CHARACTERIZATION OF OIL AND GAS RESERVOIR HETEROGENEITY

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Petroleum Development Laboratory
University of Alaska Fairbanks
437 Duckering Building
Fairbanks, AK 99775-1260

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Principal Investigator:
G. D. Sharma

Project Manager:
Idaho Operations Office

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OBJECTIVE

The ultimate objective of this cooperative research project is to characterize Alaskan petroleum reservoirs in terms of their reserves, physical and chemical properties, geologic configuration in relation to lithofacies and structure, and development potential.

The project has two tasks: Task 1 is a geological description of the reservoirs including petrophysical properties, i.e., porosity, permeability, permeability variation, formation depth, temperature, and net pay, facies changes and reservoir structures as drawn from cores, well logs, and other geological data. Task 2 is reservoir fluid characterization—determination of physical properties of reservoir fluids including density, viscosity, phase distributions and composition as well as petrogenesis—source rock identification; and the study of asphaltene precipitation for Alaskan crude oils.

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SUMMARY OF TECHNICAL PROGRESS

Determination of Petrophysical Properties of the Milne Point Unit

The Milne Point Unit is located adjacent to the West Sak Field. The field is operated by Conoco, Inc. It is estimated to contain 100 million barrels of oil-in-place. Oil production is from the Cretaceous Kuparuk River Formation at depths ranging from 6900 ft to 7200 ft subsea.

Petrophysical properties of the milne Point Unit are derived from well logs. Core data and completion reports were used to augment the well log data. The results of well log analyses show that the porous and permeable zones can be grouped into two sand lobes: the Middle Kuparuk lobe and the Lower Kuparuk lobe. The Middle Kuparuk lobe is found at depths ranging from 6900 to 6940 ft subsea. The average porosity in the Middle lobe is about 25% and the average water saturation is 42%. The Lower Kuparuk lobe lies between 7086 ft and 7134 ft. The values of porosity and water saturation are slightly higher in the Lower lobe than in the Middle Kuparuk lobe (Table 1).

Endicott Field

Additional well logs from the Endicott field were analyzed during this quarter. Figure 1 shows the log traces from Endicott Well SDI 3-47. Data from comparative analyses (e.g., Figure 1) show that the log-derived porosities were consistent with the values of porosities measured from cores. However, the log-derived values of water saturation were consistently higher than those obtained from core measurements. Efforts are currently underway to explain the observed differences.

Reservoir Fluid Characterization

As part of the reservoir fluid characterization task, a polydispersed molecular thermodynamic model has been developed to predict the conditions for asphaltene precipitation for Alaskan crude oils.

The model treats the asphaltenes as a heterogeneous mixture of pseudocomponents in crude oil. The properties of each pseudocomponent of asphaltenes are calculated

using the average molecular weight of the fraction. The model is coupled with the Peng-Robinson equation-of-State and their departure function models to compute the molar volume and the solubility parameter for equilibrium liquid phase of the oil-solvent mixtures.

The model has been validated using the data measured from asphaltene precipitation experiments conducted with several West Sak crude oil-solvent mixtures. The work currently in progress is to use the West Sak oil-solvent mixtures to study the effects of pressure and temperature on asphaltene precipitation in the West Sak.

REFERENCES

1. Oil and Gas Journal, 1985, "Milne Point Unit—Small but Welcome," Vol. 83, No. 25, pp. 55-58.

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Table 1. Log-Derived Petrophysical Properties

ZONE	LOBES	INTERVAL DEPTH	AVERAGE GROSS THICKNESS (ft)	NET PAY (ft)	AVERAGE POROSITY (%)	AVERAGE WATER SATURATION (%)
Middle Kuparuk	Upper Lobe	6902- 6919	17	5	23	43
Middle Kuparuk	Lower Lobe	6920- 6940	20	9	27	41
Lower Kuparuk	Upper Lobe	7086- 7103	17	3	28	49
Lower Kuparuk	Lower Lobe	7111- 7134	23	6	28	46

Figure 1. Comparison Between Log-Derived and Core-Derived Properties SDI 3-47.

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