Yorktown is a mappable unconformity truncating the Eastover; seaward, in the lower James River area, marine-shelf deposits of both units converge and are distinguishable only on the basis of their faunas. These units thicken southward toward the Albemarle embayment. Across the same region, the distribution of upper Pliocene and lower Pleistocene transgressive and regressive deposits records a continued trend of tilting toward the southeast.

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Significance of Great Lateral Extent of Thin Units in Newark Supergroup (Lower Mesozoic, Eastern North America)

The lacustrine sediments of the Newark Supergroup accumulated in rift valleys developed during the early phases of the fragmentation of Pangea. Analogy with modern rift valleys has led us to expect abrupt facies transitions and syndepositional structural complexity. However, in contrast to their supposed modern analogs, many thin (< 6 m) organic-rich lacustrine units within the Newark can be traced over large areas (+2,000 km^2) with only gradual lateral changes in thickness and lithology.

Lateral correlation is afforded by: (1) detailed ecostratigraphic correlation of fossils in lacustrine cycles, (2) key marker beds such as earthquake-induced fluidized beds, (3) detailed paleomagnetic reversal stratigraphy (by others), and (4) matching of microlaminae and turbidites. These observations suggest that the lakes which produced the organic-rich units were very large (+2,000 km^2) and deep (+100 m) while at their maximum extent.

The continuity of thin beds across the major intrabasin faults and the gradual lateral change in thickness over the basins show that these faults were not active during the deposition of the units and that the size of the subsiding blocks of these Mesozoic basins was much larger than is currently the case in the east African rifts. Simple analogy between Newark and African rift systems in structure and facies is not justified and obscures their real and important differences.

OSSI, JOHN CHRISTOPHER, Univ. Maryland, College Park, MD

New Method for Interpreting Coal-Forming Environments of Deposition

Coal petrographic methods used to characterize coals for industrial purposes have further application in the interpretation of environments of deposition through the plotting of maceral data that have been grouped on the basis of mutual abundance using correlation coefficients. Huminite (or vitrinite), exinite, inertinite ternary diagrams do not readily distinguish environmental conditions during peat deposition because the three categories of macerals are based on broad ranges of reflectance. Macerals within each group are not genetically related. Lignite cores from Neshoba County, Mississippi, having an undetermined depositional environment, have been analyzed petrographically. Petrographic data from other Gulf Coast lignites of known environments of deposition (determined by nonpetrographic means) were grouped using the genetically discrete maceral associations formed by combining macerals that correlate with each other. These genetically discrete maceral groups are termed "lithogroups." When maceral data are plotted on ternary diagrams by lithogroups, the plot reveals fields that are characteristic of particular environments of deposition. The Neshoba lignites overlap in the fluvial/deltaic region of the ternary plot. An important factor controlling peat composition is thought to be pH, thereby affecting the petrography of the resulting coal.

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Kirkwood Formation and Cohansey Sand of New Jersey: Age and Spatial Relation to Chesapeake Group of Virginia and Maryland

Time and space equivalency between the well-studied Neogene beds of Virginia and Maryland and those to the northeast in New Jersey are only generally understood. Diatom and foraminifer assemblages from a recently cored hole through the Cohansey Sand and underlying Kirkwood Formation indicate that Kirkwood is the same age as the Calvert Formation of Maryland (early to early middle Miocene). The Cohansey yielded no mega-invertebrates; however, pollen studies showed that the Kirkwood and overlying Cohansey have similar microfloras. The Cohansey is probably also middle Miocene in age and equivalent to the Choptank Formation of Maryland.

In New Jersey, the Cohansey is as high as 300 ft above sea level, with no Miocene or Pliocene deposits above it. In Virginia and Maryland, the Choptank is generally below 200 ft and is overlain by higher Miocene and Pliocene marine deposits in a series of small basins. The Cohansey and Kirkwood represent deposition in an older Miocene basin that was a highland when younger Miocene and Pliocene sediments were deposited in basins to the south.

The altitudes and areal distribution of the Miocene and Pliocene formations from New Jersey to Virginia suggest that tectonic movements along the continental margin have controlled sediment supply and sites of deposition. Eustatic changes in sea level only slightly modified this pattern.

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Folds Along Junction of Central and Southern Appalachian Trends in Southeastern West Virginia and Adjacent Virginia

Field mapping of crest and trough lines of the larger folds clarifies the junction between central Appalachian structural trends (striking about N25°E) and southern Appalachian trends (striking about N65°E) in southeastern West Virginia and adjacent Virginia. Previous interpretations have argued whether the change in orientation is gradual or abrupt, whether the two trends formed simultaneously, whether the more obviously overthrust southern Appalachians overrode the central trend, whether the central Appalachians were overprinted across the southern trend, whether the junction of the two trends is caused by rotational movement, or whether the differences result from a major basement fracture zone separating the two blocks.

Our mapping shows that the folds are continuous across the junction of the trends, with a gradual bending of the fold traces. For tens of miles north of the junction of the two trends, gentle folding striking about N35°E can be mapped within the relatively flat major synclines of the central Appalachian area, but cannot be readily traced into the steeper flanks and more sharply folded crests of the major anticlines. We believe that these gentle anticline folds trending N35°E are related to the initial folding of the southern segment that trends N65°E. Subsequent to the development of the southern Appalachian folds, the central area was simultaneously folded and rotated, reorienting the northern extension of the southern fold generation to their present position of N35°E. This suggests that the southern fold and fault trend was overprinted by the central trend, a conclusion consistent with studies of stylolites by Dean and Kulander. Near the junction of the central and southern trend, structural domes and depressions formed as a result of fold interference.

PATCHEN, DOUGLAS G., West Virginia Geol. Survey, Morgantown, WV, and RICHARD SMOSNA,* West Virginia Univ., Morgantown, WV

Sedimentary Basin Analysis of Middle Ordovician Limestones in Central Appalachians

Seven of 28 wells penetrating the Trenton Limestone in West Virginia have reported shows of natural gas, enough to continue industry's interest in this potential reservoir. The formation consists of thin limestones interbedded with shales and bentonites. Sediments were deposited on a ramp that sloped eastward from a shallow platform in northwest Ohio into the foreland basin of Virginia, and the unit forms a wedge-shaped mass that thickens into the basin. Limestones of the upper ramp were deposited on sand shoals (skeletal grainstones) and restricted flats (lime mudstones), which passed downslope into skeletal patches of a deep, muddy environment (packstones and wackestones). Rapid downwarping of the carbonate ramp produced a major transgression, and deeper limestone facies migrated westward during time. Bentonites spread across the region from distant volcanic islands. In West Virginia, a lower bentonite package is present in the Black River Limestone to the southwest, whereas an upper package occurs in the Trenton to the east and north. This distribution indicates that the site of volcanic activity shifted during time. A growing orogenic source area shed terrigenous sediment into the basin and onto the Trenton ramp. Initially, these muddy influxes came from the north and from the south, but terrigenous mud eventually swamped the entire ramp and carbonate sedimentation then came to an end. Trenton Limestones have only minor intergranular porosity because of abundant mud matrix and cementation. The only significant contribution to porosity is in fractures. Thus, wells with Trenton shows are characterized by high initial potential that decreases rapidly.

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Early Days Along Oil Creek, Pennsylvania (1859-1865)

Beginning in late August 1859, with the success of the Drake well at 69.5 ft, early oil exploration concentrated along Oil Creek in the stretch between Titusville and Oil City, but other areas in northwest Pennsylvania also saw discoveries. Tributaries to the creek had their share of activity. Pioneer, Benninghoff, Cherry, and Wildcat Runs were famous names. Wildcat became the standard word for a rank exploratory well. The 1859 (and later) oil boom rivaled and usually surpassed the excitement of the 1849 gold rush in California according to some adventurers who saw both.

A proliferation of oil strikes in the narrow valley included wells such as the Noble and Delamater ("Golly, ain't that well spittin' oil?"), which produced over 700,000 bbl in 21 months, Buckeye well (1,000 b/d and the first oil from the creek to be exported abroad), the Maple Shade (never stopped flowing even when it burned) and the Phillips well (4,000 b/d). These wells were among a multitude of phenomenal gushers. Most wells had a total depth of less than 500 ft, some less than 200 ft. The drillers, operators, investors, and brokers learned of the local sequence of Upper Devonian Venango sands (First, Second, Third Stray or Gray, and Third) and described their trends as veins or streaks. These beach, bar, and nearshore deposits abruptly pinched out, leaving one wildcatter with a few barrels and a neighboring well with initial gauges in the hundreds or thousands.

This study traces the early major oil strikes down Oil Creek and describes the geology of the shallow sands that they tapped. Period photographs and steel engravings of the 1860s are compared to a photographic essay of the creek as it is today. Many of the famous wells are still there. Oil Creek is a shrine to the unique personality of the oilman and the titan industry, which at the outset, had to cope with rugged conditions and seemingly capricious sands.

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Mapping Paleostructures from Time-Related Aeromagnetic Lineaments and Photolineaments

A classification of aeromagnetic lineaments has been adapted for use with photolineaments mapped from Landsat and aerial photographs. William Dean Gibbons, a Texas geophysicist, recently defined sets of structurally high, linear, aeromagnetic anomalies for each Phanerozoic period: e.g., N19°W and N71°E for the Cambrian. Assuming that many of these aeromagnetic trends had drag-fold origins, a Cambrian model of a wrench system with drag folds and N19°W and N71°E would have the primary stress direction at N64°W, primary first-order wrench at N86°E, and complementary first-order wrench at N34°W. This model was tested on several Cambrian (Knox) oil fields in Kentucky by mapping dense sets of N34°W, N19°W, N86°E, and N71°E lineaments from aerial photographs and interpreting drag folds from the lineaments. Comparing structural contour maps on the Knox with Cambrian drag-fold maps indicates that drag-fold maps are an approximation of structural contour maps with clusters of drag folds corresponding to closed highs. Similar trials on Kentucky oil fields in the Ordovician also gave encouraging results, indicating that the method has potential in exploration. Several porosity and permeability trends were also identified from time-related lineaments for the Knox and various Ordovician reservoirs.

This procedure for mapping paleostructure has been further tested in the Mid-Continent on structures formed during various periods from the Cambrian to Cretaceous and is being used, with Landsat, for regional exploration and, with aerial photographs, for detailed studies. A current project involves exploration for Pennsylvanian and Permian paleostructures in the Denver-Julesburg basin.

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Depositional Supersequences Among Cenozoic Strata of U.S. Atlantic Continental Margin

Integration of outcrop, borehole, and seismic reflection stratigraphy reveals the broad-scale depositional framework of Cenozoic strata of the U.S. Atlantic margin. The principal feature of the framework is a series of depositional supersequences bounded by interregional erosional unconformities that can be traced from coastal plain outcrops to the continental rise. The Atlantic continental margin is divided into five depositional areas: the Salisbury, Albemarle, and Charleston embayments; a composite of the entire Atlantic coastal plain; and a composite of the Atlantic shelf and slope. The major depositional episodes are early and middle Eocene in all depositional areas, late Eocene in all areas except the Albemarle embayment, early Oligocene on the composite shelf and slope, late Oligocene in all depositional areas but minor in the Salisbury embayment, and early, middle, late Miocene and Pliocene in all areas.

Paleoenvironmental and paleo-oceanographic analyses of the sediments and associated fossil assemblages indicate that alternation of major depositional and erosional episodes is controlled chiefly by the relative position of sea level. Thus, the supersequences correlate with the supercycles of the Vail sea level model. The bounding unconformities, in turn, correlate with the major global unconformities of the Vail model. Local variations among such things as terrigenous sediment supply, subsidence rates, and the position of major geostrophic currents, however, may accentuate or diminish the sea level effects.

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Proposed Model for Interaction Between Basement Structures and Folds in Cover Rocks of Central and Southern Appalachians

Field studies, analysis of side-looking airborne-radar data, and examination of proprietary seismic reflection profiles suggest that, although the Eastern Overthrust belt tectonic regime is thin-skinned, the fold plunges, wavelengths, and frequencies appear to be controlled primarily by a Precambrian basement fault system.

Field studies have shown that thrust faults generally predate or are contemporaneous with associated folds. Thus, the proximity of faults controls, to a large degree, the wavelength of the associated folds. In addition, because faults converge downward toward the major decollements, the shorter the distance between the decollement and the ground surface, the more numerous the faults and, consequently, the narrower the associated fold wavelength. Changed decollement levels, in turn, appear to be related to basement faults.

Abrupt changes in wavelength of folds along strike appear to indicate the presence of cross-strike (lateral) ramps that connect decollements at different stratigraphic levels. The position of lateral ramps appears to be controlled in turn by cross-strike faults in the Precambrian basement, as seen on proprietary seismic data.

A map of Mesozoic basins in the eastern United States shows that Precambrian highs between basins and east-west border faults are aligned with lateral ramps. Mesozoic reactivation is therefore indicated. Later reactivation is suggested by the fact that more than 35% of recent earthquakes are coincident with lateral ramps.

Many lateral ramps can be extrapolated seaward and are exactly coincident in strike and nearly coincident in spacing with transform faults. It is hypothesized that the basement faults acted as zones of least resistance along which modern transform faults developed during episodes of seafloor spreading.

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Provenance of Selected Sandstones and Mud Rocks of Dunkard Group (Upper Pennsylvanian-Permian) in Ohio, West Virginia, and Pennsylvania

A standard QFL count and a special count of quartz grains indicate that the Dunkard sandstones are rich in quartz and sedimentary and metasedimentary lithic fragments, but poor in feldspar and igneous lithic fragments. Plots of the Dunkard detrital mode on provenance diagrams