

The origin of sulfate ion in groundwater at the Higashi-Hachimantai area, Investigation using sulfur isotopic ratio

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Although the water pollution is not caused by human activities, dissolved ion content of most water samples in Higashi-Hachimantai area is larger than that in surrounding area. The sulfate ion (SO_4^{2-}) concentration of water samples in the study area is especially larger than normal natural water samples. The purpose of this study is to investigate the origin and formation process of SO_4^{2-} in groundwater using sulfur isotopic ratio ($\delta^{34}\text{S}$).

Major chemical compositions of water samples were divided into two types on the boundary of the Matsu River through the central part of study area. One is a Ca-HCO_3 (Iwate) type water in Kanazawa area at the southern part of the river and another is a Ca-SO_4 (Hachimantai) type water in Kashiwadai area at the northern part.

The $\delta^{34}\text{S}$ of dissolved sulfate in Iwate type groundwater was different from that in Hachimantai type one as well as major chemical composition and d-excess. The $\delta^{34}\text{S}$ values of two water samples in Iwate type were higher values of +10.0 and +12.3 per-mil, while those of two water samples in Hachimantai type were lower values of -2.6 and -1.6 per-mil. From the result of carbon isotopic ratio ($\delta^{13}\text{C}$) in dissolved inorganic carbon, Iwate type groundwater is obviously affected by volcanic CO_2 gas. Therefore, SO_4^{2-} in Iwate type groundwater seems to be originated from volcanic sulfur species, such as SO_2 . On the other hand, Hachimantai type groundwater with lower $\delta^{34}\text{S}$ value seems to be produced by the oxidation of sulfide minerals such as Fe_2S , since the Aka River which is an acid river containing acid mine drainage from Matsuo mine located on about 4km northwestern part of study area, has the lowest $\delta^{34}\text{S}$ value of -6.2 per-mil. It is, however, estimated that Hachimantai type groundwater in the Kashiwadai area, which have intermediate $\delta^{34}\text{S}$ value between Iwate type groundwater (>10 per-mil) and the Aka River (-6.2 per-mil), is mixed with Iwate type groundwater which flows from the Mt. Iwate into Kashiwadai area, passing through under the Matsu River through the central part of study area. According to the measurement of flow rate in the Aka River, the infiltration water from the river would not contaminate the groundwater.

Keywords: Mt. Iwate, Hachimantai, groundwater, mixing, sulfate ion, sulfur isotopic ratio