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Chemical and isotopic composition of hot spring at the Owakudani geothermal areaon Hakone volcano, Japan

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[Introduction]

Hakone volcano has a caldera whose size is about 8km and 12km in E-W and N-S direction, respectively. Late central cones are structured by andesitic-deictic lava and lava dome (Takahashi et al., 1991; Nagai et al., 2008). Owakudani geothermal area has been created by a sector collapse and developed on the north flank of Kamiyama central cone several thousand years ago (Aramaki and Oki, 1971). Hot spring water contains much SO_4^{2-} caused by oxidization of H_2S in volcanic gas near the surface and a small amount of Cl^- (Oomori et al., 1986). Volcanic gas from Owakudani has been investigated for a long time. However, the newest data about hot spring has been reported by Kikukawa (2001). In this study, we report the relationship between the volcanic activity and the chemical data variation, the chemical composition and isotopic composition (δD and δ^{18}O), for the last 2 years.

[Sampling and analysis]

Hot spring water was sampled in Owakudani geothermal area from May 2013 to December 2014. The sampling point was named point 1 sampling from May 2013 to January 2014 and point 2 sampling from April 2014 to December 2014. Point 1 was flowing out hot spring water. On the other hand, point 2 was kept the water level constant in the hole and not following out from verge of the hole. The distance of point 1 and point 2 is dozen of maters. The point 1 dry up if there is little precipitation. Temperature was measured on the field. Samples were filtered through a 0.45 micrometers disc syringe and determined pH in laboratory. Na^+, K^+ contents were analyzed by Atomic Absorption Spectrometer (AAS). Fe^{2+}, Ca^{2+}, Si, Al^{3+}, Mg^{2+}, Mn^{2+} contents were analyzed ICP- MS. Analysis of F^-, Cl^-, NO_3^-, SO_4^{2-} was conducted by ion chromatography (IC). δD and δ^{18}O were analyzed by Cavity Ring-Down Spectrometer analyzer.

[Results and discussion]

Major cations were Fe^{2+} (62-692 mg/L) and Al^{3+} (19-385 mg/L). Fe^{2+} and Al^{3+} show the similar temporal trend. Point 1 hot spring had high concentration of Ca^{2+} (140-473 mg/L), but point 2 hot spring had low concentration of Ca2+ (6-26 mg/L). The major anion was SO_4^{2-} (478-7300mg/L). Other anions were such as Cl^- (3-83mg/L). However, the pH, water temperature and chemical composition of this study point differed from previous research (Kikukawa, 2001). The above research sampling point was located within 100m from point 1 and 2, which suggests that the chemical composition of hot spring water could be changed even if they are located closely. Relationship the earthquake swarm and the volcanic gas have been indicated (Daita, 2013). The frequency of earthquake swarm surrounding Hakone volcano during (Hot Spring Research Institute of Kanagawa Prefecture) this study showed increasing trend along Cl^-/SO_4^{2-} rate increasing. Accordingly, Cl^-/SO_4^{2-} rate may be relevant to the volcano activity. The δD and δ^{18}O range of hot spring water in point 1 was from 53.3 to 10.2 ‰ and from -7.3 to 8.3 ‰, respectively. In case of point 2, that range was from -34.2 to 29.7 ‰ and from -0.7 to 2.5 ‰, respectively. Compared above, hot spring water point 1 had more wide isotopic variation than that of point 2. Those different isotopic characters among them might be caused by the different welling up styles. The δD and δ^{18}O of hot spring water showed decreasing trend along the number of earthquake swarm increasing.The point 2 was clearer correlation with earthquake swarm than point 1.

Keywords: hot spring, volcanic activity, Hakone