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TITLE: GEOSCIENCE/ENGINEERING CHARACTERIZATION OF THE INTERWELL
ENVIRONMENT IN CARBONATE RESERVOIRS BASED ON OUTCROP ANALOGS, PERMIAN
BASIN, WEST TEXAS AND NEW MEXICO

Contract No. DE-AC22-93BC14895

Contractor Name and Address: Bureau of Economic Geology (BEG), The University of Texas at
Austin, Austin, Texas 78713

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Project Manager: Robert E. Lemmon, Bartlesville Project Office

Reporting Period: January 1, 1996–April 30, 1996

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QUARTERLY TECHNICAL PROGRESS REPORT

for

GEOSCIENCE/ENGINEERING CHARACTERIZATION OF THE INTERWELL ENVIRONMENT IN CARBONATE RESERVOIRS BASED ON OUTCROP ANALOGS, PERMIAN BASIN, WEST TEXAS AND NEW MEXICO

Contract No. DE-AC22-93BC14895

Objective

The objective of this project is to investigate styles of reservoir heterogeneity found in low-permeability pelleted wackestone/packstone facies and mixed carbonate/clastic facies found in Permian Basin reservoirs by studying similar facies exposed in the Guadalupe Mountains. Specific objectives for the outcrop study include construction of a stratigraphic framework, petrophysical quantification of the framework, and testing the outcrop reservoir model for effects of reservoir heterogeneity on production performance. Specific objectives for the subsurface study parallel objectives for the outcrop study.

Summary of Technical Progress

Subsurface Activities

Recovery of much of the South Cowden field is only 20 percent of the original oil in place. Perforations typically extend from near the top to only about halfway through the reservoir. The additional waterflood-displaceable oil that might be produced by adding deeper perforations was estimated with numerical simulation.

A three-dimensional model was constructed for a 40-acre area in the northeast 160 acres of section 7 (Moss unit tract 20). The petrophysical properties in the model are intended specifically to represent the tract 20 area. The well arrangement represents an injection pattern similar to that historically applied in the area: a line drive with two injectors on the west edge and three producers on the east. This well arrangement approximately matches the average number of injectors per section (eight) and the average injector-producer ratio (1:2) in sections 5, 6, 7, and 8.

Three approaches were tested for constructing the model: (1) smooth mapping of average properties in geologically defined high-frequency cycles, (2) two-dimensional heterogeneous stochastic simulation of average properties in geologically defined high-frequency cycles, and (3) direct three-dimensional heterogeneous stochastic simulation. All the approaches were based upon porosity, permeability, and initial water saturation data from well logs. Waterflood simulations with these models give similar results, but the direct three-dimensional stochastic simulations gave the best match to historical performance data (fig. 1).

Figure 1. Waterflood simulations using a stochastic simulation model (curves) compared with historical performance data (symbols) for section 7 of the South Cowden field. Injection and production volumes are expressed as fractions of the displaceable hydrocarbon pore volume (DHCPV).

The incremental recovery was calculated by subtracting a base case matching the historical completion strategy from a case where all wells are deepened to penetrate the entire formation at the time of one displaceable hydrocarbon pore volume injection (fig. 1). This time corresponds approximately to the present waterflood maturity in section 7. The predicted incremental recovery suggests that an additional 5 percent of the original oil in place will be recovered in about 10 years by adding well completions to the bottom of the formation (fig. 2), or about 2 million barrels of incremental oil to be recovered from section 7. The time scale of the prediction was established by matching injectivity of the model to the average for sections 5, 6, 7, and 8.

Figure 2. Estimated additional recovery from recompleting South Cowden Moss unit in the bottom half of the reservoir, expressed as a fraction of the original oil in place (OOIP). Time zero is the date of recompletion.

U.S. DEPARTMENT OF ENERGY
MILESTONE SCHEDULE ☐ PLAN ☒ STATUS REPORT

1. TITLE Geoscience/Engineering Characterization of the Interwell Environment in Carbonate Reservoirs Based on Outcrop Analogs, Permian Basin, West Texas, and New Mexico												2. REPORTING PERIOD 101/85-12/31/85						3. IDENTIFICATION NUMBER DE-AC22-83BC14895									
4. PARTICIPANT NAME AND ADDRESS Bureau of Economic Geology The University of Texas at Austin P.O. Box X, University Station Austin, Texas 78713												5. START DATE September 29, 1993						6. COMPLETION DATE September 28, 1996									
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		FY94												FY95						FY96						a. Plan	b. Actual
		O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	Q2	Q3	Q4	Q1	Q2	Q3	Q4				
1	Geologic Framework																									100%	100%
2	Petrophysical Quantification																									100%	100%
3	Performance prediction using reservoir simulation																									95%	95%
4	Application of outcrop results to subsurface reservoirs																									90%	90%
5	Technology transfer																									33%	33%
11. SIGNATURE OF PARTICIPANT'S PROJECT MANAGER AND DATE
F. J. Lucia 5/20/96			