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Exploration of orogenic, fault-hosted geothermal systems using an integrated, multi-disciplinary approach.

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Non-magmatic, orogenic geothermal systems are recognized as significant energy resources for electricity production or direct uses. This study focuses on the non-magmatic geothermal system hosted by the Agua Blanca fault, Ensenada, Mexico. The Agua Blanca fault is a 140 km long transtensional structure with segments recording up to 11 km of dextral strike-slip displacement and normal throws of up to 0.65 km. We have identified at least seven geothermal areas manifested by hot springs discharging at temperatures ranging from 38 °C to 107 °C. These systems involve topography-driven infiltration of meteoric water deep into the Agua Blanca fault and exfiltration of the heated water at valley floors and along a local beach known as La Jolla.

For this contribution, we present recent and ongoing exploration activities aiming to (i) obtain a fundamental understanding of the governing thermal-hydraulic-chemical processes controlling the circulation of meteoric water in the hydrothermally active fault system and (ii) quantify the natural discharge rate and its respective advective heat output. Chemical and isotopic analyses of thermal springs and seismic epicenters' location reveal that meteoric water penetrates between 5 to 10 km deep into the brittle orogenic crystalline basement and thereby attains temperatures between 105 and 215 °C. Interestingly, the deepest circulation and hottest reservoir temperatures occur where the extensional displacement along the fault shows maximum values. However, our data provide no evidence that meteoric water infiltrates beyond the brittle-ductile zone in the crust (12-18 km).

For the La Jolla beach thermal area, we have quantified the advective heat output from thermal images acquired with an unmanned aerial vehicle equipped with a thermal camera and from water flow and direct temperature measurements. The total thermal water discharge is 330 ± 44 L s^{-1} and occurs over a surface area of 2804 m^2 at temperatures up to 52 °C. At 20 cm depth, the temperature is as high as 93 °C. These observations collectively imply a current heat output of 40.5 ± 5.2 MW_t (Carbajal-Martínez et al., 2020). We are currently estimating the shape and magnitude of the subsurface thermal anomaly at La Jolla beach by performing coupled thermal-hydraulic-chemical simulations using the code Toughreact.

We conclude that meteoric water circulation through the Agua Blanca fault system reflects the interplay between the permeability distribution along the fault system and the rugged regional topography. Under ideal conditions such as at La Jolla beach, such circulation generates rather large thermal outputs that could supply the thermal energy for a multi-effect distillation desalinization plant and contribute to cover the shortage of fresh water in Ensenada.