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Seasonal change of arsenic concentrations in groundwater at the south of Osaka prefecture

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Introduction

Naturally arsenic polluted groundwater occurs mainly in the Cenozoic sediments. Biochemical reaction is supposed to play a key roll for such arsenic dissolution into the groundwater from the sediments. In order to elucidate the participation of microbial activity in the arsenic behavior in aquitard, seasonal change of the arsenic concentration, major chemistry and sulfur isotopes of the groundwater in the south of Osaka Prefecture were investigated.

Methods

The targeted well was drilled in the Quaternary Osaka group. Bottom of the well is about 50m depth, and the groundwater level is 2m below the surface. Well water can be electrically pumped up from about 20m depth, however, the well is not used very often. Thus, the well water would be stagnant. During October to December, 2001, water samples were collected from six different depths of the well using a vacuum pump. The sampling depths were 0, 1.4, 2.5, 3.7, 15.7, and about 20m(collected by electric pump, accurate depth is unknown.).After measuring temperature, pH, Eh and alkalinity in the field, arsenic and other dissolved components were analyzed in the laboratory. Sulfate in the groundwater was collected as barium sulfate, which was converted to sulfur dioxide to determine sulfur isotope ratios.

Results

The well water is characterized to contain high ferrous ion, and arsenic contents vary in accordance with the ferrous ion. Total arsenic and ferrous ion concentrations of the surface waters range from 2.4ppb to 8ppb and 0 to 28ppm, respectively. The arsenic content is less than that of the deeper waters ranging from 8.5ppb to 10.6ppb. Ferrous ion of the deeper water is almost the same about 30ppm. Arsenic and ferrous ion in the samples from 1.4-3.7m depth decrease in the December, while those does not change in the samples deeper than 15.7m.

Nitrate ion is detected in the surface water, ranging from 0.02 to 0.86ppm, while it is not detected in the deeper samples. Instead of nitrate ion, about 1ppm ammonium ion is included in the samples from October to November. On the December, ammonium ion decreases to about 0.7ppm, however, nitrate ion is not detected. In the deeper samples than 15.7m, ammonium ion content does not change during the period. sulfate content of 0-3.7m deep samples are stable to be about 15ppm, except that it increases to 25ppm in 15.7m depth in the December.

Isotopic ratios of sulfate-sulfur range from +25.9 to +32.7permil(CDT). That of the surface water are from +25.9permil to +28.4permil in the October and November. Those of the deeper samples were larger than that of the surface water, ranging from +26.4 to +35.9permil. The maximum value +35.9permil was obtained from the water at 3.7m depth in the November. Sulfur isotopic ratio did not change at all depths in the December(+32-+32.5permil). At 15.7m depth, sulfur isotopic ratios ranging from +32 to +33permil.

Discussions

From the October to November, the surface of the water is oxidizing in which FeOOH is a stable phase. At that depth, the arsenic content is lower than that of the deeper waters. When ferrous ion becomes dominant in the deeper water, arsenic content increases. On the December, oxidizing water appears in the deeper water to 3.7m, and arsenic content decreases in this depth interval. Those results indicate that arsenic decreases in association with precipitation of FeOOH, which absorbs arsenic, and that arsenic is released into groundwater when FeOOH decomposes.

Isotopic ratio of sulfate-sulfur is larger in autumn than in winter, probably due to the higher activity of microorganism in the autumn, causing reducing condition of groundwater, in which ferrous ion is stable.

It is probable that the primary source of arsenic is pyrite in the Osaka group sediments. However, arsenic dissolution into groundwater is controlled by the stability of FeOOH. Microorganism activity must play an important role for determining oxidation-reduction state of the groundwater.