

The trace metal flux during the utilization of geothermal fluid in rift settings: Nesjavellir, SW Iceland

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Geothermal systems represent dynamic and complex environments where interactions between fluids, gases, and host rock at high temperature and pressure dictate the distribution and mobility of trace metals. These elements can have significant implications for the resource utilization and environmental management. High-temperature geothermal systems, particularly those associated with volcanic activity, exhibit elevated concentrations of metals such as As, Hg, B, Pb, and Zn. Airborne emissions from geothermal power plants, can contribute to atmospheric deposition of trace metals, influencing local air quality and soil chemistry. Recent advancements in geothermal resource utilization have explored the potential for extracting valuable trace metals from geothermal brines such as Li, Zn, Mn, and REEs to meet the increasing demand in the energy and technology sectors.

In this study we investigate the geochemistry of trace metals in fluid produced from the Nesjavellir high temperature geothermal reservoir in Iceland. The Nesjavellir deep fluid is dilute, of meteoric origin with temperatures ranging from about 265 to 300°C, neutral pH of 7.1-7.7 and CO₂ and H₂S concentrations of 30-561 and 60-194 ppm, respectively. The maximum concentrations of some of the trace constituents e.g., As, Cr, Cu, and Pb exceeded the environmental limits both in the liquid and in the vapor phase, confirming their high mobility in both phases. The calculated flux of these elements can be as high as 1400 kg/yr for As, 40 kg/yr for Cr, 110 kg/yr for Cu, and 15 kg/yr for Pb. Although this fluid has relatively low trace metal concentrations compared to geothermal fluids in other geological settings, the calculated values suggest that its discharge at the surface could negatively impact the environment. Since this field has been considered a potential location for IDDP drilling and full-scale geothermal CO₂ and H₂S injection for emission reduction, trace metal geochemistry should be further investigated to assess the risks related to metal contamination during these operations.