Geochemical characteristics of silica scales precipitated from the geothermal water at the Onuma geothermal power plant.

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The scale precipitation is a major problem in water-dominated geothermal power plants as it reduces the production rate of geothermal energy. The scale precipitates at different physical and chemical conditions in each geothermal power plant as a result from a fluid-rock interaction for specific conditions of the each plant. Thus it is important to understand the chemical characteristics of the scale and process of scale precipitation from geothermal fluid. Understanding of those will be applied to effective protection against the scale precipitation. On the other hand, information on the process of transportation of metals and its precipitation from hydrothermal fluid will be useful to understand the formation of hydrothermal ore deposit.
In this study, we present the geochemical characteristics of geothermal water and scales from the Onuma geothermal power plant at Akita, Japan. The samples were collected from pipes for transportation of thermal water at the plant. The geothermal water were analyzed major elements by Ion Chromatography (Thermo Fisher Scientific Dionex ICS-2100 and ICS-3000) at Akita Prefecture Industrial Center and trace elements by Q-ICP-MS (Agilent 7700) at Akita University. The silica scale is analyzed for trace elements by Q-ICP-MS (Agilent 7700) at Akita University after the acid digestion of samples.
The scale consists of mainly amorphous silica and/or trace amounts of montmorillonite kaolinite, and/or pyrite. The geothermal water is Cl type.
The scale contains Na (0.63-1.32%), Ca (0.76-1.39 %), Mg (107-7417 μg/g), Fe (0.03-1.44%), Al (3.6-5.4%) and trace amounts of Cu (2-53 μg/g), Zn (3-180 μg/g), and lithophile elements, such as Li (2-11 μg/g), Rb (135-183 μg/g), Sr (173-378 μg/g), and REE. Chondrite-normalized REE patterns of scales in this study showing both of slightly LREE enriched and HREE enriched patterns with positive anomalies of Eu. Yttrium behaves in a similar manner as the HREE, especially Ho, as these elements have similar ionic radii. Yttrium and Ho positively correlate with Y/Ho ratios of 31.2–50.2. It is slightly higher than the upper continental crust Y/Ho value of 27.5 estimated by McLennan (2001).
The analytical results of scales show high Au concentration of 1.5-23.3 μg/g, comparable to the average of gold ore contains few μg/g. Gold is positively correlated with Ag and Pb. The concentrations of Au, Cu, Pb, and Li of scale show the negative correlation with Eu anomalies. The amounts of trace elements correlated with the concentrations of Na, Ca, and Al, suggesting that clay minerals such as montmorillonite and kaolinite can contain significant amounts of the elements. This result indicates that clay minerals could remove trace elements from geothermal water in the pipeline.

Acknowledgements
We appreciate the Mitsubishi Materials Co. Ltd. and Akita Power Generation Co. Ltd. for obtaining scale and geothermal fluid samples from the Onuma geothermal power plant. We would like to thank Dr. Yukio Enda at the Akita Industrial Technology Center for help during ion chromatography analysis. This work was partly supported by JSPS Grants– in– Aid for Scientific Research (C) (19K04008).

Keywords: geothermal, silica scale, trace element

