EGU21-1101
https://doi.org/10.5194/egusphere-egu21-1101
EGU General Assembly 2021

NMR contribution in sub-horizontal well for porosity-permeability heterogeneity characterization in limestones: implications for 3D reservoir prediction and flow simulation in a world class geothermal aquifer

Maxime Catinat[1,2], Benjamin Brigaud[1], Marc Fleury[3], Miklos Antics[2], Pierre Ungemach[2], Melanie Davaux[2], Julien Gasser Dorado[2], Hadrien Thomas[1], Codjo Thomas Florent Essou[2], Simon Andrieu[4], and Emmanuel Mouche[5]

[1]Université Paris-Saclay, GEOPS, CNRS, 91405 Orsay, France
[2]GEOFLUID, 165 Rue de la belle étoile, 95700 Roissy CDG, France
[3]IPF Energies Nouvelles, 1-4 Avenue Bois Préau, 92852 Rueil-Malmaison, France
[4]BRGM, 3 Avenue Claude Guillemin, 45100 Orléans, France
[5]Université Paris-Saclay, CNRS, CEA, UVSQ, Laboratoire des Sciences du Climat et de l'Environnement, 91191 Gif-sur-Yvette, France

With around 50 heating networks today operating, the aera around Paris is the European region which concentrates the most heating network production units in terms of deep geothermal energy. In France, the energy-climate strategy plans to produce 6.4TWh in 2023, compared to 1.5TWh produced in 2016. Despite an exceptional geothermal potential, the current average development rate of 70MWh/year will not allow this objective to be achieved, it would be necessary to reach a rate of 6 to 10 times higher. The optimization of the use of deep geothermal energy is a major challenge for France, and in Ile-de-France, which has a population of nearly 12 million inhabitants. This project aims to reconstruct and simulate heat flows in the Paris Basin using an innovative methodology (1) to characterize, predict and model the properties of reservoirs (facies, porosity, permeability) and (2) simulate future circulations and predict the performance at a given location (sedimentary basin) on its geothermal potential. This study focuses on a high density area of well infrastructures around Cachan, (8 doublets, 1 triplet in 56 km^2). A new sub-horizontal doublet concept has been recently (2017) drilled at Cachan to enhance heat exchange in medium to low permeability formations. Nuclear Magnetic Resonance (NMR T2) logs have been recorded in the sub-horizontal well (GCAH2) providing information on pore size distribution and permeability. We integrated all logging data (gamma ray, density, resistivity, sonic, NRM T2) of the 19 wells in the area and 120 thin section observations from cuttings to derive a combined electrofacies-sedimentary facies description. A total of 10 facies is grouped into 5 facies associations coded in all the 19 wells according to depths and 10 3rd order stratigraphic sequences are recognized. The cell size of the 3D grid was set to 50 m x 50 m for the XY dimensions. The Z-size depends on the thickness of the sub-zones, averaging 5 m. The resulting 3D grid is composed of a total of nearly 8.10^5cells. After upscaled, facies and stratigraphic surfaces

are used to create a reliable model using the "Truncated Gaussian With Trends" algorithm. The petrophysical distribution "Gaussian Random Function Simulation" is used to populate the entire grid with properties, included 2000 NMR data, considering each facies independently. The best reservoir is mainly located in the shoal deposits oolitic grainstones with average porosity of 12.5% and permeability of 100 mD. Finally, hydrodynamic and thermal simulations have been performed using Pumaflow to give information on the potential risk of interference between the doublets in the area and advices are given in the well trajectory to optimize the connectivity and the lifetime of the system. NMR data, especially permeability, allow to greater improve the simulations, defining time probabilities of thermal breakthrough in an area of high density wells.