Optimal conditions for selective precipitation of REEs and some metals controlled by the function of pH and temperature. An example from Tamagawa hot spring, Akita Prefecture.

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Increasing demand for rare earth elements (REEs) makes them a promising direction for the economy. However, with uneven territorial distribution, novel sources, such as geothermal fluids and recovery technologies, are required for cost-effective REEs production.

Acidic geothermal fluids are an effective transporting agent of some selected metals, actinoids, and REEs in the Earth’ s crust. High temperature and low pH conditions enhance fluid transfer while cooling down and pH drop cause selective precipitation. The Tamagawa hot spring of Akita Prefecture, Obuki spring, is an example of a chloride-rich acidic hot spring with low pH of 1.1 that discharges ~9000 L/min (Ogawa et al., 2019). The discharged acid hot spring water mixing to Shibukuro and Tama rivers causes cooling down, and gradual pH changes up to 4.4. In this study, we discuss the effect of pH, temperature, and co-precipitation of groups of elements using statistical analysis, focusing on REEs, selected metals (Ga, Tl, In), U, and Th. An understanding of selective precipitation behavior will allow creating an effective extraction strategy.

As many as 14 waters and 18 sediments samples were taken from the Obuki springs to the dam located 20 km downstream, and water temperature changed from 98.0℃ to 11.4℃. The pH dropped from 1.1 to 3.0 at the neutralization facility located ~300m downstream and then to 4.4 at the dam. The concentration of REEs in the water showed a similar pattern, gradually decreasing from the Obuki to the dam. The concentration of selected elements in sediments was normalized to PAAS. As a result, REEs excepting Eu suggested a depleted pattern; Ga and In varied from 10 to 1 times higher than PAAS; U and Th were depleted. However, selected co-precipitation with iron was expected, which required the formation of thin-film around sediments particles. We applied HNO_3 acidic dissolution to remove only the film. Accordingly, re-analyzed concentrations increased up to 12 times for Th in one sample, Ga increased 3~4 times for 11 samples, La, Pr, Nd, Sm, Gd, Tb, Ce also increased several times in a few samples. Co-precipitation phenomena were further undertaken by statical analysis.

Selective precipitation of REEs increased as a function of pH and temperature due to iron complexation. Our results define optimal conditions of the potential utility for selective REE recovery from hot springs deposits.

Keywords: Hot spring deposits , Rare earth elements, Acid geothermal fluids

