

Uncertainties in the deep reservoir temperature estimation of Chaves thermal waters (N Portugal)

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For many years, the temperature of geothermal reservoirs has been estimated using gaseous, aqueous, and multi-mineral geothermometers. Geothermal systems are usually associated with active tectonic zones, morphostructural landscapes, and deep crustal processes. In addition, thermal waters are often enriched in acid gases of deep origin. The input of these acid gases into the hydrothermal systems enhances leaching and fluid-rock interaction processes, leading to overestimating geothermal temperatures.

The Verín–Chaves–Penacova extensive megastructure zone, trending NNE–SSW, controls the Chaves tectonic basin within a crystalline bedrock and thick sedimentary filling strike-slip morphostructure. The thermal springs, which emerged up to 70°C in Chaves urban area (N Portugal), have been well-known since Roman times. Several thermal wells supply a thermal spa and a low-enthalpy urban district heating network.

With sodium bicarbonate facies, high mineralization, neutral pH, and a high CO₂ content, the composition of Chaves thermal waters is the result of water–gas–rock interaction, promoted by temperature and the acidity introduced by CO_{2(g)} of mantle [1] or thermometamorphic origin. Geothermometric temperatures point to deep temperatures of about 120 °C.

Simulations of the plagioclase (7% An) dissolution in an open system to CO_{2(g)} show that Chaves's thermal waters interact with the reservoir rocks at an equilibrium temperature of around 100 °C. Since the water is not in equilibrium with the CO_{2(g)}, the gas–water interaction in the reservoir is not long enough to address mature waters.

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References:

1. Carreira et al. (2010). *Journal of Vulcanology and Geothermal Research*, 189, 49-56.