

## **A new viewpoint on the polymerization of silicic acid in geothermal water**

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Silica scale formation is a serious problem at many geothermal power plants in the world. In order to elucidate the formation mechanism of silica scale, it is important to understand the polymerization of silicic acid in geothermal water. Recently, the dynamic light scattering (DLS), which can measure directly the hydrodynamic size of polysilicic acid, has been used in addition with spectrophotometric method based on the formation of yellow molybdosilicic acid, which can show whether the polymerization of silicic acid occurs. In this study, we observed the polymerization of silicic acid in geothermal water at Takigami geothermal power plant, Japan, by another spectrophotometric method which can measure the uptake of aluminum ion into polysilicic acid in addition with the DLS and the spectrophotometric method for silicic acid.

Two phase geothermal fluid was introduced into the water/vapor separator. Geothermal water was collected from the separator in a polyethylene bottle. The temperature of the geothermal water (90 °C) was maintained in a water bath. The polymerization reaction of silicic acid was traced for 2 h. At adequate intervals, a part of the geothermal water was taken out and adjusted to pH 2 by adding hydrochloric acid to retard the polymerization of silicic acid.

The monosilicic acid concentration (as Si) changed from 263 ppm at 0 h to 173 ppm at 2 h. While, the diameter of polysilicic acid particle changed from 2.5 nm at 5 min. to 11.0 nm at 2 h. Using Si concentration consisting of polysilicic acid and their averaged diameter, the number of polysilicic acid particles can be estimated. The number of polysilicic acid particles changed from  $1.5 \times 10^{18}$  / L at 5 min to  $4.8 \times 10^{16}$  / L at 2 h. The number of Si consisting of a polysilicic acid particle changed from 459 at 5 min. to 40200 at 2 h. In addition, the Si / Al atomic ratio of polysilicic acid particles roughly ranged from 53 to 88. All of the aluminums were taken up into polysilicic acid particles during the polymerization of silicic acid in geothermal water. These atomic ratios are close to those of silica scales formed at geothermal power plants, suggesting that aluminum may play a role of nuclei of the formation of polysilicic acid.