of the island arc suggest that these fracture zones have existed throughout the Tertiary history of the region.

LEWIS, J. SCOTT, Mobil Exploration and Producing Services, Inc., Dallas, TX, and ALAN C. DONALDSON, West Virginia Univ., Morgantown, WV

Lithostratigraphy and Chronostratigraphy of Catskill-Pocono Delta, Upper Devonian-Lower Mississippian, Northern West Virginia

In the central Appalachian basin, sandstones of the Catskill-Pocono delta have produced commercial oil and gas for over a century. In northern West Virginia, spatial and temporal relationships in this sequence (Chemung, Hampshire, and Pocono Formations) are poorly defined and understood.

Correlation using base-lined (relative method) gamma-ray logs, supplemented by lithologic logs and outcrop study, elucidates detailed lithostratigraphic and chronostratigraphic interrelationships including: (1) development of a stratigraphic and sedimentologic "framework" for these strata, (2) illustration of "true" thickness variations of subsurface rock units, (3) determination of distribution and position of "clean" sandstone and red-bed lithofacies, (4) identification of persistent sandstone trends through time, (5) positioning of time lines, which pass through apexes of maximum onlap and offlap, and (6) recognition of an angular unconformity as the upper sequence boundary.

Resultant cross sections illustrate subtle stratigraphic relationships including intertonguing lithofacies, updip and downdip pinch-outs of shallow marine sandstones, and probable cross-slope channel and lobe deposits of turbiditic origin. In addition, subsurface-to-outcrop correlation resulted in identification and description of various gas-bearing sandstones on outcrop, and in correlation of subsurface lithostratigraphic units to outcrop lithofacies.

A similar methodology is recommended for subsequent studies to determine "true" and/or net thickness of a particular facies (i.e., organic-rich shale, "clean" sandstone, or "tight" sandstone). The same approach may be used in other basins where: (1) adequate numbers of gamma-ray logs are available, (2) a consistent shale base line may be determined, and (3) a "clean" sandstone lithofacies or uniform carbonate section is present for determination of a clean sandstone or minimum deflection base line.

LEYTHAEUSER, D., and R. G. SCHAEFER, Inst. Petroleum and Organic Geochemistry, Jülich, Federal Republic of Germany, and A. YÜKLER, Integrated Exploration Systems, Jülich, Federal Republic of Germany

Diffusion of Low Molecular Weight Hydrocarbons Through Pore Space of Sedimentary Rocks: Its Recognition, Quantitation, and Geologic Significance

Based on theoretical considerations, diffusion of low molecular weight hydrocarbons through the water-saturated pore system of sedimentary rocks can be expected as a common and ubiquitous process in the subsurface. Wherever concentration gradients develop (e.g., with the onset of hydrocarbon generation near the contact between organic-rich and organic-lean strata) diffusion of mobile components should occur. Diffusion processes play a dual role in the subsurface: as an initial step for transportation of hydrocarbons from source rocks toward carrier rocks, and at a later stage, when a reservoir accumulation has formed, as a destructive process by light hydrocarbon dissipation through the cap rock.

Geochemical evidence to illustrate the role and the effects of diffusion in both processes generally is represented by characteristic relationships between concentration depth trends and the molecular size and structure of the various hydrocarbon species in the transported mixture. Also, shale cap rocks of productive reservoir hydrocarbon accumulations are permeable, and diffusive loss of light hydrocarbons is significant. For individual light hydrocarbons, diffusive halos can be recognized in the cap rock above the reservoir accumulation.

Based on newly determined effective diffusion coefficients, model calculations have been made for quantitation of the outlined observations. In this way it was possible to demonstrate that molecular diffusion through the water-saturated pore space of shale source rocks represents an effective process for primary migration of gas and can account for transportation of such.

LIGHT, MALCOLM P. R., Bur. Econ. Geology, Austin, TX

Maturity Anomalies, Fluid Flow, and Permeability Preservation in Frio and Anahuac Formations, Upper Texas Gulf Coast

The Pleasant Bayou geopressured-geothermal test wells in Brazoria County, Texas, display a prominent thermal maturity anomaly in the Oligocene Anahuac and Frio Formations. Highly geopressured, more-mature shales are interbedded with hydropressured to moderately geopressured sandstones in the upper Frio and Anahuac. In contrast, shales and sandstones in the lower Frio, including the Andrau geopressure-geothermal production zone, are highly geopressured and exhibit lower thermal maturities.

In the deeper lower maturity sandstones, porosity is dominantly secondary. These sandstones are more permeable by an order of magnitude than the more-mature shallower sandstones. The intense dissolution of grains in the highly geopressured lower Frio Formation is directly related to the increasing solubility of CO_2 (released during the maturation of organic matter) with increasing pore pressure.

Maturity data at Pleasant Bayou indicates that the upper Frio was subjected to an extended period of upwelling basinal-fluid flow that caused the thermal anomaly. Updip flow of hot basinal fluids was largely arrested in the lower Frio by the high geopressure. Consequently, the maturity of the lower Frio was not increased.

Late-state porosity and permeability destruction by carbonate cementation seen elsewhere in the Gulf Coast was inhibited in the deeper Frio by the low influx of Ca^{2+} ions contained in the fluids. These Ca^{2+} ions were released from albitization of feldspars at more-mature, deeper levels.

LINDLEY, J. IONE, Univ. North Carolina at Chapel Hill, NC

Fluid and Rock Interaction in Permeable Volcanic Rock

Four types of interrelated changes—geochemical, mineralogic, isotopic, and physical—occur in Oligocene volcanic units of the Mogollon-Datil volcanic field, New Mexico. These changes resulted from the operation of a geothermal system that, through fluid-rock interaction, affected 5 rhyolite ash-flow tuffs and an intercalated basaltic andesite lava flow causing a potassium metasomatism type of alteration. (1) Previous studies have shown enrichment of rocks in K_2O as much as 130% of their original values at the expense of Na_2O and CaO with an accompanying increase in Rb and decreases in MgO and Sr. (2) X-ray diffraction results of this study show that phenocrystic plagioclase and groundmass feldspar have been replaced with pure potassium feldspar and quartz in altered rock. Phenocrystic potassium feldspar, biotite, and quartz are unaffected. Pyroxene in basaltic andesite is replaced by iron oxide. (3) $\delta^{18}O$ increases for rhyolitic units from values of 8-10 permil, typical of unaltered rock, to 13-15 permil, typical of altered rock. Basaltic andesite, however, shows opposite behavior with a $\delta^{18}O$ of 9 permil in unaltered rock and 6 permil in altered. (4) Alteration results in a density decrease. SEM revealed that replacement of plagioclase by fine-grained quartz and potassium feldspar is not a volume for volume replacement. Secondary porosity is created in the volcanics by the chaotic arrangement of secondary crystals.

LINDSAY, ROBERT F., Gulf Oil Exploration and Production Co., Houston, TX

Madison Group (Mississippian) Reservoir Facies of Williston Basin, North Dakota

Twenty-seven oil fields producing from the Mission Canyon Limestone and Charles Formation (middle and upper Madison Group) were studied: (1) along the eastern basin margin (Bluell, Sherwood, Mohall, Glenburn, Haas, and Chola fields), (2) northeast of Nesson anticline (Foothills, North Black Slough, South Black Slough, Rival, Lignite, and Flaxton), (3) along Nesson anticline (North Tioga, Tioga, Beaver Lodge, Capa, Hoffland, Charlson, Hawkeye, Blue Buttes, Antelope, and Clear Creek), and (4) south of the basin center (Lone Butte, Little Knife, Big Stick, Fryburg, and Medora).

Mission Canyon reservoirs along the eastern margin are in several shoaling-upward carbonate to anhydrite cycles of pisolitic packstone or