PROJECT FACT SHEET

CONTRACT TITLE: Quantitative Methods for Reservoir Characterization and Improved Recovery: Application to Heavy Oil Sands/Fundamental Geoscience Awards

ID NUMBER: DE-AC26-98BC15119

B&R CODE: AC1005000

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PROJECT SITE
CITY: Clemson **STATE**: SC
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CITY: **STATE**:

CONTRACT PERFORMANCE PERIOD:
9/30/1998 to 9/29/2001

PROGRAM: Supporting Research
RESEARCH AREA:
PRODUCT LINE: ADIS

FUNDING (1000'S)	DOE	CONTRACTOR	TOTAL
PRIOR FISCAL YRS	305	115	420
FISCAL YR 1999	250	115	365
FUTURE FUNDS	34	115	149
TOTAL EST'D FUNDS	589	345	934

OBJECTIVE: To improve well-to-well predictability of reservoir heterogeneity in heavy oil sands.

PROJECT DESCRIPTION:

Background:

Work to be Performed: This project consists of the following tasks: (1) Collect Property Data from Outcrops and Reservoir, and Build Digital Database; (2) Build Property Models Using Advanced Quantitative Methods, Including Non Gaussian Fractals and Universal Multifractals; (3) Run Multiple Realizations of Outcrop and Reservoir Property Distributions, Examining Effects of Scale and Applying results to West Coalinga Field; (4) Build Numerical Flow and Transport Simulation Model; and (5) Technology Transfer.

PROJECT STATUS:

Current Work: The current work involves collecting and loading property data to build a digital database and defining fractal structure in the data sets.

Scheduled Milestones:

Accomplishments: The first twelve months of the project have focused on collecting data for characterization and modeling. In addition, data from Coalinga Field has been analyzed to define the fractal structure present in the data set.

Detailed investigation of outcrop exposures of the Temblor Formation on the Coalinga Anticline was conducted during May and June. Twelve vertical sections were measured, and the sedimentary features were described in detail for approximately 2300 feet of section. The exposures logged were selected to provide information on vertical and lateral variations within the Temblor Formation. Sedimentological description of the exposures included logging of grain size, percent sand, biogenic features, and sedimentary structures. Complete gamma-ray profiles were recorded for each section using a hand-held scintillometer. Gamma-ray values were recorded at 0.5-foot intervals. All gamma-ray data have been loaded into a digital database. Digital photo-mosaics of the exposures were made. Based on study of the Temblor Formation exposures, two major transgressive-regressive cycles are recognized in the formation.

The collection and loading of property data from Temblor reservoir sands in West Coalinga Field focused on two phases:
1) Detailed description of cores and comparison to geophysical logs; and
2) Quality control and loading of digital core-analysis data.

Both phases were completed in close collaboration with Chevron, with Chevron providing core-analysis data, core descriptions produced by their geologists, use of core photographs, facilities for core examination, and manpower support for core layout and preparation. Approximately 4470 feet of cores from 13 wells in Coalinga Field were described by Clemson University personnel during the summer. Description included logging the same features and using the same format as followed for the outcrop work: grain size, percent sand, biogenic features, and sedimentary structures. In addition, notations of Chevron's facies classification and degree of oil staining were recorded. In order to facilitate integration of outcrop results with subsurface information from Coalinga Field, five of the thirteen cores described are from the northern part of the oil field, which is nearest to the surface exposures. All of the cores were provided by Chevron, and the work was performed at the Chevron Geologic Warehouse in Richmond, California.

Working cooperatively with Chevron personnel, core-analysis (i.e., porosity and permeability) data were loaded into a digital database (Excel spreadsheets). Prior to loading, data were examined for quality control, and depths were adjusted to match geophysical logs. Quality control work was done by Chevron personnel and by Clemson personnel working closely with Chevron.

To obtain information that will contribute to developing a geologically realistic outcrop-conditioned model for application to characterizing heavy-oil sands in Coalinga Field, fifteen stratigraphic sections of Upper Cretaceous outcrops in southern Utah were studied. These sections are in the in the A Sandstone, which corresponds to the middle portion of the John Henry Member of the Upper Cretaceous Straight Cliffs Formation. A total of 1,150 feet of section were described in detail. Sedimentological description of the exposures included logging of grain size, percent sand, biogenic features, and sedimentary structures. Based on the vertical sequences of texture and sedimentary structures, the most common depositional environments represented are estuarine and tidal. Due to the long, continuous nature of the outcrops, it is possible to trace units between most of the logged sections. Gamma-ray profiles of each section were recorded using a hand-held scintillometer. All gamma-ray data have been loaded into a digital database.

In early May of this year, several specific sites in the field area near Escalante, Utah were identified for permeability measurement. However, because of the outcrop lithology and weathering, it became apparent during initial outcrop testing that existing field methods for permeability measurement were inadequate in providing the high quality of data needed for the fractal analysis. It was concluded that in order for our planned measurements to be successful, it would be necessary to develop a small cylindrical permeameter probe that could be inserted and sealed in a small drill hole, and also the necessary theory to calculate intrinsic permeability from injection pressure and mass flow rate measurements. When this conclusion was reached, field permeability measurements were postponed, and work on the new methodology began. We have been working on the new methodology since mid-June, and excellent progress has been made. When the new instrumentation and analytical techniques are available, we plan to return to Utah, probably in the late spring or early summer of 2000, and complete the permeability measurements.

During the first twelve months of the project, techniques were identified for applying multi-scaling (multifractal) concepts to permeability distributions in cores from West Coalinga Field. Spectral analyses and the Double Trace Moment (DTM) method were used to analyze the scaling and multifractality of the permeability data. This was accomplished by estimating the parameters of the Universal Multifractal (UM) model. The UM parameters ? (the multifractality parameter and the Levy index), ? (the codimension of the mean field and the width parameter of the Levy distribution), and Hm (the stationarity parameters) were estimated at 1.78, 0.17, and 0.25, respectively. One-dimensional and 2-D isotropic permeability fields were generated, and 2-D anisotropic fields were generated according to an empirical procedure that was developed. The results of this work indicate the presence of fractal scaling in the permeability data from West Coalinga Field.

Two abstracts were submitted and accepted for presentation at professional meetings. The following presentation was made at the annual national meeting of the Geological Society of America: "Depositional Patterns and Sequence Stratigraphy of the Miocene Temblor Formation, San Joaquin Basin, California." A paper on "A New Mini-Permeameter Probe and Associated Analytical Techniques for Measuring the In Situ Spatial Distribution of Permeability" will be presented at the national fall meeting of the American Geophysical Union. An annual report that describes results from the first twelve months of the project was prepared and transmitted to the U.S. Department of Energy.

During the next twelve months, efforts will focus on collecting permeability data from outcrops in southern Utah using the new mini-permeameter being developed; continuing to generate property distributions using fractal structures; and conditioning the fractal function to the data sets. In addition, the effects of geologic discontinuities and scale on detection and prediction of