DELINEATING THE GEOTHERMAL STRUCTURE AND FLOW PROPERTIES IN A SUB-HORIZONTAL WELL WITH THE USE OF WIRELINE AND LWD DATA IN A MULTIPHYSICS APPROACH

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Abstract:

Geothermal projects are rapidly developing in Continental Europe to provide an alternative energy source. These projects typically involve a doublet of a producer and injector well, which are typically vertical wells drilled with minimal measurement technology. We discuss how advanced wireline measurements guided the decision making for completion strategy in a subhorizontal geothermal well in the suburbs of Paris, France, which at the time was a world premiere in geothermal well design. In addition, we will describe how these measurements aided understanding of the overall structural model. The project provided a 150% increase in geothermal productive/injective capacity vs. previous conventional approaches.

The study was conducted in the Cachan project in the Paris Basin, which was developed to provide a city on the outskirts of Paris with geothermal heat. The project targets thin porous oolitic layers within a dolomite formation as an excellent geothermal target to produce from. The well was geosteered with Logging While Drilling (LWD) density images after which wireline Nuclear Magnetic Resonance (NMR) and dipole sonic measurement tools were operationally efficiently conveyed on tractor throughout the long horizontal drain section.

A multi-physics approach combining the density images, high resolution magnetic resonance poro-permeability data and oriented sonic measurements was applied to study the homogeneity of the layers along the well and determine the flow properties and possible compaction effects. NMR logs were primarily used to assess the porosity and permeability variations of the oolitic reservoirs with high resolution, highlighting the intervals with the highest fluid movability through the thin layers.

NMR measurements were also applied to describe the pore system and assess the fluid movability through the thin layers. NMR carbonate porosity partitioning analysis was used to classify rock type with similar reservoir quality and assist with the definition of rock properties cutoffs for development strategy. In addition to typical applications for rock mechanics and petrophysics, the sonic data in combination with the azimuthal density helped explore any possible effect of the proximity of the adjacent layers within the thin oolitic section (in the order of 1 meter). By combining measurements from different spacings and taking the opportunity to analyze the non-standard individual azimuths from the sonic technology, a more detailed structural model was obtained after integration with the density image. This enabled understanding whether permeability variations are truly related to layer variations or a result of the measurements sensing properties of an adjacent layer and defining the heterogeneity of the oolites.

Bio:

Erik Wielemaker is a Principal Acoustic Domain Champion for the Eastern Hemisphere with the Wireline product line of Schlumberger. Based in The Hague. He holds an MSc in Geophysics from the University of Utrecht, The Netherlands. He joined Schlumberger in 1997.