Exploring the shallow geothermal resources in the Chilean Southern Volcanic Zone: Insight from the Liquine thermal springs

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Abstract

Southern Volcanic Zone (SVZ) hosts numerous thermal springs (25-85 degrees C), related to Liquine-Ofqui Fault System (LOFS) and Andean Transverse Faults (ATFs), suggesting the feasibility of low- to high-enthalpy geothermal exploitation. However, the local understanding of processes and factors controlling the high-temperature groundwater circulation remained undefined, which limits its exploitation. Following a brief review of SVZ, we address the previous issue by a hydrogeochemical and isotopic analysis of 15 thermal springs at Liquine area (representative of SVZ), supplemented by geochemical simulations. We demonstrate that fault zones and derived hydraulic properties have a predominant control on the ascending high-temperature groundwater circulation and hydrogeochemical processes. Spring discharges and outflowing temperatures are higher along the LOFS damage-zone and ATF than those along the LOFS fault core-zone. Albite dissolution is the main water-rock interaction that is enhanced by absorbed geothermal gases (H2S and CO2 in LOFS; CO2 in ATF). Trace element contents (Li, Rb, Cs, As, Mo) are influenced by hydraulic properties and geothermal gases within faults. Intrinsic hydraulic properties of fault zones, where damage-zone is more permeable than the core zone, affect the Li, Rb, Cs contents. While As and Mo solely differ according to the gases presence. Water stable isotopes point that steam heating processes enhance the hydrogeochemical reactions through the LOFS damage-zone and ATF, whereas only low-temperature processes occur through the LOFS core-zone. LOFS damage-zone and ATFs are great targets for the shallow geothermal resource exploitation. But simulations indicate an elevated risk of scaling with consequences on the operation plants due to silicate mineral precipitations. Finally, Liquine thermal springs provide interesting insights to respond to the current and future energy challenges in Central-South Chile.

Palabras clave

Palabras clave de autor: Water-rock interaction; Gas absorption; Water stable isotopes; Trace elements; Hydrogeochemistry; Fault zone
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