establish an accurate geochemical cross section of the basin if the development of the Devonian shale is to be optimized.

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Paleozoic Disruptive Deformation in North American Continent and Its Relation to Formation and Development of Interior Basins and Deformation Within Orogenic Core

The two major disruptive tectonic events during the Paleozoic which affected the North American craton seem to be associated with Appalachian-Ouachita orogenic events. The first Paleozoic cratonic disruption was tensional rifting, which occurred during the Avalonian intrusive-metamorphic event (±560 m.y.). Evidence continues to mount that these Cambrian rifts of the Appalachian-Ouachita foreland, such as the Rome trough of Kentucky and West Virginia, are not Cambrian aulacogens. By time and position, the rifts seem to be incipient basins along a developing back-arc trough. However, this disruptive deformation was not restricted to the developing arc trough, but extended far into the craton where it commonly involved reactivation of older rift zones. These zones formed the axial portion of the subsequently developed Paleozoic basins. The Paleozoic basins developed by epeirogenic movement after a period of relative quiescence during Late Cambrian through Early Ordovician (pre-Taconic) time.

The second Paleozoic continental disruption created large upthrust blocks in the craton during the Pennsylvanian and early Permian, probably by compressional deformation. This event ties, both by time and position, to deformation within the Ouachita part of the orogenic core. Upthrust crustal blocks in the craton may be bounded by reactivated faults of precursor rifts. When they formed, the upthrusts often developed near the axial part on the middle Paleozoic basins to form the late Paleozoic yoked basins. The occurrence of axial rifts within interior and foreland basins, and of axial upthrusts in the craton-margin basins, suggests an interrelation among rifts, basin formation, and the late-forming yoked basins. The developing foreland trough (the Appalachian-Ouachita geosyncline) has a tectonic history similar to that of the cratonic basins but, along its trend, tensional bending of the basement predominated.

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Tectonics of Petersburg Region, West Virginia

Detailed surface mapping, combined with investigations of two deep wells, nearby seismic profiles, and other studies enabled construction of detailed cross sections to basement across the Nittany anticlinorium of West Virginia.

Mapping shows the local large anticlines to be thrust faulted, to plunge into synclines, and to divide near terminations into several smaller plunging anticlines. Bed-extension structures occur in ductile rocks between noses of anticlines that plunge past each other in opposite directions, and there appears to be an increase in the density of longitudinal jointing in plunging anticlinal noses. Field sections show that much pre-folding shortening occurred by intraformational wedging and solution cleavage.

The northeast-trending Wills Mountain anticline, adjacent to the Appalachian structural front, is a northwestward thrust along the ramping Sponaugle thrust with decreased stratigraphic displacement and throw northeastward. However, northeastward along trend, northwestward forward motion is transferred to a higher level by growth of the Kittlelick thrust and consequently the Hopeville anticline, thus maintaining a consistent surface expression of the Willis Mountain anticline northeastward. The deep structures of the anticlinorium in the Petersburg region consist of several imbricated structural blocks involving Cambrian-Ordovician carbonate rocks, with small net slips on southeast-dipping reverse faults located east of the larger Wills Mountain structural block.

Shortening estimated from the cross sections reveals relative age relations of major structures, ramping thrusts, and decollements within the Nittany anticlinorium and also allows predictions of amounts of shortening and deformation outside the anticlinorium. Most structures in the Petersburg region developed by a west-northwest-directed gravity-spreading mechanism in which decollements allowed the ductile units to shorten nearly twice as much as the more rigid units.

The study provides insight for exploration for potential hydrocarbon resources within numerous subsurface, perhaps complex, structural traps and areas of increased fracturing in which effective permeability has probably been increased, particularly in the Devonian shale.

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Cottageville Gas Field Correlation Analyses for Reservoir Modeling

At the Los Alamos Scientific Laboratory we are currently developing a model for the fractured Devonian gas shale reservoir in Cottageville, West Virginia. This involves integrating all the available geologic, geophysical, and gas-production data into a self-consistent model that will account for the observed flows and pressures. The purpose is to further the understanding of possible production mechanisms in a highly fractured reservoir and to develop tools and methodology to apply to other reservoirs.

We are using a single-phase Darcy-flow simulator and a data base management code that provides capabilities for selecting, ranking, rotating, mapping, meshing, and plotting various attributes of wells in the field.

We have been determining how to use the known data in the model by various correlation processes. Subsea depths of stratigraphic zones near the producing horizon, obtained from 99 wells in the field, have been interpolated onto a 250-m-interval grid pattern from which isopachs and structure (including their first and second derivatives in the two horizontal directions) have been calculated. Individual well-flow data, as represented by initial or final open flow, integrated produc-