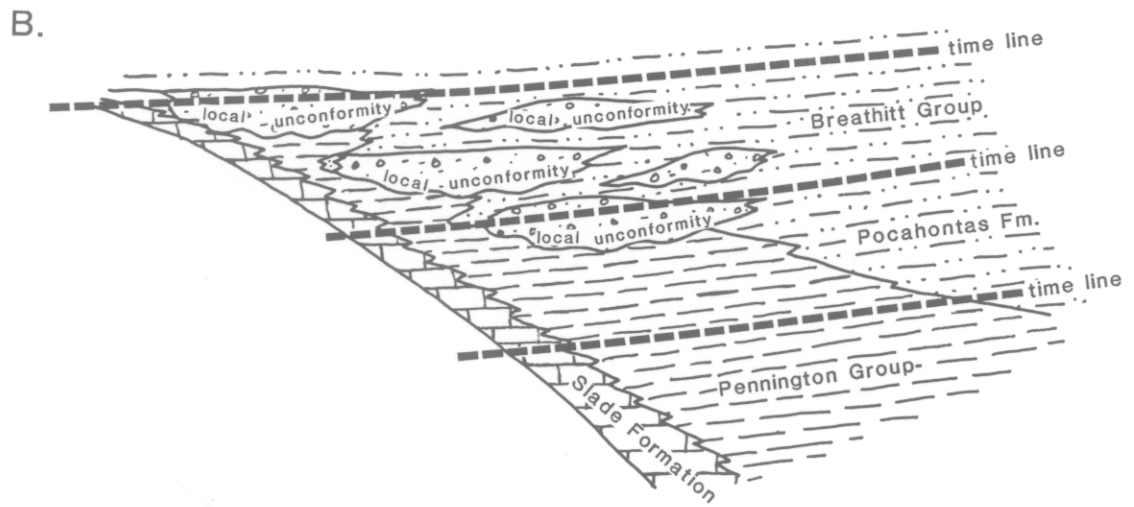
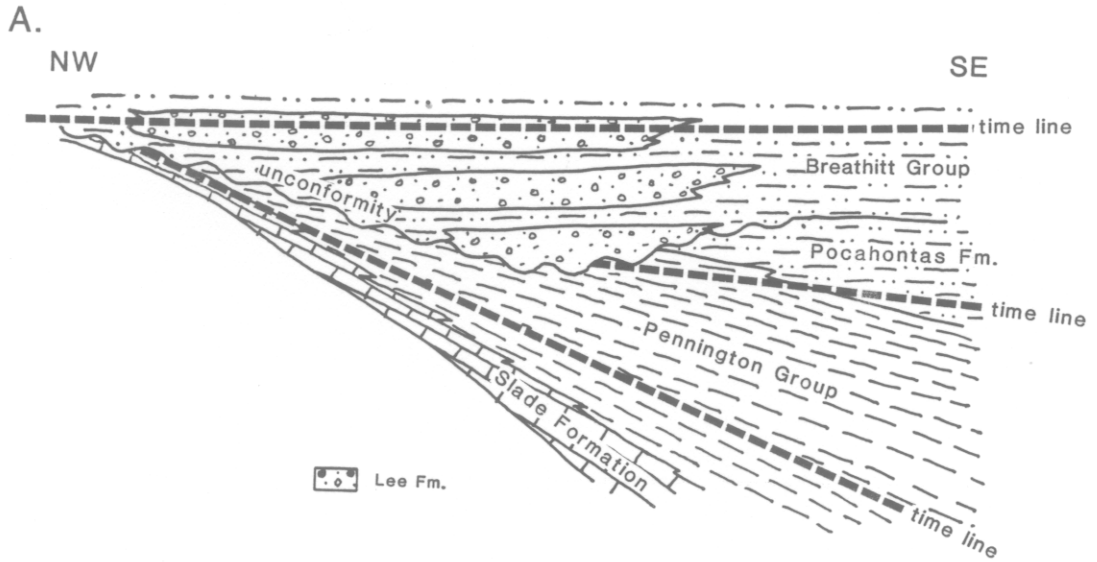


are possible in a progradational sequence; the first is a coalescing series of diachronous unconformities (Fig. 32b). In this variation, several channel-scour unconformities, although formed at different times, are in places physically connected with no interbedding across the discordant boundary. The second variation is a series of unconnected diachronous unconformities (Fig. 32c). In this variation, individual unconformities are not physically connected to adjacent unconformities. Interbedding between terrestrial and marine lithologies can occur in transitional areas lateral to the unconformities.

The above unconformity models are re-examined, with constraints provided by the structural and stratigraphic framework resulting from this study. Generalized schematic dip diagrams similar to the Grundy Section (Fig. 13) are illustrated using a Regional-Unconformity interpretation (Fig. 33a) and a Diachronous-Series Unconformities interpretation (Fig. 33b). These diagrams show the effects that erosion would have had on lithologies that thin on the basin margin toward the northwest. Toward the northwest in these diagrams, progressively-younger terrestrial lithologies overlap progressively-truncated or channeled marine lithologies. This kind of overlapping of a progressively-truncated sequence appears to contradict the

Figure 33. Unconformity models applied to stratigraphic framework of the Central Appalachian basin. (A) Regional-event model (Tabular-erosion hypothesis), (B) Diachronous-series of unconformities model (Barrier-shoreline hypothesis).



Diachronous-Series Unconformities model (Fig. 32b,c), which predicts that younger terrestrial lithologies should overlie younger marine lithologies in the direction of progradation. However, erosion of thin marine formations along the margin of the basin must be considered. Because lithological units along the margin of a basin are thinner than along the axis of the basin, regional erosion may remove more units at the margin, thereby producing a progressive truncation toward the margin of the basin. In addition, erosion along the margin is likely to be deeper than along the axis of the basin, thus enhancing the truncation toward the margin. Such a progressive truncation is expected in the Regional Unconformity model, but an apparent truncation is also possible in the Diachronous-Series Unconformities model where local channel unconformities are physically coalesced. The occurrence of truncation alone, therefore, is insufficient to prove which unconformity model is correct.

The correct interpretation may be impossible to derive based on subsurface stratigraphy alone, although the stratigraphic framework places constraints on either interpretation. This means that biostratigraphy must be used to corroborate the more useful model.

### Biostratigraphic Evidence

The traditional biostratigraphic framework for the Carboniferous in the central Appalachians carries a corollary that sequences such as the Bedford-Berea-Sunbury and the Borden-Ft. Payne-Warsaw-Salem, long considered to be Early Mississippian, are older than sequences such as the Slade Formation and the Pennington Group, considered to be Late Mississippian, which, in turn, are older than rocks considered to be Early Pennsylvanian in age. Different faunal and floral assemblages were used to determine the relative ages of the rocks. Ferm (1971, p. 1, 2) summarized the nature of the biostratigraphic framework for the traditional (Tabular-Erosion) interpretation:

"...there was obvious evidence of major erosional "breaks" in the sequence, separating faunas of vastly different types and, presumably, of different ages. Sandstones of the Lee Formation lay upon the eroded surface of underlying beds indicating an episode of widespread removal of older strata, and the time significance of this event was indicated by faunas which, in the underlying Newman [Slade] and Pennington, were dissimilar to those of the overlying coal measures. What is more, faunal sequences similar to those in eastern Kentucky were found elsewhere in the United States and, indeed, around the world confirming the temporal character of the event.. ."

Interpretations based on the Barrier-Shoreline model, however, diverge considerably from this traditional view. As stated by Merrill (1973, p. 1124-1125):

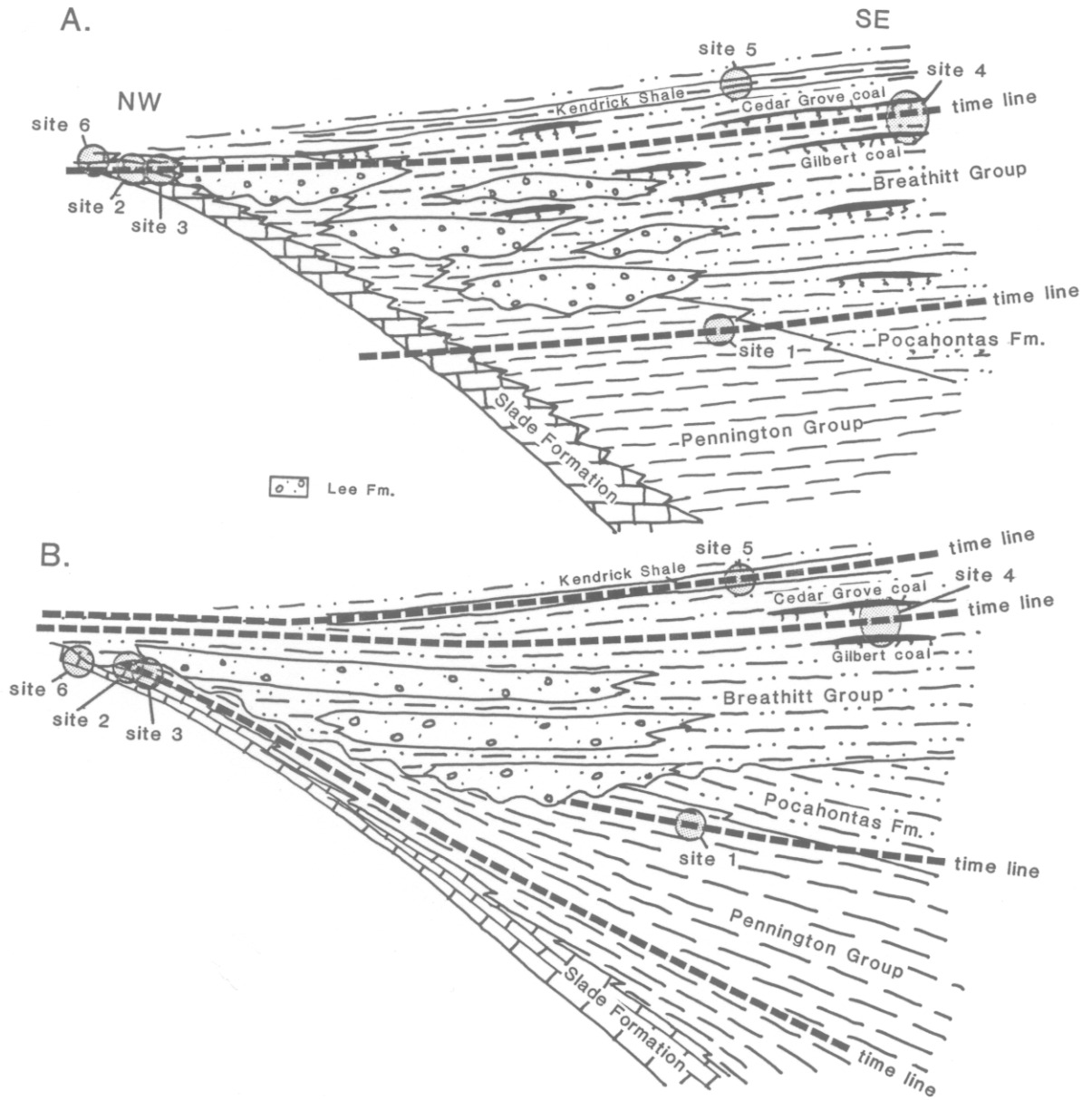
"In simplest terms, the paleoecologic/lithogenic model of Ferm, et al. (1971) includes partially contemporaneous prodeltaic (Borden), carbonate barrier/flat (Newman) [Slade], lagoonal/intertidal (Pennington), deltaic/bayfilling (Breathitt) sediments. Not only are the rocks conformable, but facies called "Mississippian" and "Pennsylvanian" were formed contemporaneously. By a derivative of Walther's Law, conformable facies were contemporaneous. Therefore, unless a bona fide unconformity (i.e., a laterally extensive, buried, subaerially developed erosion surface) exists within this succession of rocks, the paleoecologic/lithogenetic model of Ferm, et al., is correct and there is partial time-equivalence between all rocks and fossils in immediate superposition...."

What the above statement indicates is that the biostratigraphic zonation, which indicates separate ages for Carboniferous lithologic sequences, was reinterpreted by the proponents of the Barrier-Shoreline model to represent faunal and floral differences reflecting different depositional environments (Horne and Ferm, 1970, p. 210; Ferm and Weisenfluh, 1979, p. 517). Thus, this interpretation would suggest that conodonts in the Slade Formation differ from those in the upper part of the Pennington Group, because they lived in different environments, and not because of different ages, Merrill (1973, p. 1125) suggested that the best paleontological evidence for the Barrier-Shoreline model would be the discovery of, "a reversal of the expected faunal succession." Despite his studies of conodont succession in

the Carboniferous rocks of northeastern Kentucky, Merrill was unable to show reversals or demonstrate conformable relationships. No reversal of faunal or floral successions from the Central Appalachian Basin has been reported thus far.

The Barrier-Shoreline hypothesis is difficult to test by biostratigraphic methods for two reasons: first, time lines in the model (Fig. 34) traverse several lithologic boundaries. Hence the time lines inevitably result in correlation of lithologies in surface exposures with lithologies unavailable for biostratigraphic sampling either due to their presence in the subsurface, or due to their absence by erosion. This model also results in time correlations between lithologies formed in such different environments that it is difficult to find one type of fossil that would occur in all the involved environments. Hence, fossil assemblages used by biostratigraphers for age determination, according to proponents of the Barrier-Shoreline model, reflect facies dependence rather than evolutionary changes and are useless as biostratigraphic indicators. Therefore, either fossils from similar environments must be compared, or fossils known to be independent of environment (e.g., spores) must be compared before their biostratigraphic usefulness can be accepted.

Figure 34. Biostratigraphic tests of the (A) Barrier-shoreline hypothesis, and (B) Tabular-erosion hypothesis. Biostratigraphic sites, shown at their relative stratigraphic positions, are discussed in the text.



Nonetheless, two series of interpretations from biostratigraphic studies seem to contradict tenets of Barrier-Shoreline hypothesis. The first compares fossils occurring on different Barrier-Shoreline time lines, and the second compares fossils occurring on the same Barrier-Shoreline time line.

#### CONODONTS ACROSS TIME-LINES

According to the Barrier-Shoreline hypothesis (Fig. 34), marine index fossils from a limestone at site 1 (Bramwell Limestone, West Virginia and Virginia) (Fig. 34) should be older than marine index fossils from a limestone at site 2 (Slade Formation, formerly the Newman Limestone in northeastern Kentucky). Gordon and Henry (1981, p. 170) give the following information about the conodont faunule of the Bramwell Member of Virginia and southern West Virginia:

John E. Repetski, U.S. Geological Survey, has identified the following conodont faunule from the Bramwell Member (USGS coll. 26789-PC):  
Adetognathus unicornis (Rexroad and Burton),  
Cavusgnathus convexus Rexroad,  
~~E.~~ naviculus (Hinde), Gnathodus bilineatus (Roundy) morphotype delta, Hibbardella cf. H. milleri Rexroad sf., and other bar forms assignable to several form taxa. This faunule is interpreted as a late Chesterian conodont assemblage (Repetski, oral commun.) that can be no older than the Adetognathus unicornis conodont zone but that may be as young as the lower part of the Rhacistognathus muricatus-conodont zone of Lane and Straka (1974). Thus, the Bramwell member can be no older than the Grove Church Shale, which overlies

the Kinkaïd Limestone and traditionally is considered the youngest unit in the type Chesterian Provincial Series. The Bramwell, however, may be younger than the Grove Church Shale and still pre-Morrowan in age if this fauna does represent the lower part of the Rhacistognathus muricatus conodont zone.

Figure 35 shows the biostratigraphic correlation of the Bramwell Member with a part of the type Mississippian section and its zonation relative to conodont assemblages.

Conodonts recovered from the Poppin Rock Limestone (samples 1-17, former Glen Dean Limestone, upper part of the Slade Formation) in northeastern Kentucky by Ettensohn and Bliefnick (1982) indicate correlation with the Gnathodus bilineatus-Kladognathus mehli assemblage zone (Fig. 35).

According to the Barrier-Shoreline hypothesis, the Bramwell conodont assemblage of Virginia and southern West Virginia should be older than the conodont assemblage from the Slade Formation in northeastern Kentucky. However, the opposite is true. The Bramwell Member appears to be considerably younger than the top of the Slade Formation. Therefore, a time line drawn from the top of the Slade Formation (former Newman Limestone) does not cross the unconformity, and because the Slade Formation is not time equivalent with any unit above the unconformity, it cannot be part of an environmental continuum that includes the Breathitt Group or Lee Formation.

Figure 35. Conodont biostratigraphic zonations, adapted from Gordon and Henry (1981), and Ettensohn and Bliefnick (1982).

		Type Mississippian Section	Conodont Assemblage Zone	Appalachian Beds
			<i>Rachistognathus muricatus</i>	
Chester	Upper	Grove Church Sh.	<i>Adetognathus unicornis</i>	Bramwell Mbr. (site 1)
		Kinkaid Ls.		
		Degonia Ss.	<i>Kladognathus- Cavusgnathus naviculus</i>	
		Clore Ls.		
		Paestine Ss.		
		Menard Ls.		
	Waltersburg Sh.	<i>Kladognathus primus</i>		
	Vienna Ls.			
	Tar Springs Ss.	<i>Gnathodus bilineatus- Kladognathodus mehli</i>	Poppin Rock Ls. (site 2)	
	Glen Dean Ls.			
	Middle	Hardinsburg Sh.	<i>Gnathodus bilineatus- Cavusgnathus altus</i>	
		Golconda Ls.		
	Lower	Cypress Ss.	<i>Gnathodus bilineatus- Cavusgnathus characteris</i>	
		Paint Creek Ls.		
Yankeetown Ss.				
Renault Ls.				