McKELVEY, V. E., Director, U.S. Geological Survey, Washington, D.C.

Keynote speaker.

OVERBEY, W. K., JR., C. A. KOMAR, and J. PASINI, U.S. Bureau of Mines, Morgantown, W. Va.

Geologic Investigations for Siting and Planning Underground Coal Gasification Project

In a new series of experiments now being conducted by the U.S. Bureau of Mines, directional control of the combustion zone in underground gasification of coal requires detailed knowledge of the geology of the test site. In particular, directional properties of the coal and rocks above and below must be known accurately in order to control the advance of the combustion zone and the movement of product gases. To obtain the information necessary to select a site for conducting these experiments, a series of surface and subsurface studies was planned.

Specifically, remote-sensing imagery and photography were examined over northern West Virginia where the coalbeds are buried deepest. From these, lineaments and fracture traces were mapped to determine the location of gas-venting zones. Structural features such as anticlines, synclines, and joint strikes also were mapped and remote sensing lineaments were field checked during the surface geologic studies. Surveys to establish bench marks for subsidence measurements were conducted. In the subsurface analysis, oriented cores of rocks above and below the coalbed were obtained and directional properties such as tensile strength, permeability, preferred-failure direction, and joint strike measurements were made.

Correlation of oriented core data with surface geologic studies was used to determine the direction for deviation of the long horizontal injection and production wells to be drilled for the coal gasification experiment. These studies showed that delineation of directional characteristics of the rock strata is essential for siting and planning any *in situ* extraction process.

PATCHEN, D. G., and R. SMOSNA, West Virginia Geol. Survey, and H. BUCHANAN, West Virginia Univ.

Stratigraphy and Petrology of Middle Silurian McKenzie (Lockport) Formation in West Virginia and Adjacent Areas

The Middle Silurian McKenzie Formation at the type section near McKenzie Station, Maryland, is composed of thinly interbedded, ripple-marked mud-cracked shale and limestone with minor amounts of siltstone. These same rock types are predominant in cuttings from wells drilled farther west over a distance of 50 mi. Southwestward from the eastern panhandle of West Virginia, however, the McKenzie contains coarser clastics. In Pocahontas County, Travis divided the formation into three units: an upper limestone and shale, a middle sandstone, and a lower limestone and shale. Westward in the subsurface, the upper limestone and shale facies is replaced by dolomite, but thin shale beds still are present near the top of the formation. The middle sandstone persists as a distinct unit as far as Roane, Kanawha, and Boone Counties, a distance of approximately 100 mi. Farther west in the state, sandy dolomite is present at this level. The lower limestone and shale unit of outcrop areas in Pocahontas County becomes more dolomitic westward and still is recognized as a sandy, dolomitic limestone as far west as Ohio and Kentucky.

The McKenzie Formation in the eastern panhandle represents accumulation in a marine environment along a low-lying coastal plain where rivers supplied clay and silt. Minor fluctuations of sea level and intermittent turbulent and calm conditions created alternating open-marine to intertidal environments. In the southwest in Pocahontas County, Travis interpreted the rocks of the lower unit as having been deposited under conditions ranging from normal marine to intertidal. The sandstone unit was formed as a beach deposit during a minor regression; it is overlain by a shallow-marine limestone and shale facies. An increasing quartz-sand content in the top signaled the coming of another regression and the beach deposit of the overlying Williamsport Formation.

Environments of deposition for the McKenzie in the western subsurface have been interpreted at a detailed level from a complete core in Wayne County. The paleoenvironment of the lowest unit was a bryozoan-stromatoporoidal bioherm. A middle sandy dolomite represents intertidal deposition. An overlying oolitic facies is considered to be of a littoral environment, and stromatolitic dolomite in the uppermost unit is interpreted as intertidal and supratidal algal mats. A core from another well on the northeast, in Mercer County, Pennsylvania, contains similar lithologies, also indicative of intertidal and supratidal deposition.

Most small gas shows and pays previously referred to as production from the Keefer or Big Six sand are actually from the biohermal facies of the lower McKenzie. Gas has been encountered in this facies in 75 percent of the wells drilled through the McKenzie in Wayne County. Gas shows also have been found in this zone in Cabell and Mingo Counties. Farther north, in Jackson, Mason, and Roane Counties, gas shows are recorded higher in the McKenzie at a level equivalent to or immediately above the middle sandy unit. This porous zone has been productive in Meigs County, Ohio, where it is called the "Ohio Newburg."

RYAN, W. M., Columbia Gas Transmission Corp.

Structure and Hydrocarbon Production Associated with Pine Mountain Thrust System in Western Virginia

Hydrocarbons have been produced in western Virginia in Lee, Scott, Washington, Buchanan, Dickinson, and Tazewell Counties. Natural gas has been found in wells drilled in Russell and Wise Counties, but this gas has not been produced because of the lack of pipeline facilities. Within this area, economic gas reserves have been found in the Mississippian Ravencliff, Maxon, Big Lime, and Berea; the Devonian brown shale; and the Ordovician Trenton and Black River zones. Production from the Ravencliff and Maxon sands is from both primary and secondary porosity. Big Lime production is mainly primary porosity but some fracture production exists. Berea, brown shale, Trenton, and Black River production is mainly from secondary fracture porosity associated with the Pine Mt. overthrust system.

In northeastern Dickinson and northwestern Buchanan Counties, Columbia Gas Transmission Corporation's Haysi field is being drilled and extensively studied in relation to Berea fracture production. Primary porosity in this field averages between 3 and 7 percent but open flows of over 3 Mcfd have been found with gas reserves in some wells projected to be up to 2 Bcf. The high open flows and good deliverability of these wells are attributed to fracture porosity. To delineate fracture traces in the Haysi area, geologic mapping has been combined with several remote sensing surveys including color and black and white infrared photography, thermal infrared scanning, side-looking radar imagery, and color photography. The remote sensing data are being evaluated; however, the radar imagery and color photography have been utilized to locate fractured zones. Wells have been located and are to be drilled on these radar lineations.

SEYMOUR, R. E., Consolidated Natural Gas System

No abstract available.

SHUMAKER, R. C., West Virginia Univ., Morgantown, W. Va.

Western Appalachian Tectonics

A research project to document and interpret western Appalachian tectonic patterns was started this past year. The first phase of the project has been the compilation of detailed geologic and structural maps on a regional base map to document the styles of deformation both along the 38th parallel faults and within the western Appalachian basin.

Preliminary results indicate the presence of a diversity of structural styles, both basement and detached deformation. Some of the more pertinent observations are: (1) Detached structures extend farther westward than commonly interpreted. (2) A north-south trend of detached folds is southwest of and parallel with Burning Springs anticline. (3) Structural styles along the 38th parallel fault trend include wrench faults, grabens, and down-to-basin faults. A major change in tectonic style occurs across the Cincinnati arch. (4) Detached structures may reflect basement structural trends so that the Cambrian and early Paleozoic basement structures affect the position and trend of upper Paleozoic basement and detached structures.

Exploration for oil and gas largely has been on detached structures within the central Appalachian basin and basement structures farther west. Only the upper part of the stratigraphic section has been tested and there is a vast new virtually untested deep frontier within this "mature" basin. However, high cost of exploration for deep Cambrian-Ordovician targets requires geologists and geophysicists to apply their best talents and techniques to all available data.

TATLOCK, D. B., The Peoples Natural Gas Co., Pittsburgh, Pa., and J. A. GREGO, Consolidated Gas Supply Corp., Clarksburg, W. Va.

Upper Devonian Stratigraphy and Production Potential: Pennsylvanian

A new surge of drilling activity is under way in Pennsylvania, with significant development and exploration for oil and gas reserves in the Upper Devonian sandstones.

Upper Devonian sedimentary rocks are present throughout 80 percent of the Commonwealth. Their origin can be traced to an eastern upland source area "Appalachia" that was elevated, possibly as a result of spasmatic collisions of the North American and North African continental plates during the Acadian orogeny. The clastic deposits spread from this eastern source area as a thick wedge of delta-plain redbeds of continental origin and merged westward into the "Chemung" marine facies.

Oil and gas accumulated in the sand deposits of the "Chemung" facies which are distributed in a northeast-southwest trending belt in western Pennsylvania. Over 500 oil and gas fields lie within this petroliferous belt. Cumulative production has exceeded 1.2 billion bbl of oil and 8.5 Tcf of gas.

Recent new-pool discoveries and successful pool-extension tests in eastern Indiana, Cambria, southern Westmoreland, and Butler Counties, plus untested Upper Devonian sands encountered during deep drilling operations in Westmoreland and Somerset Counties, will provide new areas for gas exploration and development in Pennsylvania.

YARBOROUGH, H., Exxon Co., Houston, Tex.

Plate Tectonics and Localization of Major Hydrocarbon Accumulations

Most of the major hydrocarbon accumulations are in basins formed during the Mesozoic and the Cenozoic. Many of these basins, their contained sediments, and their structural and stratigraphically trapped oil and gas fields appear to be genetically related to the hypotheses of plate tectonics.

Of particular interest are those basins that formed at plate boundaries. Three fundamental methods of basin development according to type of plate-margin deformation are reviewed: tensional, compressional, and shear-zone. Basin types, structural styles, and sedimentary histories are reviewed for different plate margins.

Significant intracratonic basins have developed as a result of shear-zones "cracking" the cratons. Furthermore, important intracratonic "stand-still" basins and their associated uplifts have resulted from viscosity inhomogeneities within the asthenosphere.

Many major worldwide eustatic changes in sea level appear to be the result of the episodic nature of sea-floor spreading. Accordingly, much of the paleogeographic history of continents appears to be related to the hypotheses of plate tectonics.

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