INTERDISCIPLINARY STUDY OF RESERVOIR COMPARTMENTS AND HETEROGENEITY

Contract No. DE-AC22-93BC14891

Colorado School of Mines
Golden, CO

Date of Report: April 30, 1996
Contract Date: September 29, 1993
Anticipated Completion: Sept. 30, 1996
Government Award: $753,266

Principal Investigator:
Craig W. Van Kirk

Project Manager:
Robert S. Thompson

Reporting Period: Jan. 1 - Mar. 31, 1996

Objectives

The major project objective is to help move small American businesses (oil and gas independent operators) from traditional practices in oil and gas reservoir management to an improved integrated team approach making better use of information and the expertise of people. This objective is being accomplished in two ways: (1) Specific examples resulting from our field study, and (2) A general manual documenting the process of integrating data and people from the disciplines of geology, geophysics, and petroleum engineering. This manual will present a new and powerful approach for optimizing the economic value of domestic oil and gas resources.

An actual oil field in the Denver Julesburg Basin in Colorado was selected to test the methods of integration. Description of a highly compartmentalized Terry sandstone reservoir is the focus of the integrated team approach. In compartmentalized reservoirs wells recover less than expected. In this regard, our field study in the Denver Julesburg Basin will be a model for many other fields in the United States.

Summary of Technical Progress

Efforts during this quarter were dedicated to history matching of the simulation model and to planning for various forecast runs. The geologic model and the engineering analysis resulted in a reservoir simulation model that is representative of the main features of the reservoir, such as the compartments and differing gas-oil contacts in each compartment. As a result of the history matching process, changes were made in the model. The economic significance of these changes, if any, will be addressed in the final report. These changes are summarized in the following sections.

Regions

The five regions for each layer separating the main compartments defined in this model are still valid. Minor changes were made in the relative location of some of the faults. The shift in the location of the faults were within the accuracy of the data used to estimate the location of the faults. This is an example where additional information reduces some of the uncertainty. It was also determined that regions 2 and 3 are in communication and therefore have the same gas oil contact (GOC).

Gas-Oil Contacts

The GOC of the five regions were modified several times throughout the process of history matching. Table 1 summarizes the GOC for each of the five regions:
TABLE 1
GOC Data by Reservoir Simulation Region

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Well Completions

The completion reports of the wells indicate that most of the wells were perforated in layer 4, several of the wells were shot also in layer 3 and some of them in layer 5. Several wells do not have completion reports. For the simulation model it was assumed that through hydraulic fracturing most of the wells were open in layers 3, 4, and 5. Layers 1 and 2 are sparse sand bodies, are thin, and have low porosity. For the simulation model it was initially assumed that neither layer 1 nor layer 2 were open to production. Throughout the history matching process it was found necessary in some wells to close layer 3, in others to close layer 5, and in some to open layer 2. When performing these modifications it was clear that these changes were consistent with the completion reports.

Initial Gas and Oil in Place

Initial conditions of gas and oil in place slightly changed due to minor local changes in thickness, but these changes are not affecting substantially the numbers reported in the last report. These values may still be refined and therefore summaries of the final values are not presented.

Sealing Faults

As mentioned earlier there were minor shifts in the location of some of the faults. The changes were minor and within the accuracy of the original data.

Gathering Centers for the Simulation Model

In several cases the production for a single well is commingled and reported on a lease basis. The production data for individual wells were created using available production data, knowledge of the date at which the new wells started production, and knowledge of the initial production rate for new wells. Using this information pseudo decline curves for each well on the lease are developed for history matching purposes. For each lease, the summation of the allocated individual production is consistent with the total lease production.

The reservoir simulator incorporates nine gathering centers. Seven of the gathering centers have two wells each. One center has three wells, and one center has seven wells.

Technology Transfer

On February 29, 1996, Robert Benson and Thomas Davis made a presentation at the 3-D Seismic Symposium sponsored by the Rocky Mountain Association of Geologists and the Denver Geophysical Society. Their presentation was titled "Three Dimensional Seismic Reservoir Characterization of Hambert Field, Denver Basin, Colorado."

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1. (Award) Contract No. DE-AC22-93BC14891
2. Title Interdisciplinary Study of Reservoir Compartments and Heterogeneity

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      (2) ☑ Quarterly ☐ Semiannual ☐ Annual ☐ Final
         ☑ Topical ☐ Phase I ☐ Phase II
         ☐ Other (specify)
         Dates covered 1/96 thru 3/96
   b. Conference/Meeting/Presentation (Complete all that apply)
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      ☐ Published proceedings
      ☐ Other (specify)
      (2) Conference Title (no abbreviations)

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