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Geochemistry of hydrothermal fluids at Sol deMañana and Laguna Colorada Geothermal areas, Southwest Bolivia

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The utilisation of geothermal resources plays an increasingly important role for electricity generation and other direct uses in Bolivia, providing an alternative energy source to fossil fuels. The geochemistry of hydrothermal fluids at Sol de Mañana and Apacheta areas (Bolivia) as part of the Laguna Colorada geothermal project has been investigated in order to assess fluid and elemental sources and processes affecting their chemical composition upon ascent to the surface. Hydrothermal fluids, obtained via samples from deep wells, have a temperature of ~250°C and are characterized by a neutral pH and elevated Cl concentration (~5400 ppm). In contrast, hydrothermal fluids collected at the surface (~10–90 °C) from hot springs, mud-pots, and fumaroles display a large range of chemical compositions, reflected in a large range of pH (2.0–9.0), Cl (0.6-385 ppm), SO_4 (8.9–2253 ppm), and CO_2 (0–54,700 ppm). Based on water isotopes (δD and $\delta^{18}O$) and geochemical modeling, the fluids originate from local meteoric water that has undergone modification upon fluid-rock interaction, boiling and volatile element partitioning between vapor and liquid, and mixing with non-thermal water. Hot springs and thermal water outflows typically display mixing between boiled deep fluids and non-thermal waters as inferred by SiO_2, B, Cl, and CO_2 content, whereas mud-pots display elevated SO_4 and low Cl and pH concentrations indicative of vapor condensate and oxidation of H_2S to H_2SO_4. Fumarole discharges are dominated by water, with elevated concentrations of CO_2 and other major gases being H_2S, H_2, CH_4, N_2, NH_3 and originate upon decompression boiling of deep hydrothermal fluids upon ascent to surface.