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ECONOMIC RECOVERY OF OIL TRAPPED AT FAN MARGINS USING HIGH ANGLE WELLS AND MULTIPLE HYDRAULIC FRACTURES

Quarterly Technical Progress Report
April 1-June 30, 1998

By
Mike L. Laue

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Performed Under Contract No. DE-FC22-95BC14940

Atlantic Richfield Co.
Bakersfield, California

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Economic Recovery of Oil Trapped at Fan Margins Using High Angle Wells and Multiple Hydraulic Fractures

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TITLE: ECONOMIC RECOVERY OF OIL TRAPPED AT FAN MARGINS USING HIGH ANGLE WELLS AND MULTIPLE HYDRAULIC FRACTURES

Cooperative Agreement No.:	DE-FC22-95BC14940 -11
Contractor Name and Address:	Atlantic Richfield Co., P.O. Box 147, Bakersfield, California 93302
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Project Manager:	Dan Ferguson, NPTO
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Disclaimer

Objective

This project attempts to demonstrate the effectiveness of exploiting thin-layered, low-energy deposits at the distal margin of a prograding turbidite complex through the use of hydraulically fractured horizontal or high-angle wells. The combination of a horizontal or high-angle well and hydraulic fracturing will allow greater pay exposure than can be achieved with conventional vertical wells while maintaining vertical communication between thin interbedded layers and the wellbore.

A high-angle well will be drilled in the fan-margin portion of a slope-basin clastic reservoir and will be completed with multiple hydraulic-fracture treatments. Geologic modeling, reservoir characterization, and fine-grid reservoir simulation will be used to select the well location and orientation. Design parameters for the hydraulic-fracture treatments will be determined, in part, by fracturing an existing test well. Fracture azimuth will be predicted by passive seismic monitoring of a fracture-stimulation treatment in the test well using logging tools in an offset well.

Summary of Technical Progress

The remaining pay intervals in Yowlumne Unit B 91X-3 were perforated during the fourth quarter of 1997. The well was allowed to produce during the second quarter of 1998. Production trends were monitored to determine the extent of cleanup. Analysis of stimulation options continued, with a focus on mitigating formation damage from drilling operations.

Production Performance

The remaining pay intervals in Yowlumne Unit B 91X-3 (behind the 7 in. liner) were perforated in November 1997. Figure 1 shows the location of all perforated intervals relative to the major Stevens sand layers. The well has been allowed to produce and clean up since then while future stimulation options are being evaluated.

Prior to perforating the remaining pay intervals, the well was producing 160 BOPD and 80 BWPD. Initial production following the wellwork was 220 BOPD and 20 BWPD. The well has now stabilized at approximately 150 BOPD and 150 BWPD and is declining slightly (Fig. 2).

Inflow performance relationship (IPR) curves were established by layer (Fig. 3). The 240 BPD total liquid rate for Sand C represents the initial production rate from the lower perforations. Adding perforations in Sands A and B were expected to add 170 BPD, however, the actual increase was only 80 BPD.

Future Plans

Production surveillance will be continued to confirm the well has cleaned up to the maximum extent possible through continued operation. The new perforations will be stimulated to improve production similar to an earlier stimulation of the lower perforations. A non-acid reactive fluid consisting of a blend of KCl water, iron chelating agents, mutual solvents, surfactants, and nitrogen was pumped through coiled tubing into the lower perforations. This treatment of the original completion interval successfully increased production from a trace of oil and 40 BWPD to 220 BOPD and 20 BWPD.

Following stimulation of the upper perforations, the well will be produced for a period of time to clean up and observe production trends and pressure behavior.

Based on these results, a hydraulic fracture treatment may be considered for these perforations.

Technology Transfer

Preparations for a public workshop continued during the second quarter. The workshop is being planned for August 20, 1998 in Bakersfield, California. The purpose of this workshop is to review the project to date with industry and other interested parties. Attention will be focused on general project information, well planning, drilling operations and completion operations to date.

During the second quarter, an invitation list for the workshop was developed. In addition, materials were selected for a compact disc to be distributed to workshop participants, as well as those unable to attend.

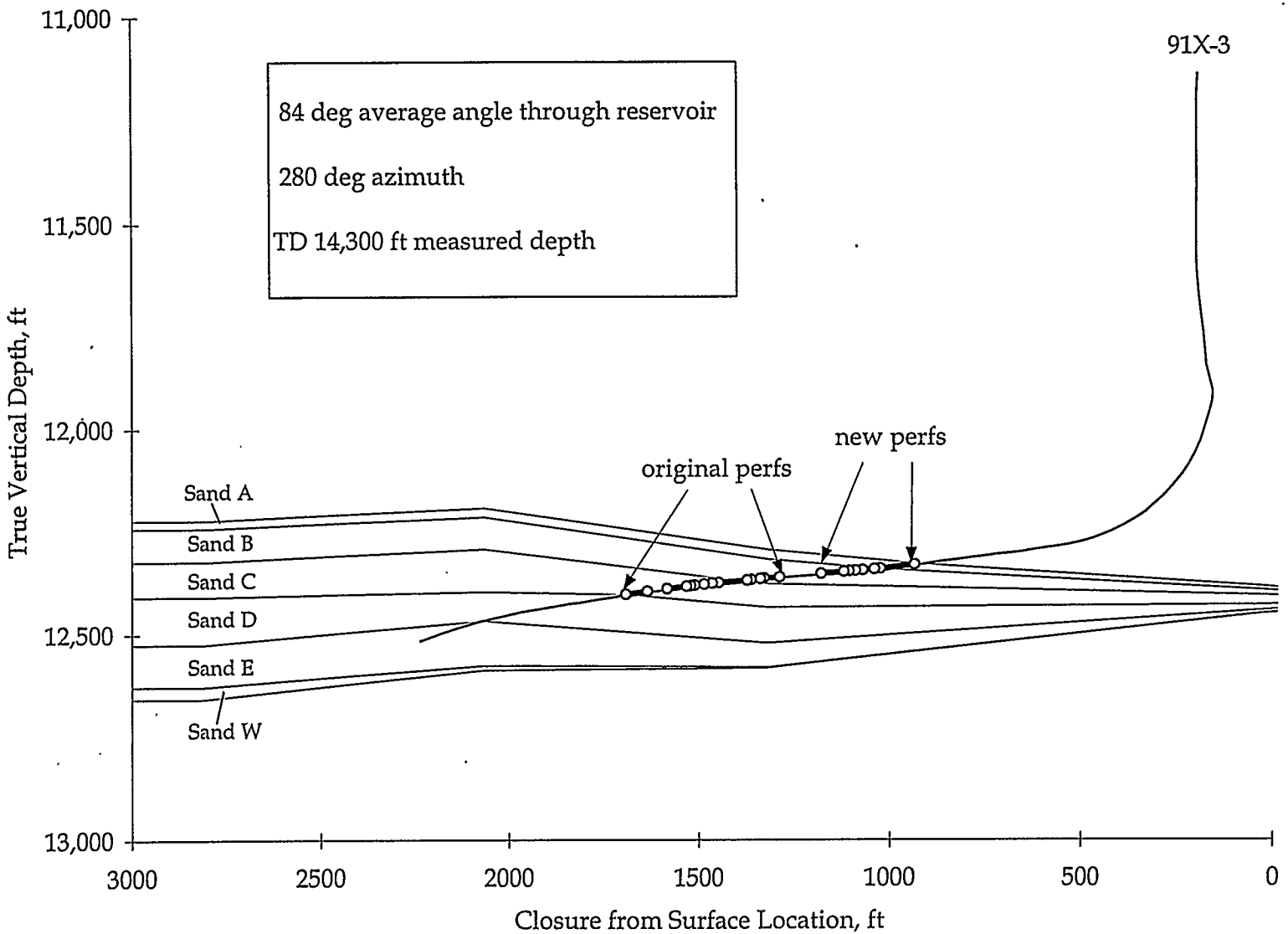

Figure 1. Actual well path relative to major Yowlumne sand intervals. Also shown are existing perforated intervals.

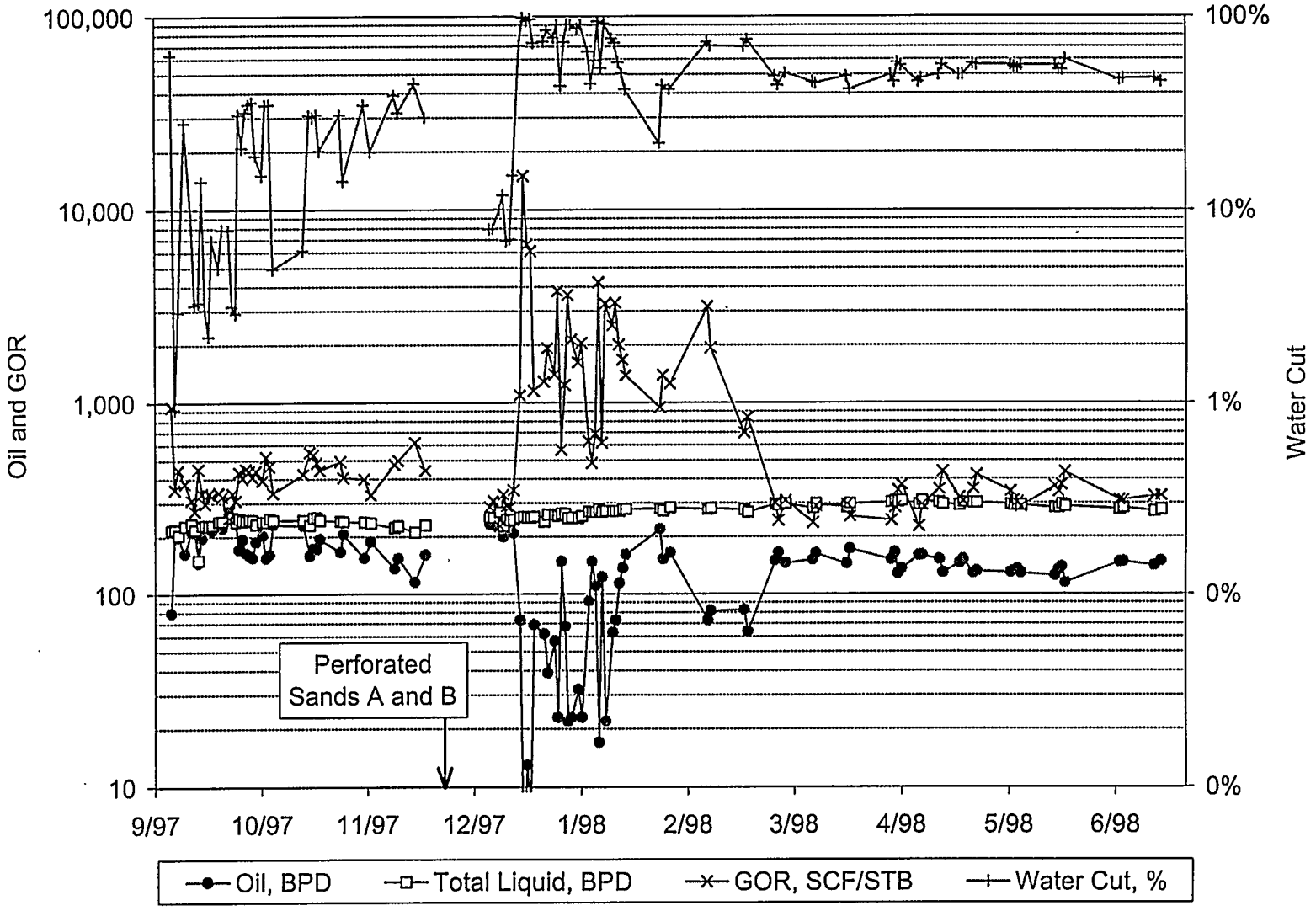

Figure 2. Well tests before and after perforating Sands A and B.

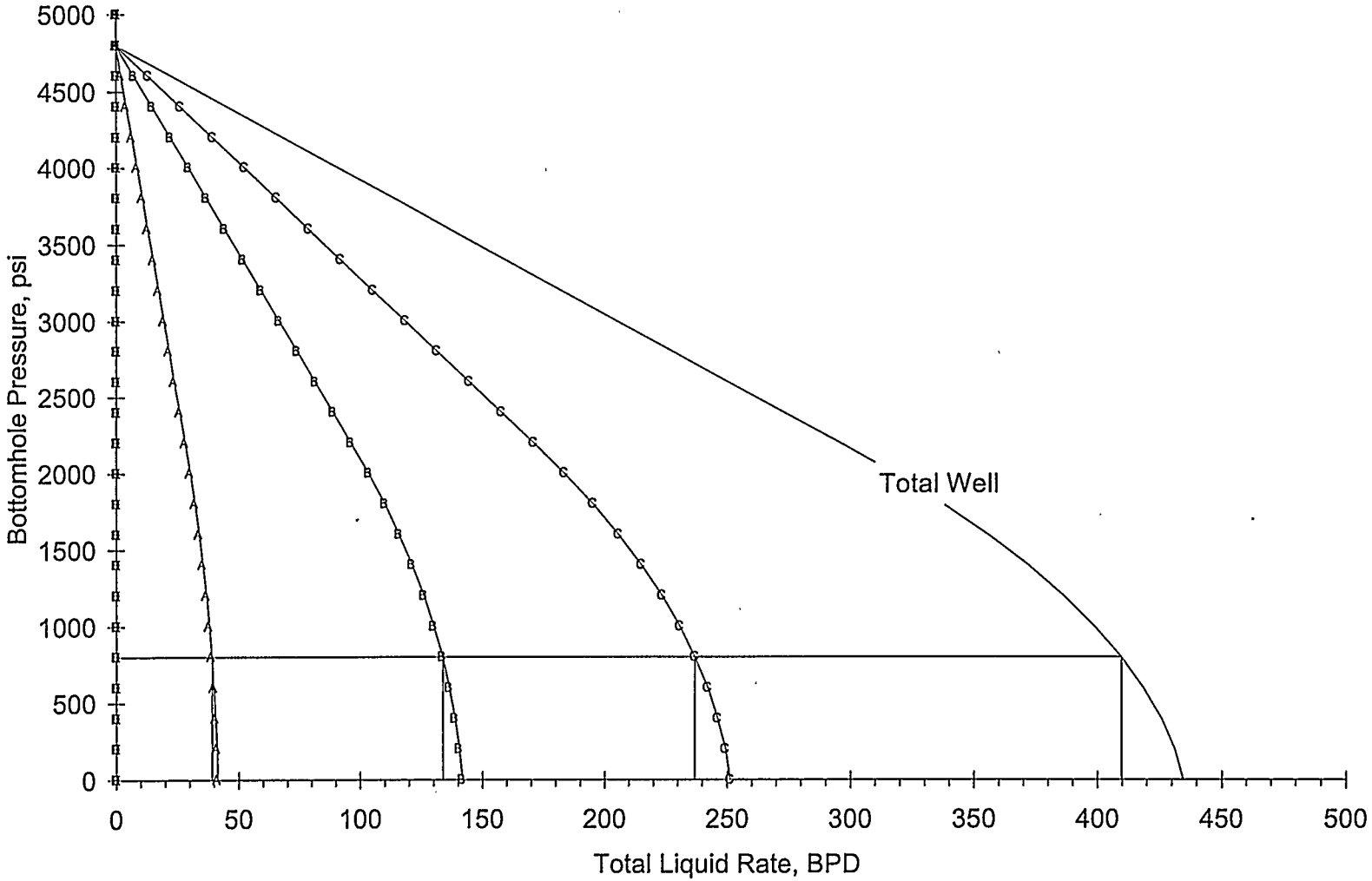

Figure 3. Vogel IPR curve for Sand C and expected IPR curves for Sands A and B.