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Fundamental study of Understanding the water cycle using oxygen and hydrogen isotopes in the region Shirahama Spring

Keisuke Tomiyama[1*], HIROYUKI II[2]

[1]Graduate School, Wakayama University, [2]Faculty, Wakayama University

1.Introduction

The Shirahama Hot Spring is a famous hot spring at the west coast of the Kii Peninsula and there are many types of hot spring for water chemistry such as bicarbonic acid, chlorine and hydrogen sulfide. Hot springs temperature ranges 40 degrees to 80 degrees. Past, there were artesian flowing wells and at present, most of source of hot spring needs pumping. Although near the Shirahama Hot Spring there is neither volcano nor volcanic activity at present, the temperature of hot spring is high and heat source is not clarified.

A present problem of the Shirahama Hot Spring is decrease of flow rate and flowing pressure of the hot spring and water chemistry changes such as contamination of sea water caused by excess pumping up.

It is important to understand the source and migration of hot spring water in the Shirahama Hot Spring area in order to preserve stable supply of hot spring water. Therefore, in this study, the source and migration of hot spring water were analyzed by oxygen and hydrogen isotopes and water chemistry.

2.Experimental Methodology

Hot spring water was sampled from the Shirahama Hot Spring and the Tsubaki Hot Spring with the type of hydrogen sulfide next to the Shirahama Hot spring along the coast. River water, cold well water and sea water was sampled from the Shirahama area and the Tonda River in side of the Shirahama Hot Spring.

Oxygen and Hydrogen isotope ratios of the sampled water were analyzed by mass spectrometer with equilibrium method between sample water and hydrogen and carbon dioxide gas. In field, EC, pH, ORP and temperature were measured. Soluble substance such as Cl^-, Br^-, $SO_4{}^{2-}$, $NO_3{}^-$, Na^+, K^+, Ca^{2+}, and Mg^{2+} was measured by ion exchange chromatograph. $HCO_3{}^-$ concentration was titrated by acid.

3.Results

The relationship between the Oxygen and Hydrogen isotopes for the sampled water shows that all sampled waters were on the Meteoric Water Line.

Hydrogen and oxygen isotope ratios of hot spring water near the shoreline sites were slightly higher than those in the mountains at the Shirahama Hot Spring area.

Chloride ion concentrations in the Hot Spring water, sea water and cold well water increase with hydrogen and oxygen isotope ratios although under the condition of low chloride ion concentration, hydrogen and oxygen isotope ratios were variable. The relation between Chloride ion concentration and hydrogen and oxygen isotope ratios were as follows;

deltaD = $0.0019 * Cl^-$ - 49.11

delta^{18}O = $0.0003 * Cl^-$ - 8.4634

As both end points were sea water and cold well water, hot spring water was thought to be mixed water by sea water and cold well water and sea water ratios for the hot spring water in the Shirahama Hot Spring were 1 to 50 %.

Reference list

1) URBAN KUBOTA NO.38, pp.42-56, 1999, 9

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