DOE/BC/14892-10
Distribution Category UC-122

Visual Display of Reservoir
Parameters Affecting Enhanced Oil Recovery

Annual Report for the Period
October 1, 1994 to September 30, 1995

By
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March 1996

Work Performed Under Contract No. DE-AC22-93BC14892

Prepared for
U.S. Department of Energy
Assistant Secretary for Fossil Energy

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EXECUTIVE SUMMARY

Several people joined the project during the last quarter of FY 1995. C. Asiala was hired as a part-time database programmer. M. Sivek was hired as an undergraduate assistant to help in the programming. J. Alex joined the program as a part-time computer draftsman.

The GeoGraphix Exploration System software package was acquired, installed on a PC in the Subsurface Laboratory at Michigan Technological University (MTU), and is currently in use. The USGS Digital Land Grid and the National Geophysical Data Center's Gravity Data CD ROM were acquired and installed on GeoGraphix.

C. Asiala is currently developing Microsoft Access databases to archive analytical data and digitized log traces. Data tables for geochemical and petrographic data, well logs, well header information, well production data, formation tops, and fault trace data have been completed. Project data reside in a number of programs, including GeoGraphix, Crocker Petrolog, Access databases, and the Multimedia Database Manager. Now that we have three different programs that store and manipulate digitized log traces (Crocker Petrolog, GeoGraphix QLA2, and TerraSciences TerraStation), there is an increased need to archive log data in one central location.

B. Watkins and D. Schueller designed and developed a Multimedia Database Manager using MacroMind Director on the Macintosh and later rewrote it for Windows in Visual Basic 3.0. We intend to use this shell as both an active database and archive and as a technology transfer mechanism. All data and information associated with the project are being stored on hard disk and will be accessible via the Database Manager. At the end of the project, all data, graphics, tutorials, manuals, etc., will be stored on CD ROM for distribution to DOE and to our target audience within the petroleum industry. At present, the Multimedia Database Manager is fully operational and efforts are being directed toward making it more user friendly.

B. Watkins continues to develop the Multimedia Database Manager shell/interface for data archiving and presentation using Microsoft Visual Basic 3.0. Interim results for this project were recently written to CD ROM for internal distribution. At present, it takes an experienced programmer to input information to the Database Manager. Watkins is developing an input interface called PioneerBuilder which will make it possible for anyone in the project to input any type of data or graphics to the Database Manager. With PioneerBuilder, data input will consist of calling up a List Box of Files and a List Box of Destinations, then simply clicking and dragging the files to their desired destinations. PioneerBuilder will be completed and ready for testing in a few weeks. When it is working to our satisfaction, C. Asiala will take over responsibility for inputting all data and graphics to the Multimedia Database Manager.

At the 1995 DOE Review Meeting for Fossil Energy Contractors in Oklahoma, T. Carr (U. Kansas) presented a "pseudoseismic" model that is based on the precept that well logs can be substituted for seismic traces in visualization software and then analyzed as if they were seismic data. We purchased the numerical computation and visualization software package MATLAB and input

several gamma-ray logs for a trial run. A "pseudoseismic" cross section was generated and results were encouraging.

Data from more than 45 project wells on the Pioneer Anticline and from 2 calibration wells in the McKittrick Front area of Cymric Field are being used in the project. All of the well logs which will be used in this project are now digitized, corrected, plotted on uniform scales, and hung on the same datum. Correlations have been made and a network for structural and stratigraphic cross sections has been laid out through the study area. Two cross-sections have been completed and three more are under construction, with more to follow later. The top of the Etchegoin Formation and the top of the Miocene have been correlated from the logs, and the top Miocene has been mapped. Fault-trace data was digitized and will soon be loaded in GeoGraphix and integrated with the formation-top data, allowing the Pioneer structure to be remapped and visualized with faults.

A new effort was initiated during the last quarter of 1995. J. Alex digitized the surface geological maps of the southern San Joaquin Valley prepared by Dibblee of the California Division of Mines and Geology and loaded them into the computer drafting program Canvas, where he edited them, combined them into one large map, and colored them. When complete, the integrated map will be printed in large format on our new HP650C color plotter. Not only will this map be useful to the project, it will likely prove popular with the Bakersfield geological community.

A QuattroPro spreadsheet which is being used to document, display, and inventory our log data set was expanded to include all 242 wells for which we have data or well files. More than 45 wells which have the best log coverage and/or are in the most critical locations are being used in the main study, which will be confined to the 12-section area in T11N/R22E. Although the main study area will be centered on the eastern end (nose) of the Pioneer Anticline, the additional wells will be available to provide regional perspective.

Our conventional and sidewall core library of samples is now essentially complete. It consists of conventional cores and core analysis data from the UNOCAL McKittrick Front Nos. 415 and 418 wells in Cymric Field and the Tenneco 62x-30 well in Pioneer Field. Sidewall core and cuttings samples and core analysis data from the Gary Drilling, KLC 44, Well No. 375x in Pioneer Field are also in our possession. Samples from all four wells underwent petrographic, petrophysical, and geochemical analysis at MTU and USF. Xray Diffraction (XRD), Fourier Transform Infrared Spectroscopy (FTIR), and Scanning Electron Microscope (SEM) analyses were performed on selected samples by R. Kramer and D. Popko at MTU and bulk chemistry analyses by Inductively Coupled Plasma Spectroscopy (ICP) were performed by J. Ryan at USF.

A data set containing over 77,000 geochemical analyses of brines recovered from wells throughout the United States was acquired from a commercial database vendor. The database is currently being organized in Microsoft Access. As soon as a California base map has been gridded and input to GeoGraphix, the well locations for all California wells which contain brine analyses will be plotted on the basemap.

Extensive petrophysical data sets were acquired from UNOCAL for the cores from the UNOCAL McKittrick Front No. 415 and 418 wells in Cymric Field. A conventional-core petrophysical data set for the Tenneco 62x-30 well in Pioneer Field was acquired independently. Petrophysical data from the cores were used to calibrate the logs in these wells. The calibrations will be used to analyze existing logs and produce computed logs in uncored wells which penetrate the same stratigraphic intervals on the Pioneer Anticline. Conventional core data were acquired for the UNOCAL McKittrick Front and the Tenneco 62x-30 wells. Sidewall core data is available for several additional wells.

FTIR spectral analyses and ICP chemical analyses were completed on a suite of mineral standards by graduate student N. Popko. Data reduction is underway. Spectral data from standards are being input to MATLAB, a numerical computation and visualization software package, which generates non-negative least-squares (NNLS) fits to the data. ICP elemental analyses will be converted to oxides, and mineralogies will be calculated and used to cross-check the FTIR results. When the FTIR technique is perfected, it will be applied to core and cuttings samples and used for the identification of mineral assemblages.

SEM EDS analyses identified clay-like minerals that have unusual chemical ratios. XRD work concentrated on the cuttings samples from Pioneer Field. Better methods were developed for removing drilling mud from the samples. Reports were prepared that describe in detail the sample preparation procedures and the analyses performed to date on the Pioneer cuttings samples and the core samples from the Cymric McKittrick Front 415 and 418 wells. J. Ryan at USF completed chemical analyses of selected samples from the McKittrick Front sample set using ICP.

Optical petrographic analyses are complete for all of the thin sections which have been prepared to date. Results include petrographic descriptions, 35mm slides, and 35mm prints of thin sections which are characteristic of each lithologic type. These findings were compiled and results were presented by DPI at the AAPG Pacific Section Meeting in May, 1995. An atlas of thin section petrology of representative reservoir samples from the southern San Joaquin Basin was acquired for the project. The atlas was compiled by M. Hayes at Chevron Research under the direction of J. Wood in 1988. The atlas, which consists of several hundred described and interpreted photomicrographs from many fields, emphasizes diagenetic alteration. The photomicrographs and their captions will be scanned into the Multimedia Database Manager, where they can be readily accessed on hard disk and eventually on CD ROM.

Data preparation and log calibration were completed for the all 13 wells in the 12-section primary study area in the immediate vicinity of Pioneer Field, as well as for the 2 McKittrick Front wells in Cymric Field. Data preparation is complete for the more than 45 wells in the original Pioneer Anticline study area and for five additional "regional" wells were added to the data set to extend our picture of the Anticline up-plunge to the west. A spreadsheet listing all of the wells in the study, log depths and corrected subsea depths of the top of the Miocene in each well, and coordinates of the surface locations of the wells and the locations of the intersections of deviated wellbores with the top of the Miocene was prepared.

Preliminary model selection was completed for all 13 wells in the 12-section area in the immediate vicinity of Pioneer Field plus the 2 McKittrick Front wells. Results curves were generated for these wells. The results curves are calculated curves showing lithology, % clay, % shale, matrix type, porosity, and S_w . Calculation of results curves for the remaining wells with modern log suites is continuing. When analyses of these wells are completed, computed logs of porosity, oil saturation, water saturation, clay volume, lithology, etc., will be prepared and plotted on a uniform scale. Parameters to be mapped and visualized will then be chosen, the reservoir will be zoned and correlated, and the results of this geological evaluation will be input to the GeoGraphix Exploration System Workbench.

The geochemical modeling program CHILLER is being used to model fluid-rock interaction. This has very practical significance because of active steamflooding of the Monterey and Etchegoin Formation elsewhere in the southern San Joaquin Valley. The database containing information on oxygen isotopes, OXYBASE, is complete.

During the summer of 1995, two software packages, BasinMod and Access.basin, were acquired and installed in the Subsurface Laboratory at MTU. One dimensional basin modeling activities were initiated this quarter with an analysis of Elk Hills 934-29R in the Naval Petroleum Reserve, the deepest well (24,442 feet) in the San Joaquin Valley.

Numerous technology transfer activities occurred throughout the year. In January, 1995, we held a meeting at USF to review both of our DOE projects. Project members ran a booth in the Exhibits Hall at the AAPG National Meeting in Houston, March 5 to 8, 1995. The booth included a poster display which described project goals and progress to date and a computer demonstration. J. Allan, D. Schueller, and S. Dyl, who is the Curator of the Seaman Mineralogical Museum at MTU, submitted a proposal to the DOE Museum Science Education Program to develop an interactive computer-based Multimedia Display, which features this and several other DOE projects, at the Seaman Mineral Museum at MTU.

DPI ran a booth in the Exhibits Hall at the Pacific Section AAPG Meeting in San Francisco in May. The booth featured our Pioneer Anticline project along with other projects and services offered by DPI. J. Huntoon and W. Pennington presented posters at the Society of Exploration Geologists (SEG) Development and Production Forum on "Cooperative Projects to Improve Reservoir Management" in Colorado in June. J. Wood attended the DOE Contractor Review Meeting in June and presented an overview of this project. Our Multimedia CD ROM system for archiving data and distributing project results elicited favorable comment.

Work has begun on a Manual for a Project Workshop. The Manual will be used as the text for a course which will be first presented in Bakersfield, CA, probably in the fall of 1996. Finally, we intend to use the Multimedia Database Manager as a technology transfer mechanism. All data and information associated with the project are being stored on hard disk and will be accessible via the interactive multimedia shell program. At the end of the project, all data, graphics, tutorials, manuals, etc., will be stored on CD ROM for distribution to DOE and to our target audience within the petroleum industry.

DISCUSSION OF TECHNICAL PROGRESS BY TASK

TASK 1. PROJECT ADMINISTRATION AND MANAGEMENT

1.1 THE SPATIAL DATABASE MANAGER

Forms for entering various types of data (well-log, petrologic, bulk chemical, Xray Diffraction (XRD), Fourier Transform Infrared Spectroscopy (FTIR), etc.) by means of keyboard entry were completed. Several Excel macro programs have been completed for use in electronically transferring text formatted data to the database manager. Text format is a standard mode of data transfer between software applications that have application-specific data storage formats. Preparation of data reporting forms and graphing macros was initiated. Data tables for geochemical and petrographic data, well logs, well header information, well production data, formation tops, and fault trace data have been completed. Well logs will be stored in the Crocker, TerraSciences, and GeoGraphix log databases and in the more general Microsoft Access database. Figure 1 shows a screen print of the Table Relationship Window.

C. Asiala is currently developing Microsoft Access databases to archive analytical data and digitized log traces. The GeoGraphix Exploration System software package was acquired, installed on a PC in the Subsurface Laboratory at MTU, and is currently in use. The USGS Digital Land Grid and the National Geophysical Data Center's Gravity Data CD ROM were acquired and installed on GeoGraphix.

B. Watkins and D. Schueller designed and developed a Multimedia Database Manager using MacroMind Director on the Macintosh and later rewrote it for Windows in Visual Basic 3.0. We intend to use this shell as both an active database and archive and as a technology transfer mechanism. All data and information associated with the project are being stored on hard disk and will be accessible via the Database Manager. At the end of the project, all data, graphics, tutorials, manuals, etc., will be stored on CD ROM for distribution to DOE and to our target audience within the petroleum industry (Figs. 2 and 3).

Scanned and digitized logs were added to the database, a CD containing all of the Multimedia Database Manager data and information was pressed, and the program was demonstrated in our booth in the Exhibit Hall at the AAPG National Meeting in Houston in March, 1995. B. Watkins and D. Schueller are working together to add hot links to the text, to find additional graphics formats that will work, and to further develop and refine the interface. The Database Manager has evolved beyond a technology transfer mechanism, and is becoming an integral part of our Spatial Database Manager. At present, B. Watkins is constructing an input interface to make it possible for anyone in the project (not just experienced programmers) to easily input any type of data or graphics to the Database Manager.

1.1.1 DATABASE INITIALIZATION

We have selected Microsoft Access as our database management platform. The Multimedia

Database Manager shell/interface, written in Microsoft Visual Basic 3.0, continues to be developed to archive all project data. Building and filling the project database is an ongoing activity. The Access database will be used to store spreadsheet-type data (e.g., petrophysical, geochemical, and mineralogical analyses) and to inventory and query other types of data (e.g., log and seismic data, scanned images and drill reports, etc.).

At present, the Multimedia Database Manager is fully operational and efforts are being directed toward making it more user friendly. Project data reside in a number of programs, including GeoGraphix, Crocker Petrolog, Access databases, and the Multimedia Database Manager. C. Asiala is developing Microsoft Access databases to archive analytical data and digitized log traces. Once in Access, this data can be transferred easily to a variety of applications software packages. Now that we have three different programs that store and manipulate digitized log traces (Crocker Petrolog, GeoGraphix QLA2, and TerraSciences TerraStation), there is an increased need to archive log data in one central location.

1.1.2 DATABASE MANAGEMENT

Every manager and site now has a high-end PC (486-based computer or better) with which to access the database and run the visualization applications programs. These computers have been networked and linked to a common server at MTU. Data and files are being regularly transferred between MTU, Bakersfield, CA, La Habra, CA, and Fullerton, CA.

The GeoGraphix Exploration System software package was acquired and installed on a PC in the Subsurface Laboratory at MTU during the summer of 1995. Graduate student S. Chittick worked all summer loading data into the program and getting the system operational. QLA2, GeoGraphix's well-log package was also purchased. Although its analytical capabilities are less sophisticated than Crocker Petrolog, it appears that it may be used to produce excellent graphic log displays and cross sections. Digitized logs were loaded into QLA2 this summer and a few trial log cross sections were constructed.

The USGS Digital Land Grid was also acquired. This data set contains surface data, such as the locations of roads, rivers, towns, etc., for the entire United States. The National Geophysical Data Center's Gravity Data CD ROM was also acquired and loaded into GeoGraphix. Both data sets for the state of Michigan were loaded into GeoGraphix as part of our other DOE project (Class II, Michigan Basin), and are fully operational for that state. Once a basemap and land grid for the state of California is set up in GeoGraphix, surface data can be displayed on any California maps that we make. Production data for all of the wells in the Pioneer Field area were acquired from the California Division of Oil and Gas and will be loaded into GeoGraphix for display as overlays on structure contour and other maps.

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PioneerBuilder which will make it possible for anyone in the project to input any type of data or graphics to the Database Manager. With PioneerBuilder, data input will consist of calling up a List Box of Files and a List Box of Destinations, then simply clicking and dragging the files to their desired destinations. PioneerBuilder will be completed and ready for testing in a few weeks. When it is working to our satisfaction, C. Asiala will take over responsibility for inputting all data and graphics to the Multimedia Database Manager.

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1.2 ORGANIZATION AND MANAGEMENT

Task management is being implemented through visits by Wood to all project sites. These visits have served to keep project personnel aware of progress at each site and serve as a focal point for people to organize and present their progress in a semi-formal format. They also offer opportunity to discuss problems and to propose changes. We intend to maintain this regular review process through the rest of project. An annual project review in Tampa, Florida, in January brought all team members together and successfully fostered communication.

In general, all parties seem to be satisfied with the present management structure and implementation. Contacts are frequent enough, and permit sufficient time for discussions and problem-solving, without being overly intrusive. All team members so far appear to be functioning well with this management style.

Several management changes occurred in FY 1995:

- J. Wood took a 9-month leave of absence from MTU, at the University of South Florida in Tampa (USF), but returned to MTU in July, 1995.
- W. Pennington has taken a position as Professor of Geology at Michigan Technological University and has agreed to take an active role in the project.
- M. Gruener has accepted a part-time position as a Research Project Coordinator in the Geology Department and is assisting Wood in coordinating this project.

In January, 1995, all project members met at USF for an Annual Project Review Meeting. Various subgroups met and worked on specific tasks and subtasks throughout the year.

Several people joined the project during the last quarter of FY 1995. C. Asiala was hired as a part-time database programmer. M. Sivek was hired as an undergraduate assistant to help in the

programming. J. Alex joined the program as a part-time computer draftsman.

1.2.1 PROJECT COORDINATION

The following is a chronological description of project meetings and activities for FY 1995:

- In February, two meetings were held in Bakersfield. At the first, Allan, Nigrini, and Olson spent two days working on the Spatial Database Manager. At the second, Nigrini and Olson worked together for two additional days on the same project.
- In late October and early November, 1994, Allan visited Wood at USF and later traveled with him to MTU where they were met by Nigrini. All three met with project staff to review progress and work together on the project.
- In November, 1994, Gruener traveled to USF to work with Wood on project management and coordination issues.
- In December, 1994, Wood spent 6 days at MTU working with research staff and graduate students on the project.
- On January 19 and 20, 1995, all members of this project and of another, related MTU DOE project (the Michigan Basin Class II reservoirs project) met in Tampa for a formal project review.
- In February, two meetings were held in Bakersfield. At the first, Allan, Nigrini, and Olson spent two days working on the Spatial Database Manager. At the second, Nigrini and Olson worked together for two additional days on the same project.
- From March 5 to 8, project members ran a booth in the Exhibits Hall at the AAPG National Meeting in Houston. The booth included a poster display which described project goals and progress to date and a computer demonstration.
- From March 30 to April 6, Wood and Allan worked together on the project at USF in Tampa.
- In early May, Berry and Olson ran a booth in the Exhibits Hall at the AAPG Pacific Section Meeting. The booth featured this DOE project and DPT's well-log interpretation and analysis services.
- On May 10 to 12 Wood, Nigrini, and Allan traveled to Bakersfield to review the status of the well-log correlation and cross-section preparation work with Berry and Olson.
- During the week of June 5, Allan traveled to MTU to work on the project with faculty and staff.

- During the week of June 12, Pennington and Huntoon made presentations on various aspects of our DOE projects at an SEG Development and Production Forum entitled:

Cooperative Projects to Improve Reservoir Management. Pennington discussed the technical aspects of the project and Huntoon covered technology transfer issues.

- Following the SEG conference, Pennington spent one day each at the GeoGraphix and TerraSciences offices in Denver addressing problems with each company's software packages.
- During the week of June 26, Wood attended the DOE Contractor Review Meeting in Oklahoma and presented an overview of the project.
- In late June, A. Nigrini traveled to MTU to work on the project with MTU faculty and staff.
- In July, A. Nigrini traveled to MTU to work on the basin and geochemical modeling subtasks with MTU faculty and staff.
- In September, J. Allan traveled to MTU to work on various project tasks.

1.2.2 BUDGET MANAGEMENT AND QUARTERLY REPORTS

S. Milligan reprogrammed the project budgets and has set up a system for logging, recording and archiving all invoices related to this project. She also developed a convenient way to visualize the project budgets by monthly expenditures, cumulative expenditures, and projected expenditures using Lotus graphics. This has been a considerable aid to manager trying to track and control their budgets. Budget analysis and tracking of expenditures is now handled within the project and checked with the university records. We feel we have a good system of controls and oversight implemented that should serve the remainder of the project with little or no further modification.

M. Gruener and A. Hein have now assumed responsibility for daily management of the budget and expenditures. A. Hein is responsible for preparation of quarterly financial reports and for distribution of all reports to DOE. J. Allan is responsible for quarterly and annual technical reports.

TASK 2. DATA COLLECTION

Data from more than 45 project wells on the Pioneer Anticline and from 2 calibration wells in the McKittrick Front area of Cymric Field are being used in the project (Fig. 4).

2.1 WELL LOGS AND WELL DATA

All of the well logs which will be used in this project are now digitized, corrected, plotted on uniform scales, and hung on the same datum. Correlations have been made and a network for

structural and stratigraphic cross sections has been laid out through the study area. Two cross-sections have been completed and three more are under construction, with more to follow later.

The top of the Etchegoin Formation and the top of the Miocene have been correlated from the logs, and the top Miocene has been mapped (Fig. 5). Fault-trace data was digitized and will soon be loaded in GeoGraphix and integrated with the formation-top data, allowing the Pioneer structure to be remapped and visualized with faults. Cross sections along structural strike and structural dip through Pioneer Anticline in the vicinity of Pioneer Field are shown in Figs. 6 and 7.

A new effort was initiated during the last quarter of 1995. J. Alex digitized the surface geological maps of the southern San Joaquin Valley prepared by Dibblee of the California Division of Mines and Geology and loaded them into the computer drafting program Canvas, where he edited them, combined them into one large map, and colored them. When complete, the integrated map will be printed in large format on our new HP650C color plotter. Not only will this map be useful to the project, it will likely prove popular with the Bakersfield geological community.

2.1.1 LOG DATABASE MANAGEMENT

A QuattroPro spreadsheet which is being used to document, display, and inventory our log data set was expanded to include all 242 wells for which we have data or well files (Table 1). More than 45 wells which have the best log coverage and/or are in the most critical locations are being used in the main study, which will be confined to the 12-section area in T11N/R22E. Although the main study area will be centered on the eastern end (nose) of the Pioneer Anticline, the additional wells will be available to provide regional perspective. Additional deep wells from the sections to the west of the study area were added to the project master spreadsheet. They will be used to follow regional trends in the Miocene and will be included on cross sections.

It was determined that additional well data was needed for the database, so DPI staff gathered additional data from existing files and public sources, and entered them into spreadsheets. When the additional data are complete, the spreadsheet information will be loaded into the database. Several directional surveys, logs, and histories are missing from project data files. Efforts to locate them from various public and commercial sources are underway.

DPI acquired county survey records that cover the project area and contain the State Plane coordinates for all surveyed section corners. DPI has also contacted a local surveyor to determine if other surveyed corners exist for the area. It appears that the records contain most, if not all, of the surveyed corners. From the corners currently in our possession, the well locations were calculated in State Plane coordinates. This step is very important when constructing computerized maps, since well locations must be placed in a real-world coordinate system to be used successfully in the construction of maps and cross sections. The State Plane system will be used for all project maps for the following reasons:

- Computers need to use an orthogonal mapping system (Lat/Long coordinates are unacceptable).

- The State Plane System is the most commonly used system in California, it is in feet (so existing well surveys and standard map scales can be applied), and it can be easily converted to other coordinate systems.

All well log calibration and analysis has, to date, been performed at DPI in the Crocker Data Processing Petrolog Program. During 3rd quarter, FY 1995, digitized log data was also loaded into the TerraSciences log evaluation package at MTU and some preliminary evaluations of the program were performed. In 4th quarter, FY 1995, several well logs were loaded into MTU's GeoGraphix log evaluation module, QLA2, where they were displayed on cross sections. Although its analytical capabilities are less sophisticated than Petrolog or TerraSciences, it appears that QLA2 will be very useful for producing polished log displays and cross sections.

2.1.2 LOG DIGITIZATION

Digitization of the more than 45 wells which will be used to construct maps and visualizations of the Miocene reservoir on Pioneer Anticline is complete. This includes five additional "regional" wells that were added to the database this summer.

2.2 CORE AND SAMPLE ACQUISITION

2.2.1A CORE AND CUTTINGS

Our conventional and sidewall core library of samples is now essentially complete. It consists of conventional cores and core analysis data from the UNOCAL McKittrick Front Nos. 415 and 418 wells in Cymric Field and the Tenneco 62x-30 well in Pioneer Field. Sidewall core and cuttings samples and core analysis data from the Gary Drilling, KLC 44, Well No. 375x in Pioneer Field are also in our possession. Samples from all four wells underwent petrographic, petrophysical, and geochemical analysis at MTU and USF. Xray Diffraction (XRD), Fourier Transform Infrared Spectroscopy (FTIR), and Scanning Electron Microscope (SEM) analyses were performed on selected samples by R. Kramer and D. Popko at MTU and bulk chemistry analyses by Inductively Coupled Plasma Spectroscopy (ICP) were performed by J. Ryan at USF.

2.2.1B ARCO/UNOCAL CORE

Conventional cores and core analysis data from the UNOCAL McKittrick Front Nos. 415 and 418 wells in Cymric Field have been in our possession for some time. ARCO has divested its interests in the Pioneer area, so core from their wells may no longer be available. However, the cores and core data from the two McKittrick Front wells are so outstanding that acquiring data from additional wells is probably unnecessary.

2.2.2 FLUIDS

A data set containing over 77,000 geochemical analyses of brines recovered from wells throughout the United States was acquired from a commercial database vendor. The database is currently being

organized in Microsoft Access. As soon as a California base map has been gridded and input to GeoGraphix, the well locations for all California wells which contain brine analyses will be plotted on the basemap.

Analyses of oil samples from the McKittrick Front 415 and 418 wells are available to us. Arrangements will be made with operators of fields on Pioneer Anticline to sample their Monterey wells. Organic geochemical analyses will be contracted out to a vendor.

TASK 3. DATA ANALYSIS AND MEASUREMENT

3.1 PETROPHYSICS

Extensive petrophysical data sets were acquired from UNOCAL for the cores from the UNOCAL McKittrick Front No. 415 and 418 wells in Cymric Field. A conventional-core petrophysical data set for the Tenneco 62x-30 well in Pioneer Field was acquired independently. Petrophysical data from the cores were used to calibrate the logs in these wells. The calibrations will be used to analyze existing logs and produce computed logs in uncored wells which penetrate the same stratigraphic intervals on the Pioneer Anticline.

3.1.1 KPF MEASUREMENTS

Conventional core data were acquired for the UNOCAL McKittrick Front and the Tenneco 62x-30 wells. Sidewall core data is available for several additional wells.

3.1.2 FTIR SPECTRA

During the first half of FY 1995, the FTIR subtask concentrated on the development of analytical techniques and the acquisition and analysis of standards. Reliable analytical techniques for sample preparation were developed. We have accumulated a suite of mineral standards suitable for analysis of Monterey samples. Accumulation of a library of FTIR spectra on mineral standards continued throughout the year. An effort will be made to use FTIR to differentiate Opal-A from Opal-CT in Monterey reservoirs.

FTIR spectral analyses and ICP chemical analyses were completed on a suite of mineral standards by graduate student N. Popko. Data reduction is underway. Spectral data from standards are being input to MATLAB, a numerical computation and visualization software package, which generates non-negative least-squares (NNLS) fits to the data. ICP elemental analyses will be converted to oxides, and mineralogies will be calculated and used to cross-check the FTIR results. When the FTIR technique is perfected, it will be applied to core and cuttings samples and used for the identification of mineral assemblages. Popko is doing this work as his Master's research under the direction of W. Pennington.

3.2 PETROLOGY

3.2.1 XRD

SEM EDS analyses identified clay-like minerals that have unusual chemical ratios. They may be zeolites. Heavy liquid separation of the clay fraction from the diatom fraction will be followed by full Xray ID scans to determine the mineralogy of each fraction. The composition of the clay fraction is important because of its effect on log response.

The following XRD information is useful in performing the final log calibration and model selection: 1) clay content, 2) clay type (smectite vs illite), 3) diatomite phase (opal A, opal CT, or quartz), 4) pyrite and apatite content, for samples of each representative lithology in the Monterey.

XRD work concentrated on the cuttings samples from Pioneer Field. Better methods were developed for removing drilling mud from the samples. Reports were prepared that describe in detail the sample preparation procedures and the analyses performed to date on the Pioneer cuttings samples and the core samples from the Cymric McKittrick Front 415 and 418 wells. One experienced technician, R. Kramer, left the project to assume a full-time position in another department at MTU. We will attempt to cover her responsibilities by hiring graduate students and staff to continue the analytical work.

J. Ryan at USF completed chemical analyses of selected samples from the McKittrick Front sample set using ICP.

3.2.2 SEM/IMAGE ANALYSIS

The fine-grained nature of the Monterey reservoir facies makes the material difficult to characterize petrographically using standard thin-section microscopy. However, the SEM provides at least an order of magnitude better resolution, particularly with regard to obtaining compositional data.

Grain mounts of selected samples were examined for morphological character and phase changes. The grainmount work is being done prior to Image Analysis, since it will provide valuable information about spatial variations in microporosity and will therefore help guide the effort to understand and quantify porosity through Image Analysis. The grainmount work resulted in the discovery of a previously unidentified component in the clay fraction, which is being investigated using XRD methods.

We have made arrangements with J. Boles of UC Santa Barbara to continue the image analysis work begun by Kramer.

3.2.3 PETROLOGY

Optical petrographic analyses are complete for all of the thin sections which have been prepared to date. Results include petrographic descriptions, 35mm slides, and 35mm prints of thin sections which are characteristic of each lithologic type. These findings were compiled and results were

presented by DPI at the AAPG Pacific Section Meeting in May, 1995. Additional work will be performed as necessary.

An atlas of thin section petrology of representative reservoir samples from the southern San Joaquin Basin was acquired for the project. The atlas was compiled by M. Hayes at Chevron Research under the direction of J. Wood in 1988. The atlas, which consists of several hundred described and interpreted photomicrographs from many fields, emphasizes diagenetic alteration. The photomicrographs and their captions will be scanned into the Multimedia Database Manager, where they can be readily accessed on hard disk and eventually on CD ROM.

3.3 LOG CALIBRATION

In a reservoir study, log data is calibrated to ground truth. The preferred ground truth is whole-core data over as much continuous interval as can be obtained given economic realities. Other valuable data include sidewall core data and well cuttings. For this project, one well from the study area has modern whole core analysis, several have sidewall cores, and one has a full suite of well cuttings. Conventional core was also obtained for the project from two wells in a similar facies of the Monterey Formation from an area with extensive current production (the UNOCAL McKittrick Front 415 and 418 wells from Cymric Field).

Since log calibration is time-consuming and the McKittrick Front 418 well contains over 700 ft of conventional core with thousands of petrophysical analyses, the completion of calibration for the McKittrick Front wells represents a significant portion of the effort in this subtask.

Data preparation and log calibration were completed for the all 13 wells in the 12-section primary study area in the immediate vicinity of Pioneer Field, as well as for the 2 McKittrick Front wells in Cymric Field. Additional refinement of the calibrations will be performed as the results of XRD, rock chemistry, and FTIR analyses of core material become available, but for now we have a working calibration equal to that used in most reservoir studies.

3.3.1 DATA PREPARATION

Data preparation is complete for the more than 45 wells in the original Pioneer Anticline study area. Five additional "regional" wells were added to the data set to extend our picture of the Anticline up-plunge to the west. A spreadsheet listing all of the wells in the study, log depths and corrected subsea depths of the top of the Miocene in each well, and coordinates of the surface locations of the wells and the locations of the intersections of deviated wellbores with the top of the Miocene are listed in Table 2.

Data preparation includes log normalization and parameter selection. The term 'normalization' as found in the literature has several meanings in log analysis. In this project, 'normalization' is used to describe the phase in a field study where all the wells in the study area are compared to one another to identify those variations in log response that can be attributed to log calibration errors. The logs are corrected, or normalized, by applying an appropriate shift to each curve as calculated

from the normalization process. Analysis parameters determined from calibration to known data points, such as cores, can then be applied with confidence to the entire project. After normalization, areal variations in reservoir properties can, with confidence, be attributed to real-world differences and not to spurious log errors.

To perform a valid normalization, the log data must be verified, edited, depth shifted, and environmentally corrected. These tasks have been completed. No lithologies with known and consistent log responses (such as carbonates or salt) were logged in the project area, so all normalizations were performed as relative shifts to a locally defined standard. A local standard was established by examining all the wells in the study area and establishing the characteristic log response of a majority in key intervals for the wells sampled.

The standard is not an absolute value, however, since log response is also influenced by geological variation and changes in fluid saturations within the reservoir and over time. A mapping approach to the normalization problem is usually recommended by DPI, but due to the fact that the wells are spread over a large area, have significant differences in structural position, and major changes in lithology, subtle problems could be recognized. Therefore, only the most significant calibration differences were corrected before the petrophysicist proceeded to parameter selection. Parameters were selected for all lithologies present.

3.3.2 MODEL SELECTION

Preliminary model selection was completed for all 13 wells in the 12-section area in the immediate vicinity of Pioneer Field plus the 2 McKittrick Front wells. Results curves were generated for these wells (Figs. 8 and 9). The results curves are calculated curves showing lithology, % clay, % shale, matrix type, porosity, and S_w . Calculation of results curves for the remaining wells with modern log suites is continuing.

When analyses of these wells are completed, computed logs of porosity, oil saturation, water saturation, clay volume, lithology, etc., will be prepared and plotted on a uniform scale. Parameters to be mapped and visualized will then be chosen, the reservoir will be zoned and correlated, and the results of this geological evaluation will be input to the GeoGraphix Exploration System Workbench. A number of analytical models have been presented over the years in the log analysis literature. Diatomite is an unusual rock type, and there is little published literature on analytical models for it. There are several important measures of reservoir quality in diatomaceous lithologies besides porosity and saturation. Lithology and the presence of fractures are also very important. Many diatomaceous rocks have adequate porosity and oil saturation for hydrocarbon production, but have too little permeability for production. The measurement and/or prediction of lithology and fracturing are therefore important parts of a reservoir evaluation in diatomites.

The models that have been selected for this project can be applied to all wells with resistivity and density-neutron logs, and are capable of predicting matrix density, clay volume, diatomite facies, accessory minerals such as carbonates, porosity, permeability, water saturation, as well as providing a qualitative measure of fracturing and fracture potential. The output of these models is the primary

input to the reservoir visualization program.

TASK 4. MODELING

4.1 GEOCHEMICAL MODELING

The geochemical modeling program CHILLER is being used to model fluid-rock interaction. This has very practical significance because of active steamflooding of the Monterey and Etchegoin Formation elsewhere in the southern San Joaquin Valley. B. Watkins has completed a new Windows interface which is presently being tested and debugged. He has begun to simplify data input and to work on a graphical output interface for rapid visual display of output.

Investigation of the feasibility of porosity prediction using CHILLER is underway. Initial results show that identification and quantification of changes in porosity are possible. These results show that, for an arkosic assemblage undergoing reaction with seawater, the change in porosity is negligible. Addition of calcite to the reaction assemblage, and suppression of quartz and albite precipitation, can increase the change in porosity by as much as 5%.

In preparation for modeling of steam flooding, Suchoski has tested our mass transfer and stable isotope modeling programs by modeling the interaction of an arkosic sandstone assemblage with seawater. The results indicate that both programs produce sound results (Fig. 10).

The stable isotope modeling program ISOTOPIA was developed to model the stable isotopic evolution of the fluid and the minerals.

Heating and cooling experiments using CHILLER and ISOTOPIA are planned to further test the models and to begin to simulate steam flooding.

4.1.1 GEOCHEMICAL MASS TRANSFER

Dr. A. B. Carpenter at Chevron Petroleum Technology Co. has provided us with a good quantitative analysis of the Opal-A zone from a Chevron well in Cymric Field (see Table below). We are using this data in trial steamflood reaction runs using CHILLER in order to determine the scope of the geochemical modeling problem. Next, pressure-temperature histories for typical flow paths need to be obtained from field data or from flow simulators. We plan to acquire streamline flow simulators from public domain software sources and will attempt to acquire field data from Chevron.

Table 1. Results of Quantitative Mineralogical Analyses from the Opal A Zone of a Chevron Well in Cymric Field

	<u>wt%</u>		
Quartz	6	calculated matrix density	2.14
Opal-A	39	measured matrix density	2.17
Calcite	<1	porosity	0.63
Dolomite	<1		
Kspar + plag	10		
Total clay	27		
Pyrite	1		
Siderite	1		
"Bitumen"	9		

During the last quarter FY 1995, CHILLER was used extensively by J. Suchoski in another DOE project in which several of our members are participating (Class I, Eugene Island). Although the results are not directly applicable to this project, the experience gained will be useful in our upcoming studies of the Pioneer reservoirs.

4.1.2 THERMODYNAMIC DATABASE

The thermodynamic database SOLTHERM contains thermodynamic information on fluid species, gases, and minerals. Over 400 species are contained in the database. The data are valid over a temperature range of 0°C to 300°C.

The database containing information on oxygen isotopes, OXYBASE, is complete. Work will soon begin on expanding the isotope database to include hydrogen, carbon, and sulfur isotopes, and on developing a suitable model for carbon isotope fractionation.

4.2 BASIN MODELING

During the summer of 1995, two software packages, BasinMod and Access.basin, were acquired and installed in the Subsurface Laboratory at MTU.

4.2.1 GEOHISTORY

One dimensional basin modeling activities were initiated this quarter with an analysis of Elk Hills 934-29R in the Naval Petroleum Reserve, the deepest well (24,442 feet) in the San Joaquin Valley. This well is unique in that it bottoms in Cretaceous sediments, thus giving us as complete a Tertiary section in the sub-surface as has been found to date. The well has excellent equilibrated downhole temperature profiles based on continuous temperature logging and a good vitrinite reflectance (Ro) profile that provide for calibration of the paleo-heat flow. In addition, estimates of the surface temperature history are available as determined from water depth information derived from abundant fossil evidence. A generalized paleo-heat flow model is provided by model studies of lithospheric

plate interactions which predicts the thermal consequences of the complex plate interactions affecting the Southern San Joaquin Valley.

The results of the 1-D modeling study of Elk Hills 934-29R demonstrate that the downhole temperature profile observed in the well is not in equilibrium with observed Ro data. The predicted Ro value at the base of the well, on the assumption that the downhole temperature data represent the regional temperature field, is 2.4 compared to the observed value of 1.56. As vitrinite is believed to equilibrate relatively rapidly, the results indicate that the observed temperature profile is not in equilibrium with the regional temperature field in this region. In fact, examination of the complex structure of the Elk Hills reservoirs, which includes en echelon anticlines, transform, normal and reverse faults (suggestive of a flower structure), numerous discrete pressure compartments with differing temperature profiles, and recent seismic and tectonic activity suggests that the observed temperature fields at Elk Hills are not likely to be in equilibrium but are reflective of migrating geothermal fluids that have been released episodically in the very recent past up to the present day.

A present-day downhole temperature profile was calculated to be consistent with the observed Ro values. The assumption was made that Ro values have been minimally influenced by the observed non-equilibrium temperature profile and still reflect the true regional temperature history. The predicted downhole temperature at 23,800 feet is 188°C compared to an observed value of 218°C. In order to match both the Ro and temperature data in the well (Figure 11), a recent heating event starting within the last 50,000 years was used. This heating is probably caused by recent movements along the many faults throughout the Elk Hills structure which lead to release of geothermal fluids from depth in the overpressured hydrocarbon generation compartments. Figure 12 is a Geohistory diagram for the Elk Hills area showing that Kreyenhagen and Tumey Formation source rocks may still be in the late oil generation window. Therefore any reservoir rocks shallower than approximately 17,000 feet are prospective. This is much deeper than any of the reservoirs presently being produced in the San Joaquin Valley, which are generally shallower than 10,000 feet.

The concept of elevated temperature profiles due to episodic release of geothermal fluids is not new. It is reflected in the oxygen isotopic compositions of vein calcite cements collected from core that show elevated isotope temperatures indicative of upwelling fluids. This phenomenon is also observed at North Coles Levee Field to the north. A paper describing the burial and temperature history of the 934-29R well is currently in preparation.

4.2.2 2D AND 3D BASIN MODELS

The following basin modeling programs were acquired over the summer and are being tested at MTU:

BasinMod - 1-D Basin Modeling Software: The BasinMod system provides users with a relatively simple, user-friendly method for modeling the evolution of single wells. Multiple well histories can also be modeled to investigate variations in basin evolution that occur from one geographic locality to another. BasinMod allows modeling of burial histories, temperature histories, compaction, lithologies, heat flow, hydrocarbon maturities, and pressures, and allows for multiwell mapping of

variables. BasinMod was acquired and installed on a PC in the Subsurface Laboratory at MTU. A. Nigrini used BasinMod to model the deepest well in the San Joaquin Basin (see Subtask 4.2.1).

Akcess.basin - 2-D, 3-D Basin Modeling Software: Earlier this summer, Access.basin was acquired and installed on the Sun Workstation in the Subsurface Laboratory at MTU. This software uses a finite-element formulation to examine the effects of thermal processes (conduction, convection, advection), fluid flow processes (compaction-driven, hydraulic-head driven), sealing mechanisms, and sedimentation/erosion during the development of a sedimentary basin. The program also predicts hydrocarbon generation (timing, location, and rate) and migration patterns. An older 3D version is now running. The latest upgrade was recently received, but requires debugging before it can be used.

TASK 5. TECHNOLOGY TRANSFER

5.1 REPORTS

To date, the main technical reports prepared and distributed have been quarterly technical reports to DOE and internal progress reports. A. Nigrini is currently preparing a paper on the BasinMod study of the deepest well in the San Joaquin Valley for publication.

5.2 MEETINGS AND WORKSHOPS

Tampa Meeting

On January 19 and 20, 1995 we held a meeting at USF to review both of our DOE projects. Our Michigan Basin project was discussed on January 19 and this project was discussed on January 20. Each project member made a presentation on his or her work. The meeting afforded project members an opportunity to learn what everyone else was doing and to discuss project plans and accomplishments in an open forum. The meeting was very successful at accomplishing these goals. R. E. Lemmon, our DOE Program Manager, attended the meeting. The agenda is appended as Attachment 1.

AAPG National Meeting

Project members ran a booth in the Exhibits Hall at the AAPG National Meeting in Houston, March 5 to 8, 1995. The booth included a poster display which described project goals and progress to date and a computer demonstration. We ran two adjacent booths, one for this project and one for our Michigan DOE Class II reservoir project. Our AAPG Exhibit was very successful. Wood, Allan, Nigrini, Schueller, and Suchoski operated the booth for this project. Other MTU faculty and graduate students affiliated with the Michigan DOE project also attended and helped run the other booth. Considerable interest was generated both in the project and in the Multimedia Database Manager which we developed to archive and display project results. Several independents and petroleum consultants were very interested in the Multimedia Database Manager and asked to be kept abreast of project developments.

DOE Museum Science Education Proposal

In May, 1995, J. Allan, D. Schueller, and S. Dyl, who is the Curator of the Seaman Mineralogical Museum at MTU, submitted a proposal to the DOE Museum Science Education Program to develop an interactive computer-based Multimedia Display at the Seaman Mineral Museum at MTU to tell the story of recent changes that have profoundly affected the U. S. domestic oil industry and to show how our group in the Department of Geological Engineering and Sciences at Michigan Technological University is using funding from DOE programs (the Advanced Extraction and Process Technology Program and the Class II Oil Recovery Program) to develop affordable, high-technology solutions to some of the industry's more pressing problems. If funded, we feel that this display will be an effective technology transfer vehicle.

AAPG Pacific Section Meeting

DPI ran a booth in the Exhibits Hall at the Pacific Section AAPG Meeting in San Francisco in May. The booth featured our Pioneer Anticline project along with other projects and services offered by DPI. Posters and an album containing interpreted photomicrographs and SEM photographs prepared by R. Kramer were on display. A handout describing our project was distributed to many interested people.

SEG Development and Production Forum

J. Huntoon and W. Pennington presented posters at the Society of Exploration Geologists (SEG) Development and Production Forum on "Cooperative Projects to Improve Reservoir Management" in Colorado in June. Pennington discussed the California Reservoir Visualization project and another DOE project which involves horizontal drilling in the Michigan Basin in which Michigan Tech is also participating. Huntoon presented a poster display on Technology Transfer. The Technology Transfer talk, entitled "Facilitating interaction between universities and industry: mechanisms for personnel and technology transfer", elicited much favorable comment. Huntoon was asked to re-present it as an invited paper at the SEG Annual Meeting this fall. Our representatives at this meeting found it to be very successful in facilitating communication (and technology transfer) between various groups carrying out DOE sponsored projects.

DOE Contractor Review Meeting

J. Wood attended the DOE Contractor Review Meeting in June and presented an overview of the project. Our Multimedia CD ROM system for archiving data and distributing project results elicited favorable comment.

Project Workshop

Work has begun on a Manual for a Project Workshop. The Manual will be used as the text for a course which will be first presented in Bakersfield, CA, probably in the fall of 1996. Previously, we had discussed initiating our technology transfer effort with a smaller workshop on database design and construction. We have now decided to discuss databases as a subsection of a larger workshop that covers the entire project. J. Wood issued a memo in September, 1995, which provided an outline for the workshop and course notes, created teams and appointed team leaders for each task, set goals for the content of each section, and established deadlines. The memo and a spreadsheet summarizing the division of responsibilities are appended as Attachment 2.

Multimedia Presentations on CD-ROM

We intend to use the Multimedia Database Manager as a technology transfer mechanism. All data and information associated with the project are being stored on hard disk and will be accessible via the interactive multimedia shell program. At the end of the project, all data, graphics, tutorials, manuals, etc., will be stored on CD ROM for distribution to DOE and to our target audience within the petroleum industry.

During the last quarter of FY 1995, a CD ROM writer was purchased and the current contents of the Multimedia Database Manager were written to CD. The CD's are now available for use in presentations. The Multimedia Database Manager is discussed in greater detail under Subtask 1.1.

TABLE 1.

WELL LOG INVENTORY

QTR. RPT. 01/95

WELL	OPERATOR	FIELD	SEC	TOWN	RANG	DATE	CONTENTS	FILE NAME	CURVES	KB	GL	TD	TOP
1	OIL PRODUCERS INC.	SUNSET	7	11N	23W	12/11/38	CORE RECORD						
2 (ROYER 2)	BIHL PETROLEUM	SUNSET	7	11N	23W	11/28/39	WELL HISTORY					9006	
3-B	EAST DONNELLY AND PIKE	MIDWAY SUNSET	7	11N	23W	05/20/63	2" ELOG, WELL HISTORY						
4A	MARICOPA ASSOCIATES	MIDWAY SUNSET	17	11N	23W	12/24/60	WELL HISTORY			904.00		710	
6K 74	STANDARD OIL OF CALIFORNIA	MIDWAY SUNSET	6	11N	23W	04/01/81	WELL HISTORY			699.00		4550	
6K 134	STANDARD OIL OF CALIFORNIA	MIDWAY SUNSET	6	11N	23W	08/12/81	WELL HISTORY			623.00		3750	
6K 153	STANDARD OIL OF CALIFORNIA	MIDWAY SUNSET	6	11N	23W	06/18/81	WELL HISTORY			601.00		4250	
6K 162	STANDARD OIL OF CALIFORNIA	MIDWAY SUNSET	6	11N	23W	06/09/81	WELL HISTORY			589.00		4150	
6K 163	STANDARD OIL OF CALIFORNIA	MIDWAY SUNSET	6	11N	23W	08/20/81	WELL HISTORY			598.00		4130	
7K-8-2	STANDARD OIL OF CALIFORNIA	MIDWAY SUNSET	7	11N	23W	03/31/83	2" ELOG						
19	VIRSAI OIL COMPANY	MIDWAY SUNSET	23	11N	23W	11/02/80	ELOG						
21E (RIPLEY TATUM 21E)	VIRSAI OIL COMPANY	MIDWAY SUNSET	23	11N	23W	11/16/80	2" DUAL IND/SFL			1835.00	1825.00	730	40
23B-2	TENNECO	SANTIAGO CREEK	23	11N	23W	08/24/83	2" ELOG			1038.00		1022	75
64	STANDARD OIL COMPANY OF CALIF	SUNSET	06K	11N	23W	04/03/48	2" ELOG			698.40		6297	48
65	STANDARD OIL COMPANY OF CALIF	SUNSET	06K	11N	23W	06/04/48	2" ELOG			708.11		6335	201
67-23	BANKLINE OIL COMPANY	MARICOPA	23	11N	23W	08/04/41	2" ELOG				1000.00	1104	110
62X-30	TENNECO OIL COMPANY	LOS LOBOS	30	11N	22W	05/18/81	SONIC; DUAL LATEROLOG M	62X30	ROP, GAS, C1,C2,C3,C4, D1, D	1183.80	1082.80	3000	120
67-20	RICHFIELD OIL CORPORATION	LOS LOBOS	20	11N	22W	05/28/83	2" ELOGS/SUB SURFACE MAGN	6720	SP, AM18, AO10, AO19	929.00	920.00	7630	350
78-30	TENNECO OIL COMPANY	MUDDY CREEK "A"	30	11N	22W	10/11/81	DUAL INDUCTION - SFL; DIP;	78-30	GR, CAL, DPHLNPHI, DRHO,	1162.60	1162.60	2000	90
77-A	INDIAN OIL COMPANY	MIDWAY SUNSET	17	11N	23W	12/04/81	2" ELOG, WELL HISTORY						
1 KCL SAN EMIGDIO	WESTERN GULF OIL COMPANY	LOS LOBOS	34	11N	22W	11/28/45	WELL HISTORY			1330.30	1328.64	3548	
103	OCCIDENTAL PETROLEUM	MIDWAY SUNSET	17	11N	23W	05/03/85	WELL HISTORY						
B-2	EAST DONNELLY AND PIKE	MIDWAY SUNSET	7	11N	23W	10/13/82	2" ELOG, WELL HISTORY						
B. AND M. US NO.1	WESTERN GULF OIL COMPANY	PIONEER ANTICLIN	30	11N	23W	11/15/47	2" ELOG, WELL HISTORY				1280.00	6882	35
B. AND M. US NO.1 RE-DRILL	WESTERN GULF OIL COMPANY	PIONEER ANTICLINE	30	11N	23W	10/02/48	2" ELOG				1280.00	2050	1550
BONYNGE NO.1	TRICO OIL AND GAS COMPANY	MARICOPA	18	11N	23W	08/05/48	2" ELOG			782.00		6885	170
BREA - MUTAU 1	WESTERN CONTINENTAL	MARICOPA	32	11N	23W	11/14/81	MUD; DISPL; SONIC; DUAL INDUC		CNL GR; HISTORY	1411.60	1386.00	10708	744
BREA - MUTAU 1 RD 1	WESTERN CONTINENTAL	MARICOPA	32	11N	23W	02/13/82	DUAL INDUC SFL GR; DUAL		INDUC W/LIN CORR; SONIC; FDC;	1411.60	1386.00	11182	5547
BREA - MUTAU 1 SIDETRACK	WESTERN CONTINENTAL	MARICOPA	32	11N	23W	12/28/81	MUD			1411.60	1386.00	12340	9536
BRONCO NO.1	OTIS HOYT	MIDWAY SUNSET	8	11N	23W	02/04/44	2" ELOG					2728	80
CALIFORNIA WESTERN NO.8	CALIFORNIA WESTERN OIL	SUNSET	17	11N	23W	08/12/30	HISTORY					4014	
CCMO 58-20	RICHFIELD OIL CORPORATION	LOS LOBOS	20	11N	22W	02/01/84	2" ELOG; SUB SURFACE SIN	5820	SP, AM18, AO10, AO19	983.00	954.00	6860	350
CCMO 58-20 RD 1	RICHFIELD OIL CORPORATION	LOS LOBOS	20	11N	22W	03/12/84	2" ELOG	5820RD1	SP, AM18, AO10, AO19	983.00	954.00	6780	6250
CCMO 78-20	RICHFIELD OIL CORPORATION	LOS LOBOS	20	11N	22W	10/03/82	2" ELOG; SUB SURFACE SU	CCMO7820	SP, AM10, AO10, AO19	948.00	938.00	6830	350
FEDERAL 28-1	COOK ENERGY INCORPORATED	CIENAGA CANYON	28	11N	23W	08/13/78	WELL HISTORY, 2" DUAL INDUC	LATEROLOG		114.70	113.60	6836	698
FRANKLEY 77-17	GENERAL PET. CORP.	MIDWAY SUNSET	17	11N	23W	04/03/47	2" ELOG						
G.P. 62X-20	TEXACO-SEABOARD INCORPORAT	PIONEER AREA	20	11N	23W	08/27/58	WELL HISTORY, 2" ELOG			983.00	969.00	6814	30
G.P. 64X-20 (T.S.I. G.P. 64X-20)	TEXACO-SEABOARD INCORPORAT	PIONEER AREA	20	11N	23W	11/28/58	2" ELOG, WELL HISTORY			1034.00	1021.00	6473	70
GOVT 1	ISLAND VIEW OIL COMPANY	MIDWAY SUNSET	17	11N	23W	06/05/83	2" ELOG, WELL HISTORY						
GOVT 2	ISLAND VIEW OIL COMPANY	MIDWAY SUNSET	17	11N	23W	12/28/83	2" ELOG						
GOVT 3	ISLAND VIEW OIL COMPANY	MIDWAY SUNSET	17	11N	23W	08/27/84	2" ELOG, WELL HISTORY						
GOVT 4	CHAPARRAL PET. INC.	MIDWAY SUNSET	17	11N	23W	03/27/85	2" ELOG						
GOVT 5	CHAPARRAL PET. INC.	MIDWAY SUNSET	17	11N	23W	07/22/85	2" ELOG, WELL HISTORY						
GOVT 102	CHAPARRAL PET. INC.	MIDWAY SUNSET	17	11N	23W	08/14/87	2" NEUT/IND; WELL HISTORY						
GOVT 104	CHAPARRAL PET. INC.	MARICOPA	17	11N	23W	06/07/76	2" NEUT/INDUCT; WELL HISTORY						
GOVT 105	CHAPARRAL PET. INC.	MIDWAY SUNSET	17	11N	23W	12/24/76	2" ELOG, WELL HISTORY						
GOVT 106	CHAPARRAL PET. INC.	MIDWAY SUNSET	17	11N	23W	08/08/76	2" NEUT/INDUCT; WELL HISTORY						
GOVT 107	CHAPARRAL PET. INC.	MIDWAY SUNSET	17	11N	23W	06/22/76	2" ELOG, WELL HISTORY						
GOVT 108	CHAPARRAL PET. INC.	MARICOPA	17	11N	23W	06/28/76	2" ELOG, WELL HISTORY						
GOVT 118	CHAPARRAL PET. INC.	MARICOPA	17	11N	23W	01/07/76	2" NEUT/INDUCT; WELL HISTORY						
GOVT 119	CHAPARRAL PET. INC.	MIDWAY SUNSET	17	11N	23W	10/11/76	2" NEUT/INDUCT; WELL HISTORY						
GOVT 121	CHAPARRAL PET. INC.	MIDWAY SUNSET	17	11N	23W	10/03/76	2" ELOG						
H & M 2	GENE REID DRILLING	MARICOPA	7	11N	23W	08/01/81	2" ELOG, WELL HISTORY						
HAVENSTRITE 6	TEXACO INCORPORATED	SUNSET	17	11N	23W	07/11/45	WELL HISTORY, 2" ELOG			824.00		3390	200
HAVENSTRITE USL 51A-17	TRICO OIL AND GAS COMPANY	MIDWAY SUNSET	17	11N	23W	07/17/58	2" ELOG, WELL HISTORY			728.00	713.20	5252	301
HAVENSTRITE USL 601	CHAPARRAL	MIDWAY SUNSET	17	11N	23W	08/28/78	WELL HISTORY			728.00	717.00	3500	
HAZELTON 6	BARNSDALL OIL COMPANY	SUNSET	17	11N	23W	06/21/44	WELL HISTORY				773.00		
HOUGHIN 3	UNION OIL COMPANY	MIDWAY SUNSET	10	11N	23W	04/11/77	8" GAMMA RAY NEUTRON; CARBON/OXYGEN LOG					5323	3622
HOYT SON 2	OTIS HOYT CO SON LEASE	MIDWAY SUNSET	8	11N	23W	08/18/44	2" ELOG; WELL HISTORY						
I-8	ARCO OIL AND GAS CO.	MIDWAY SUNSET	24	11N	23W	04/11/81	DUAL INDUC/SFL						
I-13	ARCO OIL AND GAS CO.	MIDWAY SUNSET	24	11N	23W	11/02/80	DUAL INDUC LATEROLOG						
I-18	ARCO OIL AND GAS CO.	MIDWAY SUNSET	24	11N	23W	04/07/81	DUAL INDUC/SFL						
I.M. WOODWARD U.S.L. 3	WESTERN GULF OIL COMPANY	SANTIAGO AREA WILD	21	11N	23W	11/30/45	WELL HISTORY			907.58		991	
I.M. WOODWARD U.S.L. 4	WESTERN GULF OIL COMPANY	SANTIAGO AREA WILD	21	11N	23W	12/08/45	WELL HISTORY			914.38	904.61	3328	
I.M. WOODWARD U.S.L. 6A	GULF OIL CORPORATION OF CALIF	MIDWAY SUNSET	21	11N	23W	02/11/81	WELL HISTORY				902.00	3310	
I.M. WOODWARD U.S.L. 12	GULF OIL CORPORATION OF CALIF	MIDWAY SUNSET (SAN	21	11N	23W	11/19/80	WELL HISTORY				900.00	871	
I.M. WOODWARD U.S.L. 13	GULF OIL CORPORATION OF CALIF	MIDWAY SUNSET	21	11N	23W	01/28/81	WELL HISTORY				900.00	881	
I.M. WOODWARD U.S.L. 17	GULF OIL CORPORATION OF CALIF	MIDWAY SUNSET	23	11N	23W	12/02/76	2" DUAL INDUC - LATEROLOG			959.00	949.00	3280	327
I.M. WOODWARD U.S.L. 20	GULF OIL CO.	SANTIAGO	23	11N	23W	08/03/77	2" DUAL INDUC FOCUSED LOG			959.00	949.00	2307	255
I.M. WOODWARD U.S.L. 24	GULF OIL EXPLORATION AND PRO	MIDWAY SUNSET	23	11N	23W	03/30/85	2" DUAL INDUC LATEROLOG			962.80	962.80	3477	532
JOHNSON 1	BIRCH ROYER OIL CO.	SUNSET	7	11N	23W	11/04/40	WELL HISTORY						
KCL 1A-8-32	SHELL OIL COMPANY	SAN EMIGDIO	32	11N	22W	4/19/39	2" ELOG; HISTORY	KCL1A832		1351.80	1552.00	4870	870

TABLE 1.

WELL LOG INVENTORY

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KCL 12-27	ARROWHEAD EXPLORATION COMP	LOS LOBOS	27	11N	22W	03/04/81	INDUCT : SONIC ; WELL HIST	KCL1227	SP, DT, SP, SN18, INDUC	988.00	955.00	7920	380
KCL 13-X	KENNETH SPERRY	LOS LOBOS	27	11N	22W	01/13/87	WELL HISTORY			1009.00	998.00		8934
KCL 18-34	OCCIDENTAL PETROLEUM CORPO	WOLF CREEK DEEP	34	11N	22W	8/28/84	2" IND ELOG RUNS 1,2,3; WELL HISTORY			1393.20	1381.00	8791	1047
KCL 24-32	STANDARD OIL COMPANY OF CALI	SAN EMIDIO	30	11N	22W	05/24/86	WELL HISTORY			1084.70		1860	
KCL 24-37	STANDARD OIL COMPANY OF CALI	MARICOPA	19	11N	22W	04/04/86	2" ELOG ; WELL HISTORY	KCL2437	SP, SN LAY	1022.00		8182	200
KCL 44-28	STANDARD OIL	PIONEER	32	11N	22W	12/10/59	2" IND ELOG RUNS 1,2,3 ; 2" GR/NEUT RUN 1,2 ; WELL HISTORY	KCL 4434				10022	400
KCL 44-34	STANDARD OIL	PIONEER ANTICLINE	32	11N	22W	08/29/59	2" IND ELOG RUNS 1 THRU 14			1258.00			
KCL 44-34 RD1	STANDARD OIL	PIONEER	32	11N	22W	08/29/59	2" LATEROLOG ; 2" IND ELOG RUNS 1 THRU 14; WELL HISTORY						
KCL 44-378	GARY DRILLING COMPANY	PIONEER	32	11N	22W	07/04/80	CYBERDIP ; CORE ANAL ; ACOUSTIC CEMENT BOND LOG ; NATURAL GAMMA RAY			1218.30	1208.30	3211	880
KCL 44-73	STANDARD OIL	PIONEER	32	11N	22W	11/18/59	2" IND ELOG RUNS 1 THRU 8 ;	KCL 4443		1212.00	1204.00	6861	20
KCL LOS LOBOS A-2-1	WESTERN GULF OIL COMPANY	SAN EMIDIO	34	11N	22W	10/28/45	ELOG					3548	40
KCL M1	CONTINENTAL OIL COMPANY	SAN EMIDIO	27	11N	22W	10/17/47	2" ELOG ; HISTORY	KCLM1	REDUCED LOG ONLY	1041.00	1028.50	8283	1000
KCL SAN EMIDIO 3	WESTERN GULF OIL COMPANY	SAN EMIDIO	31	11N	22W	09/30/48	WELL HISTORY			1318.90		4019	
KERN COUNTY 3 NO. 1	STANDARD OIL COMPANY	MIDWAY SUNSET	28	11N	22W	1824	WELL HISTORY				937.87	5883	
LEUTHOLTZ A NO.8	RICHFIELD OIL CORPORATION	SUNSET	22	11N	23W	08/28/48	WELL HISTORY					3500	
LINCOLN 1	NAOC	MIDWAY SUNSET	18	11N	23W	05/18/20	X SEC						
LINCOLN 2	NAOC	MIDWAY SUNSET	18	11N	23W	11/18/20	X SEC						
LINCOLN 3	GENERAL AMERICAN OIL CO OF TE	MIDWAY SUNSET	18	11N	23W	11/30/81	2" ELOG, WELL HISTORY, CORE DATA						
LINCOLN 4	GENERAL AMERICAN OIL CO OF TE	MIDWAY SUNSET	18	11N	23W		2" ELOG, WELL HISTORY, X SEC WALLACE 4 TO BIRCH RANCH 2A						
LLU 38-21	RICHFIELD OIL CORPORATION	SAN EMIDIO	21	11N	22W	04/15/83	2" ELOG ; SUB SURFACE MAG	LLU3821	SP, AM18, AO10, AO19	918.00	907.00	7900	360
LLU 41-28	RICHFIELD OIL CORPORATION	LOS LOBOS	28	11N	22W	02/21/83	2" ELOG ; HISTORY	LLU4128	SP, AM18, AO10, AO19	945.00	938.00	7204	810
LLU 46-21	RICHFIELD OIL CORPORATION	LOS LOBOS	21	11N	22W	08/28/58	2" ELOG ; SUB SURFACE MAG	LLU4621	SP, O18, O84, O18	904.00	881.00	8500	840
LLU 66-20	RICHFIELD OIL CORPORATION	LOS LOBOS	20	11N	22W	07/23/58	2" ELOG ; WELL HISTORY	LLU6620	SP, O18, O84, LAY	924.00	911.00	8370	460
LLU 87-20	RICHFIELD OIL CORPORATION	LOS LOBOS	20	11N	22W	01/07/83	2" ELOG ; WELL HISTORY	LLU8720	SP, AM10, AO10, AO19	953.00	944.00	8870	350
LLU 87-20	RICHFIELD OIL CORPORATION	LOS LOBOS	20	11N	22W	01/07/83	2" ELOG ; WELL HISTORY	LLU8720	SP, SN, LN, LAY			8170	480
LLU A 18-21	RICHFIELD OIL CORPORATION	SAN EMIDIO	21	11N	22W	08/27/82	2" ELOG ; WELL HISTORY	LLU1821	SP, AM10, AO10, AO19	913.00	901.00	8020	850
LOS LOBOS 82X-30 C	TENNECO OIL COMPANY	LOS LOBOS	30	11N	22W	05/25/81	DIP; DUAL LATEROLOG MICR	LL82X-30C		1081.00	1050.00	2702	318
LUMBER 6	COPA OIL	MIDWAY SUNSET	8	11N	23W	11/28/88	2" ELOG						
METSON 7-24	SIGNAL OIL AND GAS COMPANY	MIDWAY-SUNSET (SAN	24	11N	23W	11/28/80	WELL HISTORY				1030.00	1185	
METSON 9-24	SIGNAL OIL AND GAS COMPANY	MIDWAY-SUNSET	24	11N	23W	12/24/80	WELL HISTORY			1089.00		1800	
METSON 10-24	SIGNAL OIL AND GAS COMPANY	MIDWAY-SUNSET	24	11N	23W	12/31/80	WELL HISTORY				1042.00	1800	
METSON 11-24	SIGNAL OIL AND GAS COMPANY	MIDWAY-SUNSET	24	11N	23W	01/14/81	WELL HISTORY				1042.00	1400	
METSON 12-24	SIGNAL OIL AND GAS COMPANY	MIDWAY-SUNSET	24	11N	23W	01/28/81	WELL HISTORY				1050.00	1800	
METSON 13-24	SIGNAL OIL AND GAS COMPANY	MIDWAY-SUNSET	24	11N	23W	03/25/81	WELL HISTORY				1047.00	1803	
METSON 14-24	SIGNAL OIL AND GAS COMPANY	MIDWAY-SUNSET	24	11N	23W	03/25/81	WELL HISTORY				1032.00	1300	
METSON 15-24	SIGNAL OIL AND GAS COMPANY	MIDWAY-SUNSET	24	11N	23W	04/01/81	WELL HISTORY				1042.00	1480	
METSON 16-24	SIGNAL OIL AND GAS COMPANY	MIDWAY-SUNSET	24	11N	23W	04/08/81	WELL HISTORY				1047.00	1770	
METSON 17-24	SIGNAL OIL AND GAS COMPANY	MIDWAY-SUNSET	24	11N	23W	05/08/81	WELL HISTORY			1048.00		1270	
METSON 18-24	SIGNAL OIL AND GAS COMPANY	MIDWAY-SUNSET	24	11N	23W	04/22/81	WELL HISTORY			1049.00		1400	
METSON 19-24	SIGNAL OIL AND GAS COMPANY	MIDWAY-SUNSET	24	11N	23W	04/15/81	WELL HISTORY			1049.00		2000	
METSON 20-24	SIGNAL OIL AND GAS COMPANY	MIDWAY-SUNSET	24	11N	23W	05/20/81	WELL HISTORY				1030.00	1750	
METSON 21-24	SIGNAL OIL AND GAS COMPANY	MIDWAY-SUNSET	24	11N	23W	05/27/81	WELL HISTORY				1038.00	1180	
METSON 22-24	SIGNAL OIL AND GAS COMPANY	MIDWAY-SUNSET	24	11N	23W	08/05/81	WELL HISTORY				1020.00	1800	
METSON 23-24	SIGNAL OIL AND GAS COMPANY	MIDWAY-SUNSET	24	11N	23W	08/12/81	WELL HISTORY				1048.00	980	
METSON 24-24	ARCO OIL AND GAS COMPANY	MIDWAY SUNSET	24	11N	23W	05/07/41	2" ELOG					4323	180
METSON 25-24	SIGNAL OIL AND GAS COMPANY	MIDWAY-SUNSET	24	11N	23W	08/19/81	WELL HISTORY				1038.00	1090	
METSON 26-24	SIGNAL OIL AND GAS COMPANY	MIDWAY-SUNSET	24	11N	23W	08/28/81	WELL HISTORY				1045.00	1170	
METSON 34-24	ARCO OIL AND GAS COMPANY	MIDWAY SUNSET	24	11N	23W	04/08/83	2" ELOG					2230	113
METSON 107-24	TENNECO OIL COMPANY	MIDWAY SUNSET	24	11N	23W	09/24/83	2" ELOG			1038.00		1187	27
METSON 127-24	SIGNAL OIL AND GAS COMPANY	MIDWAY-SUNSET (SAN	24	11N	23W	11/28/80	WELL HISTORY				1035.00	1400	
METSON B-101	ARCO OIL AND GAS CO.	MIDWAY SUNSET	24	11N	23W	08/03/81	2" DUAL INDUCT W/LINEAR CORR.			1028.00	1016.00	1088	32
METSON B-103	ARCO OIL AND GAS CO.	MIDWAY SUNSET	24	11N	23W	08/07/81	2" DUAL INDUCT/SFL			1017.00	1007.00	1845	80
METSON B-108	ARCO OIL AND GAS CO.	MIDWAY SUNSET	24	11N	23W	08/12/81	2" DUAL INDUCT/SFL			1010.00	1000.00	1734	9050
METSON C-19	TENNECO OIL CO.	MIDWAY SUNSET	24	11N	23W	05/10/70	2" ELOG			1058.50	1048.50	809	50
METSON C-20	TENNECO OIL CO.	MIDWAY SUNSET	24	11N	23W	03/22/70	2" ELOG			1054.00	1044.00	1154	100
METSON C-21	TENNECO OIL CO.	MIDWAY SUNSET	24	11N	23W	04/25/70	2" ELOG			1088.00	1048.00	1047	30
METSON F-2	TENNECO OIL COMPANY	MIDWAY SUNSET	24	11N	23W	05/23/70	2" ELOG			1042.00	1032.00	1105	38
METSON F-3	TENNECO OIL COMPANY	MIDWAY SUNSET	24	11N	23W	10/09/69	2" ELOG			1042.00	1032.00	1231	100
METSON G-2-24	TENNECO OIL COMPANY	MIDWAY SUNSET	24	11N	23W	05/08/70	2" ELOG			1040.00	1028.00	1222	100
METSON H-1	TENNECO OIL CO.	MIDWAY SUNSET	24	11N	23W	04/05/70	2" ELOG			1038.00	1025.00	1221	30
METSON H-2-24	TENNECO OIL COMPANY	MIDWAY SUNSET	24	11N	23W	04/27/70	2" ELOG			1038.00	1025.00	1238	30
METSON H-3-24	TENNECO OIL COMPANY	MIDWAY SUNSET	24	11N	23W	04/20/70	2" ELOG			1035.00	1024.00	1374	110
METSON H-4-24	TENNECO OIL COMPANY	MIDWAY SUNSET	24	11N	23W	04/18/70	2" ELOG			1033.00	1023.00	1269	83
METSON H-5-24	TENNECO OIL COMPANY	MIDWAY SUNSET	24	11N	23W	04/29/70	ELOG			1034.00	1023.00	1280	80
METSON I-13	ARCO OIL AND GAS COMPANY	MIDWAY SUNSET	21	11N	23W	10/23/80	2" DUAL INDUCT LATEROLOG					2220	50
METSON I-18 SIDETRACK	TENNECO OIL CO.	MIDWAY SUNSET	24	11N	23W	04/07/81	2" DUAL INDUCT/SFL			1022.00	1012.00	1878	480
METSON I-8	TENNECO OIL CO.	MIDWAY SUNSET	24	11N	23W	08/18/80	2" DUAL INDUCT/SFL			1032.00	1022.00	1358	48
METSON I-8	TENNECO OIL CO.	MIDWAY SUNSET	24	11N	23W	08/18/80	2" DUAL INDUCT/SFL			1023.00	1013.00	2000	50
METSON P-4	TENNECO OIL CO.	MIDWAY SUNSET	24	11N	23W	09/18/83	2" DIL			1040.40	1029.40	1280	270
METSON Q-1	TENNECO OIL CO.	MIDWAY SUNSET	24	11N	23W	08/18/84	2" DUAL INDUCT SFL W/2" CORR			1038.90	1028.90	1264	70
METSON R-2	TENNECO OIL CO.	MIDWAY SUNSET	24	11N	23W	04/27/84	2" ELOG			1040.00	1030.00	1249	55
METSON SWD NO.4 RD NO.1	ARCO OIL AND GAS COMPANY	MIDWAY SUNSET	24	11N	23W	01/19/84	2" DUAL INDUCT SFL W/LINEAR CORR			988.00	978.00	4518	620
MOBIL FEE 332-8K	ALBERT STEVENSON	MIDWAY SUNSET	8	11N	23W	08/02/81	WELL HISTORY				870.00	8841	

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[illegible]

TABLE 1.

WELL LOG INVENTORY

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SUNSET 20 1	MOBIL OIL CORPORATION	MIDWAY SUNSET SOUTH	20	11N	23W	10/27/77	WELL HISTORY						
SUNSET 20 2	MOBIL OIL CORPORATION	MIDWAY SUNSET SOUTH	20	11N	23W	10/27/77	WELL HISTORY						
SUNSET 20 3	MOBIL OIL CORPORATION	MIDWAY SUNSET SOUTH	20	11N	23W	10/27/77	WELL HISTORY						
SUNSET A 48X-18	SOCONY MOBIL OIL COMPANY INC	MIDWAY SUNSET	18	11N	23W	10/03/83	WELL HISTORY ZEROX COPY OF 2" INDUCTION ELECTRICAL LOG						
SWD NO.3	TENNECO OIL COMPANY	MEYSON	24	11N	23W	08/01/82	2" DIL						
T-33 (RIPLEY TATUM T-33)	VIRSAI OIL COMPANY	MIDWAY SUNSET	23	11N	23W	10/21/90	2" DUAL INDUCT-SFL						
T-34 (RIPLEY TATUM T-34)	VIRSAI OIL COMPANY	MIDWAY SUNSET	23	11N	23W	10/03/80	2" DUAL INDUCT-SFL						
T-35 (RIPLEY TATUM T-35)	VIRSAI OIL COMPANY	MIDWAY SUNSET	23	11N	23W	02/08/81	2" DUAL INDUCT-SFL						
T-36 (RIPLEY TATUM T-36)	VIRSAI OIL COMPANY	MIDWAY SUNSET	23	11N	23W	03/08/81	2" DUAL INDUCT-SFL						
T-38 (RIPLEY TATUM T-38)	VIRSAI OIL COMPANY	MIDWAY SUNSET	23	11N	23W	08/08/81	2" DUAL INDUCT-SFL						
T-39 (RIPLEY TATUM T-39)	VIRSAI OIL COMPANY	MIDWAY SUNSET	23	11N	23W	08/18/81	2" DUAL INDUCT-SFL						
T-40 (RIPLEY TATUM T-40)	VIRSAI OIL COMPANY	MIDWAY SUNSET	23	11N	23W	05/12/81	2" DUAL INDUCT-SFL						
T-44 (RIPLEY TATUM T-44)	VIRSAI OIL COMPANY	MIDWAY SUNSET	23	11N	23W	08/18/81	2" DUAL INDUCT-SFL						
U.S. CASE COMM. NO.2	WESTERN GULF OIL CO.	SANTIAGO	23	11N	23W	12/24/47	2" ELOG						
U.S.L. 23 NO.1	ARCO	MIDWAY SUNSET	23	11N	23W	08/04/78	2" DUAL INDUCT/LATEROLOG						
U.S.L. 23 NO.8	VIRSAI OIL COMPANY	MIDWAY SUNSET	23	11N	23W	09/29/87	2" DUAL INDUCT/SFL						
U.S.L. GOVT 101 (ISLAND VIEW)	CHAPARRAL PET. INC.	MARICOPA	17	11N	23W	09/01/75	2" ELOG; WELL HISTORY						
U.S.L. GOVT 122	CHAPARRAL PET. INC.	MARICOPA	17	11N	23W	01/05/75	2" ELOG						
USA 37-28	WESTERN MINERALS	MARICOPA	25	11N	23W	03/24/42	2" ELOG						
WOODWARD 8	WESTERN GULF OIL COMPANY	MIDWAY SUNSET	23	11N	23W	01/27/49	2" ELOG						
WOODWARD U.S.L. 1	WESTERN GULF	SANTIAGO AREA	23	11N	23W	04/20/48	2" ELOG						
WOODWARD U.S.L. 18	GULF ENERGY AND MINERALS	MIDWAY SUNSET	23	11N	23W	07/08/79	2" DUAL INDUCT GUARD LOG						
WOODWARD U.S.L. 27	GULF ENERGY AND MINERALS	MIDWAY SUNSET	23	11N	23W	08/11/77	2" DUAL INDUCT/LATEROLOG						
WOODWARD U.S.L. 28	GULF ENERGY AND MINERALS	MIDWAY SUNSET	23	11N	23W	08/21/77	2" DUAL INDUCT/LATEROLOG						

Table 2

API	B	T	R	WELL	LEASE	OPERATOR	Surface Coordinates		FIELD	DATE	KB	QL	TD	LOG	LOG	DIRECT	TOP MIOCENE		OFFSET		TOP MIOCENE			
04-029							N	E						TOP	BASE	DRILLED	DD	SS	Z	NS	EW	N	E	
0370300	19	11N	22W	37	KCL 24	Standard (Chevron)	555,833	1,819,375		04-Apr-48	1032		8152	200			3787	-785	0	0	0	555833	1819375	
2025000	19	11N	22W	4	KCL-San Emidio	Western Gulf (Chevron)	554,859	1,819,524		01-Oct-48	1059	1047	3818	20			1405	-348	0	0	0	554859	1819524	
2125001	19	11N	22W	4RD	KCL-San Emidio	Western Gulf (Chevron)	554,859	1,819,524		01-Oct-48	1058	1047	3208	20		X-	1405	-348	0	0	0	554859	1819524	
1538100	19	11N	22W	25-19	San Emidio A	Richfield (ARCO)	557,118	1,818,714	Los Lobos	24-Mar-55	980		8958	450		X-M	8835	-5855	0	0	0	557118	1818714	
1538101	19	11N	22W	25-19RD1	San Emidio A	Richfield (ARCO)	557,118	1,818,714	Los Lobos	07-Apr-55	980		8780	6300		X-M			0	0	0			
0143000	19	11N	22W	35-19	San Emidio A	Richfield (ARCO)	556,847	1,818,418	Los Lobos	07-Dec-54	986		8915	370		X-	6541	-5555	0	0	0	556847	1818418	
0143001	19	11N	22W	35-19RD1	San Emidio A	Richfield (ARCO)	556,847	1,818,418	Los Lobos	20-Dec-54	986		8858	5790		X-			0	0	0			
0143002	19	11N	22W	35-19RD2	San Emidio A	Richfield (ARCO)	556,847	1,818,418	Los Lobos	09-Jan-55	986		8708	6736		X-			0	0	0			
0143100	19	11N	22W	45-19	San Emidio A	Richfield (ARCO)	556,784	1,820,112	Los Lobos	23-Nov-54	983		8815	362		X	6636	-5653	0	0	0	556784	1820112	
0143101	19	11N	22W	45-19RD1	San Emidio A	Richfield (ARCO)	556,784	1,820,112	Los Lobos	23-Nov-54	983		8888	362		X			0	0	0			
0143102	19	11N	22W	45-19RD2	San Emidio A	Richfield (ARCO)	556,784	1,820,112	Los Lobos	23-Nov-54	983		8760	362		X			0	0	0			
	19	11N	22W	46X-19	San Emidio A	Western Continental	556,868	1,820,436	Los Lobos	10-Jan-53	990	978	8698			X								
	19	11N	22W	46X-19RD	San Emidio A	Western Continental	556,868	1,820,436	Los Lobos	10-Jan-53	990	978	8608			X	6728	-5737	-71	31	-4	556868	1820432	
0143200	19	11N	22W	58-19	San Emidio A	Richfield (ARCO)	556,689	1,820,804	Los Lobos	01-Oct-54	982		8830	350		X	6708	-5728	-2	4	55	556689	1820804	
0143300	19	11N	22W	66-19	San Emidio A	Richfield (ARCO)	556,583	1,821,461	Los Lobos	03-Sep-54	974		8438			X	6670	-5696	0	0	0			
0143301	19	11N	22W	66-19RD	San Emidio A	Richfield (ARCO)	556,583	1,821,461	Los Lobos	03-Sep-54	974		8840			X-			0	0	0			
0143400	19	11N	22W	79-19	San Emidio A	Richfield (ARCO)	556,400	1,822,108	Los Lobos	24-Jul-54	972	980	8954	380		X	6835	-5964	-1	8	54	556400	1822102	
	19	11N	22W	86-19	San Emidio A	Richfield (ARCO)	556,383	1,822,784	Los Lobos	08-Mar-54	967	955	7070	400			6865	-5999	-1	33	25	556418	1822809	
	19	11N	22W	86-19RD1	San Emidio A	Richfield (ARCO)	556,383	1,822,784	Los Lobos	01-Oct-54	967	955	6828	400		X			0	0	0			
	19	11N	22W	86-19RD2	San Emidio A	Richfield (ARCO)	556,383	1,822,784	Los Lobos	08-Mar-54	967	955	6825	400		X-			0	0	0			
	19	11N	22W	89D-2	San Emidio A	Tenneco (ARCO)			Los Lobos										0	0	0			
UNKNOWN	20	11N	22W	86-20	CCMO	Tenneco (ARCO)	556,367	1,826,017	Los Lobos	23-Jul-58	924	911	8370	450		X			0	0	0			
UNKNOWN	20	11N	22W	57-20	CCMO	Tenneco (ARCO)	555,617	1,826,121	Los Lobos	07-Jan-53	953	944	8870	350		X-	6750	-5797	0	0	0	555617	1826121	
UNKNOWN	20	11N	22W	58-20	CCMO	Tenneco (ARCO)	555,198	1,825,457	Los Lobos	01-Feb-54	963	954	8880	350			6853	-5892	-2	54	22	555198	1825457	
UNKNOWN	20	11N	22W	58-20RD1	CCMO	Tenneco (ARCO)	555,198	1,825,457	Los Lobos	12-Mar-54	963	954	8777	5250		X			0	0	0			
UNKNOWN	20	11N	22W	87-20	CCMO	Tenneco (ARCO)	555,613	1,826,829	Los Lobos	28-May-53	929	920	7520	350		X	7475	-5648	0	0	0	555613	1826829	
UNKNOWN	20	11N	22W	78-20	CCMO	Tenneco (ARCO)	555,174	1,827,450	Los Lobos	03-Oct-52	948	936	7269	350		X	6763	-5805	0	-32	-1	555174	1827449	
1538900	20	11N	22W	85-20	CCMO	Tenneco (ARCO)	556,910	1,827,807	Los Lobos	06-Aug-54	872	859	10414	530	10322			10065	-9193	0	0	0	556910	1827807
1538900	20	11N	22W	85-20	CCMO	Tenneco (ARCO)	556,910	1,827,807	Los Lobos	11-Jul-56	872	859	9395	7018	8384					0	0	0		
	20	11N	22W	87-20	CCMO	Tenneco (ARCO)	555,839	1,828,098	Los Lobos	08-Sep-53	907	898	9159	500	8155			7700	-4793	0	0	0	555839	1828098
0143600	20	11N	22W	17-20	San Emidio A	Richfield (ARCO)	556,107	1,823,448	Los Lobos	18-Jun-54	964	952	8840	380		X	6840	-5880	-4	-8	55	556107	1823448	
0143700	20	11N	22W	27-20	San Emidio A	Richfield (ARCO)	556,013	1,824,126	Los Lobos	22-Oct-53	958	948	7248	350			6830	-5872	0	0	0	556013	1824126	
0143701	20	11N	22W	27-20RD1	San Emidio A	Richfield (ARCO)	556,013	1,824,126	Los Lobos	13-Dec-53	958	948	6869	350		X-			0	0	0			
0143702	20	11N	22W	27-20RD2	San Emidio A	Richfield (ARCO)	556,013	1,824,126	Los Lobos		958	948	7248	5080		X-			0	0	0			
0143800	20	11N	22W	37-20	San Emidio A	Richfield (ARCO)	556,857	1,824,770	Los Lobos	15-Feb-55	967	955	8779	500		X	6855	-5889	-1	4	53	556857	1824770	
1538200	20	11N	22W	47-20	San Emidio A	Richfield (ARCO)	555,823	1,825,195	Los Lobos	11-Jul-53	951	942	8820	501		X-			0	0	0			
UNKNOWN	21	11N	22W	18-21	LLU		555,108	1,828,828	Los Lobos	27-Jun-52	913	901	8006	550			7250	-6337	0	0	0	555108	1828828	
UNKNOWN	21	11N	22W	36-21	LLU	Richfield (ARCO)	555,185	1,830,085	Los Lobos	18-Apr-53	918	907	7883	360			7324	-6908	0	0	0	555185	1830085	
0052000	21	11N	22W	48-21	LLU	Richfield (ARCO)	555,405	1,830,727	Los Lobos	26-Aug-58	904	891	8500	540		X	8340	-7436	0	0	0	555405	1830727	
	21	11N	22W	1	San Emidio	Shell (BWEF)							4828						0	0	0			
UNKNOWN	21	11N	22W	27-21	San Emidio	Richfield (ARCO)	556,139	1,829,138	Los Lobos	05-Mar-54	877	866	9110	680		X	9020	-8143	0	0	0	556139	1829138	
3617700	27	11N	22W	12-27	KCL	MACPET	553,876	1,833,893	Los Lobos	04-Mar-61	966	955	7903	380		X	7825	-6857	0	0	0	553876	1833893	
3718400	27	11N	22W	M1	KCL	Cenoco	553,564	1,838,278		17-Oct-47	1041	1029.5	8331	1000			7880	-6818	0	0	0	553564	1838278	
0107900	27	11N	22W	13-X	KCL	Kenneth Sperry	553,153	1,834,278	Los Lobos	13-Jan-57	1009	998	6982	9834			6834	-5825	0	0	0	553153	1834278	
1538400	27	11N	22W	34-27	San Emidio A	Richfield (ARCO)	552,590	1,836,733		11-Jan-52	1034	1022	7284	720		X	7140	-6108				552590	1836733	
1538400	27	11N	22W	34-27RD	San Emidio A	Richfield (ARCO)	552,590	1,836,733		11-Jan-52	1034	1022	6824	720		X								
	27	11N	22W	26-27	Santiago D	Tenneco (ARCO)	551,200	1,834,780		15-Jun-51	1088	1103	6739	52			4577	-3489	0	0	0	551200	1834780	
0370400	28	11N	22W	1	KCL 3	Standard (Chevron)	554,589	1,830,788	Midway-Sunseri	1824	936	837.87	5883						0	0	0			
UNKNOWN	28	11N	22W	41-28	LLU		554,531	1,830,752	Los Lobos	21-Feb-53	945	936	7804	510			7195	-6250	0	0	0	554531	1830752	
1538400	28	11N	22W	11-28	San Emidio A	Richfield (ARCO)	554,404	1,829,838	Los Lobos	08-May-55	948	934	7084	655		X	6811	-5864	-1	52	82	554404	1829800	
1538401	28	11N	22W	11-28RD1	San Emidio A	Richfield (ARCO)	554,404	1,829,838	Los Lobos	11-Jun-55	948	934	6880	8280		X			0	0	0			
1538500	28	11N	22W	25-28	San Emidio A	Richfield (ARCO)	551,898	1,829,336	Los Lobos	27-Apr-53	1048	1037	3310	350			3200	-2152	0	0	0	551898	1829336	
1538500	28	11N	22W	61-28	San Emidio A	Richfield (ARCO)	552,484	1,832,052	Los Lobos	01-Dec-53	953	942	8256	530		X	8191	-7239	-1	-10	68	552484	1832150	
1538501	28	11N	22W	61-28RD	San Emidio A	Richfield (ARCO)	552,484	1,832,052	Los Lobos	01-Dec-53	953	942	8225	530		X								
1538600	28	11N	22W	62-28	San Emidio A	McPharlin	553,849	1,832,082	Los Lobos	20-Sep-55	982	969	7100	419		X	6880	-6903	-8	-95	88	553849	1832180	
1538601	28	11N	22W	62-28RD	San Emidio A	McPharlin	553,849	1,832,082	Los Lobos	20-Sep-55	982	969	6515	419		?			0	0	0	553849	1832180	
1538700	28	11N	22W	82-28	San Emidio A	McPharlin													0	0	0			
1538800	28	11N	22W	84-28	San Emidio A	Richfield (ARCO)	552,524	1,833,431		14-Jan-51	1041	1020	7200	740			5550	-4509	0	0	0	552524	1833431	
1538801	28	11N	22W	84-28RD	San Emidio A	Richfield (ARCO)	552,524	1,833,431		14-Jan-51	1041	1020	5378	740		X			0	0	0			
8199400	29	11N	22W	55-29	Santiago C	Tenneco (ARCO)	551,898	1,831,421	Los Lobos	28-Aug-50	1068	1053	5000	900			3623	-2555	0	0	0	551898	1831421	
1538900	29	11N	22W																					

Table 2

6438400	30	11N	22W	82X-30	Los Lobos	Tenneco (ARCO)			Los Lobos	25-May-81	1081	1050	2702	318					1081	0	0	0	0	0
6508400	30	11N	22W	82X-30	Los Lobos	Tenneco (ARCO)	553,818	1,822,728		27-May-81	1085		2700					1292	-227	0	0	0	553818	1822728
6548500	30	11N	22W	65-30	Muddy Creek A	Tenneco (ARCO)	551,888	1,821,488		29-Jul-81	1142.8	1131.9	4000	700				1234	-91.1	0	0	0	551888	1821488
	30	11N	22W	78-30	Muddy Creek	Tenneco (ARCO)	551,808	1,822,228		22-Oct-81	1182.8	1152.8	2000	90				1174	-11.4	0	0	0	551208	1822228
	30	11N	22W	72-30	Santiago A	Tenneco (ARCO)	553,848	1,822,148	Los Lobos	24-Sep-80	1093	1048	3503	850				1367	-304	0	0	0	553848	1822148
2124800	31	11N	22W	3	KCL San Emidio	Western Gulf (Chevron)	547,882	1,820,898		30-Sep-80	1318.9		4019					519	799.9	0	0	0	547882	1820898
2121500	31	11N	22W	3-A	KCL San Emidio	Western Gulf (Chevron)													0	0	0			
2385400	31	11N	22W	1	Monteion	Union (Unocal)	549,212	1,818,072			1287		2070					385	902	0	0	0	549212	1818072
	31	11N	22W	Core Hole		Shell (SWEPI)													0	0	0			
1371200	31	11N	22W	78-31	Union	Shell (SWEPI)	545,896	1,822,288		23-May-39	1348		4314	870	4026			1184	184	0	0	0	545896	1822288
UNKNOWN	32	11N	22W	2		Texaco							3533						0	0	0			
	32	11N	22W	8-32	KCL-1A	Shell (SWEPI, Cal Resources)	544,582	1,823,581		19-Apr-39	1351.8	1552	4870	870				1442	-90.2	0	0	0	544582	1823581
0940400	32	11N	22W	12	KCL 44	Standard (Chevron)	548,553	1,823,540	Pioneer	04-Jan-80	1248	1240	5350	22	5348			800	448	0	0	0	548553	1823540
0940500	32	11N	22W	23	KCL 44	Standard (Chevron)	547,893	1,824,200	Pioneer	10-Dec-89	1258	1242	4835	32	4831			937	321	0	0	0	547893	1824200
0940800	32	11N	22W	25	KCL 44	Standard (Chevron)	548,585	1,824,225	Pioneer	26-May-84	1290	1282	4330	20	4323			970	320	0	0	0	548585	1824225
0940700	32	11N	22W	32	KCL 44	Standard (Chevron)	548,553	1,824,880	Pioneer	28-Dec-89	1208		4780	29	4755			1180	49	0	0	0	548553	1824880
0940900	32	11N	22W	34	KCL 44	Standard (Chevron)	547,233	1,824,880	Pioneer	29-Jun-89	1258		10022	400				1037	221	0	0	0	547233	1824880
0940801	32	11N	22W	34RD1	KCL 44	Standard (Chevron)	547,233	1,824,880	Pioneer	29-Jun-89	1258		4030			X-			0	0	0			
0940900	32	11N	22W	43	KCL 44	Standard (Chevron)	547,893	1,825,520	Pioneer	18-Nov-89	1212	1204	5851	20				1212	0	0	0	0	547893	1825520
0941000	32	11N	22W	45	KCL 44	Standard (Chevron)	548,804	1,825,542	Pioneer	05-Oct-89	1258	1250	4325	28	4321			1083	185	0	0	0	548804	1825542
	32	11N	22W	375X	KCL 44	Gary Drilling Co.	546,784	1,826,817	Pioneer	04-Jul-80	1218.3	1208.3	3211	650				1282	-65.7	0	0	0	546784	1826817
3615300	32	11N	22W	1	Pioneer	Milham Exploration Co.	547,543	1,823,980	Pioneer	08-Jun-28	1290		1506					917	343	0	0	0	547543	1823980
0369200	33	11N	22W	55-33	KCL	Standard (Chevron)	548,585	1,828,157		05-Dec-84	1304.88	1298.88	2700	502				2480	-1175.1	0	0	0	548585	1828157
3615800	33	11N	22W	2	Pioneer	Milham Exploration	548,533	1,828,758		31-Aug-28	1228	1225	1758					1578	-362	0	0	0	548533	1828758
2385500	33	11N	22W	C-2	San Emidio	Union (Unocal)	545,587	1,828,808		12-Apr-37	1285	1285	1839	47	1830			1580	-315	0	0	0	545587	1828808
2385800	33	11N	22W	C-3	San Emidio	Union (Unocal)	547,898	1,828,840		28-Apr-37	1109		3226					1821	-712	0	0	0	547898	1828840
3529800	34	11N	22W	18-34	KCL	Occidental Pet. Co.	544,584	1,834,151		29-Jun-84	1393.2	1381	8781	1047				3120	-1728.8	0	0	0	544584	1834151
2124700	34	11N	22W	1	KCL San Emidio	Western Gulf (Chevron)	545,819	1,834,151	Los Lobos	26-Nov-15	1330.3	1328.84	3548	40				3136	-1808.7	0	0	0	545819	1834151
2385700	34	11N	22W	C-1	San Emidio	Union (Unocal)	547,728	1,836,223		25-Mar-37	1222		4805	17	4797			4335	-3113	0	0	0	547728	1836223
36018	25	11N	23W	41	Rioley	G.Ray Robinson			Midway-Sunset	02-Dec-63	1084		7509	50	7500									
	25	11N	23W	44	Rioley	Norbel Oil			Midway-Sunset	18-Jul-65	1152		2010	50	2010									
87523	25	11N	23W	1	Rioley Trust	Arosby Oil			Midway-Sunset	18-Dec-72	1113	1101	5812	100	5800			X						
48632	25	11N	23W	3	Rioley Trust	Lawber Petroleum			Midway-Sunset	08-Apr-74	1101	1091	4500	50	4500									
48632	25	11N	23W	2FD	Rioley Trust	Lawber Petroleum			Midway-Sunset	24-Feb-78	1101	1081	4080	550	4090			X						
48672	25	11N	23W	3	Pyramid-Rioley Trust	Montana Petroleum			Midway-Sunset	17-Sep-74	1080	1070	3750	50	3740									
36546	25	11N	23W	1	Santiago	Robt.W. Moore			Midway-Sunset	16-Sep-64	1227		1200	150	970									
	25	11N	23W	8	Western Minerals	Western Minerals			Midway-Sunset	30-Nov-08	1209		2050											
36054	25	11N	23W	37-25	Western Minerals	Tidewater Assoc.			Midway-Sunset	24-Mar-42	1213		1700	170	1700									
53172	25	11N	23W	1	Montana-McFarland	McFarland Energy			Midway-Sunset	10-Sep-78	1180	1170	1585	180	1570									
	28	11N	23W	12	Western Minerals	Western Minerals			Midway-Sunset	25-Feb-11	1175		803											
01300	35	11N	23W	1	USL-Woodward	Pavley Petroleum			Midway-Sunset	09-Feb-87	1200	1185	13131	100	13090									
89486	36	11N	23W	11-36	ARCO	Stone Exploration			Midway-Sunset	30-Oct-81	1344	1330	4217											

FIGURE CAPTIONS

Figure 1.

Screen print of the Table Relationship Window in the Microsoft Access database. Data tables for geochemical and petrographic data, well logs, well header information, well production data, formation tops, fault trace data, etc., are shown.

Figure 2.

Through the Multimedia Database Manager archive/tutorial shell authored in Visual Basic, the user will be able to access a variety of text, graphics, and animations generated by or related to the project. The kinds of information available via pull-down menus in the archival mode are shown here.

Figure 3.

Screen print showing some of the information available via pull-down menus in the archival mode in the Multimedia Database Manager.

Figure 4.

Munger map showing the locations of Pioneer and Cymric Fields in the southern San Joaquin Valley, California.

Figure 5.

Structure contour map on the top of the Miocene Monterey reservoir for the Pioneer Anticline, constructed by DPI from wells in the project database. Two cross-sections (a strike section and a dip section) have been completed along section line shown on figure. Three more cross sections are under construction, with more to follow later.

Figure 6.

Structural-strike cross section through Pioneer Anticline along the section line shown in Fig. 5.

Figure 7.

Structural-dip cross section through Pioneer Anticline along the section line shown in Fig. 5.

Figure 8.

Analyzed results log which has been calibrated to core in the Unocal McKittrick Front 418 well, Cymric Field. Interval includes the Tulare Fm. - Monterey Fm. contact. Note large increase in porosity across contact and very high porosity in Monterey Opal-A facies diatomite beneath the contact. This interval represents just a small portion of the 700 ft of core that was analyzed and calibrated to the log suite in this well.

Figure 9.

Analyzed results log which has been calibrated to core in the Tenneco 62x-30 well, Pioneer Field. Note the much lower porosity in the Opal-CT facies encountered in this well.

Figure 10.

The geochemical modeling program CHILLER will be used to model reservoir matrix changes that occur during thermal EOR production practices. The predicted reservoir changes will include mineralogy, porosity and permeability. Quantitative mineralogical characterization of the reservoir will provide input data for determining the minerals likely to undergo significant dissolution and knowledge of an injection and production program will provide the pressure and temperature history conditions necessary to model possible chemical reaction histories. Comparison of modeled production fluid compositions with observed data from actual production histories can be used to adjust model parameters through multiple iterative modeling trials until a reasonable history match is obtained. These data can then be used to suggest changes in the injected fluid compositions that may reduce some of the more harmful effects such as the production of clay coatings that decrease permeability. The example above is of feldspar and quartz dissolution at 100°C which shows that significant quantities of chlorite and muscovite (an analog for illite) are likely to be produced in the steamflood EOR process.

Figure 11.

A plot of temperature and maturity (R_o) as a function of depth in Elk Hills 934-29R. Solid lines represent calculated values derived after calibrating formation thermal conductivities and heat flow history to achieve a match with the observed data shown as crosses.

Figure 12.

A geohistory diagram for the Elk Hills 934-29R well showing isotherms and the oil window (see legend) as defined by vitrinite reflectance kinetic modeling. The bold hatched area at the top of the diagram represents sea depths.

Figure 1

Visual Display of Reservoir Parameters Affecting EOR (multimedia shell using Visual Basic Professional)

File	Project	Regional Geology	Wells	Databases	Geochemical Modeling	Help
Intro	Public Abstract	Maps ➡	All Wells	XRD	burial histories ➡	map
Exit	Participants	Cross Sections ➡	Calibration Well	SEM	geochemical models ➡	index
	Location	3D Views ➡	Well 1	etc.		
	Tasks and timeline	(Maps)	(well data)		(burial)	
	Quarterly reports	aerial photo	general well data		discussion of how generated	
		map view of structure	production history		example wells	
		Munger maps	petro data		(geochemical models)	
		DEM ➡ (?)	thin sections		fluid-rock ➡	
		CA G&O ➡ (?)	other analytical		2ndary porosity ➡	
					steam flood models ➡	
		(Cross sections)			(fluid-rock)	
		horizon 1			statement of problem	
		horizon 2			x-y plots	
		...			other visuals	
		(horizon info window)			(2ndary porosity)	
		lithologic description			(steam flood)	
		core information			reactions	
		core photos			EOR processes	
		(3D views)				
		topography				
		simple structure				
		volume model of reservoir				
		(volume model window)				
		porosity				
		permeability				
		oil saturation				
		water saturation				
		clays				
		geochemical information				

Users will be able to access the files in two ways:
1) as archival material
2) as a tutorial

Figure 2

Figure 3

BASEMAP SHOWING
LOCATIONS OF PIONEER
FIELD AND THE MCKITTRICK
FRONT AREA OF CYMRIC
FIELD

34

STRUCTURE ON TOP MIOCENE

CHEVRON OIL CO.
KCL 86-33
32-T11NRJ2W

GARY DRILLING CO.
KCL 44-37EX
32-T11NRJ2W

CHEVRON OIL CO.
KCL 44-43
32-T11NRJ2W

TENNECO OIL CO.
MUDDY CREEK A 86-30
30-T11NRJ2W

TULAREAN JOAQUIN
SANDSHALES

ETCHEGORN SANDS
CLAY SHALE/STAIN SANDS

MIOCENE
CHERTY DIATOMITE/
DIATOMACEOUS SHALE

DPI 2811 N Street, Bakersfield, CA 93301 Phone: (805)322-5657

SCHEMATIC CROSS SECTION ALONG STRUCTURAL STRIKE SHOWING STRATIGRAPHIC RELATIONSHIPS

DOE GRANT: VISUAL DISPLAY OF RESERVOIR PARAMETERS AFFECTING
EOR - JOINT PROJECT BETWEEN MICHIGAN TECHNOLOGICAL UNIVERSITY
(MICHIGAN) AND DPI (BAKERSFIELD, CA)

DRAWN BY: DMG DATE: 7/95

FIGURE 6

SAN EMIDIO A 58-19
19-111NR22W

LOS LOBOS 82X-30
30-111NR22W

MUDDY CREEK A 88-30
30-111NR22W

DPI 2811 H Street, Bakersfield, CA 93301 Phone: (805)372-8867

SCHEMATIC CROSS SECTION ALONG
STRUCTURAL DIP
SHOWING STRATIGRAPHIC RELATIONSHIPS

DOE GRANT: VISUAL DISPLAY OF RESERVOIR PARAMETERS AFFECTING
EOR - JOINT PROJECT BETWEEN MICHIGAN TECHNOLOGICAL UNIVERSITY
(MICHIGAN) AND DPI (BAKERSFIELD, CA)

DRAWN BY: DMO DATE: 2/95

FIGURE 7

DEPTH
FT
1:240

DRY CLAY			TOTAL WATER			TOTAL POROSITY		
0	DEC	1	1	DEC	0	0.80	DEC	0.30
	WET CLAY			EFFECTIVE WATER			EFFECTIVE POROSITY	
0	DEC	1	1	DEC	0	0.80	DEC	0.30
	SHALE			UNLIM WATER			CORE POROSITY	
0	DEC	1	2	DEC	1	80	PCT	30
	EFFECTIVE POROSITY			CORE OIL				
1	DEC	0	0	PCT	100			
	BULK VOL WATER			CORE WATER				
1	DEC	0	100	PCT	0			

1100

DRY CLAY			TOTAL WATER			TOTAL POROSITY		
0	DEC	1	1	DEC	0	0.80	DEC	0.30
	WET CLAY			EFFECTIVE WATER			EFFECTIVE POROSITY	
0	DEC	1	1	DEC	0	0.80	DEC	0.30
	SHALE			UNLIM WATER			CORE POROSITY	
0	DEC	1	2	DEC	1	80	PCT	30
	EFFECTIVE POROSITY			CORE OIL				
1	DEC	0	0	PCT	100			
	BULK VOL WATER			CORE WATER				
1	DEC	0	100	PCT	0			

Figure 8

DEPTH
FT
1:240

Figure 9

Reactant Minerals: Kfeldspar/Quartz = 3/1

Figure 10

Elk Hills (EH)

29RDELT.MOD

EH 934-29R

Figure 11

Elk Hills (EH)

EH 934-29R

29RDELT.MOD

Figure 12

Tampa Meeting

Agenda

Thursday, January 19

CRYSTAL FIELD

	<u>TITLE</u>	<u>SPEAKER</u>
<u>Agenda</u>	Introduction	M. Gruener
Thursday, January 19	Crystal Field Project - Overview	J. Wood
9:00	Database Management	A. Nigrini
9:20	Geology of Crystal Field	W. Harrison
9:40	Horizontal Well	Terra Energy (?)
10:00	Log Analysis	W. Harrison/ W. Pennington
10:20	Break	
10:40	Modeling	J. Huntoon
11:00	Technology Transfer	J. R. Allan
11:20	CD ROM Project Archive	D. Schueller
11:40	open	
12:00	LUNCH	
1:00	Winterfield Field	S. D. Chittick
1:20	PIA	J. Boles
1:40	(open)	
2:00	Pore Fluid Chemistry	J. R. Wood
2:20	(open)	
2:40	Thermal modeling	M. Luo
3:00	BREAK	
3:10	Discussion	
4:00	Adjourn	

Tampa Meeting

Agenda

Friday, January 20

PIONEER FIELD

<u>TIME</u>	<u>TITLE</u>	<u>SPEAKER</u>
8:30	Introduction	M. Gruener
8:40	Pioneer Field Project - Overview	J. Wood
9:00	Database Management	A. Nigrini
9:20	Geology of Pioneer Field	DPI
9:40	Log Analysis	DPI
10:00	Break	
10:20	Bulk Analysis	J. Ryan
10:40	X-ray Mineralogy	J. Compton
11:00	FTIR	N. Popko
11:20	PIA	R. Kramer
11:40	open	
12:00	LUNCH	
1:00	Modeling	J. P. Suchoski
1:20	Technology Transfer	J. R. Allan
1:40	CD ROM Project Archive	D. Schueller
2:00	Pore Fluid Chemistry	J. R. Boles (?)
2:20	open	
2:40	Summary	J. Wood
3:00	BREAK	
3:10	Discussion	
4:00	Adjourn	

Memorandum

*To: All DOE California Project Participants:
 DPI: R. Berry, D. Olson
 MTU: J. Allan, C. J. Asiala M. Gruener, A. Hein, J. Huntoon, Ming Luo, D. McDowell, A. Nigrini, D. Schueller, J. Suchoski, W. Pennington, N. Popko, B. Watkins*

From: J. R. Wood
Date: September 5, 1995
Subject: Manual for Project Workshop

I am circulating the first draft of the course outline for our California project on the Pioneer Anticline as well as a timeline for this aspect of the project. The course outline contains assignments for the people to be responsible for various parts of the course manual either as the lead person or as part of the team that will work on that particular section. Locate your sections on the outline and on the timeline. I have already discussed these assignments with most of you already, but if I have missed someone or you wish to make changes, contact me as soon as possible.

The 1st short course will likely be offered in Bakersfield, Ca. in the fall of 1996. A final date and venue will be adopted this winter at our annual meeting.

I have a suggested number for the minimum or maximum number of pages of text (1 1/2 line spacing, 8 1/2 x 11) as well as a suggested number of figures. The lead person in each section should contact the team members and finalize these numbers by Oct. 1. Respond either to me or Mark Gruener at MTU (906-487-2894).

There is also a column in the manual outline that says "TIME" in minutes. This is the suggested time allotted for your presentation(s) at the workshop. If you need more or less time, let us know by Sept. 1. Note that the total time allotted as of now is about 695 minutes, which is about right for a two-day short course.

Note that the total number of text pages is presently estimated at between 365 and 511 pages, which again I think is about right. The number of figures is estimated at 259, which comes out to about 2.68 minutes per figure, which also strikes me as about right. If anyone thinks these estimates are seriously in error, please call me and let's discuss it ASAP.

SOME HELPFUL HINTS

1. I strongly suggest to everyone that you organize your text and presentations around your figures. In other words, get your figures organized first, even if they only exist as captions or sketches. **Please submit your figures (even as sketches) and captions by Jan. 1, 1996.** Sooner if possible. See the timeline.

2. Plan to submit your finished text by March 1, 1996. Even is your task is not finished, try to submit a text that is as finished as possible. You can leave room for additions.
3. Try to draft as many figures as possible electronically. Figures printed from LOTUS 1-2-3, MS Access etc. will be fine. For more complicated drafting, I suggest CANVAS or Corel Draw. MATLAB might be a good choice as well since we are starting to use that product in the visualization task. If you need figures from GEOGRAPHIX, let us know and we will work with you to get it done.
4. The manual will be edited and printed using LOTUS AmiPro. Please submit electronic copy compatible with this word processor.
5. Everyone will be listed as an author on the appropriate chapter(s). I will be the editor. We will try to get the manual published as a peer reviewed publication, but that may not be practical for the first short course. Eventually you will be able to cite your work and include it in your vita.
6. We have plans to put the manual on the Project CD ROM. If all goes will, you may be able to project material from this ROM onto the screen during your presentations. However, plan your presentations as though you will only have an overhead projector and a 35 mm projector at your disposal.
7. You can probably use the material you develop for the short course for part or all of your final report with some reformatting and editing. So keep that in mind. I will issue a call for your final report sometime this spring.
8. We will have another annual meeting this January, 1995, probably in Bakersfield, California. We will review progress on this manual at that time.

I feel we have an opportunity to turn out an excellent publication that will be useful to the industry and will fulfill the DOE objectives. It is important that every one focus on this task and move it to the top of your priority lists. Everyone has done very well so far in the tasks and I think things are coming together nicely. As we prepare this manual, I think you will see how things fit together and how much has been done.

DOE VISUALIZATION PROJECT ON PIONEER ANTICLINE						
OUTLINE FOR WORKSHOP MANUAL			# Pages		Minutes	# Figures
	LEAD	TEAM	MIN	MAX	TIME	
INTRODUCTION	JRW	ALL	5	8	15	4
WELL LOGS	DPI	AN & JRA				
DATA CAPTURE					30	10
Digitize logs			5	8		
Digitize Well Locations, Mechanical Data, Header Data			3	5		
Digitize Reservoir Data (Core, Rock and Fluid Data)			3	5		
Digitize Production Data			1	2		
DATA PREPARATION					45	10
Build Log Database (Edit, Depthshift, Environ. Corrections)			6	8		
Build Cross Sections			3	5		
Build Base Maps			3	5		
DATA ANALYSIS					45	10
Interpretation			5	8		
Correlation			3	5		
Mapping Reservoir Properties						
Porosity			1	2		
Permeability			1	2		
Lithology			1	2		
Oil Saturation			1	2		
REPORTING					45	10
Methodology			3	5		
Case history - Pioneer Field			8	10		
LOG VISUALIZATION					45	10
Export Data			3	5		
Demonstrations of Applications			20	25		
LAB MEASUREMENTS						
SOLIDS						
X-Ray Diffraction	DCP	SDM	15	20	20	10
FTIR	DCP		15	20	20	10
California	DCP		15	20	20	10
California	DCP	SDM	15	20	20	15
Petrographic Image Analysis	JRW/JRB	SDM	15	20	20	15
FLUIDS			15	20		
Oils (Literature search; company files)	JRA	AN	10	12	20	10
Formation Waters (Lit. search; company files)	JRW	JRA;AN	10	12	20	10
VISUALIZATION						
GEOLOGY						
Maps	WDP	DPI;CJA	15	20	20	10
Cross Sections	WDP	DPI;CJA	15	20	20	10
3D Rendering ("Psuedo-seismic")	WDP	DPI;CJA	15	20	45	10
ENGINEERING (?)			20	30	45	20
MODELING						
GEOCHEMICAL						
Fluid-rock interactions (CHILLER)	AN	JRW;JPS	20	30	45	20
Thermodynamic Database	JRW	JPS;AN	10	15	20	10
BASIN ANALYSIS						
Geohistory	AN	JRW	20	30	30	10
Thermal History	AN	JRW	20	30	30	10
DATA MANAGEMENT						
PC Databases	AN	DPI	10	15	30	10
CD ROM	CJA	JRW; MJG	20	30	45	10
SUMMARY	JRW	JRA;AN;DPI	15	15		5
TOTALS			365	511	695	259