Early workers in the CSB recognized the volcanic origin of slate-belt rocks, as well as subsequent metamorphic alteration. More recently, the sedimentologic-stratigraphic aspects of the CSB have been investigated. Interpretations of tectono-sedimentary environments have been made, based on petrologic, geochemical, and stratigraphic relationships, in light of the articulation of the concepts of plate tectonics and accreted terranes.

Age interpretations of the CSB have been based on degree of metamorphism, radiochronology, and sparse fossil evidence. Age interpretations in the late 1800s and early 1900s suggested a Precambrian age for the CSB. This was modified in the 1960s by the discovery of a purported Middle Cambrian trilobite and a lead-alpha date of 440 to 470 ± 60 Ma. Post-1960s radiometric dates for the CSB range from 705 ± 15 Ma to 511 ± 14 Ma, representing various postdepositional intrusion and cooling events. The discovery of a mid-Cambrian Atlantic province trilobite fauna and upper Precambrian Ediacarian fossils not only unequivocally date the southern part of the CSB, but also support the accreted terrane concept and Euro-African origin of sedimentary units of CSB.

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Early Mesozoic Lacustrine Sedimentation in Culpeper Basin, Virginia, and in Deep River Basin, North Carolina: A Comparative Study

Lacustrine rocks in the Culpeper basin were deposited in open lacustrine, marginal lacustrine, and mud-flat environments. Lateral and vertical facies relationships suggest that lacustrine deposition was controlled by a complex interplay of tectonic movement and climatic change. Lacustrine units thicken stratigraphically upward and toward the fault zone that bounds the basin on the west, suggesting tectonic control on lake formation. Some lacustrine sequences show an asymmetric arrangement of facies consisting of a diastem overlain by open lacustrine black shale, followed by marginal lacustrine and mud-flat deposits. This pattern suggests rapid deepening, possibly tectonic in origin, followed by gradual shallowing. Other lacustrine sequences consist of a symmetrical arrangement of facies representing gradual deepening followed by gradual shallowing, possibly as a result of climatic change.

Preliminary work in the Deep River basin (Durham and Sanford subbasins) has shown that, at several localities, lacustrine units are present at the tops of fluvial fining-upward cycles. The lacustrine rocks include both shallow-water and mud-flat deposits. The lacustrine shales are overlain by massive, mottled units interpreted as paleosols, they coarsen upward into ripple cross-laminated and wavy-laminated siltstone and very fine-grained sandstone, or they are truncated at the top by fluvial channel scour.

Lacustrine units in the Culpeper and Deep River basins contain shallow-water and mud-flat deposits. Facies relationships show that, in Culpeper basin, relatively large lakes were present, whereas in Deep River basin, many lacustrine units were deposited in shallow flood-plain lakes.

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Evidence for Dominance of Normal Dip-Slip Motion on Segment of Flemington Fault in Newark Basin of New Jersey

A fracture study conducted on a series of outcrops along U.S. Route 202, beginning approximately 1.5 km east of the Delaware River and extending eastward for a distance of approximately 1.5 km, provides ample evidence for normal dip-slip faulting and virtually no evidence of strike-slip faulting. The study area is located approximately 1 km south of the Dilt's Corner fault, the southern splay of the Flemington fault, and along a line nearly perpendicular to the axis of a broad, open anticline plunging approximately 10°S, 20°E. This anticline is one of several transverse folds on the hanging-wall side of the Flemington-Dilt's Corner fault system.

Measurement of more than 150 small faults revealed fewer than 10 with a significant strike-slip component of motion. Most of the small faults in the area strike northeasterly and dip steeply either to the northwest or to the southeast. Of particular interest are faults that strike N40°E and dip approximately 70° to the northwest or southeast. These faults appear to define a conjugate set, and as such would require σ_1 to be nearly vertical, σ_2 to be horizontal and trending N40°E, and σ_3 to be horizontal and trending S50°E.

In 1962, Sanders suggested that in addition to considerable dip-slip displacement, the Flemington fault might have a major right-lateral strike-slip component of motion. Manspeizer used right-lateral strike-slip motion on the Flemington fault as part of his rhomb-graben model for the Newark basin. Recently, Burton and Ratcliffe have suggested that the Flemington fault has both right-lateral and normal components of motion on it. Strike-slip motion, at least on the Dilt's Corner splay of the Flemington fault, is not compatible with the observed field data.

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Petrology, Porosity, and Permeability of Berea Sandstone (Mississippian), Perry Township, Ashland County, Ohio

Thin sections and SEM studies of 46 porosity and permeability plugs taken from a core of Berea Sandstone from Perry Township, Ashland County, Ohio were conducted to ascertain the relationship between porosity and permeability and 16 petrographic variables. Statistical analysis indicates that these properties are significantly related with four petrographic variables. Porosity and permeability are positively correlated with maximum pore size (partly resulting from early but incomplete quartz cementation) and grain size. They are negatively correlated with total cement and matrix.

Petrographic studies identified 3 diagenetic zones on the basis of diagenetic cementation. Patchy dolomite and minor quartz are the most common cements occurring throughout the sandstone portion of the core between 692 and 742 ft. This zone exhibits the highest average porosity (15.6%) and permeability (15.2 md). These high values are in part the result of initially large pores and potash feldspar dissolution. Between 697 and 717 ft, siderite cement replaces patchy dolomite and minor quartz and framework grains. Siderite cement is most prevalent at the top of the zone and becomes less abundant with depth. In this zone average porosity and permeability measurements are 13.1% and 7.7 md, respectively. The lowest porosity and permeability measurements are between 719 and 737 ft, where there is a zone of alternating tight quartz-cemented sandstones and patchy dolomite and minor quartz cement. Average values of 12.5% for porosity and 2.0 md for permeability in this zone reflect the interpenetration of framework grains, numerous microstylolites, and complete cementation.

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Stratigraphy of Yorktown (Lower and Middle Pliocene) and Chowan River (Upper Pliocene) Formations in Southeastern Virginia

The Yorktown and Chowan River formations exhibit vertical and lateral variations in lithology and fauna. The Yorktown, which rests disconformably on the Eastover Formation (upper Miocene), is comprised of a fossiliferous shallow marine sand with a discontinuous basal pebbly sand (Sunken Meadow Member). The upper Yorktown consists of intertonguing and intergrading shelf, shoal, and restricted marine deposits (Rushmere, Mogarts Beach, Moore House, and a possible unnamed uppermost member). The shelf deposits are principally fossiliferous, marine silty fine sand, and the shoal sediments are planar and cross-bedded biofragmental sands. The restricted marine sediments range from silty fine sand to silty clay and contain a limited fauna. Near the Fall Zone, the Yorktown is comprised of nonfossiliferous quartz-rich sand. Differential upward movement of the outer Atlantic coastal plain created an offshore shoal, west of which were embayed conditions. The Bacons Castle, Windsor, and higher formations rest with a regional angular unconformity on the Yorktown.

The Chowan River formation is restricted to the outermost coastal plain in Virginia and is composed of planar and cross-bedded shelly fine sand. The basal Chowan River contains scattered allochthonous pebbles and boulders, sideritic nodules, and brackish to marine fossil assemblages. The Yorktown and Chowan River formations represent the last incursions of relatively warm seas into southeastern Virginia during the late Tertiary.

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Tectonic Influence on Late Devonian Sedimentation near Cincinnati Arch, Kentucky

Cores from more than 75 near-outcrop localities in Kentucky have been studied to determine the thickness and extent of shale containing more than 8% organic carbon by weight. Detailed microstratigraphy of the Upper Devonian sequence is made possible by the completeness of cores, the spacing of holes, and the recognition of key lithostratigraphic and biostratigraphic markers associated with radioactivity profiles of the sequence.

Episodic and localized subsidence of the arch along the west flank of the Appalachian basin is demonstrated by erratic thickness changes in the lowermost units of the Ohio Shale. These units include equivalents of the Blocher, Morgan Trail, and Camp Run Members of the New Albany Shale to the west. The syndepositional movement appears to have been most intense along the Irvine-Paint Creek and Kentucky River fault zones. These zones also had an influence on the preserved distribution of the Silurian and Middle Devonian units immediately underlying the shale.

Earlier studies indicated that most formal members of the New Albany Shale of the Illinois basin diminish or disappear where traced across the Cincinnati arch eastward into the lower part of the Ohio Shale. This study documents the details.

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Depositional Environments and Sedimentology of Vinita Beds, Richmond Basin, Virginia

The Carnian (middle to late Middle Triassic) Richmond basin of northeast Virginia is the oldest of the exposed Newark rift basins of the eastern seaboard. These basins formed during the Mesozoic divergence of the continents. As presently defined, the Richmond basin is a large synclinal feature measuring 32 mi (53 km) long by 8 mi (13 km) wide, and is located west of Richmond and east of Amelia, Virginia. Sediments of the Richmond basin have been assigned to the Richmond group and have been stratigraphically subdivided into the following informal units, lowest to highest: coarse boulder breccias, coal measures, Vinita beds, and Otterdale Sandstone.

The Vinita beds are composed of arkosic sandstones, shales, siltstones, and minor amounts of coal, and are mineralogically immature. They are composed of angular to subrounded rock fragments, quartz, and feldspars, and are highly micaceous and kaolinitic. In places, feldspars make up as much as 50% of the rock. Sandstones and conglomerates are crossbedded and channeled, and shales and siltstones are thinly laminated. The Vinita beds are rich in fossil fish, branchiopods, and plant fragments. These rocks were deposited in braided streams as well as in paludal and possible lacustrine environments in a humid, heavily vegetated setting. Hydrocarbon shows reported in the basin occurred in the lower Vinita beds.

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Organic Geochemical Investigations of Eastern U.S. Early Mesozoic Basins

Shales rich in organic matter and coalified plant fragments (phytoclasts) in the early Mesozoic basins of the Newark Supergroup of the eastern United States are the topic of a current multidisciplinary study to understand their burial history, their role in ore-forming processes, and their hydrocarbon potential. Samples from the Hartford, Newark, Culpeper, Richmond, Taylorsville, and Deep River basins were analyzed using elemental analysis, nuclear magnetic resonance spectroscopy (NMR), Rock-Eval pyrolysis, stable isotope mass spectrometry, pyrolysis-gas chromatography, and gas chromatography-mass spectrometry.

The composition of the preserved organic matter in these samples is highly variable. Most sedimentary rocks of Triassic to Jurassic age in the Hartford, Newark, Culpeper, Richmond, and Deep River basins are in a catagenetic stage of thermal alteration. Samples from the Lower Jurassic Towaco Formation of the Newark basin are the least thermally altered samples analyzed and are apparently at a late diagenetic stage. Most of the older Triassic samples and a few of the latest Triassic to Jurassic samples, however, are highly thermally altered. Phytoclasts from the Lower Jurassic Feltville and Portland Formations, from the Newark and Hartford basins, respectively, are essentially aromatic; however, phenolic groups were observed in the NMR spectra.

The initial organic geochemical results imply that the organic matter basically exists in two populations, one with a low to medium rank or level of maturation and the other representing a much higher maturation level. No gradual change in maturation from one rock unit to the next was observed for the samples analyzed, and the distribution of maturities apparently is neither stratigraphically nor temporally controlled. The presence of phenolic groups in the phytoclasts from the Feltville and Portland Formations suggests that carbonization rather than coalification processes may have occurred.

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Interpretation of Natural Controls on Devonian Shale Gas Production from Seismic Data

Columbia Gas and the Gas Research Institute are studying a set of Devonian shale gas wells in southwestern West Virginia to determine the geologic controls on shale gas production. Approximately 25 line-mi of Vibroseis seismic data were recorded to (1) evaluate the regional geologic setting and structural style of the area; (2) evaluate relationships among the regional geology, a high producing shale gas area, and a postulated fault zone; (3) evaluate the local geologic setting of three study wells; and (4) attempt to recognize stratigraphic controls on shale gas production.

Several initial conclusions concerning production controls have been reached. (1) Basement faulting extended up through the shale section, and resultant fracturing influenced gas production in the northern area of the seismic survey. (2) Reflection patterns in the shale contain information on the lithologic character of the shale. Local lenses of silt or sandy shale are probably present within the more fine-grained shale section. These lenses may be geologic features with increased permeability. (3) Areas of dimmed reflection energy on seismic lines correlate with areas of high gas reserves, suggesting that these areas are fractured shale.

Information from the seismic survey is being integrated with core, log, and well-test data to understand the active controls on shale gas production in the study area.

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Coal Occurrence in Progradational Deltaic Sequence, Raleigh County, West Virginia

Surface outcrops and data from 75 core holes were used to study the Pennsylvanian Kanawha Formation in a 100 mi^2 area of western Raleigh County, West Virginia. The interval consists of approximately 1,400 ft of prograding alluvial-deltaic deposits and includes 22 coal seams.

The interval developed across drowned orthoquartzite coastal sandstones (Nutall) that mark the approximate top of the New River Formation. Its lower portion (Douglas to Eagle coals) is a generally coarsening-upward, prodelta/distal-deltaic succession of units dominated by dark shale and containing brackish-marine intercalations that extend across most of the area. Coals are widespread but commonly thin (about 1 ft), and the rate of lateral change is low. The top of this lower section is capped by outer deltaic sandstones (Eagle coals).

The upper portion of the Kanawha Formation is dominated by outer deltaic strata (to Hernshaw coal) grading upward to inner (Stockton coal) deltaic sandstones. Brackish-marine intercalations associated with autocyclic shifting of detrital lobes are restricted in areal extent. The outer deltaic coal beds are thick (up to about 6 ft) and laterally uniform; succeeding inner deltaic coals are thinner (less than 3-4 ft) and are variable laterally.

Deltaic deposits grade upward into lower alluvial plain strata of the Allegheny Formation near the ridge crests. Associated coals locally may be thick (up to 6 ft), but abrupt changes in thickness and shale partings are typical.