

## The effect of the change of geothermal system for the scaling on surface facilities

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Geothermal usage such as geothermal power generation, hot spring, space heating based on the volcanic hydrothermal activity is progressing in worldwide. In using geothermal energy, the scale precipitation from fluid composition on surface facilities such as pipeline, heat exchanger become serious problem to maintain the system.

Therefore it is necessary to predict the kind and precipitation rate of the scale in usage temperature region.

And during long term, the situation of scaling change with geochemical composition.

For example, the Kakkonda geothermal area, Iwate prefecture, north-eastern of Japan, there is 80MW geothermal power plant using high temperature fluid from the reservoir at the boundary between Quaternary Kakkonda granite and Pre-Tertiary formations about 3km depth. And metal sulfide minerals deposited at production wellhead and pipeline from fluid. From one of production well, in early stage, the fluid pH is about 4. At this well, scale precipitated including amorphous silica, chalcocite ( $\text{Cu}_2\text{S}$ ), bornite ( $\text{Cu}_5\text{FeS}_4$ ), loellingite ( $\text{FeAs}_2$ ) and native antimony (Sb). On progress of production the fluids from deep reservoir suffered by the fluid of shallow reservoir and meteoritic water. The pH change to about 6 and  $\text{SiO}_2$  decreased and the scale changed to tetrahedrite ( $\text{Cu}_{10}[\text{Fe,Zn}]_2[\text{As,Sb}]_4\text{S}_{13}$ ) and sulfur increased.

And in the case of two-year circulation test in the Hijiori EGS system in Yamagata Prefecture, Japan, amorphous silica and calcium carbonate scale tended to precipitate in the flow line, with the ratio of silica and calcium carbonate depending on fluid temperature and chemical composition. In the case of well HDR-2, with reservoir temperature decreasing, scale changed from amorphous silica to calcium carbonate. The scale change was controlled the dissolution and precipitation of anhydrite in reservoir. At reservoir has high temperature, anhydrite precipitated in reservoir but after cooling reservoir, the high Ca fluid flow up surface facilities and cause to precipitate calcium carbonate.

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