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

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

In the central Appalachian basin, sandstones of the Catskill-Pocoono delta have produced commercial oil and gas for over a century. In northern West Virginia, spatial and temporal relationships in this sequence (Chesung, Hampshire, and Pocoono 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 the subfacies 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 apaxes 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 "light" 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.


Diffusion of Low Molecular Weight Hydrocarbons Through Porous 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 have a dual role in the subsurface: as an initial step in the 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.

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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 geopressed, more-mature shales are interbedded with hydropressed to moderately geopressed 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 geopressed 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 geopressed lower Frio Formation is directly related to the increasing solubility of CO₂ 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-stage porosity and permeability destruction by carbonate cementation seen elsewhere in the Gulf Coast was inhibited in the deeper Frio by the low influx of Ca²⁺ ions contained in the fluids. These Ca²⁺ ions were released from albitionization of feldspars at more-mature, deeper levels.

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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 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 K₂O as much as 130% of their original values at the expense of Na₂O and CaO with an accompanying increase in Rb and decreases in Sr. (2) X-ray diffraction results of this study show that phenocristic plagioclase and groundmass feldspar have been replaced with pure potassium feldspar and quartz in altered rock. Phenocristic potassium feldspar, biotite, and quartz are unaffected. Pyroxene in basaltic andesite is replaced by iron oxide. (3) δ¹⁸O 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 δ¹⁸O of 5 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.

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Mission 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 Mission Group) were studied: (1) along the eastern basin margin (Bluell, Sherwood, Mohall, Glendora, Capa, Hoffland, Charlestown, Hawkeye, Blue Buttes, Antelope, and Clear Creek), and (2) northeast of Nesson anticline (Foothills, North Black Slough, South Black Slough, Rival, Lignite, and Faxon). (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 pisolithic packstone or