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Quarterly Technical Progress Report
09/30/93 - 12/31/93
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Increased Oil Production And Reserves From Improved Completion Techniques In The Bluebell Field, Uinta Basin, Utah

Contract DE-FC22-92BC14953

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DISCLAIMER

Quarterly Technical Progress Report

INCREASED OIL PRODUCTION AND RESERVES FROM IMPROVED COMPLETION TECHNIQUES IN THE BLUEBELL FIELD, UINTA BASIN, UTAH

COOPERATIVE AGREEMENT NUMBER:	DE-FC22-92BC14953
INSTITUTION:	Utah Geological Survey
DATE OF REPORT:	1/10/1994
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PROGRAM MANAGER:	Craig D. Morgan
PRINCIPAL INVESTIGATOR:	M. Lee Allison
CONTRACTING OFFICER'S REPRESENTATIVE:	Edith Allison
REPORTING PERIOD:	09/30/93 - 12/31/93

Objective

The objective of this project is to increase the oil production and reserves in the Uinta Basin, Utah, by demonstration of improved completion techniques in the Bluebell field (figure 1). Low productivity is attributed to gross production intervals of several thousand feet that contain perforated thief zones, water-bearing zones, and unperforated oil-bearing intervals. Geologic and engineering characterization and computer simulation of the Tertiary Green River and Wasatch Formations in the Bluebell field will determine reservoir heterogeneities related to fractures and depositional trends. This phase will be followed by drilling and recompletion of several wells to demonstrate improved completion techniques based on the reservoir characterization. Transfer of the project results will be an ongoing component of the project.

Summary of Technical Progress

Outcrop studies

Outcrops of the Green River Formation are being investigated to better understand reservoir quality and distribution. The study includes describing depositional environments facies distributions, petrophysical properties, and fracture susceptibility. A 2,713-foot (827-m) stratigraphic section in the Willow Creek Canyon area of Carbon and Duchesne Counties, Utah, was described. The section was divided into 719 units. Petrographic classification indicates a minimum of 18 major rock types which were analyzed for plug porosity and permeability. Porosity values range from 0.2 to 27.2 percent and permeabilities range from < 0.01 to 1,342 millidarcies. Interpreted depositional environments range from paralic fluvial to open-lacustrine. Samples were collected for fracture-inducement studies to determine the potential fracture type and density for each significant potential reservoir facies. The individual facies will be correlated with geophysical logs from wells near the outcrop to determine the log characteristics. These will be used in combination with petrophysical properties of drill cuttings and core to identify and correlate important reservoirs in the Bluebell field.

Subsurface studies

Digitizing of geophysical well logs from the Bluebell field is 14 percent complete (34 logs digitized of the 240 planned). The digital data will be used for field-wide correlation and determination of porosity trends, sandstone to shale ratios, oil saturation, and clay content of the various reservoir types. Detailed correlation and analyses of the primary reservoir facies is being done in the eastern portion of the field where the demonstration phase of the project is tentatively located.

Imaging logs and dip logs from the Bluebell field are being examined to determine fracture orientation, density, and distribution, and principle stress direction in the various reservoirs within the productive interval. Borehole imaging logs are not part of the normal logging suite in the Bluebell field. Therefore, to encourage their use and to gather the needed imaging data, the program is offering to pay a portion of the

logging cost associated with running such logs. Bluebell field operators and logging companies have been notified of this offer.

Oil and gas cumulative production, flush-oil production, initial potential, and gas/oil ratios for both the initial and cumulative production were contoured for the Bluebell field (Morgan, 1994). The cumulative production from individual wells in the Bluebell field typically ranges from < 100,000 to 500,000 barrels of oil per well in the eastern portion of the field. In contrast, many of the wells in the west-central portion of the field have produced 1,000,000 to 3,000,000 barrels of oil per well. A typical well in the Bluebell field produces one- to two-thirds of its cumulative volume of oil during its first five years of production. The gas-to-oil ratio is typically 500 to 1,000 cubic feet (14 to 28 m^3) of gas per barrel of oil during the initial production and rarely changes significantly during the life of the well. The wells in the Bluebell field are commonly perforated over a gross interval of 1,000 to 2,500 feet (300-760 m) (figure 3) with 20 to 40 separate reservoirs open to the wellbore.

A well database for the Bluebell field was developed which includes current operator name, well name, location, elevation, status, spud and completion dates, current status, and monthly production history since 1984. Input tables were generated for age information, formation top data, completion history, oil and gas analyses, and logs, cuttings, and core that are available at the Utah Geological Survey.

Engineering studies

Oils from the Bluebell field are generally characterized as either black or yellow wax crude. The black wax crude is produced from the shallower, lower Green River Formation. The yellow wax is a slightly higher gravity, more mature crude that is produced from the deeper Wasatch Formation. Short- and long-column compositional analyses were conducted on both crudes. The long-column analysis provided the carbon number distribution from C_5-C_{44} and a $C_{44}+$ fraction. The yellow wax crude had a $C_{44}+$ fraction of 0.28 and the black wax crude was 0.48 (figure 4). These data are consistent with the API gravities of these crude oils, which were reported to be 39° API and 33° API respectively. Analysis of the lighter yellow wax showed a lower percentage of residual high-boiling fraction. The short-column analysis revealed that all of the yellow wax crude oil eluted before the residence time for carbon number C_{90}. Thus all of the $C_{44}+$ fraction had a carbon number distribution between C_{44} and C_{90}.

Preliminary investigation of the reservoir and hydrocarbon parameters determined the oil bubble point to be about 3,200 pounds per square inch (22,000 Kpa). The oil formation factor is 1.45 to 1.50 at a gas-to-oil ratio of 800 to 900 cubic feet (22.7 to 25.5 m^3) of gas per barrel of oil. The initial reservoir pressure was estimated to have been approximately 4,000 pounds per square inch (27,000 Kpa) at an average depth range of 10,000 to 12,000 feet (3,000-3,700 m).

Initial reservoir pressure is difficult to accurately determine in most wells in the Bluebell field. Reservoirs in the lower Green River Formation and the upper portion of the Wasatch Formation are typically at normal pressure with a gradient of 0.40 to 0.50 pounds per square inch per foot (9.2-11.2 Kpa/m). Reservoirs in the lower portion of the Wasatch are commonly overpressured with gradients as high as .60 to .70 pounds per square inch per foot (13.5-15.7 Kpa/m). Drill-stem tests which can provide a shut-in pressure are rarely conducted in the Bluebell field. As a result, the

few tests that have been run do not provide sufficient data to evaluate or predict reservoir pressure for the field or vertically through the section. An attempt to identify the top of the high-pressure zone in the lower Green River and Wasatch Formations by plotting the mud-weight gradient was inconclusive. Although operators typically built the mud weight from 9 pounds per gallon to 14 pounds per gallon (1079-1679 kg/m^3) within a 50- to 100-foot (15-30 m) interval, many did so prior to encountering the high-pressure zone and drilled to total depth over-balanced. Shut-in pressure determined during the completion of the wells represent the lowest pressure in the perforated interval. The perforated interval is typically 1,000 to 2,000 feet (300-600 m) and may include both normal- and over-pressured zones (figure 5).

The Quinex Energy 1-7 Michelle Ute (section 7, T. 1 S., R. 1 E., Uinta Base Line) and 1-17 Malnar Pike (section 17, T. 1 S., R. 1 E.) wells are being consider for recompletion as part of the demonstration phase of the project. The Michelle Ute has produced 102,200 barrels of oil in nine years and the Malnar Pike has produced 89,687 barrels of oil in six years (as of 9/31/93). A decline curve analyses indicates the Michelle Ute would produce 156,000 barrels of oil and the Malnar Pike would produce 123,000 barrels of oil if they produced for 20 years. The wells are currently near their economic limit and cannot be produced for the calculated 20 years without additional recompletion work. Preliminary original-oil-in-place (OOIP) calculations of the perforated intervals in the Michelle Ute and Malnar Pike wells indicate 3.65 million and 6.5 million stock-tank barrels oil respectively (assumed is a 30 percent water saturation and a 40-acre drainage area). The preliminary calculations show that the wells may only recover 1 to 3 percent of OOIP.

Completion information from the digitized wells is being entered into a database in order to evaluate the effectiveness of the various completion techniques used over the years.

Next Quarter Planned Activities

The planned activities for the next quarter are:

1. Continue digitizing well logs from the Bluebell field.
2. Continue entering data into the well database and the completion evaluation database.
3. Complete a structure contour map of the top of the lower Green River Formation.
4. Begin petrophysical examination of cuttings and core from the Bluebell field.
5. Begin developing a dual-porosity reservoir model for several primary reservoirs in the proposed demonstration portion of the field.

References

Morgan,C.D.,1994, Oil and gas production maps of the Bluebell field, Duchesne and Uintah Counties, Utah: Utah Geological Survey Oil and Gas Field Study 15, 4p., 7 plates, scale 1 inch = 0.8 miles.

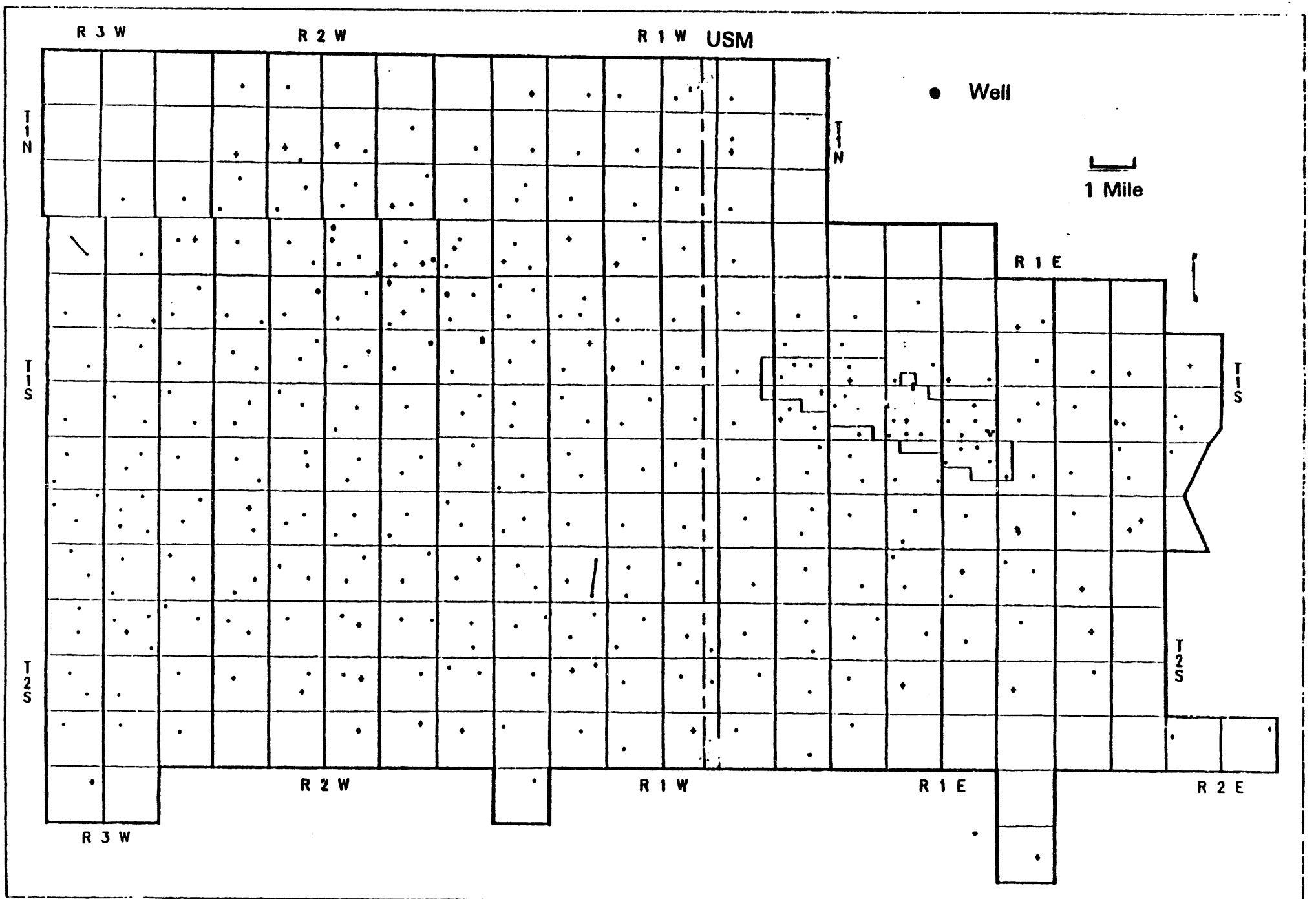

Figure 1. Drill hole location map of the Bluebell field, Duchesne and Uintah counties, Utah.

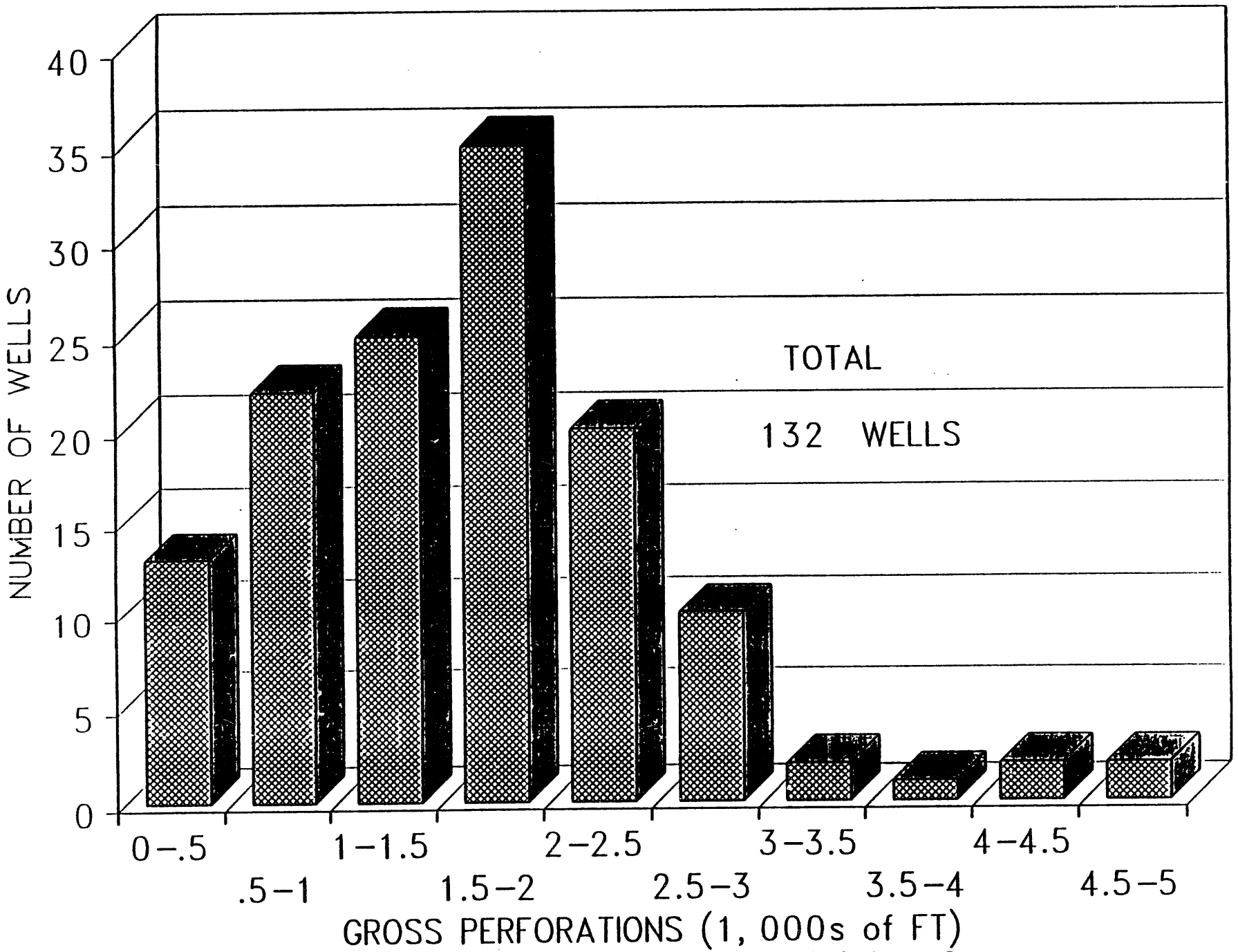

Figure 2. Histogram of gross perforated interval of wells completed in the Lower Green River and Wasatch Formations in a portion of the Bluebell field (T. 1 S., R. 1 E., R. 1 W. and 2 W., Uinta Base Line)

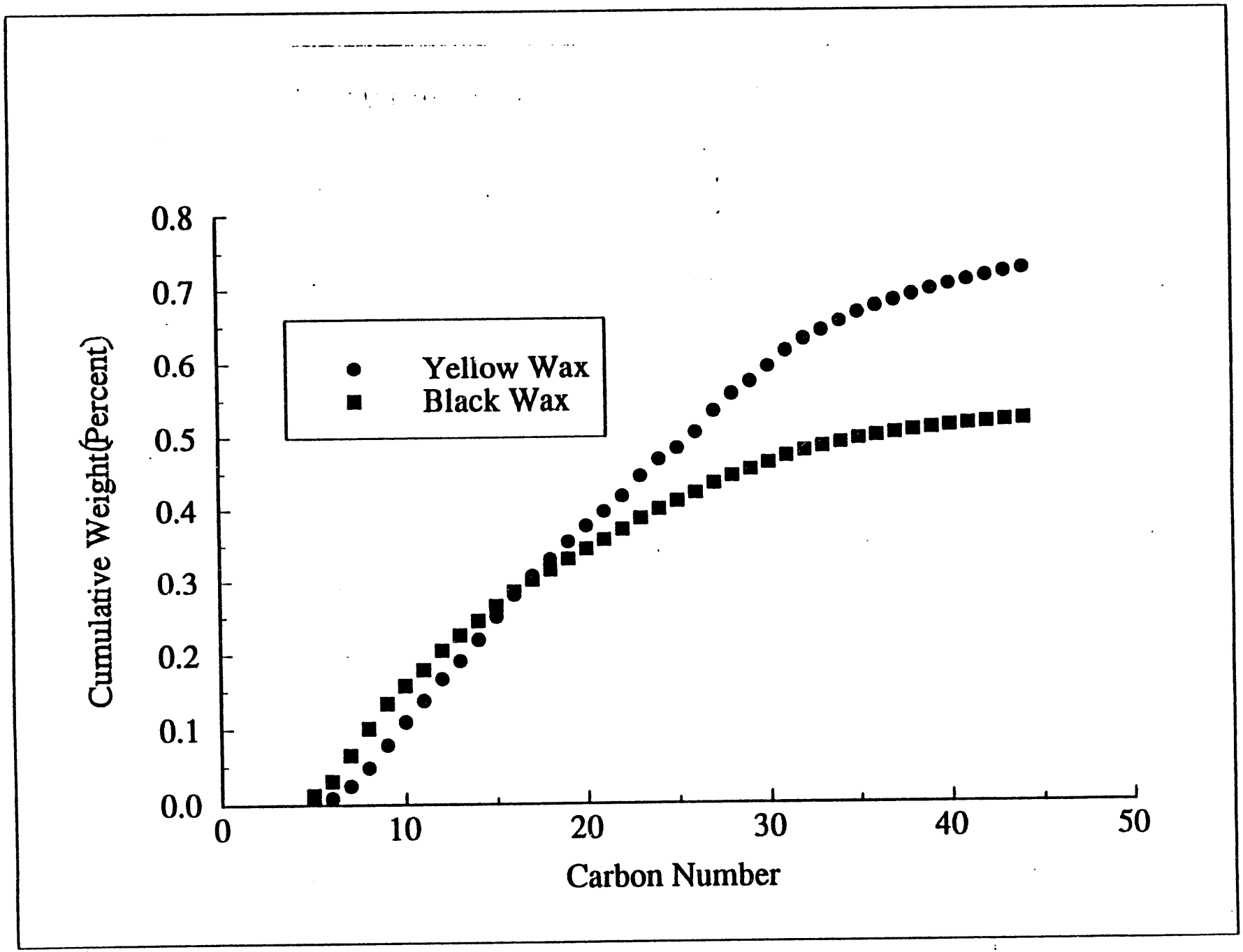

Figure 3. Long-column compositional analysis of a yellow and black wax crude from the Bluebell field.

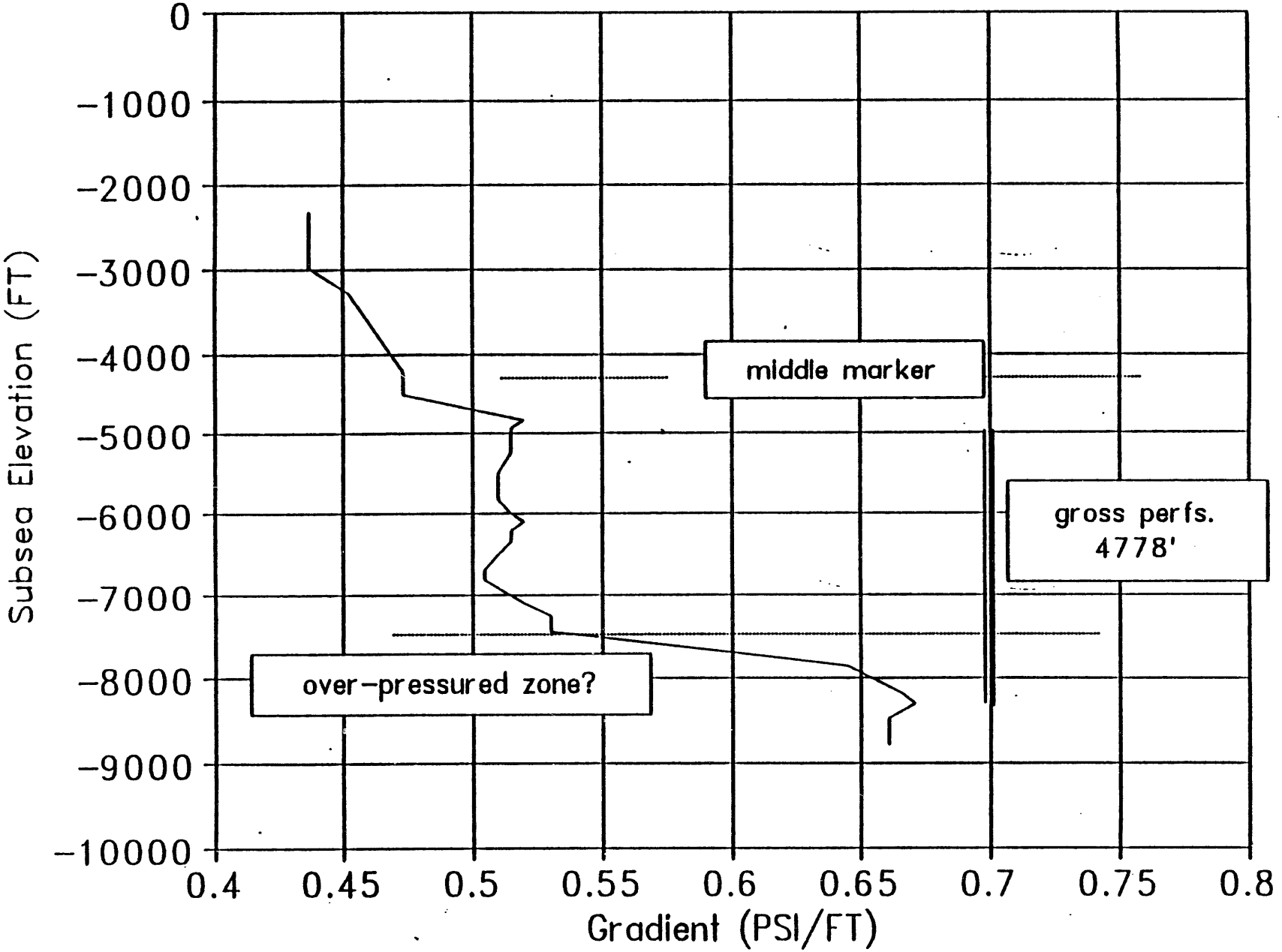

Figure 4. Mud-weight pressure gradient calculated from the mud weights reported on the mud log of the 1-17 Malnar Pike well. The actual formation fluid pressure (unknown) is less than the mud-weight fluid pressure. The gross perforated interval includes both apparent normal- and over-pressured zones.

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