The Study on Isotopic Characteristic of Spring Water in Jinan

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Abstract. The spring water samples were collected in research area. And this paper discussed the stable isotope characteristics for shallow groundwater and karst water. The stable isotopes in spring water have a wide range from -61.57‰ to -54.43‰ for δD, -8.86‰ to -7.94‰ for δ18O. The d-excess values range from 3.79‰ to 9.48‰ with an average value of 7.8‰. And the trend line for spring water in Jinan is that δD=4.07δ18O-25.38, with a low slope. And the isotopes data for the spring water, shallow groundwater and karst water isotope were analysis.

Introduction

The stable isotope study become an important for groundwater[1-6]. A number of studies have been conducted on groundwater by isotope. And the stable isotopes were useful to understand the origin of groundwater. Using the isotope technique to study the source of groundwater is not only contribute to estimate the available capacity of groundwater resources, but also reveal the circulation law of groundwater. Therefore, it could also makes a contribution to planning the development of groundwater resources, avoiding the environmental problem such as the deterioration of water quality. The δD and δ18O in river water or lake water will be increase due to evaporation In the area, few study has been to done on analyzing the variation of oxygen and hydrogen isotopes in the spring water in Jinan. It is well know that the relationship between the δ18O and δD in groundwater can provide a line, and the line can be used by studying isotope. So it is essential to do some work for the spring water in Jinan.

The purpose of this study was to determine the oxygen and hydrogen isotopic composition in spring water in Jinan. In this paper, the isotopic variations of spring water will be given. And the study can provide some information about evaporation in groundwater.

Study Area and Methods

There are numerous mountain springs in Jinxiuchuan river basin area and the water quality is very good. It is the main drinking water for the local people's water resource. The climate in jinan is semi-humid. And the average annual precipitation amount is 650mm.

The values of isotope can be described by the isotopic abundance ratios. The isotopic compositions are generally given as δ values, the relative deviations with respect to a standard value, as defined by:
\[ \delta = \left( \frac{R_{\text{sample}}}{R_{\text{standard}}} - 1 \right) \times 1000 \% \]

where R value refer to \(^2\text{H/}^1\text{H}\) or \(^{18}\text{O/}^{16}\text{O}\) in sample and standard, respectively. The accepted standard for the isotopes in water is that Vienna Standard Mean Ocean Water. And that is close to the original standard of SMOW as defined by Craig.

And the spring water samples were collected at 5 locations. The concentration of stable isotope were analysed by Laser mass spectrometry (Liquid water isotope analyzer) in the provincial key laboratory of the Yellow River delta. The measurement accuracy (standard error) in the above measurement was 0.2‰ V-SMOW in \(\delta^{18}\text{O}\), 0.5‰ V-SMOW in \(\delta\text{D}\).

**Result and Discussion**

The spring water samples were collected in research area. And this paper discussed the stable isotope characteristics for spring water, shallow groundwater and karst water. The stable isotopes in spring water have a wide range from -61.57‰ to -54.43‰ for \(\delta\text{D}\), -8.86‰ to -7.94‰ for \(\delta^{18}\text{O}\). The d-excess values range from 3.79‰ to 9.48‰ with an average value of 7.8‰. The trend line for spring water in Jinan is that \(\delta\text{D}=4.07\delta^{18}\text{O}-25.38\), with a low slope.

![Figure 1. \(\delta^{18}\text{O}\) versus \(\delta\text{D}\) for spring samples.](image)

Fig.2 depicts the relationship between the \(\delta\text{D}\) and \(\delta^{18}\text{O}\) for the rainwater [7]. The slope reveals that the rain in Jinan almost happens in the wet environment. And the groundwater is reacharged by rainwater with evaporatation before infiltritation.
Figure 2. $\delta^{18}O$ versus $\delta D$ for rainwater samples with the global meteoric water line\textsuperscript{[7]}.

The Fig. 3 shows space variation for d-excess values of springs in Jinan. The values is high in the mountain area, and it is low in the plain.

The Fig. 4 Shown that variation for d-excess values of shallow groundwater. The data come from the pater\textsuperscript{[8]}. The stable isotopes in shallow groundwater have a wide range from -68‰ to -56 ‰ for $\delta D$, -9‰~7.9‰ for $\delta^{18}O$. And there are six sample points for the shallow groundwater. The value is high in the mountain zone, and it is low in plain. And the d-excess values in Zhao Xian village is high due to the climate, While other sampling points on the low side of deuterium surplus value, and the water vapor source has a humid climate environment. It may be influenced by precipitation in the process of water droplets evaporation again.
Figure 4. The variation for d-excess values of shallow groundwater in Jinan.

The Fig.5 Shown that variation for d-excess values of karst groundwater. The data come from the pater[9]. The stable isotopes in karst groundwater have a wide range from -64‰ to -57 ‰ for δD, -9.2‰~8‰ for δ18O. There are eight sample points, and the deuterium surplus is high mountain area. The values is higher in Gangtou town where the climate is dry, and the deuterium surplus values in the sample more close to the global average of 10 ‰.

Conclusion

This paper study the isotope characteristic in springs water in Jinan. The stable isotopes in spring water have a wide range from 61.57‰ to -54.43 ‰ for δD, -8.86‰~7.94‰ for δ18O. The d-excess values range from 3.79‰ to 9.48‰ with an average value of 7.8‰. And the isotopes data for the spring water, shallow groundwater and karst water isotope were analysis. The regression slope for the δ18O and δD indicates that the groundwater is recharged by the precipitation with evaporating.
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References


