KUUSKRAA, VELLO A., and FRANK MORRA, JR., Lewin and Associates, Inc., Washington, D.C.

Replacement Costs of Domestic Crude Oil

In the long run, selling prices will equate with replacement costs if companies are to remain in business. Thus, the study of replacement costs provides a powerful analytic tool for further understanding of the uncertainties in future oil prices and domestic crude oil productive capability.

The analysis provides insights about the time at which supplemental sources of fuel from synthetic or alternative sources may become economic, and provides one means for quantifying the costs and benefits of these alternative decisions.

Most important, the engineering and geologic methodology used in the replacement cost analysis provides the essential and long sought-for "bridge" between the domestic resource base and economically producible supplies.

Much of the uncertainty in future prices and productive capacity for conventional oil stems from international decisions. Use of the replacement cost methodology will help to more clearly understand the effect of other uncertainties, such as: (1) the size of the conventional oil resource base; (2) the level of domestic oil production capacity the industry and nation may wish to maintain; (3) the timing and technical success in enhanced oil recovery; and (4) the constraints that may impede the development of energy in frontier areas.

This analysis discusses these uncertainties and quantifies their impact on domestic energy replacement costs and sustainable levels of oil supply. The major findings of the analysis are:

A. The source of future domestic crude oil supplies will increasingly shift toward frontier, hostile geographic areas and toward enhanced oil recovery.

B. If crude oil exploration and development remain orderly and relatively free of constraints, considerable quantities of lower cost crude oil will be available for the remainder of this decade. However, as these supplies are consumed, the replacement costs will begin to rise rapidly.

C. Many events could dramatically accelerate the time when domestic replacement costs begin their steep climb. Three such occurrences are: (1) a low crude-oil resource base (U.S. Geological Survey, 95%) case; (2) low success with, or constraints on, enhanced oil recovery technology; and (3) lack of access to Arctic or deep-water resources.

KUYKENDALL, MICHAEL D., Oklahoma State Univ., Stillwater, OK

Petrography, Diagenesis, and Depositional Setting of Glenn (Bartlesville) Sandstone, Berryhill Unit, Glenn Pool, Oklahoma

Petrography and physical stratigraphy of the "Glenn" (Bartlesville) sandstone in the 160-acre Berryhill unit, Glenn Pool, were established from 10 cores and more than 60 modern well logs. The reservoir mostly is sublitharenite to litharenite; lithic constituents chiefly are metamorphic rocks and rip-up clasts. Principal diagenetic minerals are kaolinite, chlorite, and illite. This evidence and data from the regional and local stratigraphic framework indicate that sands were upper delta-plain deposits. Logs of the closely spaced wells show moderately complex short-distance change in geometry of the sandstone and attendant reservoir heterogeneity. All this information is integral in ongoing plans for enhanced recovery and in current research on enhancement of well logs by signal processing.

LAFEHR, T. R., Colorado School Mines, Golden, CO

Integrated Geology and Geophysics

We have an increasing need for geologists and geophysicists to work together on exploration projects. Pitfalls or weakness in a subdiscipline may be minimized or even avoided by an integration of all available data (e.g., geologic constraints, well logs, core analyses, seismic and nonseismic geophysical information).

Two case histories are provided to demonstrate the importance of integration. The first is lithologic identification by combining seismic reflection, refraction, and gravity data in a situation where any one tool, if used alone, could not solve the problem. The second geologic example is a structural problem taken from the overthrust of Wyoming. The examples include drilling results after the interpretations were performed.

LAND, LYNTON S., Univ. Texas, Austin, TX

Evidence for Vertical Movement of Diagenetic Fluids, Texas Gulf Coast

Both the study of burial diagenesis and the study of present-day formation waters of Jurassic through Pleistocene formations from the Texas Gulf Coast document local vertical fluid transport of at least several kilometers. Evidence includes the following. (1) Discharge at the land surface of Mesozoic-derived brines as "bad water." (2) Emplacement of Mississippi Valley-type lead-zinc mineralization by fluids derived from Mesozoic formations in salt dome cap rocks at or near the land surface. (3) Emplacement of uranium in Tertiary aquifers as a result of reduction by ascending reduced sulfur, presumably of Mesozoic origin. (4) Emplacement of calcite cement derived from Mesozoic strata in Tertiary sandstones. (5) Presence of fluids in Plio-Pleistocene rocks with chemical signatures that could only have been derived from Mesozoic strata.

Material-transport calculations indicate that the volumes of fluid involved far exceed the volume of connate water deposited in the basin, strongly suggesting some mechanism of thermally driven convective flow.

LARESE, RICHARD E., and EDWARD D. PITTMAN, AMOCO Production Co., Tulsa, OK, and MILTON T. HEALD, Univ. West Virginia, Morgantown, WV

Effects of Diagenesis on Porosity Development, Tuscaloosa Sandstone, Louisiana

The Lower Cretaceous Tuscaloosa sandstone is of interest because of high porosity (up to 29%) at depths as great as 21,000 ft (6,400 m). We believe that the porosity is 70% primary and 30% secondary. Diagenetic events are major controls for the high porosity but overpressure also contributes.

Primary porosity exists because quartz diagenesis was retarded by chlorite grain coats. Where grains coats are absent or thin, prismatic quartz overgrowths occur. Chlorite coats constitute up to 29% of the rock. Chlorite originates from alteration of lithic material (i.e., volcanic and basic igneous intrusives) in the sandstone. An excellent direct correlation exists between the amounts of lithic fragments and chlorite coats. Sandstones with extensive chlorite and lithic fragments are not good reservoirs because of reduced permeability resulting from rearrangement and mechanical breakage of weak grains during compaction. Commonly, authigenic titanium minerals (e.g., anatase) are associated with the altered lithic material.

Secondary porosity has formed from the dissolution of lithic fragments and feldspars, and to a lesser degree carbonates. Secondary porosity related to highly chemically susceptible lithic fragments developed early (prechlorite) and was subject to later collapse; whereas pores related to later dissolution of less soluble lithic material and feldspar were less affected by compaction because of a more stable framework. Diagenetic evidence indicates that the dissolution occurred prior to, during, and after the formation of chlorite coats.

Calcite cement occludes porosity in some intervals. However, textural evidence from leaching experiments suggests that dissolution of this calcite is not a major source of secondary porosity.

LAW, BEN E., U.S. Geol. Survey, Denver, CO

Geologic Characteristics of Low-Permeability Gas Reservoirs in Greater Green River Basin of Wyoming, Colorado, and Utah

Large gas resources occur in low-permeability Upper Cretaceous and Lower Tertiary reservoirs in the Greater Green River basin of Wyoming, Colorado, and Utah. Most of the gas-bearing reservoirs are overpressured, beginning at depths of 8,000-11,500 ft (2,440-3,500 m). The reservoirs are typically lenticular nonmarine and marginal marine sandstones. In situ permeabilities to gas are generally less than 0.1 md, and porosities range from 3-12%. Secondary porosity, after dissolution of framework grains and cements, is the dominant type of porosity. Gas accumulations are characterized by the presence of water updip and little or no recoverable water downdip. The seal of these overpressured gas-bearing reservoirs cuts across structural and stratigraphic boundaries and is not associated with any particular lithologic unit. The trapping mechanism is