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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

Bureau of Economic Geology
The University of Texas at Austin

Contract Start Date: September 29, 1993

Anticipated End Date: September 28, 1996

Government Award \$354,400

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Reporting Period – July 1, 1995 – September 30, 1995

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Objectives

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

Outcrop Activities

Mapping and documenting ooid channel deposits continued through the third quarter. Figure 1A illustrates the geometry of one channel deposit found in West Dog Canyon, and there are other channel deposits with similar geometries. The channels, which are perpendicular to depositional strike, are thought to be formed by tidal currents. Permeability of the channel ooid grainstone is very high, whereas the flanking sandstones and packstones are dense and relatively impermeable. Thus, the channel is a super-permeability conduit. Dip-elongate channel bodies appear to be confined to the

transgressive system tract. Conversely, highstand systems tract ooid grainstone bodies form strike-elongate shoals that are laterally continuous along dip and across strike for thousands of feet. Figure 1B is an isopach map of a typical ooid grainstone shoal found in the highstand systems tract.

Subsurface Activities

A report on the geological characterization of the South Cowden field has been completed and submitted as the 1995 annual report.

Dissolution of anhydrite is a major contributor to productivity in the South Cowden field. The dissolution results in higher porosity, well-connected pore space, and enhanced permeability for a given porosity. Dissolution can be recognized in cores by (1) absence of anhydrite, (2) incipient inversion of anhydrite to gypsum, (3) calcite replacement of anhydrite, and (4) chalky anhydrite. Anhydrite dissolution and alteration also result in a unique porosity/acoustic transit time cross plot. Figure 2A compares the transit time/porosity cross plot for wells with anhydrite alteration with those without anhydrite alteration. Because these trends are very different, they provide a wireline log method for using uncored wells to map the distribution of dissolution porosity.

A map of dissolution porosity (fig. 2B), based on core and wireline log data, shows a belt of anhydrite removal and alteration on the eastern and southern flanks of the field. This suggests that the dissolution is the result of undersaturated waters flowing out of the Midland Basin before or during oil migration. Production maps show that the highest production is in areas of dissolution porosity.

An initial simulation model of part of the Moss Unit has been prepared using a simple layering scheme and geostatistical techniques. We will compare performance results from this model

with results from more complicated models that we are preparing, which are constrained by the geology and operational history. Flow simulations using this simple model show higher recoveries than does actual field performance.

Plans

Petrophysical research tasks are 90 percent complete. We will begin to prepare the petrophysical chapters of the final report. Simulation studies will continue focusing on using geological and operational constraints to construct a model that will adequately display the location of remaining oil saturation in a 640-acre area that includes acreage owned by Unocal, Fina, and Phillips. We will continue working with Unocal and Phillips to develop plans to improve recovery from this field.

References/Publications

We presented results of this study at the annual review meeting of the Reservoir Characterization Research Laboratory in Carlsbad, New Mexico, which was attended by 40 industry representatives.

Roger Barnaby led a one-day field trip to the outcrop study area. A field guidebook, "Stratigraphic Hierarchy, Sequence Architecture and Interwell-Scale Heterogeneity: Grayburg Formation Brokeoff Mountains, New Mexico" was prepared by Barnaby and W. B. Ward, and distributed to field-trip participants.

A report titled "Effects of Stratal Architecture and Diagenesis on Reservoir Development in the Grayburg Formation: South Cowden Field, Ector County, Texas," prepared by Stephen C. Ruppel and Don G. Bebout, was distributed to the sponsors.

Figure 1. Isopach maps of grainstone bodies from outcrops of the Grayburg Formation in the Brokeoff Mountains maps are based on measured sections on Plowman Ridge and in West Dog Canyon. (A) Ooid grainstone channel in transgressive systems tract of Grayburg high-frequency sequence 2, cycle 2, showing dip-elongate channel geometry. (B) Ooid grainstone body in the highstand systems tract of Grayburg high-frequency sequence 2, cycle 12, showing strike parallel shoal geometry.

Figure 2. Porosity enhancement from anhydrite dissolution. (A) Acoustic-positivity cross plot showing effect of dissolution porosity on acoustic travel time. (B) Map showing distribution of anhydrite dissolution within Grayburg Formation of South Cowden field based on core data and acoustic log response.

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MILESTONE SCHEDULE ☐ PLAN ☒ STATUS REPORT

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1	Geologic Framework																									100%	100%		
2	Petrophysical Quantification																									100%	100%		
3	Performance prediction using reservoir simulation																									90%	75%		
4	Application of outcrop results to subsurface reservoirs																									80%	80%		
5	Technology transfer																									0%	0%		

11. SIGNATURE OF PARTICIPANT'S PROJECT MANAGER AND DATE
P.A. Gray For F.J. Lucia F. J. Lucia 11/8/95