

Scaling formations in a geothermal plant in the Upper Rhine Valley: From fluid to solid composition

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For geothermal energy use, saline fluids are pumped from deep aquifers to the surface. Due to changing p, T conditions and other processes, scalings are formed within the surface installations of geothermal plants. According to the state of technology, the formation of sulfate scalings (barite and celestine) is successfully reduced by addition of inhibitors. However, some precipitates still form. These residual scalings consist of lead, antimony and arsenic (up to 90 mass%), but information on the exact mineralogical composition and the metal binding environment including oxidation state is scarce.

During this study fluid and scale samples were taken and analyzed by different microscopic, spectroscopic and radioanalytical methods. The elementary composition of scalings was determined by ICP-MS after total digestion or by X-ray fluorescence. In-situ X-ray fluorescence measurements were used to record the local distribution of the elements within the surface installations. Through repeated sampling campaigns scalings and water composition are locally and temporally correlated.

In the fluids, the total percentage of lead, antimony and arsenic is minor (approximately 1 mass%). In particular, lead and antimony are highly enriched within the solid deposits compared to their fluid concentrations. The lead accumulation is also detectable through an enhanced level of radioactive ²¹⁰Pb.

In summary, variations of the lead/antimony/arsenic ratio inside the surface installations were substantiated by analytical data. The stoichiometric ratio of these three elements to sulphur is variable as well. The solid-phase investigations (XRD, SEM-EDX, XANES) reveal the dominance of lead sulfide, besides lead, antimony and arsenic in various oxidation states. Moreover, these methods confirm the hypothesis that the investigated scalings contain also to a smaller extent solid metals, e.g. Pb(0).