Interdisciplinary Study of Reservoir Compartments
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ANNUAL TECHNICAL REPORT

Interdisciplinary Study of Reservoir Compartments
Contract No. DE-AC22-93BC14891

Colorado School of Mines

Report Date: October 28, 1994

Craig W. Van Kirk
Principal Investigator

Reporting Period: October 1, 1993 to September 30, 1994

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Annual Technical Report
Interdisciplinary Study of Reservoir Compartments
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Project Objectives:

This DOE research project was established to document the integrated team approach for solving reservoir engineering problems. A field study integrating the disciplines of geology, geophysics, and petroleum engineering will be the mechanism for documenting the integrated approach. This is an area of keen interest to the oil and gas industry. The goal will be to provide tools and approaches that can be used to detect reservoir compartments, reach a better reserve estimate, and improve profits early in the life of a field.

Summary of Progress:

Field selection consumed nearly the first four months of the project. Nine candidate fields were presented and discussed. Emphasis was placed on selecting a field where the integration of each of the disciplines could be demonstrated. The project team's first selection, South Casper Creek, was not acceptable to the DOE because of its eolian depositional environment. The second choice was the Lambert Field area which is the field area being studied.

During the remainder of the year, a significant portion of the data was gathered and entered into a data base.

Cores have been described, log analysis performed on over 100 wells, and regional mapping and correlation of sedimentary packages completed. This work is the basis for the preliminary understanding of the reservoir compartmentalization.

Compressional(P) and shear(S) wave velocity data was measured on 8 core plugs at various conditions and lithologies. These results will help establish the correlation between each facies and its geophysical response. The analysis of the 3D seismic data has been started and supports the interpretation that the structural component will be a significant factor for reservoir compartmentalization in this reservoir. Engineering data also supports this conclusion.

The experimental permeability work completed includes the pressure decay profile permeability measurements on the cores. The comparison of these measurements with the facies identified

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by visual inspection of the cores are in good agreement. Relationships of porosity and permeability with net confining stress were developed. Core relative permeability measurements were also completed during the year.

Additional experimental measurements completed include Young's Modulus, Shear Modulus, Poisson's ratio, and the bulk compressibility as a function of the effective stress. This data will be useful during the simulation phase of the study.

Preliminary engineering analysis of the pressure build-up data from two wells supports the conclusion that sealing faults may act as barriers to flow.

Significant Accomplishments:

Success in any integrated study hinges on the team members. The Lambert Compartmentalization project team consists of professors and students from each of the three departments: Geology, Geophysics, and Petroleum Engineering. The importance of a team effort can not be under estimated. Team members that are willing to listen, provide feedback, and contribute are a necessity. Fortunately, the Project Team members working on this project are exceptional. The meetings are exciting, open, and productive.

From a technical point, data base management may be the biggest challenge. Data gathering and management have been an ongoing task since the selection of a study area. The challenge is to organize, store, and be able to retrieve the raw and processed data needs of each of the disciplines. The data base structure has been determined and is meeting the needs of the project team.

The complex nature of the Aristocrat-Lambert area, as noted in the quarterly reports, is a significant conclusion from a geologic perspective. The system is more complex than the study team first thought and probably more complex than perceived by most operators in the area. The preliminary 3D seismic interpretation and engineering analysis supports the complex interpretation.

Results of the log analysis should be noted. Application of log analysis techniques demonstrates that bulk volume water (BVW) is a better parameter for discriminating pay from no-pay than

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porosity, water saturation, or shale volume cutoffs. This method helps to distinguish thinly laminated sands that commonly occur in the study area. The method is based on work done by Tixier in 1949.

From the experimental relative permeability work, it should be noted that the effect of increasing the net confining stress from 100 psig to 3500 psig and the temperature from 70 F to 140 F causes only a minor shift in the end points and the shape on the relative permeability curves. These variations could easily be within the limits of experimental procedures, the equipment, and data smoothing techniques.

Finally, the process of technology transfer has started. During the year, one abstract "Structural and Stratigraphic Compartmentalization of the Terry Sandstone and Effects on Reservoir Fluid Distributions: Part II, Lambert-Aristocrat Fields, Denver Basin, Colorado" was presented at the First Biennial Conference on Natural Gas in the Western United States, October 17-18, in Golden, Colorado. Abstracts are now being prepared for an International AAPG Conference. Several papers are planned for the second year of the project.

Future Work:

The integrated process of evaluating the Lambert area will continue as scheduled. Outcrop work is the only task that has been deferred. As mentioned in the quarterly reports, this task was deferred until a better understanding of the depositional environment could be determined. The outcrop work will be completed in 1995.

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<950> ABSTRACT

This DOE research project was established to document the integrated team approach for solving reservoir engineering problems. The goal will be to provide tools and approaches that can be used to detect reservoir compartments, reach a better reserve estimate, and improve profits early in the life of a field. Field selection consumed nearly the first four months of the project. The choice was the Hambert Field area which is the field area being studied. During the remainder of the year, a significant portion of the data was gathered and entered into a data base. Cores have been described, log analysis performed on over 100 wells, and regional mapping and correlation of sedimentary packages completed. Compressional (P) and shear (S) wave velocity data was measured on 8 core plugs at various conditions and lithologies. The analysis of the 3D seismic data has been started and supports the interpretation that the structural component will be a significant factor for reservoir compartmentalization in this reservoir. The experimental permeability work completed includes the pressure decay profile permeability measurements on the cores. Relationships of porosity and permeability with net confining stress were developed. Core relative permeability measurements were also completed during the year. Additional experimental measurements completed include Young's Modulus, Shear Modulus, Poisson's ratio, and the bulk compressibility as a function of the effective stress. Preliminary engineering analysis of the pressure build-up data from two wells supports the conclusion that sealing faults may act as barriers to flow.