

The hottest thermal spring in Europe (82°C, Chaudes-Aigues, French Massif Central) and its geothermal potential : a multidisciplinary approach.

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Located in the southern Massif Central, the village of Chaudes-Aigues is a remarkable example of French thermalism. In addition to hosting the hottest spring in Europe (the Par spring) at a temperature of 82°C and a constant flow rate of 500 L.min⁻¹, 26 other springs with temperatures between 25 and 68°C have been identified. At first sight, this system could be linked to the surrounding volcanic edifices (the Cantal and Aubrac volcanoes), but to date there is no evidence of a magma chamber influencing fluid circulation. The emergence zone is located near a network of microgranite dykes in the gneissic basement. It is also at the intersection of three major Variscan fault systems forming a Y-shaped structure. According to previous studies, two hydrodynamic circuits coexist, one at a depth of around 5 km and the other at 2 km, but the general functioning of the system and the origin of the emerging waters remain unknown. Geothermometers indicate a reservoir temperature of 170 ± 20°C. This suggests that there is significant geothermal potential at depth. In this sense, the Chaudes-Aigues region is an ideal natural laboratory for exploring this type of geothermal reservoir. The numerical approach was organized in three successive stages. Heat equation, mass conservation and Darcy law were coupled using Comsol Multiphysics™ software (finite elements method). An initial 2D dynamic numerical approach indicates a convective system involving a geothermal reservoir of 90 km³ between 2 and 5 km depth. Then, in order to understand the hydrodynamic functioning of the granitic reservoir and the interactions between the different fault cluster oriented N150 (southern branch of the Y), 3D models were performed. Taking into account the 3-dimensional topography allows the impluvium zone to be determined and the system residence times to be constrained. The two infiltration zones correspond mainly to the Aubrac massif and to the Cantal massif to the north. Initial results show a deep circulation of fluids from the Aubrac towards the Chaudes-Aigues fault cluster. Other convective loops exist in this deformation zone and would explain the existence of the Chalnette hot spring (34°C, 10 km to the south) in the Margeride granite. A lineament study and highly localised dynamic models will also supplement the observations made in the field. Traces of fluid palaeocirculation indicate that the intersections between faults oriented N30 and N140 are fundamental to the functioning of the current system. These results will be completed by geochemical analyses to understand the origin of the thermal waters and the hydrogeological processes at depth.