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Triple oxygen isotopic compositions of DO in natural spring water seeping at the foot of volcanoes

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Many natural springs are located around volcanoes. Natural springs, located at the foot of Fuji volcano, are enriched in DIC (up to 1.2 mmol L^{-1}), nitrate (up to 0.12 mmol L^{-1}), and DO (up to 0.3 mmol L^{-1}, close to air saturated). The stable isotopic compositions of DIC and nitrate suggest that the respiration (remineralization) reaction of organic matter as the primary source for both DIC and nitrate. Because the respiration reaction consumes DO, we must assume some external sources for DO in source groundwater of the natural springs to explain the apparent unbalance between DIC, nitrate, and DO during the respiration reaction within the groundwater. In this study, we determined the triple oxygen isotopic compositions of DO in water taken from the natural springs to clarify both the source of DO and the system that regulate the groundwater enriched in DO.

The ^{17}O anomalies of DO always coincided with that of atmospheric oxygen, so that atmospheric oxygen must be the only source of DO in groundwater. On the other hand, DO exhibited ^{18}O over ^{16}O ratios lower than the atmospheric oxygen (up to 11 per mil in delta notation).

The ^{18}O over ^{16}O ratios of DO in meteoric water must be equal to those of atmospheric oxygen. Besides, they become higher during the respiration through the kinetic isotope fractionation under closed system. Thus, some DO addition processes that accompanied kinetic fractionation must be responsible for both DO enrichment in the groundwater and ^{18}O-depletion in DO. We concluded that the groundwater was not a complete closed system. Rather, atmospheric oxygen had been supplied to the groundwater through molecular diffusion via soil/rock pore accompanying large isotopic fractionation.

Keywords: natural spring, dissolved oxygen, isotopic compositions, gas exchange, diffusive fractionation, soil pore