

Operator Uses Deep Azimuthal Resistivity to Expand Production in a Sandstone Formation

STRATASTAR™ SERVICE ENABLES MORE EFFECTIVE RECOVERY OF TRAPPED HEAVY OIL IN SAGD OPERATION

CANADA

CHALLENGE

- » Recover heavy oil trapped in soft sand formation
- » Optimize placement of two horizontal wells (injector and producer)
- » Avoid steam waste from steam injection process
- » Understand local vertical permeability variations

SOLUTION

StrataStar™ deep azimuthal resistivity service, featuring:

- » Electromagnetic propagation signal for measuring wellbore resistivity while drilling
- » Advanced inversion processing
- » High-resolution resistivity mapping

RESULT

- » Verified StrataStar service performance in SAGD reservoir
- » Demonstrated the value of high-resolution reservoir mapping for tailored steam injection design to minimize waste
- » Increased understanding of geology surrounding the injector-producer well pair

OVERVIEW

Steam-assisted gravity drainage (SAGD) production design allows the recovery of heavy oil trapped in sandstone formations. It requires a pair of horizontal wells with a slight vertical separation (shown below). Steam injected from the injector well lowers the bitumen viscosity, so it flows down toward the producer well below.

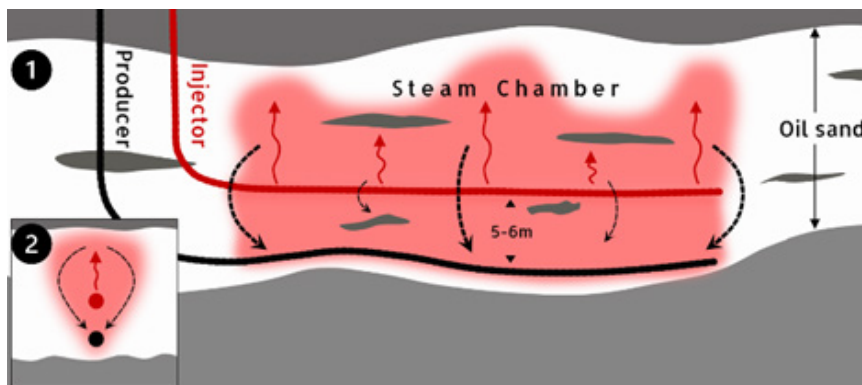


Illustration of SAGD production mechanics with lateral (1) and cross-section (2) views.

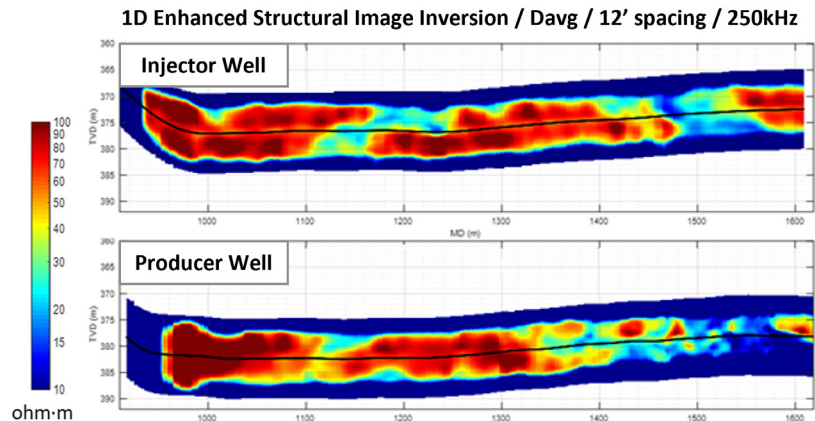
CHALLENGE

Vertical permeability is a critical parameter that impacts the effectiveness of the SAGD recovery process. Layered shale lenses and mudstone breccias from past riverbanks occur within the Canadian sandstone formation. However, their location remains unknown until penetrated while drilling the well, and even then, geologists can have difficulty estimating their vertical extension. These natural steam barriers have a detrimental effect on the bitumen recovery because they prevent the chamber from developing around the wells, leading to a lower return on the investment.

SOLUTION

The Halliburton Sperry Drilling StrataStar™ service, the new generation of deep azimuthal resistivity, was recommended for this application as a field trial of the new service. The innovative technology uses an oriented electromagnetic propagation signal to measure the resistivity up to 30 feet (± 9 meters) all around the borehole while drilling. Combined with advanced inversion processing, it delivers a high-resolution resistivity map, revealing structural features and fluid distribution along the well to drive optimal well placement.

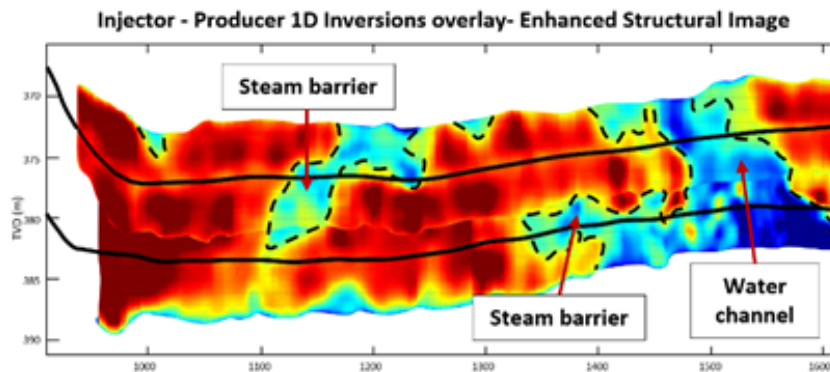
The StrataStar service was implemented in a pair of horizontal injector-producer wells to verify the resistivity mapping accuracy. The 2,300-foot-long (701-meter-long) producer was drilled first, followed by the injector three weeks later. The high-resolution mapping service was run while drilling both wells, with its fastest sampling rate of 16 seconds to accommodate the 500 foot/hour (152 meters/hour) average rate of penetration (ROP). The two StrataStar datasets were processed independently, revealing the high and low resistivity zones at 16.5 to 19.7 feet (5 to 6 meters) above and below each well.



High-definition 1D inversion canvas of the horizontal injector-producer pair showing the distribution of high (red) and low (blue) resistivity above and below each well. The vertical scale is exaggerated with a horizontal to vertical distance ratio of 20.

RESULT

When the two inversion results were combined, the independent maps complemented the other's datasets perfectly (shown below). The operator obtained a clear picture of the reservoir, showing the hydrocarbon in place, the steam barriers, and a water wet channel zone near the toe of the wellbore.



Overlay of the high-definition 1D inversion canvas of the horizontal injector-producer pair, revealing a 65.6-ft-high (20-m-high) picture of the reservoir. The vertical scale is exaggerated with a horizontal-to-vertical distance ratio of 20.

This information enabled a customized completion design based on the geology surrounding the injector-producer pair. Steam waste was minimized by blanking off sections adjacent to mudstone breccia, shales, and even water-flushed channels. The StrataStar service helped lower the overall production cost by driving more efficient steam oil recovery, improving project economics, and maximizing asset value.

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