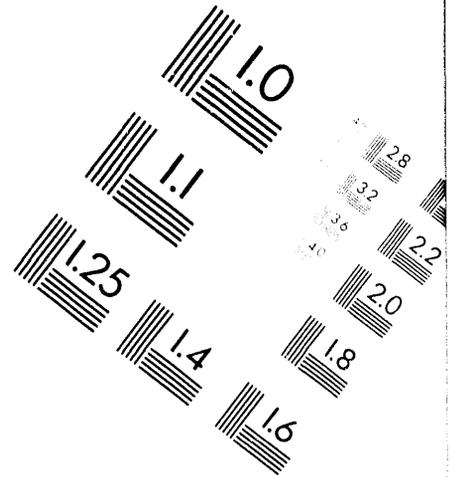
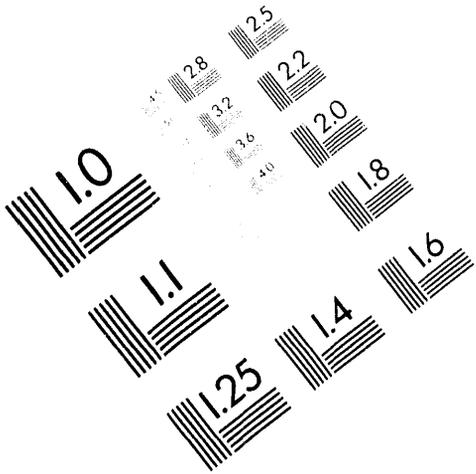




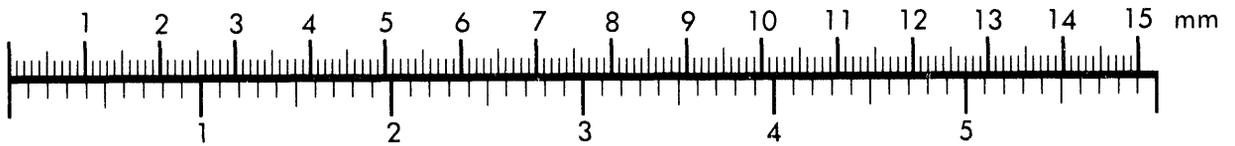
AIM

Association for Information and Image Management

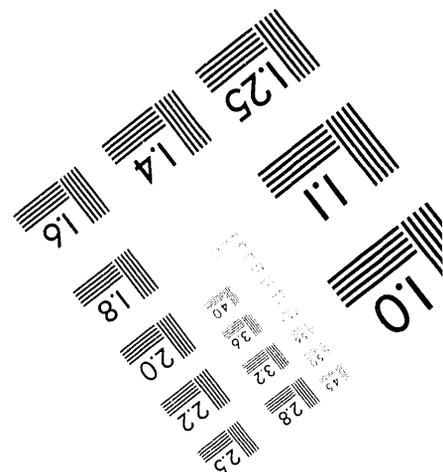
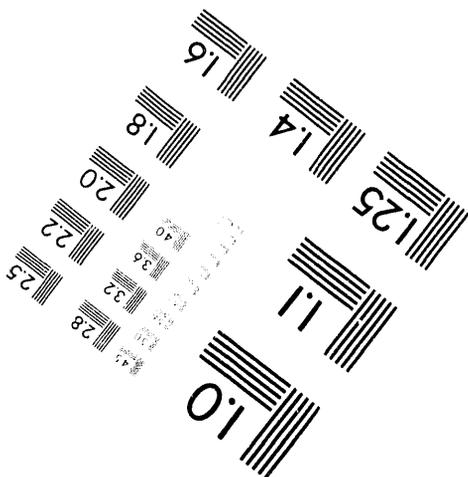
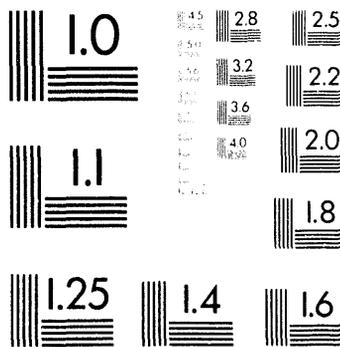
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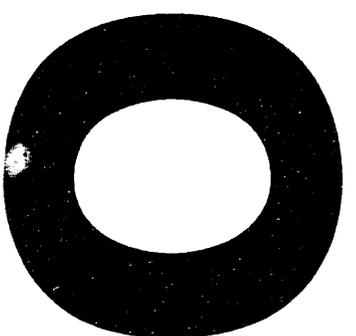
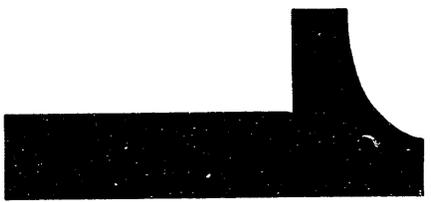
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**GEOLOGICAL AND PETROPHYSICAL CHARACTERIZATION
OF THE FERRON SANDSTONE FOR 3-D SIMULATION OF A
FLUVIAL-DELTAIC RESERVOIR**

(Contract No. DE-AC22-93BC14896)

Submitted by

Utah Geological Survey
Salt Lake City, Utah 84109
April 22, 1994

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Contract Date: September 29, 1993
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Program Manager: Thomas C. Chidsey, Jr.
Principal Investigator: M. Lee Allison

Contracting Officer's Representative

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Reporting Period: January 1 - March 31, 1994

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Objective

The objective of this project is to develop a comprehensive, interdisciplinary, quantitative characterization of a fluvial-deltaic reservoir which will allow realistic interwell and reservoir-scale modeling to be used for improved oil-field development in similar reservoirs world wide. The geological and petrophysical properties of the Cretaceous Ferron Sandstone in east-central Utah (figure 1) will be quantitatively determined. Both new and existing data will be integrated into a 3-D representation of spatial variations in porosity, storativity, and tensorial rock permeability at a scale appropriate for interwell to regional-scale reservoir simulation. Results could improve reservoir management through proper infill and extension drilling strategies, reduce economic risks, increase recovery from existing oil fields, and provide more reliable reserve calculations. Transfer of the project results to the petroleum industry will be an integral component of the project.

Summary of Technical Progress

The technical progress is divided into several sections corresponding to subtasks outlined in the Regional Stratigraphy Task and the Case Studies Task of the original proposal. Other subtasks are dependent on field work which will begin in April, 1994. The primary objective of the Regional Stratigraphy Task is to provide a more detailed interpretation of the stratigraphy of the Ferron Sandstone outcrop belt from Last Chance Creek to Ferron Creek (figure 1). This regional study will include determining the dimensions of each sandstone body, its depositional environment, and the nature of its contacts with adjacent rocks or flow units. The study will provide a basis for selecting prime outcrops for detailed case studies of the major reservoir types (meander belt, mouth-bar complex, wave-dominated delta front, bar-finger sands, distributary channel, tidal channels). The morphological framework established from the case studies will be used to generate subsequent flow models for the reservoir types.

The primary objective of the Case Study Task is to develop a detailed geological and petrophysical characterization, at well-sweep scale or smaller, of the primary reservoir lithofacies typically found in a fluvial-dominated deltaic reservoir. Sedimentary structures, lithofacies, bounding surfaces, and permeabilities measured along closely spaced traverses (both vertical and horizontal) will be combined with data from core drilling to develop a 3-D morphology of the reservoirs within each case study area.

Regional Stratigraphy

Surface Mapping/Interpretation of the Outcrop Belt. Most of the Ferron Sandstone outcrop belt within the study area (figure 1) will be obliquely photographed and photomosaics constructed. An initial test set of photographs was digitized and transferred to a compact disc (CD). Image editing software has been purchased and 48 photographs from the test set were reproduced from the CD without significant loss of resolution. These and future photographs will be assembled into reproducible photomosaics for annotation of lithofacies, measured sections, and other data in the field for both the regional and case study analysis.

Collect and Interpret Existing Surface and Subsurface Data. The UGS is continuing to collect and compile published and unpublished maps, measured sections, well logs, core descriptions, mini-permeameter data, reports, and other data. We have identified nine potential sources of basic geological and geophysical drill data on the Ferron Sandstone (table 1). The largest data holder is the Bureau of Land Management (BLM), which has hundreds of drill records from coal exploration holes drilled by Consolidation Coal Company (CONSOL). Records indicate that 356 wells were drilled on the unleased federal lands in the study area.

We obtained lithologic logs for 12 drill holes from the J.B. King mine area (formerly the Dog Valley mine). An attempt is being made to obtain drill hole data from seven drill holes by CalMat on the Hidden Valley coal (HVCC) mine property. This property is within the Ivie Creek case-study area.

To date, the UGS has acquired 101 geophysical logs from the 480 wells in the study area and 1,880 feet (550 m) of core or core descriptions from the 405 wells cored (table 1). Information from 285 wells and core holes has been entered on data forms with 156 of these also entered into ASCII files (table 1).

Case-Study Sites. Three case-study sites for detailed analysis of the major reservoir types have been selected and approved by the project team; **Muddy Creek Canyon**, **Ivie Creek**, and **Willow Creek Wash** in the north, central, and southern parts respectively of the study area (figure 1). The entire Ferron section will be analyzed at the Muddy Creek Canyon site. In this area, the Ferron Sandstone is composed of seven deltaic units. Some of these units are stratigraphically simple; others include a variety of facies and display abrupt lateral variations.

The Ivie Creek site was selected to examine the abrupt facies changes in the No. 1 delta-front unit. The basal unit is a thick, sandy, parasequence which pinches out to the west. This basal unit is overlain by a thin, silty, parasequence which extends farther to the west.

The Willow Springs Wash site is the largest of the study areas and was selected for the excellent 3-D aspect of exposures in the Willow Springs Wash and Indian Canyon areas. The focus of our work at this site will be parasequences of the No. 1 delta-front unit.

Case Studies

Core Hole Locations. Eight core holes are planned in the Ivie Creek area (figure 1). These wells will be drilled down dip 200 to 1,200 feet (60 to 365 m) from the Ferron outcrop. Cores and geophysical logs from these wells will provide data for 3-D morphology interpretation of individual lithofacies. Surface right-of-ways from Utah Division of State Lands and Forestry and the U.S. Bureau of Land Management are being obtained. A survey of current mineral lease ownership showed no active coal or other mineral holders. We are currently proceeding with the staking and permitting procedures through the Utah Division of Oil, Gas and Mining in order to drill and complete the core holes by the end of October, 1994.

Databases. The UGS computer database has been modified for this study to integrate various geologic attributes of the Ferron Sandstone to point-source locations. The formats for lithologic, paleocurrent, and core descriptions have been developed to standardize data collection. The database is designed so that geologic information, such as types and percentages of lithologies and sedimentary structures, can be incorporated into statistical models and exported into software programs to produce strip logs and lithofacies, percentage of lithofacies, and percentage of

texture/fabric reservoir maps.

Assigned stratigraphic rank of the various units measured in the field will be included in the database and the thicknesses of these units calculated. We have evaluated, selected, and ordered a software package for 3-D visualization of this data.

Interpretation. A large-diameter core (7 7/8 inch) from a University of Utah Research Institute (UURI) Ferron drill hole (the UURI No. 1) was logged and important core segments photographed. The core hole was drilled in the Muddy Creek case-study area (figure 1) in 1991. The tops of lithologic and genetic units were noted and the principal facies boundaries were interpreted. The geophysical log of the UURI No. 1 was interpreted and compared to with the core description. This information along with data from the cores to be taken later in the project will be used to prepare strip logs, produce facies maps, and define "type" logs for the principal reservoir(s) in the case study area.

Next Quarter Planned Activities

Presented below are planned activities for the next quarter:

1. Continue collecting measured sections, well logs, core descriptions, mini-permeameter values, and other data. Begin entering this information into the database and prepare strip logs.
2. Complete aerial photography of entire Ferron outcrop in the study area (approximately 80 miles (130 km), digitize the negatives onto CDs, reproduce photos from the CDs, and construct photomosaics for regional stratigraphic and case study field work.
3. Complete permitting work for core hole locations in the Ivie Creek case-study area.
4. Begin regional outcrop mapping.
5. Begin case studies of the Ivie Creek and Willow Springs Wash areas including lithofacies mapping and measuring sections.
6. Obtain additional software to develop a 3-D gridded database.

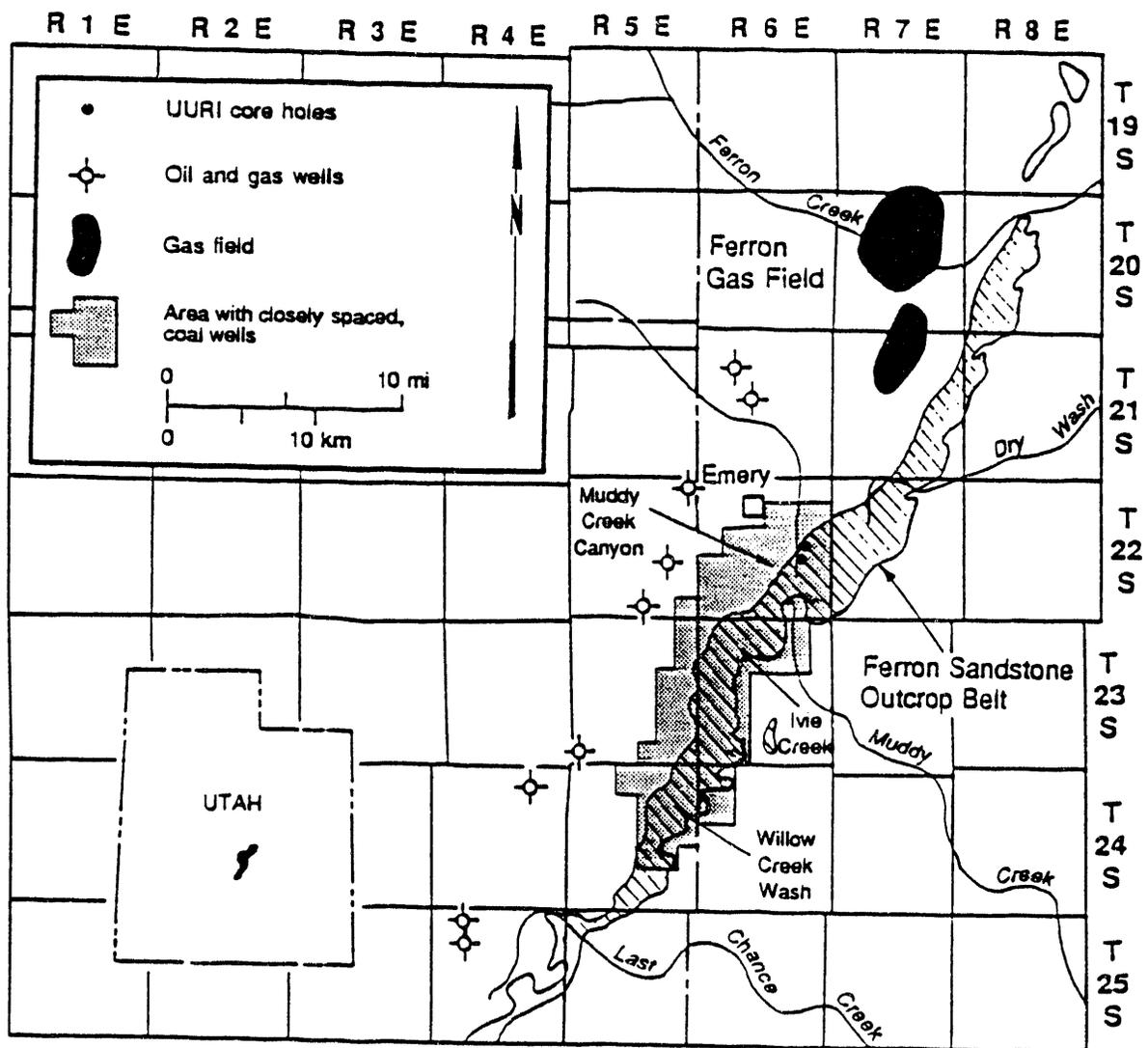


Figure 1. Location map of the Ferron Sandstone study area (cross-hatched) showing potential detailed case-study sites.

Table 1. Summary of well, geophysical log, and core data in the Ferron Sandstone study area.

Source of wells	No. of wells with geophysical logs	No. of logs obtained by the UGS *	No. of wells cored/ footage cored	Cored footage obtained by the UGS *	No. of wells entered on forms	No. of wells in ASCII format
Oil & Gas						
UURI	2	2	2/800	800	0	0
ARCO	7	0	7/3,527	descriptions only	0	0
BP	5	5	5/1,000	1,000	0	0
other	58	40	0	0	0	0
Coal						
CONSOL	356	40	356/unknown	descriptions only	285	156
USGS	33	14	29/1,402	descriptions only	0	0
BLM	0	0	6/1,156	descriptions only	0	0
JB KING	12	0	0	0	0	0
HVCC	7	0	0	0	0	0
TOTAL	480	101	405/7,885	1,800	285	156

* as of March 31, 1994

DATE

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