# MEETINGS

## HGS LUNCHEON MEETING—FEBRUARY 28, 1990

ERIK K. DAVIDSEN—Biographical Sketch

Erik K. Davidsen received his BS and MS degrees from the University of Texas at Austin in 1983 and 1986, respectively. A native of Iowa City, Iowa, he studied aerospace engineering at Iowa State University before coming to Texas, where he studied greenstones of the Franciscan Formation near San Simeon, California for his thesis. Mr. Davidsen is employed by Chevron U.S.A. Inc. in Houston. His oil industry career has included summer jobs with Tenneco Oil Co. in Lafayette, Mobil Oil Corp. in Denver, and the Bureau of Economic Geology in Austin. Mr. Davidsen began his career with Chevron in 1986 working the Permian Basin in Midland. In 1987, he became the project leader of the geological characterization study team on the North Ward Estes field, Ward and Winkler Counties, Texas.

### REJUVENATION OF A MATURE GIANT - NORTH WARD ESTES FIELD, TEXAS

In the United States today, considerable emphasis has been placed on the exploitation of existing fields. New reserves are not replacing production. Concurrently, production in many "giant" fields is declining. However, understanding these giant fields through reservoir characterization can assist in slowing or reversing declines in production. The ability to conduct reservoir characterization studies will become increasingly more critical to long term success in many mature fields.

Reservoir characterization is the multi-discipline process of identifying and quantifying reservoir properties that control fluid flow. Characterization studies provide the technical foundation for overall field development that may include designing, implementing or modifying enhanced recovery projects. Such studies are crucial to the successful management of reservoirs. Key elements that contribute to successful reservoir characterization studies are; 1) a multi-disciplined approach of geologists, engineers, geophysicists, field personnel and technicians to ensure integration of all data on a field-wide basis, 2) a clear definition of purpose and priorities for all departments involved to focus efforts toward common goals, 3) a financial and manpower commitment to ensure long term success, and 4) adequate computer support, particularly for large reservoirs, to provide efficient data storage and manipulation.

Although each field study has unique goals and problems, all share certain aspects that are common to the reservoir characterization process. The basic steps involved in this process are: 1) data collection and preparation; 2) rock description and development of a depositional model; 3) petrophysical, lithofacies, and core to log relationship determination; 4) data integration and map generation; and 5) project implementation. Each of these aspects is discussed using the North Ward Estes reservoir characterization study as an example.

The North Ward Estes field is located along the western edge of the Central Basin Platform in Ward and Winkler Counties, Texas. The field is part of a productive trend that extends uninterrupted for 90 miles on the edge of the platform. The field has produced approximately 320 million barrels of oil (one-third the cumulative production of the trend) from more than 3000 wells since its discovery in 1929. Production is from Upper Guadalupian back-reef lagoonal sandstones of the Yates, Seven Rivers, and Queen Formations.

In 1986, Chevron initiated a field-wide reservoir characterization study project. The primary objectives of the study were to calculate original oil in place for the economic assessment of a large $CO_2$ flood and numerous waterflood expansion/realignment projects and to support the design and implementation of these projects, while concurrently identifying and exploiting workover opportunities. To date, a total of 9.75 man-years and $1.5 million ($1.25 million in computer processing and support) have been spent on the geological characterization phase of the project. Certainly, undertaking a reservoir characterization study of this magnitude is risky, especially during times of fluctuating oil prices. However, with an estimated 700 MMBO still in the ground, the potential benefits outweigh the risk.

The characterization project began by building a computer database which involved: 1) digitization of 15 million curve feet of log data and 30,000 feet of core analysis from 528 wells, 2) correlation and input of 68,000 marker tops, 3) coding and input of core lithologies, 4) core to log depth correction, and 5) input of well histories and well bore diagrams from 3,124 wells.

Examination and description of over 300 feet of core led to the recognition and refinement of a back-reef tidal flat to lagoon depositional model. The model indicates that the reservoir sands were deposited during an overall progradational shallowing-upward sequence that experienced minor transgressive and regressive cycles. New development opportunities were identified based on the depositional model along the updip (evaporative) and downdip (carbonate) margins of the field.

The very fine grained, well sorted sandstones at North Ward Estes have low permeability. Petrologic analysis indicates that ubiquitous clay (corrensite) creates a low permeability high porosity reservoir. Lithofacies maps were made for each sand unit using lithologic description from core. Porosity-permeability ($\phi$-K) relationships were then established for each lithofacies, because the clay content reflects variation in energy associated with the original depositional environment. Density logs were normalized and transformed to read porosity, and porosity cutoffs were established for effective pay based on the $\phi$-k relationships. Structure and porosity-feet maps were then merged with fluid contact and water saturation data to calculate volumetrics.

Data integration capabilities of the computer facilitated the efficient management of the reservoir through mapping lithofacies, effective-feet of pay, oil porosity-feet, permeability-feet, and maximum permeability. These maps were, and continue to be, vital in determining reserves, sand continuity and distribution, injection thief zones, and directional permeability. In addition, the integration of wellbore information has provided an efficient method to identify add pay, deepening, and plugback candidates.

Implementation of the reservoir characterization study at North Ward Estes has had significant impact on production from this giant field. In 1986, the decline rate was 15%, but recent decline has been only about 6%, largely due to an aggressive workover program associated with the reservoir characterization study. Thirteen secondary and enhanced recovery projects, including a large-scale $CO_2$ flood, are being or will be implemented to arrest or possibly reverse the decline in production. Reservoir characterization has been invaluable in the modelling, design, and implementation of these projects. Development drilling opportunities have also been recognized from this work. Clearly, proper characterization studies are the key to successful reservoir management.