to about 50,000 square kilometers. The mountainous includes a series of different natural units. The high part of the mountainous is a natural landscape zone (A zone) characterized by the relief of recent volcanic activities and the corresponding lava accumulation the erosion higher mountains and low mountains. The lower part of the mountainous is a natural landscape zone (B zone) characterized by the higher mountainous, low mountainous and the corresponding regional metamorphism predominated. In order to study well, chose the natural landscape zone (C zone) characterized by plain of inhomogeneous settlement and wetted land as a comparison, which is next to the Changbai mountainous. Thus the zoning control of the regional nature landscape and regional geological process, the regional environmental geochemical characteristics of the groundwater are also different in the Changbai mountainous. The zoning of the natural environments, such as geology, geomorphology, soil and vegetation, etc.[6], results in a pronounced zoning of the regional environmental geochemistry of the groundwater in the Changbai mountainous region. Therefore it can be divided into three regional environmental geochemical zones (A, B, C zones) of groundwater as follow:

A.The Latest Volcanic Activity and Erosion-leaching Zone (A zone)

This zone lies in the eastern part of the Jilin

City and Liuhe county. The relief has been dissected moderately or intensively and the lave plateaus and platforms superimposed on the higher mountains, low mountains and hills, forming and unique geomorphology. The volcanic activities occurred frequently from Miocene to Holocene. Most of the volcanic rocks are meta-alkali basalt and olivine basalt; besides, there is a small amount of alkaline trachyte as well as tuff breocia. Rocks in the Palaeozoic era and pre-Palaeozoic era are various metamorphic rocks, argillite, carbonatite and fragmental rocks; Groundwater is contained as phreatic water and piezometric water in pores, fissures and caves of all the geological periods. In the area of Antu, Changbai and Jinyu, groundwater comes out as either thermal water of different temperatures (from warm water to hot water) or carbonated mineral water of low temperature. Incidence of the Kaschin-Beck disease in the A zone ranges from 0.03% to 17.58%.

B.The Ancient Magmatic Activity and Erosion-leaching Zone (B zone)

This zone lies in the eastern part of Changchun city and Yushu county as well as the western part of Duihua county and Fusong city. The relief is characterized by higher mountains, low mountains and hills. The magmata activities occurred frequently from pre-Sinian period to Mesozoic era, forming various stages of magmata rocks, among which the Varisoan and the early Yenshan stages era is the largest in scale. The active characteristics at the beginning and end with intrusion, displaying and evolution regularity from basic rocks to acidic rocks, then to alkaline rocks, but dominantly the acid rocks or acidic meta-alkaline rocks. Some subsiding or fault basis trending NE-SW were formed on the basis of the ancient magmata activities, such as the Yitong-Yilan subsiding basin and the HuiFa River subsiding basin, where the fragmental and carbonate sediments were accumulated from the late Palaeozoic to the Mesozoic-Cenozoic age, and deposited some coal beds of economical value. Incidence of the Kaschin-Beck disease in the B zone ranges from 0.24% to 17.59%.

C.The Migrating-accumulated Balance Zone With Relative Uplift (C zone)

This zone lies in the high piedmont plain (which belongs to the western part of jilin city and Liuhe county). It was a subsiding area in geological structure, but it rose in early Cenozoic era, forming a relative uplift zone composed of loess and clayey soil (locally, sands and gravels) of Quaternary period. The stratums of Cretacious system were only found a little.

II. MATERIAL AND METHODS

174, 156, 70 water samples were collected in the A,B,C zone respectively, and 29 indexes were under detection, including PH, COD, NH_4^+, Fe^{2+}, Fe^{3+}, K^+, Na^+, HCO_3^-, SO_4^{2-}, H_2S, Mg, Ca, Fluoride, Cl, NO_3^-, Sr, Zn, As, V, Cr, Se, Co, Cu, I, Ni, Pb, Cd, SiO_2, Mo, etc.

III. RESULTS AND DISCUSSIONS

A. PH Value

PH value in the A zone is average 7.01, that belongs to neutral environment, the lowest value is 6.35, the highest value is 7.85.PH value in the B zone is average 6.70, that belongs to a acidic environment, the lowest value is 4.30, the highest value is 9.09.PH value in the C zone is average 7.41, that belongs to a alkalescence environment, the lowest value is 4.00, the highest value is 8.86.According to the above data, we draw results as follows: The Kaschin-Beck disease prevails in the area where the drinking groundwater mostly belong to neutral or acid; drinking groundwater in the no Kaschin-Beck disease prevailing district belong to alkalescence.

B.Reduction and Oxidization Index

Eh value is often used as a reduction and oxidized index, but usually it changes very frequently, very unstable. So, we chose COD, NH_4^+, Fe^{3+}, Fe^{2+}, Fe^{3+}/Fe^{2+} and other indexes as reduction and oxidization indexes.

COD: COD value in the disease district is average 2.12, the lowest is 0.30, the highest is 14.70; COD value in the no disease district is average 1.84, the lowest is 0.30, the highest is 9.90. The latter's average value weighs over 1.15 times as much as that of the former.

NH_4^+: the concentration of NH^+_4 in the drinking groundwater in the disease district is over 1.95 times as much as that in the no disease district; A and B zone respectively are over 2.65, 1.26 times as much as that of C zone.

Fe^{2+},Fe^{3+},Fe^{3+}/Fe^{2+}: the concentration of Fe^{3+}, or the value of Fe^{3+}/Fe^{2+} in the drinking groundwater in the disease district is lower, but concentration of Fe^{2+} is higher; on the contrary the concentration of Fe^{3+}, the value of Fe^{3+}/Fe^{2+} in the drinking groundwater in the no disease district is higher, but Fe^{2+} is lower; the concentration of Fe^{2+} in the A, B zone are respectively over 6.72, 2.83 times as much as that in the C zone; the concentration of Fe^{3+} in the C zone is respectively over 8.28, 2.64 times as much as that in the A, B zones, the value of Fe^{3+}/Fe^{2+} in the C zone is over 3.99 times as much as that in the Kaschin-Beck disease zone.

Humic Acid: The concentration of humic acid in drinking groundwater in the disease area is higher and is lower in the non-disease area: it's average is 0.292 ppm, the lowest is 0.002 ppm, the highest is 1.990 ppm in the A zone; it's average is 0.671 ppm, the lowest is 0.010 ppm, the highest is 1.800 ppm in the B zone; it's average is 0.224 ppm, the lowest is 0.004 ppm, the highest is 2.800 ppm in the C zone. The concentration of humic acid in the B, A+B zone is over 2.99, 2.14 times as much as that in the C zone.In one word, from the data of the above, we can draw conclusions as follows: Kaschin-Beck disease in the Changbai mountainous prevails in the environment of reduction; the environment of no disease belongs to oxidization.

C.Concentrations of the Elements in the Drinking Groundwater

According to difference notable examination results of the concentration of elements in the drinking groundwater among A, B, C zones, conclusions has been drawn: concentrations in the drinking groundwater are have extremely difference ($P<0.01$) (table 1).

Table1. The Difference notable Examination Result of the Concentrations ($P < 0.01$)

Component	Disease district			Non-disease district	unit	Ratio of C/ (A+B)
	A	B	(A+B)	C		
Na^+	15.96	12.24	14.10	68.21	PPM	4.84
SO_4^{2-}	16.37	14.64	15.51	43.65	PPM	2.81
Zn	2.69	6.79	4.74	22.90	PPB	4.83
Sr	22.71	95.61	59.16	444.73	PPB	7.52
V	0.379	0.630	0.504	1.842	PPB	3.65
Co	0.135	0.158	0.146	0.382	PPB	2.62
Se	0.018	0.016	0.014	0.056	PPB	3.29

* concentrations of above elements are average data

D.Cluster Aanalysis

In order to study the relationship between Kaschin-Beck disease and hydrological geochemistry character well, use cluster analysis method to analyze the above elements[7], draw the conclusions as follows: relationship among Na^+ SO_4^{2-}, Zn, Sr, V, Co, Se are more closer, R value is more than 0.5;all the components can be divided into 2 groups; the first group are composed of Na^+, SO_4^{2-}, Zn, Sr, V, Co, Se; the second group are composed of COD, Fe^{2+}, Fe^{3+}, NH^{4+}, pH. So, the components in the drinking groundwater would be divided into two classes: Environmental hydro-geochemical indexes and human body elements. This division reflects the general character of the drinking groundwater in the Changbai mountainous; the drinking groundwater in the Kaschin-Beck disease area has the same matter source and obeys the entire matter cycle principle of the groundwater system [8]. On the other hand, Kaschin-Beck disease prevails in the special environment. So, the division of A, B zone in the Changbai mountainous is correct.

IV. CONCLUSIONS

Actually there is one problem in regard to the original environment in the Changbai mountainous: the deficiency in material in the environment, such as Na^+, SO_4^{2-}, Zn, Sr, V, Co, Se deficiency in the groundwater, result in Kaschin-Beck disease prevailing. In one word, because of the deficiency in material in the groundwater, it results in the disease prevailing in the Changbai mountainous.

Results of this study provided more deeply and broadly scientific information to the management and protection of drinking groundwater of Changbai mountainous region. This study revealed the water environmental risk level of rural drinking water in the research area. By doing these may provide the scientific basis for the risk management of drinking water quality in research area.

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