

Maximizing Geothermal Exposure using Geosteering to Drill a Horizontal Doublet in the Paris Basin

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Geothermal district heating (GDH) doublets in the central part of the Paris Basin, in the capital city suburban areas, face two major concerns:

- 1- the replacement of aging and declining well infrastructures, when not damaged, and productive/injective capacities;
- 2- GDH doublet densities, in some areas approaching overpopulation, which limit well replacement opportunities and cloud new development issues related to space limitations in urban areas and thermal breakthrough/reservoir cooling shortcomings.

The Paris suburban Cachan site was considered a relevant candidate for the first implementation of an alternative well architecture design. This innovative sub-horizontal well (SHW) architecture was used in two wells: a production well and an injection well known as GCAH1 and GCAH2, respectively. GCAH1 was recorded as a world-first at that time with a 1,000-m length, 8 1/2-in. open hole horizontal drain. In March 2018, GCAH2, was successfully tested at the Paris suburban Cachan site, thus validating the design.

On the Cachan site, real-time, advanced technology was deployed to enable achieving the optimum project results. A 24/7 dedicated well placement team surveyed parameters recorded while drilling, which included point-the-bit rotary steerable system (RSS) and logging-while-drilling (LWD) gamma ray, resistivity, neutron, and azimuthal density/porosity measurements integrated with surface-monitored cutting petrography and advanced XRF and XRD mineralogical analysis. Real-time information made it possible to update the reservoir model based on offset well data. It also enabled making adjustments to the well trajectory in order to stay in the targeted, thin-layered (metric size) zones with a view to secure high geothermal production/injection flowrates of 450 to 500 m³/hr. The well placement team collaborated often remotely to devise the drilling strategy and make decisions.

The key achievements for the Cachan project were the following:

- Two geosteered geothermal wells: a production well (GCAH1) and an injection well (GCAH2).
- Target interval: Mid-Jurassic, Dogger Bathonian oolitic limestone.
- Total footage drilled in the lateral section: 1,001 m in two runs, 100% in the target interval; 1,005 m in one run, 100% in the target interval; and two separate high-porosity layers of 6- and 2-m thickness, intercepted.
- Average rate of penetration (ROP) in the lateral section: 7 m/hr.
- Doublet productivity: 450 m³/h nominal (heating period: Oct. 2019 to Nov. 2020).

These drilling achievements show the potential of real-time geosteering navigation technology, usually applied to hydrocarbon drilling, to maximize heat recovery from deep-seated sedimentary reservoirs. The geosteering technique was successfully used for optimal well placement, a reliable well trajectory, and maximum reservoir exposure.

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