

CO₂ emission and geothermal features of the French Massif Central.

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The French Massif Central, a volcanic area located in central-southern France belonging to the European Cenozoic Rift System (ECRIS), hosts deep-CO₂-rich hydrothermal systems. Their surficial manifestations include a huge number of low rate CO₂-rich springs, bubbling pools and mofettes. Since the seventies, the region was widely investigated for geothermal purposes, becoming the scene of the development of increasingly responsive geothermometers [1]. Here, using new chemical and isotopic data of Massif Central springs coupled with data from previous works, we analyse the geochemical characteristics of the Massif Central fluids, their origin and their thermal content. The circulating waters i) exhibit a chemical composition which reflects the chemistry of the rocks when they circulate; ii) are characterized by a partial equilibrium with respect to silicates [2] iii) are oversaturated with respect to calcite and vi) show pCO₂ values up to 2 bar. Temperatures of the hydrothermal reservoirs, estimated through Na/K, Na/Li, Mg-Na-K and silica geothermometers, range from 120 °C to 200 °C, in agreement with previous studies. The CO₂/enthalpy ratio ranges from 0.001 and 0.006 kg MJ⁻¹, of the same order of magnitude of the global baseline value [3].

[1] Fouillac, C. (1983), Chemical geothermometry in CO₂-rich thermal waters. Example of the French Massif Central. *Geothermics* 12, 149-160.

[2] Giggenbach, F. (1988), Geothermal solute equilibria. Derivation of Na-K-Mg-Ca geothermometers. *Geochim. Cosmochim. Acta* 52, 2749-2765.

[3] Kerrick, D.M., McKibben, M.A., Seward, T.M. & Caldeira, K. (1995), Convective hydrothermal CO₂ emission from high heat flow regions. *Chem. Geol.* 121, 285–293.