ation.

Other major fracture sets are well developed in isolated areas of Cuyahoga County. Superimposed on the major fracture sets is a random, fine-scale fracture network which constitutes 50.8% of all fractures.

The major fracture sets conceivably provide pathways for the migration of natural gas. In northeastern Ohio, the only commercial production of natural gas is in areas of apparently increased fracture intensity.

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Pyrolysis of Eastern Gas Shales—Effects of Temperature and Atmosphere

Shale samples from well cores from Christian County, Kentucky, and Effingham, Henderson, and Tazewell Counties, Illinois, were studied for the noncondensable (at room temperature) hydrocarbon gases produced during pyrolysis. The data show a direct correlation of the total hydrocarbon gas (C_1 to C_5) yield from the shale pyrolyzed at 600°C to the organic carbon content of the shale and relations of the gas released from specially "canned" core sections at room temperature to the organic carbon content and to the total porosity of the shale.

The composition of the noncondensable hydrocarbon gases was studied on selected black-shale samples with stepwise increases in temperature. The formation of alkanes is favored over alkenes at low temperature. Alkenes, C_1, and C_2 species from thermal cracking are positively identified when the shale has been heated to above 120°C, if other conditions remain constant.

The effect of the pyrolysis atmosphere on the yield of light hydrocarbons (C_1 to C_8), acetaldehyde, acetone, carbon monoxide, and carbon dioxide during thermal degradation of selected gram-sized black-shale samples was studied also. The effects of varying the amount of oxygen in the pyrolysis atmosphere have been monitored. The yield of an individual hydrocarbon generally increases until the oxygen content of the pyrolysis atmosphere reaches 10%. Above 10% oxygen there is a slight decrease in yield. The yield of carbon monoxide and carbon dioxide increases directly with the increase of oxygen content of the pyrolysis atmosphere.

Data derived from this study may improve our understanding of the potential for gas production and the prediction of gas production from the eastern black shale. It may also provide information useful for controlling the quality of the gas produced by shale pyrolysis.

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Regional Coalification Patterns in Eastern Kentucky, Virginia, West Virginia, Ohio, Maryland, and Southern Pennsylvania

An isoreflectance map, based on the average maximum reflectance of the vitrinite macerals, was compiled from 329 coal samples from Kentucky (75 samples), Virginia (14 samples), West Virginia (200 samples), Ohio (10 samples), Maryland (15 samples), and southern Pennsylvania (15 samples). This map shows that coalification increases toward the Allegheny Front (or in west-to-east and northwest-to-southeast directions) in the northern part of the Appalachian coal basin. The dry-ash-free fixed carbon contents of the coals show the same general trends.

The isoreflectance map shows that the rank increases to a maximum in two directions: (1) from Ohio eastward to the Allegheny Front in southern Pennsylvania, Maryland, and Mineral County, West Virginia; and (2) from Ohio and northeastern Kentucky to the central part of McDowell County, West Virginia. This increase in rank can be attributed to the eastward thickening of the strata, but the major factor in the coalification was probably the increase of thermal activity and temperatures coupled with the Appalachian orogeny.

An attempt to determine the temperatures of coalification by using the level of metamorphism of P. J. Hood showed that the temperatures during the effective times for coalification were approximately 85 to 90°C near the northwestern boundary of the coalfield and approximately 180°C in central McDowell County where the highest reflectance of 1.80% R_{max} occurred.

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Exploration Strategy for Unconventional Natural Gas Resource—Devonian Shales

Exploration rationales, exploration techniques, and prospects are the key elements of EGSP's ideal exploration strategy for the Devonian shales of the Appalachian, Illinois, and Michigan basins. An exploration rationale is a theory of how several known or suspected geologic circumstances may combine to create a favorable environment for the generation and accumulation of producible hydrocarbons. The unconventional nature of the Devonian shales as a natural gas resource demands shale-specific rationales. These are characterized by a hypothesized geologic mechanism for the creation of a natural fracture system, because fracture permeability is essential to shale production. Although fractures are a necessity, they alone are not sufficient. Hence, shale-specific rationales include supporting information on black shale thickness, kerogen content, thermal maturity, reported shows, production history, etc. Exploration rationales are area-specific, but generally not site-specific. Prospect development is the process by which site-specific prospects issue from area-specific rationales. Exploration techniques are the means employed, short of drilling, to evaluate rationales and optimize local geologic factors in site selection.

The development of seven exploration prospects associated with the Newman Ridge and Greendale synclines in eastern Tennessee and southwestern Virginia illustrates EGSP's exploration strategy.

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Middle and Upper Devonian Stratigraphy in North-