Integrated Synthesis of the Permian Basin: Data and Models for Recovering Existing and Undiscovered Oil Resources From the Largest Oil-Bearing Basin in the U.S.

SEMI-ANNUAL TECHNICAL REPORT

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Table of Contents

Introduction

This report describes the work accomplished during months 1 through 6 of the project, a synthesis of geological data and models for the Permian Basin of west Texas. A map of the area being covered by the study is displayed in figure 1. Excellent progress has been made toward all goals and objectives of the project.

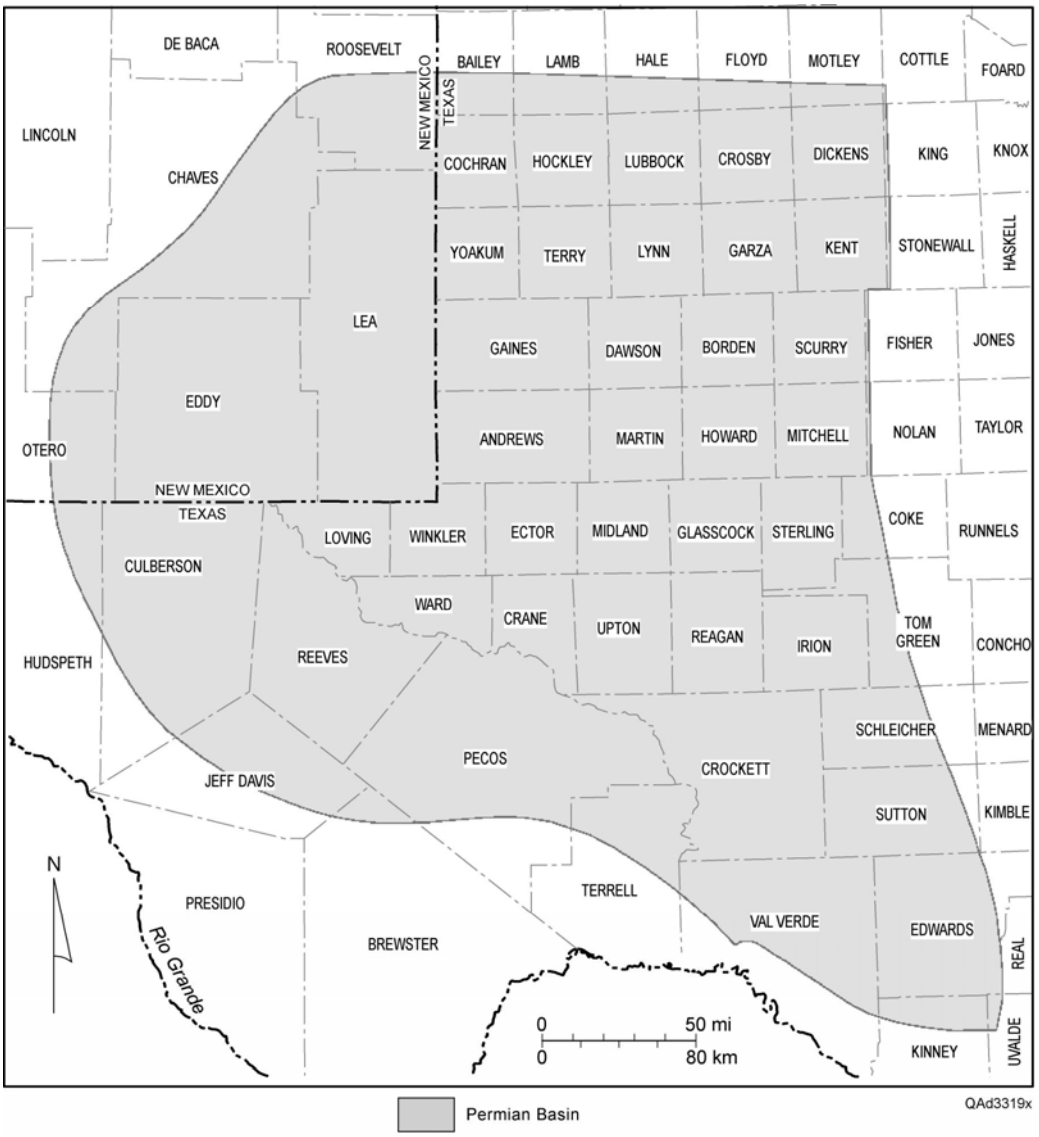

Figure 1. Map of Precambrian basement structure in project study area. Contours are feet below mean sea level.

Executive Summary

During the first 6 months of the project, primary effort has been placed on the first of the key deliverables for the first project year: a comprehensive synthesis of the geology of hydrocarbon-producing systems in the Permian Basin. To this end, draft chapters of this synthesis volume have been completed or are nearing completion on five important reservoir systems: the Middle Ordovician Simpson Group, the Upper Ordovician Montoya Group, the Ordovician -Silurian Fusselman, the Upper Silurian Wristen Group, and the Lower Devonian Thirtyone Formation. In addition, work is well underway on the following chapters: Upper Permian Yates Formation, Queen formation, and Delaware Mountain Group.

Significant progress has also been made on the second major deliverable of the project: collection and assembly of geological data for important geological systems in a GIS database. To date, we have created GIS data layers that include the following: (1) structure map and stratigraphic tops for the Ellenburger Group, (2) structure map and stratigraphic tops for the Precambrian basement, and (3) contour map and data on geothermal gradient. It should be noted that the Precambrian basement map is by far the most detailed map ever constructed for basement in the Permian Basin.

To date, five companies (two majors and three independents) have signed up as project sponsors and have provided supplementary funding: a total of $130,000. Four additional companies have expressed a desire to join. The University of Texas System has indicated they will also provide supplementary funding for the project. Two industry service companies have agreed to provide geophysical data for the project. Finally, there is

good likelihood that funds will become available from the State of Texas to provide further support for the project later in the year.

Results and Discussion

During the first 6 months of the project, most efforts were directed toward data collection and synthesis. In general we began data collection at the base of the Paleozoic section. First efforts were to assemble data on the structure of the top of the Precambrian and the top of the Lower Ordovician Ellenburger Group. We accomplished this using data from Barnes (Barnes and others, 1999, 2002; personal communication, 2005) and Ewing (1990) respectively. These data were loaded into ARC MAP software and used to produce spatially registered maps. We also gathered information on bottomhole temperature data and created digital maps of geothermal gradient across most of the project area.

A significant amount of time was spent on gathering data on lower Paleozoic reservoir plays including the Middle Ordovician Simpson Group, the Upper Ordovician Montoya Group, the Ordovician -Silurian Fusselman Formation, the Upper Silurian Wristen Group, and the Lower Devonian Thirtyone Formation. These data were used to begin writing of chapters on the geology and reservoir development in these systems. In addition, data collection is well underway on the following plays: Upper Permian Yates Formation, Queen formation, and Delaware Mountain Group. We have also begun initial study and data collection on the Barnet shale play, a very active development and exploration play in the Ft. Worth Basin that is generating a great deal of interest across the Permian Basin.

Finally, work has begun on assembling a regional wireline log database from which cross sections, type logs, thickness maps, and structure maps will be prepared. We are in

the process of identifying approximately 50 wells per county or about 2,000-2,500 wells across the project area.

Significant Accomplishments

Our most significant accomplishments to date have been the construction of geothermal and basement structure maps for the project area; these maps and associated data are among the first data sets added to the basin-wide GIS data project. The basement map (Figure 1) is especially significant in that it represents the most detailed map of Permian Basin basement structure ever produced as well as the first digital, spatially-registered GIS map available. Also significant is our GIS map of the structure of the basin at the top of the Ellenburger Group (Figure 2). This map, which is derived from The Tectonic Map of Texas by Thomas Ewing (Ewing, 1990), is the first digital basin structure map of this detail. We have also produced a map of the distribution of geothermal gradients in West Texas. This map is based on bottomhole temperature data reported in AAPG Datapages. These data were first corrected and then statistically smoothed to create a more reasonable depiction of the temperature distribution in the Texas part of the Permian Basin (Figure 3).

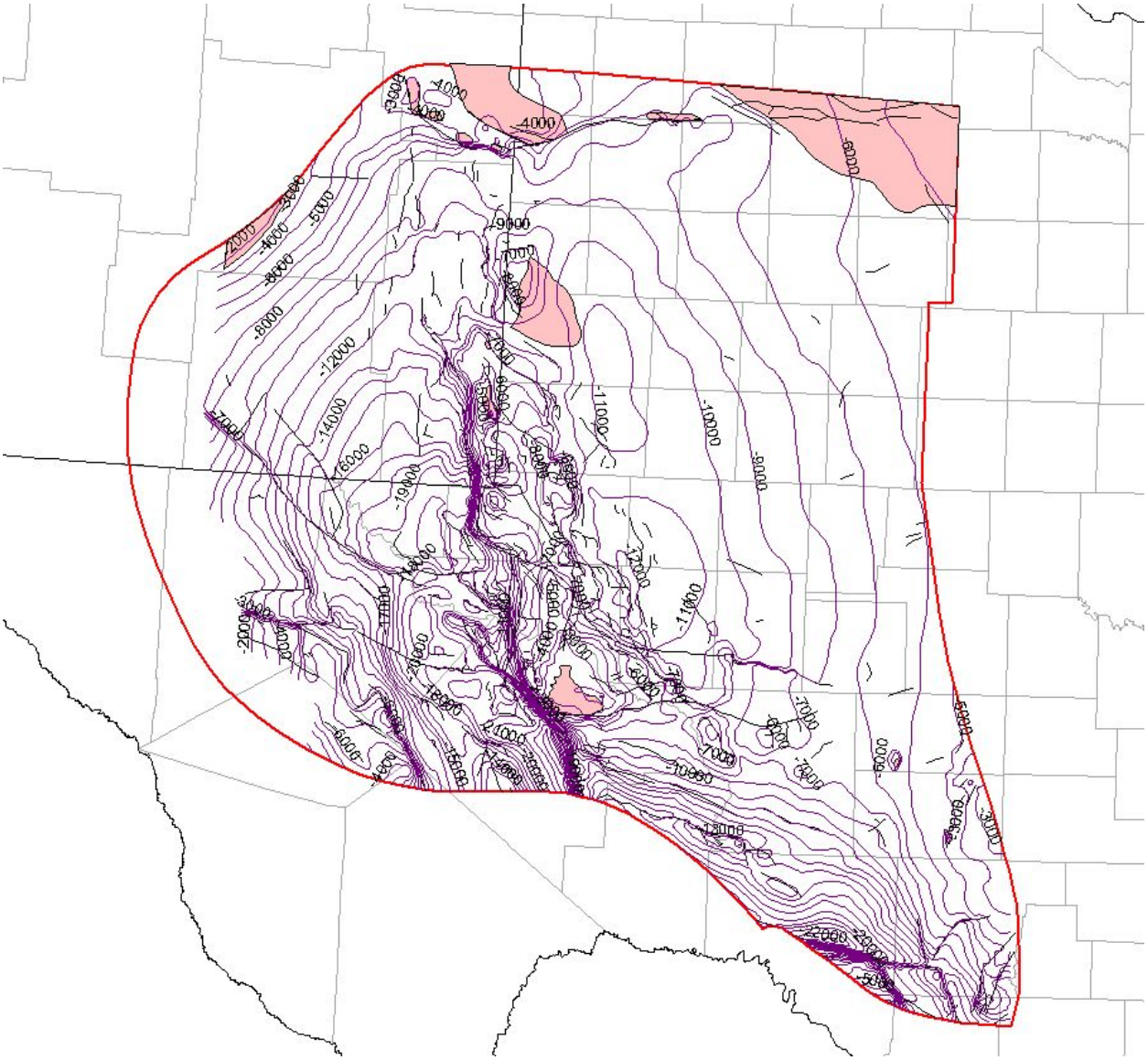

Figure 2. Map of Precambrian basement structure in project study area. Contours are feet below mean sea level.

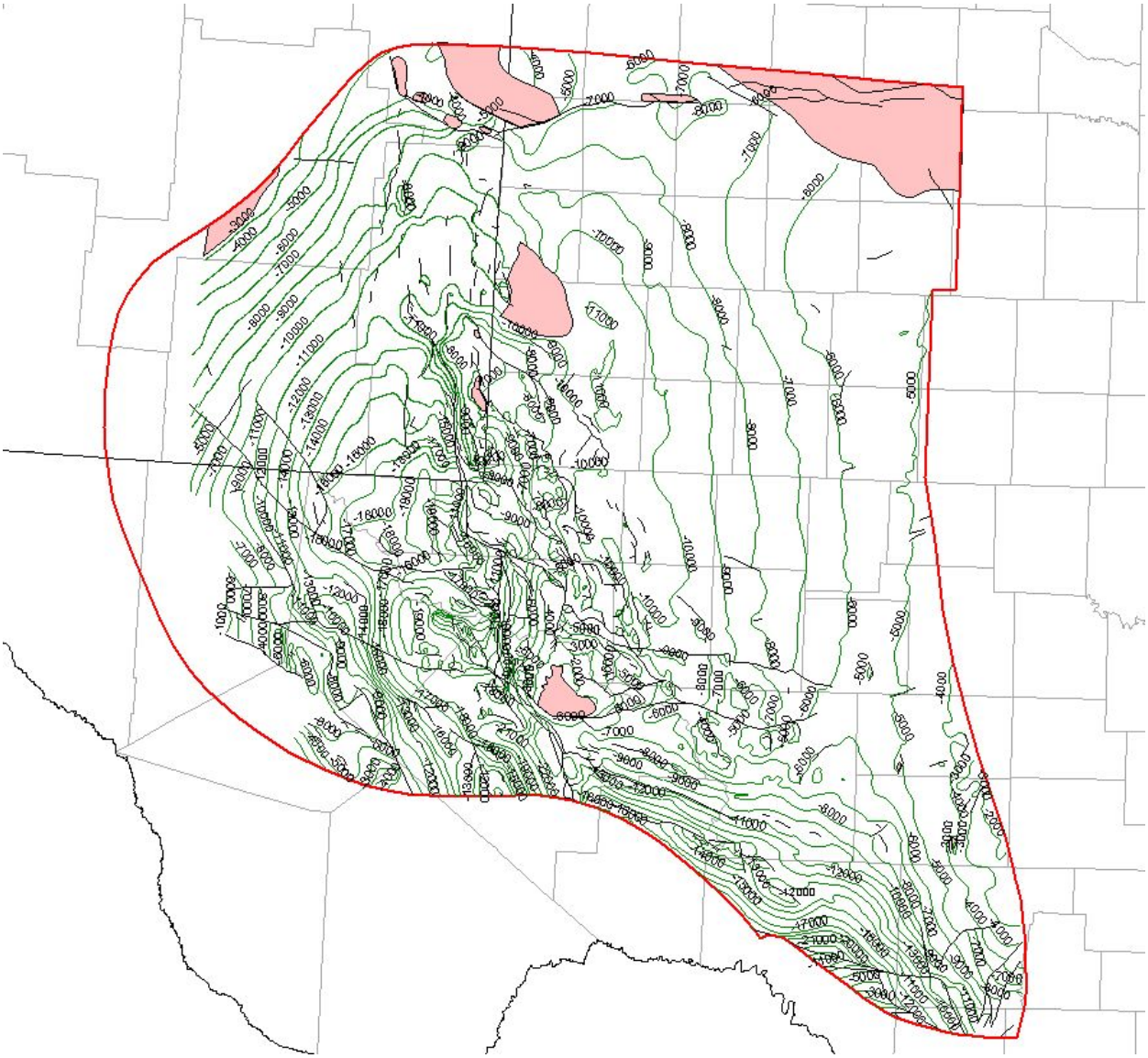

Figure 3. Map of Ellenburger Group structure in project study area. Data from Ewing (1990). Contours are feet below mean sea level.

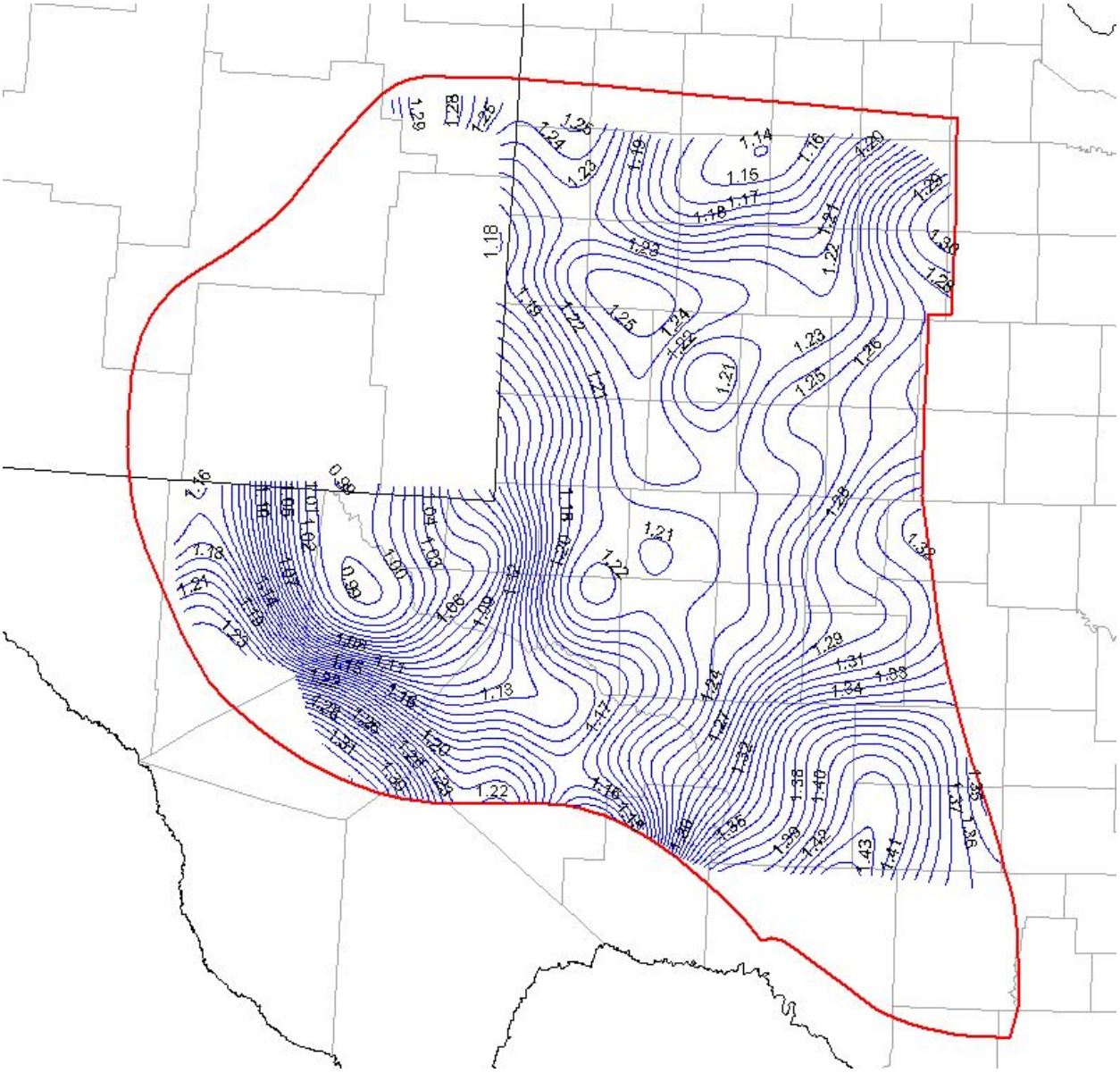

Figure 4. Map of geothermal gradient in project study area. Contours are degrees Fahrenheit per 100 feet and are based on geostatistically smoothed data.

Problems and Delays

No problems or delays were experienced.

Cost and Schedule Status

Approved budget for period one.

DOE OIL EXPLORATION
BUDGET
YEAR ONE

Area of Interest 2B	Effort (hours) Federal	Effort (hours) Non-Fed	Hourly Rate	Year One Federal	Year One Non-Federal	TOTAL PROJECT
Salaries and Wages						
S. Ruppel Principal Investigator	1307	0	39.07	51,064	0	51,064
S. Tinker Director	87	0	85.38	7,428	0	7,428
C. Kerans Geologist	87	260	51.01	4,438	13,263	17,701
B. Hardage Geophysicist	87	0	55.18	4,801	0	4,801
S. Dutton Geologist	205	0	46.36	9,504	0	9,504
B. Loucks Geologist	0	433	52.92	0	22,914	22,914
U. Hammes Geologist	0	693	39.00	0	27,027	27,027
Rebecca Jones Research Scientist Assoc.	227	0	26.99	6,127	0	6,127
F. Brown Geologist	43	0	57.10	2,455	0	2,455
M. Hudec Geologist	43	0	46.08	1,981	0	1,981
T. Tremblay Research Associate	867	0	26.81	23,244	0	23,244
W. Galloway (UTIG) Geologist	0	0	70.31	0	0	0
GRA	520	1387	19.23	10,000	26,672	36,672
Graphic Illustrator*	43	0	17.79	765	0	765
Editor*	43	0	19.11	822	0	822
Subtotal Salaries and Wages				122,629	89,876	212,505
Fringe Benefits				39,241	28,760	68,001
Tuition				1,500	4,000	5,500
Materials and Services						
Expendable supplies				1,829	0	1,829
Subtotal Materials and Services				1,829	0	1,829
Computer				8,184	4,800	12,984
PC and SGI Usage						
Travel						
Austin - Midland (fieldwork)						
3 trips; 2 people; 2 days						
Per diem @ $110/day/person				1,320	0	1,320
Vehicle mileage @ $.35/mile				735	0	735
Austin - Tulsa (DOE Briefing/Review Meetings)						
2 trips; 1 person; 3 days						
Airfare @ $250/ea.				500	0	500
Per diem @ $110/day/person				660	0	660
Ground transportation @ $45/per day				270	0	270
Subtotal Travel				3,485	0	3,485
Total Direct Costs				**176,868**	**127,436**	**304,304**
Total Indirect Costs (50%)				**87,684**	**0**	**87,684**
Total Costs				**$ 264,552**	**$ 127,436**	**$ 391,988**

Actual costs incurred to date.

	DOE	SHARE
Salaries	51,211	9,918
Fringe Benefits	11,617	2,092
Tuition	1,463	0
Materials and Services	1,024	0
Computer Usage	3,508	0
Travel	3,167	0
Indirect Costs	34,883	0
TOTAL COSTS TO DATE	**$106,873**	**$12,010**

Schedule Status

Not applicable this reporting period.

Industry Involvement and Supplemental Funding

In order to most effectively facilitate technology transfer and to increase the available funds to complete project goals we have actively solicited oil and gas company involvement in the project. To date, five companies (two majors and three independents) have agreed to participate as project sponsors. These companies have already provided a total of $130,000 in additional funds to be used during the project. Four other companies have indicated they would like to join the project in the near future. Additionally, two industry service companies have agreed to provide geophysical data for the project. We also anticipate that we will receive funding from The University of Texas System in direct support of the project. Finally, there is very strong likelihood that funds will become available from the State of Texas to provide further support for the project later in the year.

Technology Transfer Activities

Two meetings (one in Midland, Texas and one in Houston, Texas in January 2005) were organized by the Bureau of Economic Geology in cooperation with the Petroleum Technology Transfer Council and held at the end of 2004 to discuss project deliverables and solicit oil industry participation and sponsorship from the oil industry (meeting agenda appended below). Presentations were given by Dr. Stephen Ruppel, Dr. Bob Loucks, and Dr. Charlie Kerans, all participating scientists on the project. Interest in the program was evidenced by the strong attendance at the meetings. In all, 65 geologists, engineers, and managers attended representing 47 companies. As a result of these meetings, 9 companies agreed to sponsor the project and provide additional funding and data. Five of these companies have already joined the project and have provided funding for one year or more.

Four other companies are pursuing company authorization to join. Two additional companies from the service sector have agreed to provide important data to the study.

Dr. Stephen Ruppel delivered a luncheon address at the Permian Basin Section of the SEPM in Midland in February entitled “Key Questions and Issues in Permian Basin Carbonate Reservoir Plays”. The purpose of the talk was to disseminate preliminary findings and publicize current project activities. Approximately 45 geologists, engineers, managers, and owners attended.

Three papers will be presented at the national AAPG meeting in Calgary in June to document important aspects of Permian Basin reservoir systems. Dr. Frank Brown will present a poster entitled “Upper Pennsylvanian and Lower Permian Sequence Stratigraphy and Depositional Systems Tracts, Intracratonic Eastern Shelf and Adjacent West Texas Basin, North- and West-Central Texas”. Dr. Stephen Ruppel will present a poster entitled “Multidisciplinary Reservoir Characterization of a Giant Permian Carbonate Platform Reservoir: Insights for Recovering Remaining Oil in a Mature U.S. Basin” and an oral talk entitled “Surprising Lessons from Multidisciplinary Characterization of a Permian Carbonate Platform Reservoir”. The latter papers stem from work recently funded by DOE under contract DE-FC26-01BC15351.

Program Announcement and Startup Planning Workshop

November 30 and December 7, 2004

Stratigraphic Synthesis of Paleozoic Oil-bearing Depositional Systems: Data and Models for Recovering Existing and Undiscovered Oil Resources from the Permian Basin

Agenda

10:00 Overview of Program scope and goals: *Ruppel*

10:30 Key questions and issues in Permian Basin reservoir plays: *Ruppel*

11:00 Deep water carbonates in the Permian: models and directions: *Kerans*

11:30 Challenges in Ellenburger hydrocarbon exploitation: *Loucks*

12:00 Lunch

- Core and poster displays: Issues and answers to understanding reservoir performance in carbonate reservoirs: Permian and Ordovician rock perspectives: *BEG Team*

1:15 Discussion and planning of program directions and focus: *BEG Team*.

Future Work

Work will continue through the end of the year on compilation, synthesis, and writing of a comprehensive summary volume on Paleozoic reservoir systems in the Permian Basin. Work will also ramp up during the second 6 months of the project on three specific depositional systems: the Devonian Thirtyone carbonate and chert, the Mississippian Barnett shale, and the Upper Devonian Woodford shale. The first of these includes a group of an established reservoir plays that have produced significant volumes

of oil but contain significant remaining resources; the last two are developing new plays in the Basin. Of the three perhaps the most timely is the Barnett shale, which because of recent gas production successes in the Ft. Worth Basin is now perhaps the hottest exploration play in Texas. To better understand the controls on reservoir development and productivity in this system, we will gather, synthesize, and interpret all available data from the Barnett throughout it's area of distribution. We will supplement existing project funds and manpower with new funding and staff made available by recently received funds from the State of Texas to fully characterize this play throughout the Permian Basin and Texas. At the same time we will characterize the very similar Woodford shale succession to determine its nature, distribution, and potential for analogous gas reservoir development.

References

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Ewing, T. E., 1990, Tectonic map of Texas: The University of Texas at Austin, Bureau of Economic Geology, 4 sheets, scale 1: 750,000.