

## Microbial influence on manganese precipitation process in the Sanbe hot spring, Shimane Prefecture

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Around the main discharge point of the Sanbe hot spring at the south slope of Mt. Sanbe volcano in Shimane prefecture, Japan, manganese oxide precipitates are distributed in an area of 60 m x 80 m, which are accompanied by flows of hot and cold spring water. Since these spring waters contain significant amount of manganese (up to 1.7 mg/L), manganese oxide precipitation is attributed to occur at present. Similar manganese oxide precipitation has been reported in some hot springs in Japan. In the previous studies, manganese precipitation process is considered to be affected by microbial activity, since inorganic oxidizing process is usually very slow.

In order to confirm microbial influence on manganese precipitation process in the Sanbe hot spring, we studied geochemistry of both manganese precipitates and spring waters and conducted manganese oxidizing experiments. We collected manganese precipitates and spring waters from three sampling sites (named as HS site, CS site and Mix site). The HS site is the wall next to the main discharge point. On the wall surface, hot spring water ( $T = 25.3$  degC,  $pH = 6.68$ ) was flowing. The CS site is located at 40 m east of the HS site, where cold spring water ( $T = 16.3$  degC,  $pH = 5.80$ ) were flowing down on the surface of the manganese precipitates. The Mix site is located 30 m southeast of the HS site.

As the result of EPMA analysis, we found many manganese precipitate samples has banded texture (each has 1-100  $\mu m$  width). In these samples, manganese content showed good correlation with barium content. The atomic ratio of Mn/Ba was in the range of  $Mn/Ba = 0.9 - 15.6$ , which is similar to the ratio in the hot spring water ( $Mn/Ba = 3.5$ ) and in the cold spring water ( $Mn/Ba = 13.5$ ). Since sulfur was not detected by the EPMA analysis, barite formation cannot account for barium enrichment. These results imply that barium is absorbed on the manganese oxide precipitate.

For the manganese oxide experiment, we prepared media adjusted to similar pH, manganese content and organic material content to the cold spring. Time series change of manganese content was monitored after addition of enriched microbes, which had been cultured for a week and separated from the manganese precipitates collected from the sampling sites. One experiment showed significant decrease of manganese content after addition of the microbe, and formation of brown particles was observed on the media. We confirmed they contain significant manganese and also barium by EPMA. The atomic ration of Mn/Ba was around 6, that is similar to the natural precipitates. The experiment result is attributed to represent that precipitation of manganese oxide and absorbance of barium on the precipitate are enhanced by microbial activity.