Geochemical study for serpentinite-hosted hyperalkaline hot spring in Hakuba Happo, Japan

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Since the discovery of the hyperalkaline hydrothermal system in the Atlantic Ocean in 2001 (Kelley et al., 2001), water-rock reaction systems associated with serpentinization attract more interest from the perspective of study for origin of life. Abiotic organic synthesis potentially occurs in the highly reduced (H_2-rich) condition created by serpentinization reaction (e.g., Holm and Charlou, 2001). In fact, abiotic hydrocarbon formation via polymerization mechanism was suggested by some geochemical data (concentration and stable carbon isotopic composition) for light hydrocarbons derived from serpentinite-hosted water-rock systems (Proskurowski et al., 2008; Charlou et al., 2010; Suda et al., 2017). However, uncertainties remain regarding carbon cycle including specific abiotic organic production mechanisms for serpentinite-hosted water-rock reaction systems. The purpose of this study is an understanding of reaction mechanisms associated with carbon cycle based on the observation of natural serpentinite-hosted system.
We have been doing the survey of Hakuba Happo hot spring that lies on a serpentinized ultramafic rock body in Nagano, Japan since 2010. The hyperalkaline waters, with temperatures of approximately 50˚C, are pumped from two borehole wells (Happo #1 and Happo #3). N_2, H_2 and CH_4 are main gas components (Homma and Tsukahara, 2008; Suda et al., 2014). These characteristics are common in typical serpentinite-hosted water-rock systems (Schrenk et al., 2013). The previous study suggests that light hydrocarbon gases (CH_4, C_2H_6, C_3H_8, C_4H_{10}, C_5H_{12}) for Happo #1 sample are mainly abiotic origin (Suda et al., 2014, 2017). On the other hand, both biological production and degradation of hydrocarbons are inferred at Happo #3 environment. Comparison of these two well sites will help to identify abiological and biological reaction mechanisms.
We plan to mainly report the results of sampling that was conducted in August and October, 2017. Water and gas samples were collected from two borehole wells (Happo #1 and Happo #3) for the analyses of dissolved inorganic carbon (DIC) and noble gases. For analysis of in-situ microbial activity associated with methane production and/or consumption, microbial cells were collected by filtration of above 700 L of spring water. DIC concentration was <28 μmol/L, which was lower than dissolved methane concentration (124-664 μmol/L; Suda et al., 2014). The results of noble gas analysis showed the contribution of helium gas that has high isotope ratio in both two well sites. This suggests the addition of deeper origin gases from mantle to Hakuba Happo hot spring system.

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