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Successful Permeability Measurement and Fluid Sampling in 0.1-mD/cP Mobility, Deepwater Angola

Saturn 3D radial probe performs IPTTs and collects fluid from a tight sand where conventional probes are ineffective

CHALLENGE

Conduct interval pressure transient tests (IPTTs) and collect fluid samples to characterize a low-permeability sandstone reservoir offshore Angola.

SOLUTION

Measure pressure and flow fluid for sampling by deploying the Saturn* 3D radial probe with its large, circumferential surface flow area that makes it possible to induce and sustain flow in low-mobility formations.

RESULTS

Thoroughly evaluated permeability and permeability anisotropy in two zones on the basis of high-quality IPTT data from the Saturn probe, with further insight provided by pressure and viscosity measurements and downhole fluid analysis (DFA) of samples acquired by the Saturn probe even in 0.1-mD/cP mobility.

Permeability too low for conventional testing

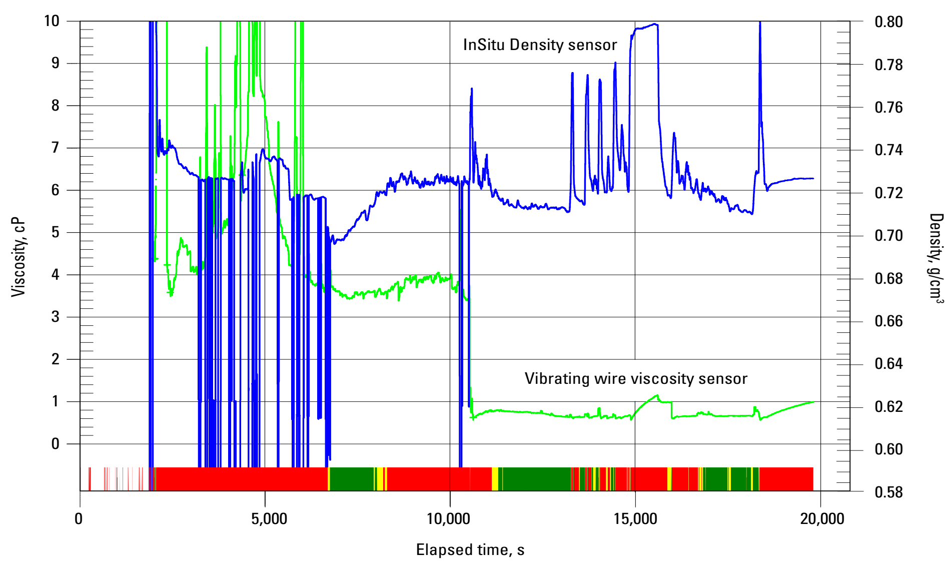
An operator needed critical pressure measurements and fluid compositional data for a deepwater appraisal well offshore Angola. However, zones within the consolidated sandstone were of such low permeability that a wireline formation tester with a conventional single probe was not able to measure pressure or extract fluid.

Circumferential fluid flow in low permeability

The Saturn 3D radial probe creates true 3D circumferential flow around the borehole even in very low-permeability formations. Instead of funneling fluid from the reservoir to a single probe, the four self-sealing elliptical ports have the industry's largest surface flow area of 79.44 in^2 to quickly establish and maintain flow from the entire circumference of the wellbore. The design of the Saturn probe also minimizes storage volume effects. The result is quicker cleanup times for fluid sampling and the efficient performance of pressure measurements, especially in low-mobility formations where conventional probes cannot function effectively.

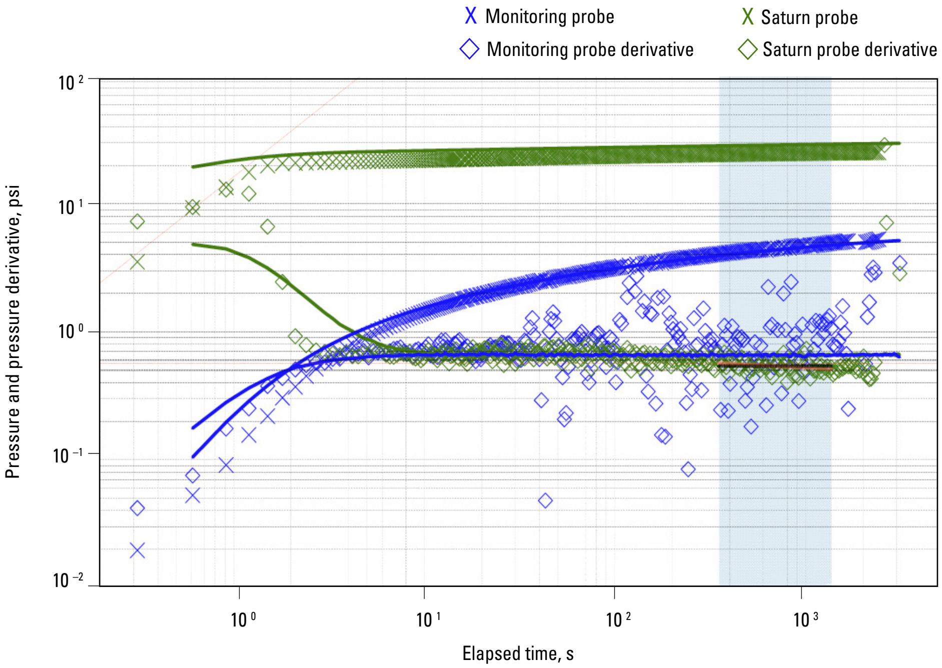
Successful IPTTs, DFA, and sampling

With the wellbore angled at 30°, the toolstring comprising the Saturn 3D radial probe and MDT* modular formation dynamics tester was reliably conveyed on the TLC* tough logging conditions system. The Saturn 3D radial probe made multiple valid pressure measurements in the tight zones of the sand reservoir. Despite mobilities no higher than 0.1 mD/cP in the lower zone, the Saturn probe retrieved samples in an average pumping time of a little more than 4 h per station. At each IPTT station the Saturn probe pumped twice the volume of fluid in half the time that a conventional single probe could extract from a similar well. The conventional probe required an average of 8.5 h per station and achieved no better than 10% contamination.



High-quality measurements (flagged green in the bottom track) of density by the InSitu Density fluid density sensor and viscosity by a vibrating wire sensor were made on fluid flowed from the higher mobility upper zone.*

DFA of the sampled fluid included in situ fluid viscosity measured with the InSitu Viscosity* reservoir fluid viscosity sensor using a vibrating wire sensor. Having accurate viscosity measurements well in advance of laboratory analysis made it possible to derive the permeability and furthered the interpretation of permeability anisotropy from two IPTTs that were conducted by the Saturn 3D radial probe in combination with a monitoring probe spaced just 1.23 m apart. Using the Saturn 3D radial probe instead of a conventional dual-packer configuration isolating an interval of the formation reduced testing time significantly and also lessened supercharging effects.



The consistency of the superimposed radial flow regimes achieved by the pressure gauges in the Saturn 3D radial probe and the monitoring probe provides high confidence in the results. The derivative plot from the Saturn probe does not have a distinct spherical flow regime; permeability anisotropy is interpreted from simultaneous matching of the Saturn and monitoring probe pressures.

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