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IDENTIFICATION AND EVALUATION OF FLUVIAL-DOMINATED DELTAIC (CLASS 1 OIL) RESERVOIRS IN OKLAHOMA

Yearly Technical Progress Report

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II. ABSTRACT

The Oklahoma Geological Survey (OGS), the Geo Information Systems department, and the School of Petroleum and Geological Engineering at the University of Oklahoma are engaged in a five-year program to identify and address Oklahoma's oil recovery opportunities in fluvial-dominated deltaic (FDD) reservoirs. This program includes the systematic and comprehensive collection, evaluation, and distribution of information on all of Oklahoma's FDD oil reservoirs and the recovery technologies that can be applied to those reservoirs with commercial success. To date, the lead geologists have defined the initial geographic extents of Oklahoma's FDD plays, and compiled known information about those plays. Nine plays have been defined, all of them Pennsylvanian in age and most from the Cherokee Group. Exhaustive literature searches have been conducted for these plays, both through published sources and through unpublished theses from regional universities. A bibliographic database has been developed to record these literature sources and their related plays. Trend maps are being developed to identify the FDD portions of the relevant reservoirs, through accessing current production databases and through compiling the literature results. A reservoir database system also has been developed, to record specific reservoir data elements that are identified through the literature, and through public and private data sources. The project team is working with the Oklahoma Nomenclature Committee of the Mid-Continent Oil and Gas Association to update oil field boundary definitions in the project area. Also, team members are working with several private companies to develop demonstration reservoirs for the reservoir characterization and simulation activities. All of the information gathered through these efforts will be transferred to the Oklahoma petroleum industry through a series of publications and workshops. The first workshop will address the Morrow Play, and will be held in June of 1995. Additionally, plans are being developed, and hardware and software resources are being acquired, in preparation for the opening of a publicly-accessible computer users laboratory, one component of the technology transfer program. That lab will be opened in conjunction with the conduct of the first workshop.

III. EXECUTIVE SUMMARY

The Oklahoma Geological Survey (OGS), the Geo Information Systems department, and the School of Petroleum and Geological Engineering at the University of Oklahoma are engaged in a five-year program to identify and address Oklahoma's oil recovery opportunities in fluvial-dominated deltaic (FDD) reservoirs. This program includes the systematic and comprehensive collection and evaluation of information on all of Oklahoma's FDD oil reservoirs and the recovery technologies that have been (or could be) applied to those reservoirs with commercial success. This data collection and evaluation effort will be the foundation for an aggressive, multifaceted technology transfer program that is designed to support all of Oklahoma's oil industry, with particular emphasis on smaller companies and independent operators in their attempts to maximize the economic producibility of FDD reservoirs.

Specifically, this project will identify all FDD oil reservoirs in the State; group those reservoirs into plays that have similar depositional and subsequent geologic histories; collect, organize and analyze all available data; conduct characterization and simulation studies on selected reservoirs in each play; and implement a technology transfer program targeted to the operators of FDD reservoirs to sustain the life expectancy of existing wells with the ultimate objective of increasing oil recovery.

The execution of this project is being approached in three phases. Phase 1: Planning and Analysis began in January, 1993, and lasted through the middle of 1994. By the end of Phase 1, Oklahoma's FDD reservoirs had been identified, play boundaries had been defined, and most of the data collection process had been completed. The play analysis and description processes had been defined, and a schedule had been developed for the implementation and technology transfer activities of Phases 2 and 3.

Technical activities for Phase 1 have been divided into four primary tasks.

1. Design and Development of Database Systems includes both the effort to develop FDD databases to capture the information gathered during this project, and the effort to reformat the in-house well, lease and field mainframe databases for p.c.-level access through a computer user lab. Three new databases are being developed for this program.

- The reservoir database is being developed to record reservoir characteristics, engineering, and production data for each identified Oklahoma FDD reservoir.
- The bibliographic and recovery technologies database is being developed to track the reference information related to the Oklahoma FDD reservoir research.
- The operator database is designed to track operators (and other interested parties) who are working within Oklahoma FDD reservoirs to target them to participate in the program during the data collection process as well as during the technology transfer phase. The operator database was originally developed at the mainframe level, and is being converted to the p.c. level for workshop tracking activities.

2. Data Research involves the efforts required to gather data related to the FDD plays, and consolidate those data into forms that can be used during the play data analyses.

One fundamental precursor to the analysis of FDD reservoirs is the appropriate delineation of the oil field boundaries in which these reservoirs occur. Project staff have continued working with the Oklahoma Nomenclature Committee of the Mid-Continent Oil & Gas Association to identify necessary updates to the official field boundaries, based on field and lease data from the Natural Resources Information System (NRIS). The emphasis during this year including key areas of Morrow and Booch production. Decisions regarding new fields and field extensions are incorporated into the NRIS files and the FDD reservoir data system.

Public domain data research continued as a primary emphasis of the project. Data available in a variety of public databases are being incorporated into the databases for this project. Comprehensive reviews also are being conducted of data sources that currently are not available in digital form, including professional journals and publications, unpublished theses and dissertations, and various library collections of well logs and scout tickets. Major emphases for this year included the Morrow, Booch, Virgilian (Hoover, Elgin, and Endicott), Missourian (Layton, Osage-Layton, and Cottage Grove), Peru, Red Fork, and Bartlesville sandstones.

Private domain data are critical to the completion of the reservoir characterization and simulation studies that are being conducted in cooperation with operators of the selected reservoirs in each play. A primary goal for these reservoir studies is to develop methodologies that are affordable, understandable, and usable for the small independent oil operator. Studies were completed this year for the Red Fork sand in the Glencoe Southeast field, and were underway for the Booch sand in the Greasy Creek field. Within the Morrow play, the Rice Northeast field was identified as the target candidate for the characterization study.

3. Play Identification/Folio Plans include efforts to organize the data and develop plans for the technology transfer program. The program is structured around the concept of exploration and development "plays" for FDD reservoirs, with the results to be compiled into play folio publications and play workshops. At the start of the project, a tentative list of plays was developed based on those oil-productive stratigraphic intervals that are known to have at least some areas of fluvial and/or deltaic deposition. Based primarily on reviews of prior research, project geologists have refined this list throughout Phase 1, and have produced trend maps to show the play boundaries. Through this effort, some of the stratigraphic intervals identified as plays or subplays on the initial list have been eliminated from consideration because an oil-producing FDD area could not be identified for the interval. The final list of FDD plays includes:

1. Tonkawa (Virgilian) Play
2. Layton & Osage-Layton (Upper Missourian) Play
3. Cleveland (Lower Missourian) Play
4. Peru (DesMoinesian) Play
5. Prue and Skinner (DesMoinesian) Play
6. Red Fork (DesMoinesian) Play
7. Bartlesville (DesMoinesian) Play
8. Booch (DesMoinesian) Play
9. Morrow (Morrowan) Play

During this year, plans were developed for producing the play folio publications and conducting the workshops. For each of the nine plays, a consistent format will be followed for the presentation of materials, and a preliminary outline was prepared that will serve as a guideline

for the play leaders as they develop their presentations. Standards were set for the maps to be included with each publication. Also during this year, the number of potential workshop attendees and the potential workshop sites for each play were identified, based on the numbers and addresses of the operators in each FDD reservoir.

4. Computer Applications include the development of computerized mapping and report programs to support the analysis of reservoir and play information. Programs are being developed to generate standard reports and tables, perform statistical analyses, generate graphical displays of the data, and produce surface and subsurface maps.

Work has continued on the design and development of the computer user laboratory. This user laboratory will be one mechanism for allowing industry, especially small independents, to access the resources developed as part of this project. User lab development activities during this year have included both the acquisition of hardware and software, and the efforts to develop user interfaces for the data and applications that will be available through the user lab. Operational and business issues for the lab also have been addressed.

During the year, a new database management system was selected for user lab applications that should provide the required flexibility, efficiency, and security for entering and storing data, and will allow links to the Windows-based applications programs that are planned for the lab.

5. The Morrow, Booch, and Layton/Osage-Layton Plays are the three plays that are scheduled for presentation during 1995. During 1994, data analysis, publication, and workshop preparation activities were focused on these three plays.

Conclusions are that considerable progress has been made during this second year of the Oklahoma FDD program. Based on all of the research that has been completed, the project staff stand poised to begin the technology transfer activities for Oklahoma operators. Efforts to prepare the first publication are underway. The computer applications and user lab efforts are progressing. Overall, it is clear that the original concept for compiling and analyzing FDD data into plays is sound. Numerous parties have provided positive feedback for the overall program, and a great deal of interest has been generated over the prospects for this effort. It is fully expected that the overall five year program will be a success.

IV. INTRODUCTION

The Oklahoma Geological Survey (OGS), the Geo Information Systems department, and the School of Petroleum and Geological Engineering at the University of Oklahoma are engaged in a five-year program to identify and address Oklahoma's oil recovery opportunities in fluvial-dominated deltaic (FDD) reservoirs. This program includes the systematic and comprehensive collection and evaluation of information on all of Oklahoma's FDD oil reservoirs and the recovery technologies that have been (or could be) applied to those reservoirs with commercial success. This data collection and evaluation effort will be the foundation for an aggressive, multifaceted technology transfer program that is designed to support all of Oklahoma's oil industry, with particular emphasis on smaller companies and independent operators in their attempts to maximize the economic producibility of FDD reservoirs.

Program efforts include identifying all FDD oil reservoirs in the state; grouping those reservoirs into plays with similar depositional and subsequent geologic histories; collecting, organizing and analyzing all available data; conducting characterization and simulation studies on selected reservoirs; and implementing a technology transfer program targeted to the operators of FDD reservoirs.

The elements of the technology transfer program include developing and publishing play summaries in the form of folios, holding workshops to release play analyses and discuss opportunities in each of the plays, and establishing a public-access computer user laboratory within the OGS. The user lab will contain all the play data, as well as other oil and gas data files, together with the necessary hardware and software to analyze the information. Technical support staff will be available to assist interested operators in the evaluation of their producing properties, and professional geological and engineering outreach staff will be available to help determine appropriate recovery technologies for those properties.

The FDD project has the potential to assist thousand of operators in Oklahoma by providing them with practical ways to improve production from existing leases and/or to reduce operating costs. Currently-available technologies can improve recovery factors in these FDD reservoirs if sufficient information is available to determine the most appropriate course of action for the operator. This project will develop the needed reservoir-level information and work with interested operators in the implementation of the appropriate improved recovery technologies.

Light oil production from Class I Oil fluvial-dominated deltaic reservoirs is a major component of Oklahoma's total crude oil output. Oklahoma's FDD reservoirs provide an estimated 15 percent of the State's total oil production. Most of Oklahoma's FDD reservoir production is by small company and independent operators, who normally do not have ready access to the information and technology required to maximize the exploitation of these reservoirs.

Production from these reservoirs is at high risk. Individual well production commonly is low (one to three barrels per day) and operating costs are high. Declines in crude oil prices or increases in operating costs result in increased well abandonment rates. Successful implementation of appropriate recovery technologies could help to sustain production from these reservoirs throughout much of the 21st century. Absent some such action, most of the

production from Oklahoma FDD reservoirs will be abandoned by the beginning of the next century.

V. DISCUSSION

The execution of this project is being approached in three phases. Phase 1: Planning and Analysis began in January, 1993, and lasted through the middle of 1994. By the end of Phase 1, Oklahoma's FDD reservoirs were identified, play boundaries were defined, and most of the data collection process was completed. The play analysis and description processes had been defined, and a schedule was developed for the implementation and technology transfer activities of Phases 2 and 3. Data from the Natural Resources Information System (NRIS), an Oklahoma data system which has been developed through the support of the Department of Energy's Bartlesville Project Office, provided the foundation for the data collection effort. Phases 2 and 3 include many ongoing activities from Phase 1, but emphasize project implementation and technology transfer activities in which the collected information is organized and made available to the industry through the various methods.

The final milestone schedule and log for Phases 1 is included as Exhibit A, with all ongoing tasks flagged as "completed" as of October 1. The first updated milestone schedule and log for Phases 2 and 3 is included as Exhibit B; this will serve as the "working" schedule for the remainder of the project.

Technical activities for Phase 1 were divided into four primary tasks:

- 1) Design and Development of Database Systems,
- 2) Data Research,
- 3) Play Identification/Folio Plans, and
- 4) Computer Applications.

For the remainder of the project, many of these Phase 1 activities are to be continued, but the primary efforts are organized according to a play publication and workshop schedule. During 1994, data analysis, publication, and workshop preparation activities were focused on three plays that are scheduled for presentation during 1995: the Morrow, the Booch, and the Layton and Osage-Layton Plays.

1. Design and Development of Database Systems

Database development activities include both the effort to develop FDD databases to capture the information gathered during this project, and the effort to reformat the NRIS well, lease and field mainframe databases for p.c.-level access through the computer user lab.

For the FDD system, a reservoir database has been designed to record reservoir characteristics, engineering, and production data for each identified FDD oil reservoir in Oklahoma. The reservoir system was developed with a flexible design that allows the capture of variable data from numerous sources into a systematic format. Eight linked data tables have been defined, with data items to capture information on reservoir location, history, geological characteristics, engineering data, and production history. The system became operational in January allowing the project staff to begin entering collected reservoir data.

The bibliographic and recovery technologies database was designed to track the reference information related to the Oklahoma FDD reservoir research. References continued to be

entered into the bibliography/recovery technologies database. Photocopies of all references that are entered are being archived so that users may access the printed version if desired.

The operator database was designed to track operators (and other interested parties) who are working within Oklahoma FDD reservoirs. These operators are being targeted to participate in the data collection process as well as the technology transfer program. The operator database originally was developed at the mainframe level. At that level, the database easily can be matched against NRIS lease production records to determine which operators are currently active in each reservoir, and therefore should be targeted for each play. However, the database also will be used to track the level of participation in the various activities of this project, and help measure the overall effectiveness of the technology transfer program. That function is more effectively accomplished at the personal computer level, and so work was initiated during this year to convert the operator file to that platform. That conversion will be completed before the first workshop in 1995.

During the year, discussions were initiated regarding the long-term utility of the database management system that was originally selected for user lab applications. That system was found to be a difficult development tool, and did not operate effectively within a Windows-based environment. Several different options were reviewed, and most of them were deemed inadequate for supporting the very large, multi-user databases that will be available through the user lab computer network. When these reviews were concluded, Oracle was selected as the most appropriate software for the application, with user interfaces to be developed in the Visual Basic language. This approach should provide the required flexibility, efficiency, and security for entering and storing data, and will allow links to the Windows-based applications programs that are planned for the lab.

The FDD database systems that were developed will continue to be used for the foreseeable future, as the new Oracle development will concentrate on reformatting the NRIS well, lease and field mainframe databases for p.c.-level access. Eventually, the three FDD databases also will be converted, and so the documentation for those databases will not be completed until after that conversion.

2. Data Research

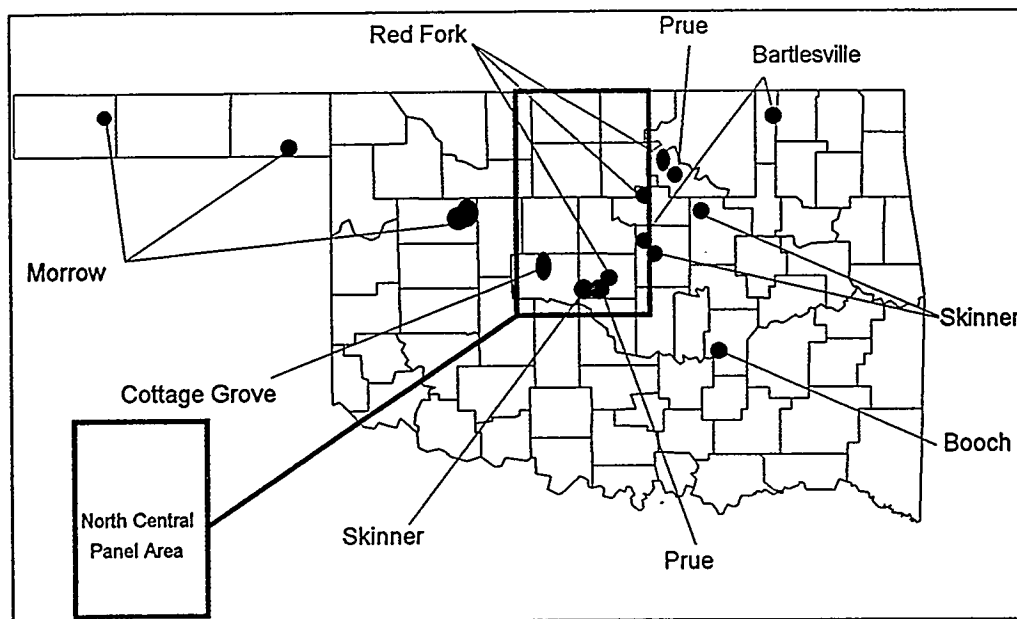
Data research activities include efforts to acquire, codify, and edit both public and private domain data for use during the project.

One fundamental precursor to the analysis of FDD reservoirs is the appropriate delineation of the oil field boundaries in which these reservoirs occur. At the beginning of this project, over 20 percent of the oil production in Oklahoma was from leases that were outside the official field boundaries as designated by the Oklahoma Nomenclature Committee (ONC) of the Mid-Continent Oil & Gas Association. Most of these "unassigned" leases were the result of field extension drilling, and the official field boundaries needed to be similarly extended. Project staff have been working with the ONC to identify updates to the official field boundaries, based on field and lease data from the Natural Resources Information System (NRIS). The project staff prepares packages for the ONC, normally on a monthly basis, which include detailed maps and reports of fields, leases, and wells within problem areas. The ONC uses these

packages to determine appropriate field updates, and their decisions regarding new fields and field extensions are incorporated into the NRIS files and the FDD reservoir database. Sixteen of these packages were prepared for the ONC during this year.

During this year, the ONC continued its review efforts for the "North Central Panel" area, and for several Morrow and Booch areas that were outside the panel area. Through these efforts, over five million barrels of primarily Morrow 1979-1994 oil production were assigned to fields in northwest Oklahoma; over 5.8 million barrels of primarily Booch production were assigned to fields in southeast Oklahoma; and roughly 20 million barrels were assigned in the north central panel area. Some of the trouble spots that have been or will be addressed are identified in Figure 2.

FIGURE 1
Problem Areas of Unassigned FDD Production:
Townships Exceeding 500 Mbls Since 1979



Data available in a variety of public domain databases are being incorporated into the databases for this project. NRIS includes a production subsystem that provides geographic locations and monthly production volumes, by lease, for all of Oklahoma's FDD reservoirs that have produced since 1979. Data from the Oklahoma Corporation Commission have been used to identify operator addresses; the monthly gross production reports received from the Oklahoma Tax Commission are used with the NRIS production files to identify all current operators in FDD reservoirs. The NRIS well history subsystem provides well completion reports for current and historical wells that penetrate (or have geographic proximity to) FDD reservoirs. Commercial data sources (e.g., Dwight's Energydata and Petroleum Information) are used, as necessary, to supplement the in-house data.

A variety of sources also exist for public domain data that currently are not available in digital form. Comprehensive reviews are being conducted of these sources to identify data on FDD reservoirs in Oklahoma. These sources include professional journals and special publications; published and open-file reports of the Oklahoma Geological Survey; and unpublished theses and dissertations at the University of Oklahoma, Oklahoma State University, and the University of Tulsa. Geoscience libraries at universities in adjacent states also are researched for relevant theses and dissertations. The Oklahoma Geological Survey's well-log, core and sample collections are important supplementary sources of reservoir information. The well log collection of the Oklahoma City Geological Society is a comprehensive and well-organized data source that frequently is accessed for project needs.

This public domain data research continued as an important emphasis during this second year of the project. Project staff collected data on FDD reservoirs from literature and theses, recording these references in the bibliographic database. Photocopies are made of all relevant documents, and a public-access file room has been developed to allow easy reference to these documents. The data captured in these searches are being entered into the databases that have been developed in Task 1. By plotting the study locations of each literary reference on maps of selected reservoir production, the depositional definitions of the various reservoirs have become more clear. During this year, literature research has been conducted for Morrow, Booch, Virgilian (Hoover, Elgin, and Endicott), Missourian (Layton, Osage-Layton, and Cottage Grove), Peru, Red Fork, and Bartlesville sandstones. The remaining FDD reservoirs will undergo similar analyses in the future.

Based on published research and production data, trend maps are being developed to show occurrences of the FDD reservoirs. Based on these trend maps, the geographic extents of the FDD plays are delineated. In addition, stratigraphic columns are being developed for each play to illustrate the FDD reservoirs in relation to the Pennsylvanian section. These FDD trend maps and other illustrations are being developed for presentation at the future FDD workshops and in the play publications.

The largest potential source of untapped data on FDD reservoirs in Oklahoma is from the operators themselves. Through the NRIS data system, the capability exists to identify the current operator of each producing oil or gas lease in the State. That capability enables the project team to contact operators for additional data in support of the overall project effort.

The private domain data particularly are critical to the completion of the reservoir characterization and simulation studies that have been initiated in Phase 1, and will be expanded in Phases 2 and 3. These studies are being conducted in cooperation with the operators of the selected reservoirs, with the goal of identifying opportunities for increasing recovery from those reservoirs. The in-depth reservoir details obtained for this subset of reservoirs complement the generalized information that is being collected on all of Oklahoma's FDD reservoirs. Operators are selected for these studies based on the quality of the data they have for the reservoir, their willingness to participate and contribute resources to the study, their willingness to make investments that will realize the recovery opportunities that are identified, and their willingness to allow the project results to be published and otherwise made available to industry. The results of these studies will supplement the play analyses.

A primary goal for these reservoir characterization studies is to develop methodologies that are affordable, understandable, and usable for the small independent oil operator. While the data collection for these selected reservoirs is in far greater detail than for other reservoirs in the

plays, it is still at a "minimized" level of detail relative to comprehensive reservoir studies that are performed in research facilities or by major companies in industry. For the most part, the data that are used are from pre-existing company files and/or public records. The typical reservoir for these studies has about 25 wells, many of which were drilled decades ago and do not have a modern suite of logs; no seismic or other geophysical data are expected to be available for these studies. Lithologies, estimates of the original hydrocarbons-in-place, and production profiles (oil, gas and water) for the reservoir are important components for the reservoir characterization. When necessary, algorithms are developed to estimate water and gas production from the reservoir, and to describe the geologic framework. The level of precision resulting from these studies is necessarily limited, but should accomplish the basic goals of helping operators target the remaining resource.

The reservoir characterization and simulation efforts were completed this year for the Red Fork sand in the Glencoe Southeast field, and were underway for the Booch sand in the Greasy Creek field. The complexity of the effort was increased with the Greasy Creek Booch study, as three separate Booch intervals were identified in the study area. Within the Morrow play, the Rice Northeast field was identified as the target candidate for the characterization study. Research has been conducted to identify an appropriate field for the Layton and Osage-Layton play.

3. Play Identification and Folio Plans

This task is an effort to organize the data and develop plans for the technology transfer program. The program is structured around the concept of exploration and development "plays" for FDD reservoirs, with the results to be compiled into play folio publications and play workshops. This method for structuring the data analysis and technology transfer program requires the identification of the major FDD oil reservoir plays within Oklahoma. At the start of the project, a tentative list of plays was developed that included all oil-productive stratigraphic intervals that are known to have at least some areas of fluvial and/or deltaic depositional environments. In Oklahoma, these FDD depositions occurred during the Pennsylvanian. In the initial phase of the investigation, any reservoirs that had uncertain classifications were included for further study. However, in the final determination only those reservoirs that qualify as FDD oil reservoirs will be included in the published play folios.

For each play, available published and unpublished reports were then reviewed to produce a tentative identification of the play boundaries. Production data from the NRIS system have been plotted in order to show the extent of production for each interval. Sometimes it has been necessary to pull and review well logs for areas in order to identify the FDD boundary of a play. As this research has developed, some of the stratigraphic intervals initially identified as plays or subplays have been eliminated from consideration, and some of the play names have been revised to more closely match industry nomenclature for the play. During this year, it was determined that, despite the presence of FDD environments within the Virgilian (Hoover, Elgin and Endicott sands), none of the Virgilian oil production came from those reservoirs. Therefore, that play was dropped from the workshop and publication list. Table 3 reflects the final listing of expected plays and subplays.

Table 1
FLUVIAL-DOMINATED DELTAIC OIL RESERVOIRS
OKLAHOMA PLAYS

Revised Listing as of January, 1995

PLAY	Reservoirs	Location	Class*	Leader	Comments
1. Tonkawa Play (Virgilian)	Tonkawa sd	NE Oklahoma Platform Nemaha Uplift NW Anadarko Shelf	B	Campbel l	
2. Layton & Osage-Layton Play (Upper Missourian)	Osage-Layton sd "True" Layton	NE Oklahoma Platform Nemaha Uplift NE Flank Anadarko Basin	B	Campbel l	Cottage Grove not an oil productive FDD reservoir
3. Cleveland Play (Lower Missourian)	Cleveland sd	NE Oklahoma Platform Nemaha Uplift NE Flank Anadarko Basin	B/C	Campbel l	
4. Peru Play (DesMoinesian)	Peru sd	NE Oklahoma Platform	C	Northcutt	
5. Prue & Skinner Play (DesMoinesian)	Prue sd Skinner sd	NE Oklahoma Platform Nemaha Uplift NE Flank Anadarko Basin	A	Andrews	
6. Red Fork Play (DesMoinesian)	Red Fork sd	NE Oklahoma Platform Nemaha Uplift NW Anadarko Shelf NE Flank Anadarko Basin	A	Andrews	
7. Bartlesville Play (DesMoinesian)	Bartlesville sd	NE Oklahoma Platform Nemaha Uplift	A	Northcutt	
8. Booch Play (DesMoinesian)	Booch sd	NE Oklahoma Platform	B	Northcutt	
9. Morrow Play (Morrowan)	Upper & Lower Morrow sd	NW Anadarko Shelf Hugoton Embayment	B	Andrews	

* Class is an estimate of the overall size of the play, based on geographic extent and on the number of reservoirs and operators in the play.

In addition to the play boundary definition effort, several other activities have been underway in preparation for the publication and workshop efforts. The geologic province map that was created as a baseline for play analyses and publications continued peer review this year. Revisions were made to the original map per the suggestions of geologists from the Oklahoma City Geological Society discussion group and the Oklahoma Geological Survey. Some discussion continues regarding specific details of the data represented on the map, and project geologists are waiting for final comments. Once a final version of the map is agreed upon it will be sent to the cartographic department of the OGS for drafting.

During this year, efforts included the development of plans for producing the play folio publications and conducting the workshops. For each of the nine plays, a consistent format will be followed for the presentation of materials. Presentations will include both general materials regarding FDD depositional environments that are consistent for all of the plays, and specific materials that uniquely describe the characteristics of each individual play. A preliminary outline has been prepared that will serve as a guideline for the play leaders as they develop their presentations. Major topics within this outline include:

1. Introduction to the project and purpose
2. Geology of FDD depositional environments and reservoirs
3. Play overview and discussion

4. Field examples within the play
5. Sample reservoir characterization and simulation

The maps, or plates, to be included with each publication will share one of two possible bases for the state of Oklahoma. One base will be for western ranges of the state and will include the panhandle. The other base will include the main body of the state minus the panhandle. These two base areas were decided upon in order to allow all maps to be produced at a scale of 1:500,000. By dividing the state in this way, each play area can be mapped at a scale that will allow adequate detail and yet not be too large for use. Both of these bases will include county boundaries, township-range grids, and select city locations.

Also during this year, the number of potential workshop attendees and the potential workshop locations were addressed. Lists of operators with recent production in various FDD plays were generated from the NRIS database. Based on the addresses of the operators, along with the number of operators in each FDD reservoir, potential sites were suggested for workshop presentations. Efforts are now under way to investigate the sites for adequate presentation facilities.

4. Computer Applications

A variety of computer applications programs are required for data analysis, for publication and workshop preparation, and to support users. Many of these programs can be standardized for repeated applications in the various plays. These programs were developed as part of the Phase 1 planning and analysis. Phase 1 also included the initiation of plans to make the project's data files available to operators, working-interest owners, royalty owners, and other interested parties through a user lab facility within the Oklahoma Geological Survey.

Computerized mapping and report programs to support the analysis of reservoir and play information. These include programs to generate standard reports and tables, perform statistical analyses, generate graphical displays of the data, and produce surface and subsurface maps. The outputs from some of these programs will be incorporated into the play folio publications and/or used as exhibits during the play workshops. At the mainframe level, commercial software systems such as SAS (Statistical Analysis System) are being used for most of the mainframe applications, editing, and data manipulation. At the personal computer level, applications are based on a variety of commercial packages. Geologic mapping is being completed through application programs such as GeoGraphix.

During this year, work continued on the design and development of the computer user laboratory. This user laboratory will be one mechanism for allowing industry, especially small independents, to access the resources developed as part of this project, either by researching the library files of information gathered from public and private domain sources, by obtaining copies of the digital data, or by using the laboratory's data and equipment to generate their own applications. Housed within the offices of the Oklahoma Geological Survey, and staffed with technical advisors who can assist users in developing their own applications, the computer user laboratory will provide particular advantages for those in industry who have little or no experience using computerized resources for their decision-making.

User lab development activities include both the acquisition of hardware and software, and the development of user interfaces for the data and applications that will be available through the user lab. Research is being continued on the most valuable and cost-effective hardware and software selections for the user lab, and some acquisitions have already been completed. Additional hardware acquisitions are expected in the coming year. Design efforts for the user interfaces are coinciding with the database development efforts previously discussed.

User lab software will consist primarily of commercial and public domain packages, since a technology transfer goal of the user lab is to provide examples of applications that operators might want to adopt for their own use. The in-house software development that is being completed for the project is primarily for site-specific activities such as developing user interfaces and user lab accounting processes. Standard word processing, spreadsheet, project management and graphics packages are all available. Geologic mapping is possible through application programs such as GeoGraphix contouring package, and spatial analyses will be possible through Arc/Info and ArcView. Public domain software also will be considered for user lab applications, since it may be an affordable option for operators setting up their own facilities.

As discussed in Task 1 above, discussions were initiated during this year about the long-term utility of the chosen database management system for user lab applications. The chosen system offered the required flexibility and efficiency for entering and storing the FDD data as well as the NRIS data that will be available through the user lab. However, the developer's learning curve for that system is very high, and there have been difficulties in achieving the desired functionality. Furthermore, most of the planned applications programs are Windows-based, and the current database system does not operate in a Windows environment. After extensive consideration, a decision was made to use an Oracle database management system using Visual Basic programming language to develop the user interfaces.

Efforts began during this year to develop the Visual Basic interfaces to allow easy access to the NRIS and FDD data. The Windows-based application utilizes mouse point-and-click technology for selecting wells according to various selection criteria. When fully developed, users will be able to easily access all of the data collected through this project. Also this year, the Oracle database management software was purchased to be used for supporting the very large, multi-user databases that will be available through the user lab computer network. The actual installation of Oracle will occur in 1995 after the current network software is upgraded to Novell Netware 3.12. The databases created in the current database management system will continue to be operated for now, but will eventually be converted to Oracle. The new Oracle system will work with the Visual Basic interface and will allow access to various Windows based applications.

User lab activities also include the development of plans for the business management and operation of the lab facility. During this year, various issues related to the operation of the lab were identified. These issues include operating hours, staffing plans, training, security, and fees. The approaches that are used by other similar facilities were investigated.

5. The Morrow, Booch, and Layton/Osage-Layton Plays

A tentative workshop schedule was developed, as shown in Exhibit B. For each workshop, a series of tasks will be completed. These tasks include data analysis and preparation of the publication by the authors, the cartographic staff, and the editorial section. An agenda for the workshop will be developed. Publicity for the workshops will be through press releases and through mailouts to the operators in the play. Materials prepared for the workshops will include slides and overhead transparencies, and each attendee at the workshop will receive a copy of the publication. After the workshop is completed, all play operators who do not attend the workshop will be given an opportunity to receive a complementary copy of the play publication.

The first scheduled workshop is for the Morrow play, planned for June, 1995. To prepare for that workshop, analyses of Morrow data proceeded along with preparation of text and illustrations. Initial data analysis efforts also were underway for the Booch play (scheduled for August, 1995), and the Layton and Osage-Layton Play (scheduled for November, 1995).

VI. CONCLUSIONS

Considerable progress has been made during this second year of the Oklahoma FDD program. Based on all of the research that has been completed, the project staff stand poised to begin the technology transfer activities for Oklahoma operators. Efforts to prepare the first publication are underway. The computer applications and user lab efforts are progressing, and the user lab will be ready for public use by the first workshop.

Overall, it is clear that the original concept for compiling and analyzing FDD data into plays is sound. Numerous parties have provided positive feedback for the overall program, and a great deal of interest has been generated over the prospects for this effort. It is fully expected that the overall five year program will be a success.

MILESTONE SCHEDULE

Exhibit B

Task Description	Due Date	Q3 '94	Q4 '94	Q1 '95	Q2 '95	Q3 '95	Q4 '95	Q1 '96	Q2 '96	Q3 '96	Q4 '96	Q1 '97	Q2 '97	Q3 '97	Q4 '97	Q1 '98					
1 Database & Applications Development	12/31/97	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F
1.1 Ongoing Database Maintenance	12/31/97																				
1.2 Applications Development	12/31/96																				
1.3 User Lab Development & Operation	12/31/97																				
2 Play Analyses, Publications, & Workshop	3/7/97																				
2.1 Play # 1: MORROW	6/22/95																				
2.1.1 Data Analysis	11/1/94																				
2.1.2 Prepare Text & Illustrations	4/7/95																				
2.1.3 Publication @ Printer	5/15/95																				
2.1.4 Identify Workshop Agenda	3/31/95																				
2.1.5 Mailout Notices	4/14/95																				
2.1.6 Workshop Press Release	5/1/95																				
2.1.7 Prepare Presentation Materials	6/14/95																				
2.1.8 Conduct Workshop	6/15/95																				
2.1.9 Folio Mailouts	6/22/95																				
2.2 Play # 2: BOOCH	9/8/95																				
2.2.1 Data Analysis	1/17/95																				
2.2.2 Prepare Text & Illustrations	6/21/95																				
2.2.3 Publication @ Printer	7/31/95																				
2.2.4 Identify Workshop Agenda	6/15/95																				
2.2.5 Mailout Notices	6/30/95																				
2.2.6 Workshop Press Release	7/14/95																				
2.2.7 Prepare Presentation Materials	8/30/95																				
2.2.8 Conduct Workshop	8/31/95																				
2.2.9 Folio Mailouts	9/8/95																				

Detail Task

Progress

Completed Task

Rolled Up Task

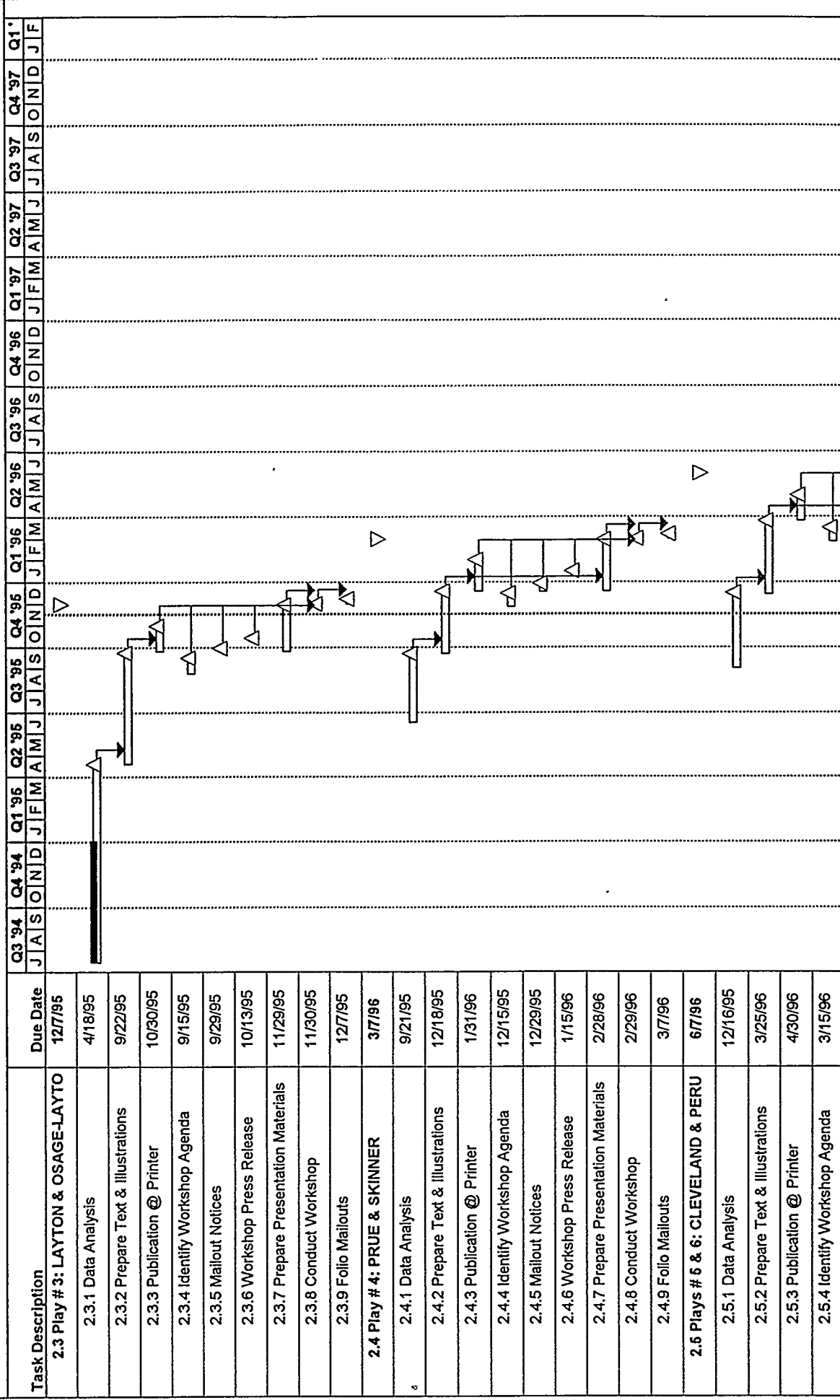
Intermediate Event

Completed Intermediate Event

Project: FDD Oil in Oklahoma: Phases 2&3
As of: 12/31/94

MILESTONE SCHEDULE

Exhibit B



Detail Task

Progress

Completed Task

Rolled Up Task

Intermediate Event

Completed Intermediate Event

Project: FDD Oil in Oklahoma: Phases 2&3
As of: 12/31/94

MILESTONE SCHEDULE

Exhibit B

Task Description	Due Date	Q3 '94	Q4 '94	Q1 '95	Q2 '95	Q3 '95	Q4 '95	Q1 '96	Q2 '96	Q3 '96	Q4 '96	Q1 '97	Q2 '97	Q3 '97	Q4 '97	Q1 '98
2.8 Play #9: SHAWNEE/TONKAWA	3/7/97	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S
2.8.1 Data Analysis	9/20/96															
2.8.2 Prepare Text & Illustrations	12/17/96															
2.8.3 Publication @ Printer	1/31/97															
2.8.4 Identify Workshop Agenda	12/17/96															
2.8.5 Mailout Notices	12/31/96															
2.8.6 Workshop Press Release	1/15/97															
2.8.7 Prepare Presentation Materials	2/27/97															
2.8.8 Conduct Workshop	2/28/97															
2.8.9 Folio Mailouts	3/7/97															
3 Professional Outreach	12/31/97															
3.1 Technical Advising	12/31/97															
3.2 Reservoir Char/Simulation Studies	9/22/97															
3.2.1 Reservoir C/S Studies: year 2	9/21/94															
3.2.2 Reservoir C/S Studies: year 3	9/20/95															
3.2.3 Reservoir C/S Studies: year 4	9/19/96															
3.2.4 Reservoir C/S Studies: year 5	9/22/97															
3.3 Professional Activities	12/31/97															
4 Management & Reporting	3/26/98															
4.1 Quarterly Reports	1/15/98															
4.1.1 q1	10/14/94															
4.1.2 q2	1/13/95															
4.1.3 q3	4/14/95															
4.1.4 q4	7/14/95															
4.1.5 q5	10/13/95															

Project: FDD Oil in Oklahoma: Phases 2&3 As of: 12/31/94	<div> <div>Detail Task</div> <div>Progress</div> <div>Completed Task</div> </div> <div> <div> <div> <div></div> <div></div> </div> <div> <div></div> <div></div> </div> <div> <div></div> <div></div> </div> </div> <div> <div> <div></div> <div></div> </div> <div> <div></div> <div></div> </div> <div> <div></div> <div></div> </div> </div> <div> <div> <div></div> <div></div> </div> <div> <div></div> <div></div> </div> <div> <div></div> <div></div> </div> </div> </div>
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MILESTONE SCHEDULE

Exhibit B

Task Description	Due Date	Q3 '94		Q4 '94		Q1 '95		Q2 '95		Q3 '95		Q4 '95		Q1 '96		Q2 '96		Q3 '96		Q4 '96		Q1 '97		Q2 '97		Q3 '97		Q4 '97		Q1 '98		
		J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J
4.1.6 q6	1/15/96														△																	
4.1.7 q7	4/15/96															△																
4.1.8 q8	7/15/96																	△														
4.1.9 q9	10/15/96																			△												
4.1.10 q10	1/15/97																															
4.1.11 q11	4/15/97																															
4.1.12 q12	7/15/97																															
4.1.13 q13	10/15/97																															
4.1.14 q14	1/15/98																															
4.2 Annual Report	1/29/98																															
4.2.1 y2	1/27/95																															
4.2.2 y3	1/29/96																															
4.2.3 y4	1/29/97																															
4.2.4 y5	1/29/98																															
4.3 Final Technical Report	3/26/98																															

Detail Task
Progress
Completed Task

Roll Up Task
Intermediate Event
Completed Intermediate Event

Project: FDD Oil In Oklahoma: Phases 2&3
As of: 12/31/94

