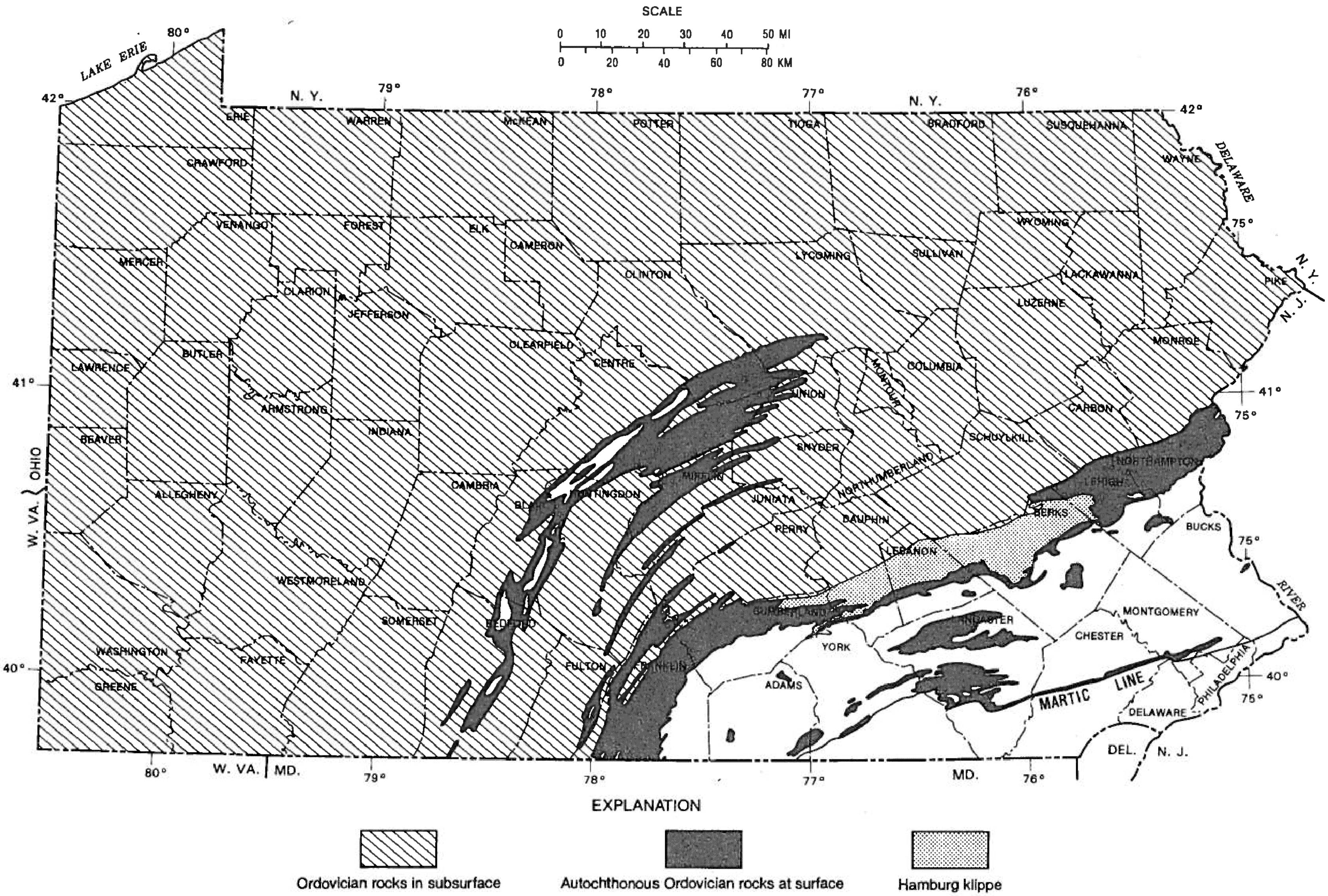

Figure 5–1. Distribution of Ordovician sedimentary rocks in Pennsylvania west of the Martic Line (modified from Berg and others, 1980, and Pennsylvania Geological Survey, 1990).

CHAPTER 5 ORDOVICIAN

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INTRODUCTION

This chapter contains a summary of lithologic, facies, and temporal relationships of sedimentary rocks of Ordovician age in Pennsylvania west and northwest of the Martic Line (Figure 5–1).

Ordovician sedimentary rocks occur only in the subsurface of northern and western Pennsylvania (Fettke, 1961; Wagner, 1966b) and crop out in central and southeastern Pennsylvania (Figure 5–1). In central and south-central Pennsylvania, the Ridge and Valley belt contains a nearly complete Ordovician section. The Great Valley contains predominantly Lower and Middle Ordovician strata. The east-central part of the Great Valley contains allochthonous Cambrian to Middle Ordovician rocks of the Hamburg klippe; these rocks have been compared to the Taconian allochthons of eastern New York and western New England (Rodgers, 1970; Lash and others, 1984). The Piedmont Lowland contains carbonates and shale of Early and possibly Middle Ordovician age (Gohn, 1978).

Possibly coeval rocks of the Glenarm Supergroup, which occur southeast of the Martic Line (Figure 5–1), are penetratively deformed and variably metamorphosed (see Chapters 3A and 4). Some were assigned Early Ordovician ages by Berg, McInerney, and others (1986), but the evidence is equivocal. These rocks could be deep-water sedimentary and volcanic accumulations, and could have formed away from early Paleozoic North America (Williams and Hatcher, 1983).

CONTROLS ON ORDOVICIAN STRATIGRAPHY

During Ordovician time, what is now Pennsylvania constituted a small part of the eastern edge of the proto-North American, or Laurentian, craton. The character of the rocks was influenced by sedimentologic and tectonic processes in the Appalachian basin, a large, elongate depocenter that lay along the southeastern margin of the craton throughout Paleozoic time (in the sense used by Colton, 1970). The

Appalachian basin is a polygenetic feature. From latest Precambrian through Middle Ordovician time, it was an eastward-thickening, miogeoclinal basin that received primarily carbonate-platform-facies and carbonate-bank-facies sediments (Figure 5–2). The platform terminated seaward at a continental slope, beyond which lay deep-basin-floor sediments. The platform prograded eastward through Cambrian and Early Ordovician time. The basin axis lies along the present eastern edge of the outcrop belt, and the maximum thickness of the carbonate sediments occurs in east-central Pennsylvania. The bank and its facies define the traditional Appalachian miogeosyncline (Champlain belt of Kay, 1951), which was a passive continental margin along the western edge of the proto-Atlantic, or Iapetus, Ocean in early Paleozoic time (Thompson and Sevon, 1982).

The craton margin was uplifted during the Taconian orogeny, beginning in Middle Ordovician time. With the onset of tectonism, the Appalachian basin evolved from a miogeoclinal carbonate platform to an exogeosynclinal foreland molasse basin. From Middle Ordovician through Late Silurian time, this basin received considerable amounts of the east-derived, terrigenous detritus that constitutes the Taconian clastic wedge (Figure 5–3).

The axis of maximum thickness for post-Middle Ordovician deposits in the foreland basin lies near the

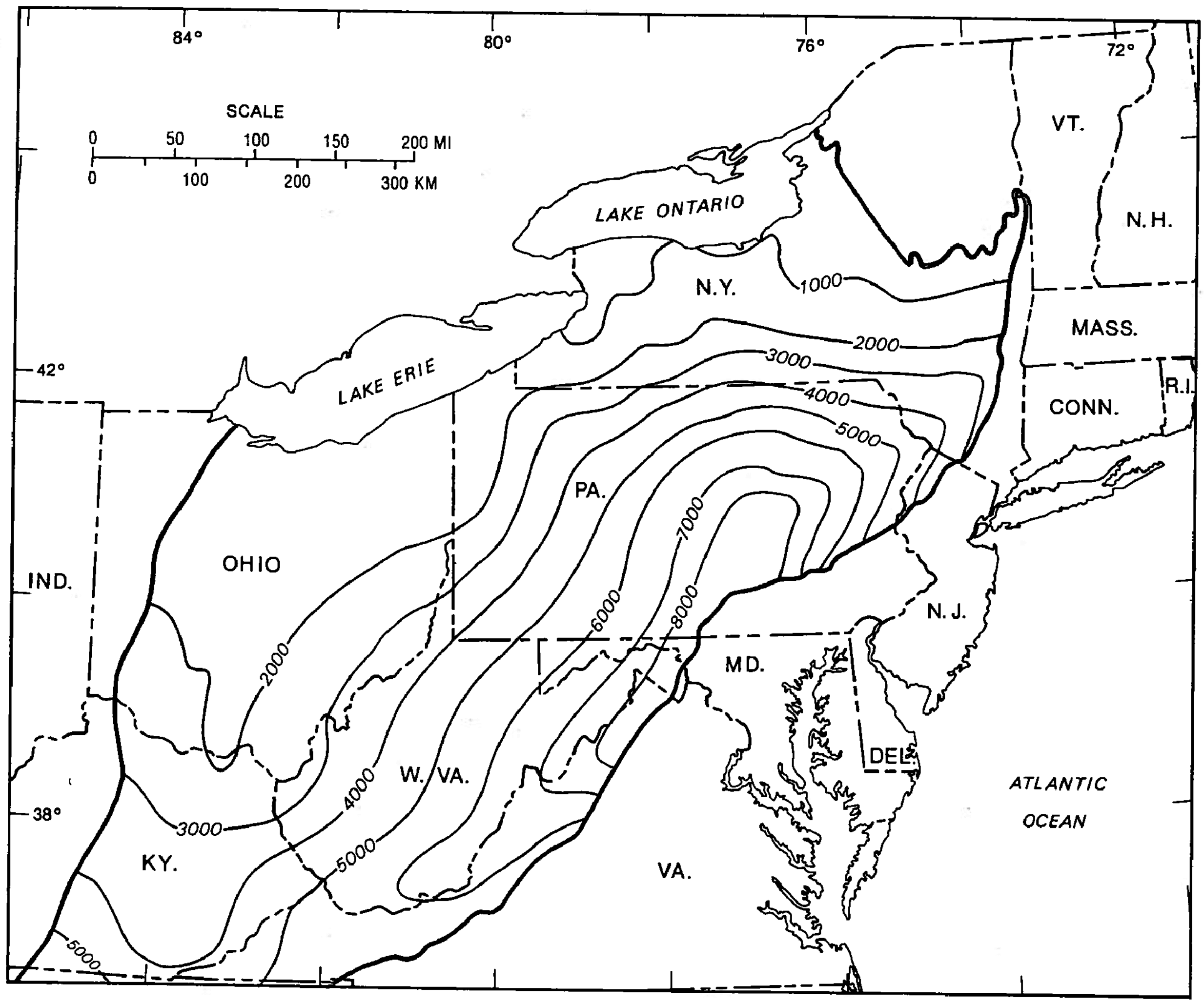

Figure 5–2. Isopach map of Upper Cambrian and Lower and Middle Ordovician rocks of the dolomite-limestone and limestone associations (modified from Colton, G. W., *The Appalachian basin—its depositional sequences and their geologic relationships,* in Fisher, G. W., and others, eds., *Studies of Appalachian geology: central and southern,* Figure 13, p. 24, copyright © 1970 by Interscience Publishers, reprinted by permission of John Wiley & Sons, Inc.). In southeastern Pennsylvania, the dolomite-limestone association includes 2,700 feet of Cambrian-age rocks. Contour interval is 1,000 feet. The heavy colored line represents the boundary of Colton's study area.

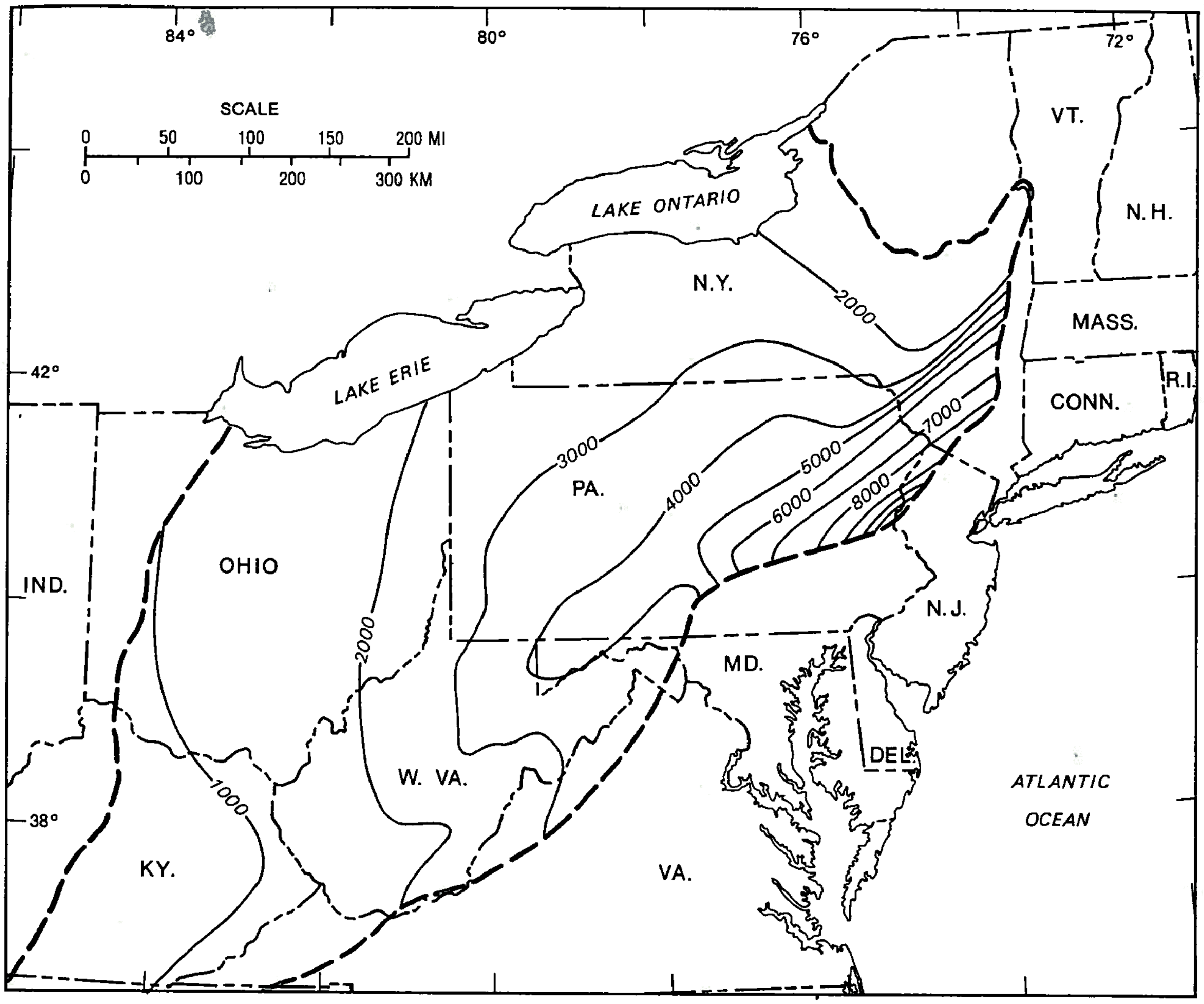

Figure 5-3. Isopach map of Upper Ordovician and Lower Silurian rocks of the siliciclastic association that constitute the Taconian clastic wedge (modified from Colton, G. W., *The Appalachian basin—its depositional sequences and their geologic relationships,* in Fisher, G. W., and others, eds., *Studies of Appalachian geology: central and southern,* Figures 16 and 18, p. 27 and 30, copyright © 1970 by Interscience Publishers, reprinted by permission of John Wiley & Sons, Inc.). Contour interval is 1,000 feet. The dashed line indicates the approximate boundary of Colton's study area.

present eastern limit of exposure (Figure 5-3). The axes of both carbonate-platform and foreland-basin sequences in the Appalachian basin nearly coincide, and the basin is, thus, sharply asymmetrical in cross section, essentially without an eastern side (Colton, 1970).

The major phases of Ordovician sedimentation were (1) a prolonged period of stable carbonate-platform deposition encompassing the first half of Ordovician time; (2) a progressive submergence of the platform, accompanied by marine limestone and initial siliciclastic sedimentation; and (3) filling of the resulting basin with marine and continental siliciclastic sediments. Each phase generated a different lithologic-sedimentologic association: the dolomite-limestone, limestone, and siliciclastic associations, respectively.

DOLOMITE-LIMESTONE ASSOCIATION

Lithology

Rocks of the dolomite-limestone association are Early and early Middle Ordovician in age. They are dominated by thin- to thick-bedded dolomite and interbedded limestone. Dolomites are generally fine grained but include minor amounts of pelletal rocks (Figure 5-4). Much dolomite is secondary, replacing limestone. The dolomites contain numerous stromato-

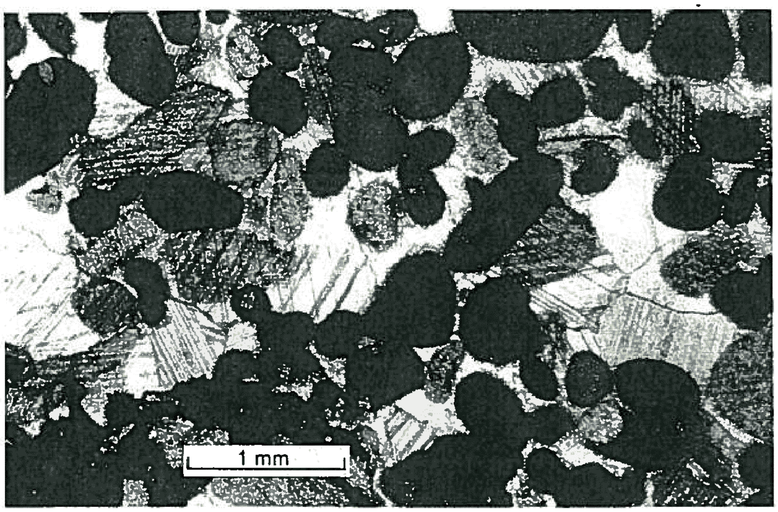

Figure 5–4. Photomicrograph of pelletal calcarenite of the dolomite-limestone association showing pellets, clastic calcite grains, and calcite cement. Plane-polarized light. The sample is from the Rockdale Run Formation, Pennsylvania Turnpike, Carlisle, Cumberland County.

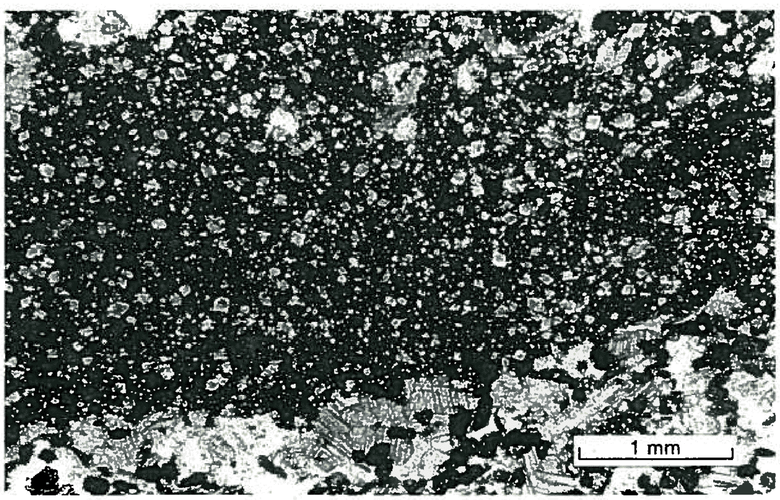

Figure 5–5. Photomicrograph of dolomitic intraclast (dark matrix) in recrystallized limestone. Plane-polarized light. The sample is from the Rockdale Run Formation, Pennsylvania Turnpike, Carlisle, Cumberland County.

lites and trace fossils, but few body fossils. The limestones are fine to coarse grained and include intraclast conglomerates (Figure 5–5), oolitic rocks, and crossbedded calcarenites. They contain more body fossils (notably trilobites and molluscs) than the dolomites. In many places, the limestones and dolomites are interbedded in shoaling-upward sequences.

Evaporites (mainly anhydrite) are rare but have been reported from the subsurface in western Pennsylvania by Wagner (1966b). Terrigenous detritus is essentially absent; a few thin quartz sandstones occur in the upper parts of the section.

Stratigraphy and Paleoenvironments

Stratigraphic nomenclature applied to Ordovician rocks of the dolomite-limestone association is given in Figure 5–6. These rocks, everywhere assigned to the Beekmantown Group, reach 4,200 feet in thickness. Thickness trends are given in Figure 5–2. In general, the rocks are more dolomitic to the north and west. This association is rare in the Piedmont Lowland and is absent in the Hamburg klippe.

The dolomite-limestone association is, in many places, truncated above by a regional disconformity at the top of the Lower Ordovician. Karstic features were locally developed on this disconformity, which is the post-Knox unconformity or Sauk-Tippecanoe unconformity of Sloss (1963). It is commonly absent in eastern belts closer to the shelf edge, where deposition was more nearly continuous.

Rocks in the dolomite-limestone association were deposited in marine to marginal-marine environments. Facies belts extended northeast-southwest across the platform, generally parallel to the craton margin. The seas covering the platform shallowed progressively to the northwest, and environments of deposition became more intertidal and supratidal in that direction. The distribution of dolomite, while probably the result of diagenesis, was controlled by local hypersalinity, paleobathymetry, and tidal range.

LIMESTONE ASSOCIATION

Lithology

Rocks of the limestone association are Early, Middle, and Late Ordovician in age (Figure 5–6). They are dominated by fine-grained limestone and

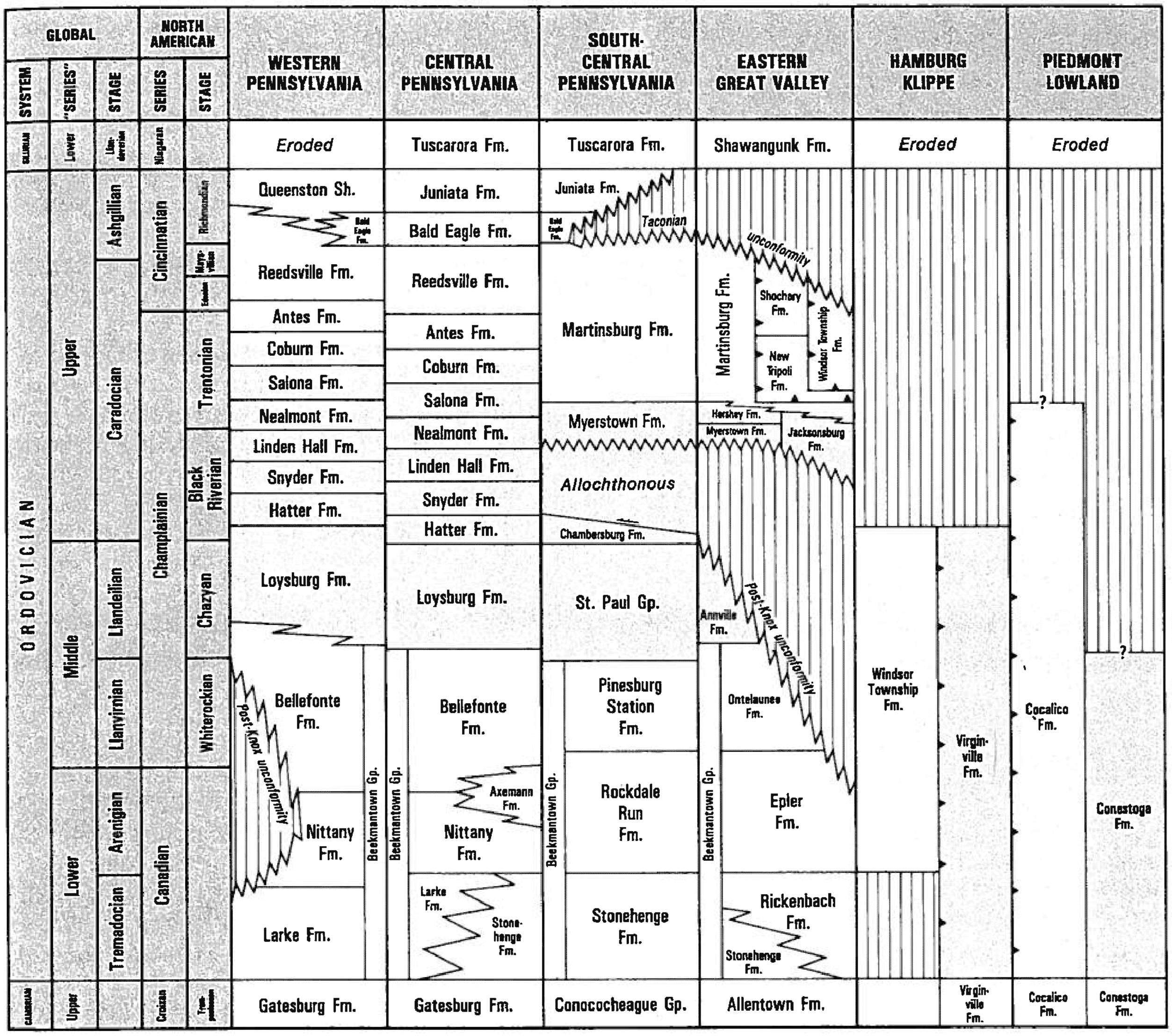

Figure 5–6. Generalized correlation chart of Ordovician strata in Pennsylvania showing lithologic-sedimentologic associations. Uncolored, dolomite-limestone association; gray tint, limestone association; colored tint, siliciclastic association. Data are from Wagner (1966b), Colton (1970), Gohn (1978), Lyttle and Drake (1979), Lash and others (1984), and Berg, McInerney, and others (1986).

include minor amounts of coarse-grained limestone and rare dolomite and terrigenous shale. These rocks are present over most of Pennsylvania and reach a thickness of 1,500 feet in central Pennsylvania.

Fine-grained limestones, the most abundant rocks, are laminated to thick bedded. These rocks are commonly dark gray to black, extensively bioturbated, and in some places fetid and carbonaceous; some are commercial-grade high-calcium limestones (see Chapter 41D). The coarser grained rocks include crossbedded pelletal and oolitic calcarenites and limestone-pebble conglomerates. Most rocks are abundantly fossiliferous (Figure 5–7).

Stratigraphy and Paleoenvironments

The stratigraphic nomenclature applied to rocks of the limestone association is given in Figure 5–6.

In the Piedmont Lowland, Lower and possibly Middle Ordovician fine-grained limestones of the Conestoga Formation truncate older rocks of the dolomite-limestone association. These limestones are facies of the platform edge and include both shallow- and deep-water types (Gohn, 1976).

In the eastern Great Valley, much of the section has been removed beneath an Upper Ordovician unconformity, the Taconian unconformity, which marks a hiatus that was of greater duration in the east (Figure 5–6). Upper Cambrian through Middle Ordovician limestones and terrigenous rocks of the Virginville Formation occur in the Hamburg klippe (Lash and Drake, 1984; Lash and others, 1984). These rocks include shales, deep-water limestones, and carbonate conglomerates (Figure 5–8) that occur as both coherent stratigraphic units and clasts in tectonic breccias. At least some rocks are Arenigian in age, based on conodonts (Repetski, 1984a, b).

The vertical sequence in the limestone association records a deepening basin floor and westward marine transgression. In central Pennsylvania, the lowest unit in this association, the Loysburg Formation, contains dolomite and stromatolites, suggesting tidal-zone deposition (Chafetz, 1969). Coarse-grained, fossiliferous limestones above the Loysburg suggest shallow-marine deposition above wave base (Rones, 1969). Fine-grained black limestones having graded bedding occur in the Salona and Coburn Formations at the top of the limestone association and suggest relatively anoxic, deep-water deposition below normal wave base (Newsom, 1983).

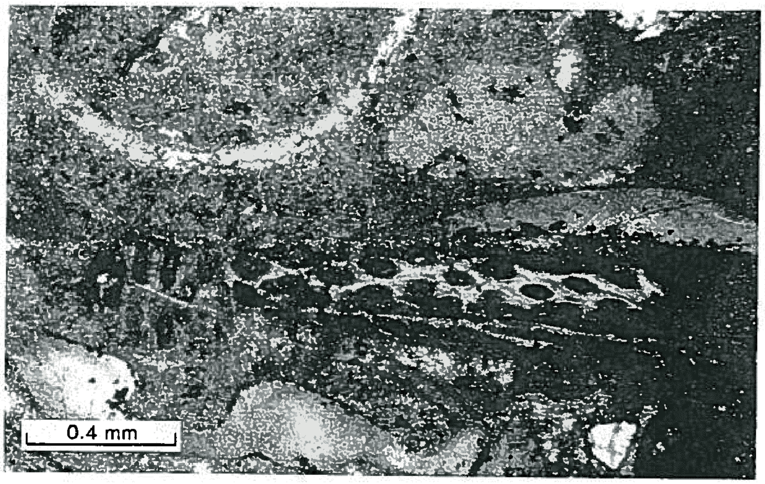

Figure 5–7. Negative print of acetate peel showing fine-grained, fossiliferous limestone of the limestone association. Brachiopod, mollusc, trilobite, and bryozoan debris are visible. The sample is from the Salona Formation, Pa. Route 453, Union Furnace, Huntingdon County.

The basin floor subsided along a progressively deepening carbonate ramp (Read, 1980; Newsom, 1983). Facies belts trend generally northeast-southwest across the ramp, approximately parallel to the craton margin (Wagner, 1966b). These facies patterns record the downward flexing of the formerly stable carbonate platform along a basin hingeline that migrated west and northwest through Middle and Late Ordovician time.

Coincident with the subsidence was initiation of terrigenous clay deposition. Siliciclastic clay first appears as an impurity and as shale laminae in the Snyder and Linden Hall Formations (Figure 5–6) and indicates that detrital clay was now continually in the water mass. Graded limestone-shale bedding in the Salona and Coburn Formations (Figure 5–9) suggests lateral transport of shelf carbonate onto a clay-floored basin by turbidity currents.

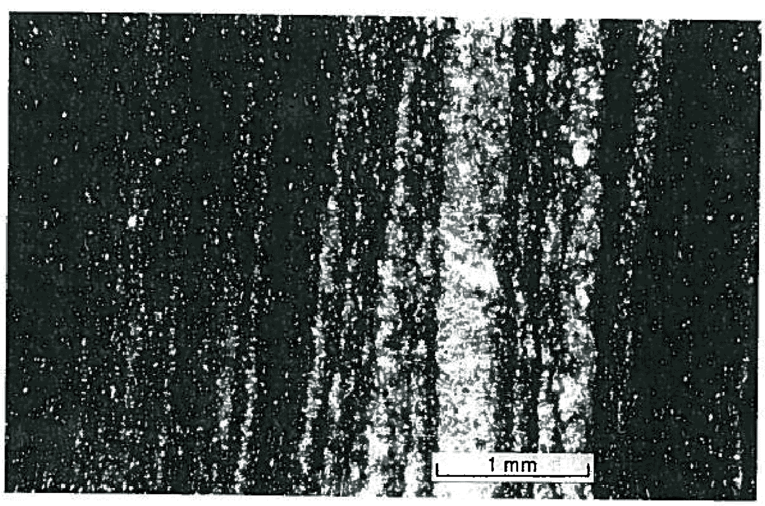

Figure 5–8. Photomicrograph showing silty shale (dark) and laminae of fine-grained limestone from the Virginville Formation, Pa. Route 61, Mohrsville, Berks County. Strong slaty cleavage is nearly parallel to bedding. Plane-polarized light.

SILICICLASTIC ASSOCIATION

The siliciclastic association comprises up to 15,000 feet of shale, siltstone, sandstone, and conglomerate.

Figure 5-9. Interbedded fine-grained limestone (light beds) and terrigenous shale (dark beds) of the Coburn Formation along U.S. Route 322, Reedsville, Mifflin County. Limestones are parallel laminated and commonly have graded bedding (not visible in the photograph). The field notebook on the left provides scale.

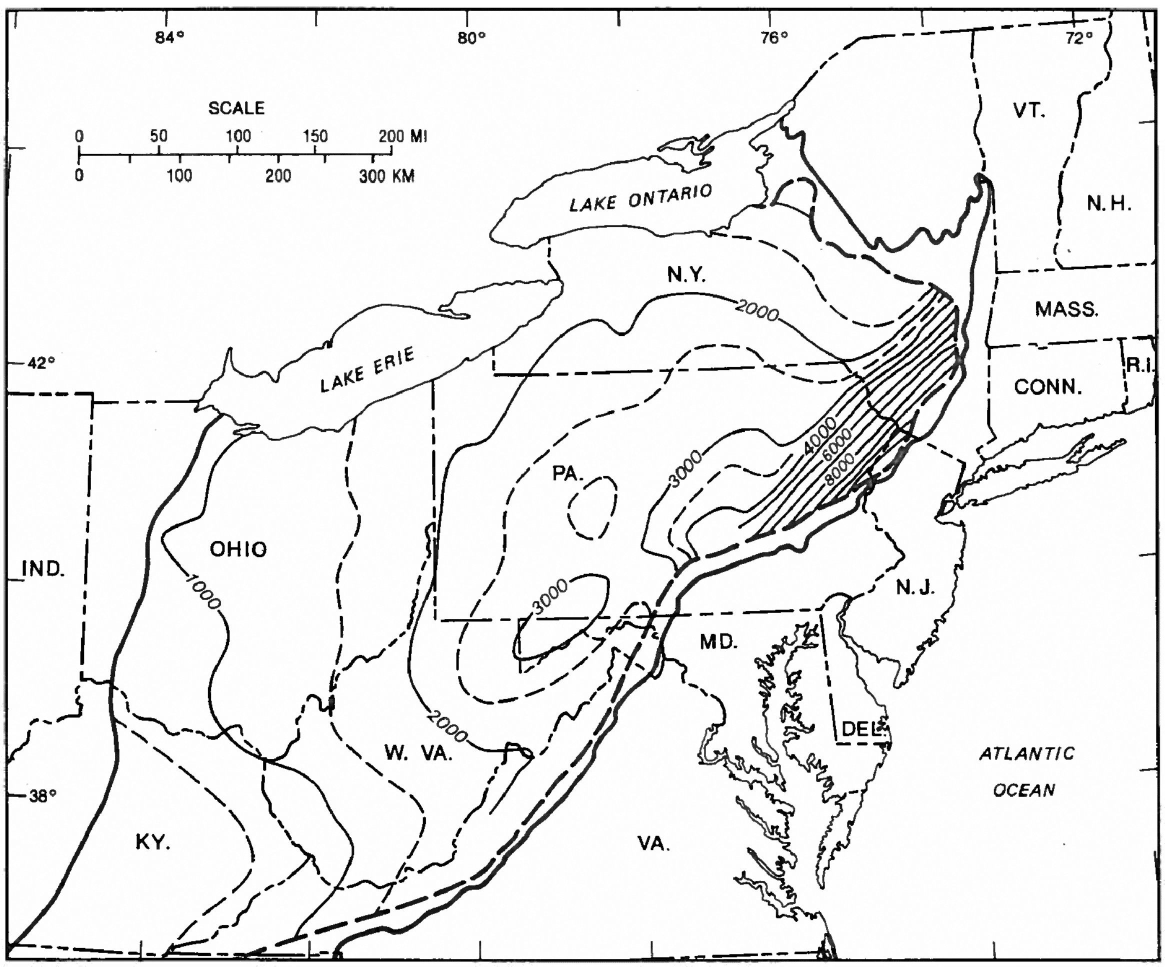

Figure 5-10. Isopach map showing thickness of Upper Ordovician rocks of the siliciclastic association (modified from Colton, G. W., *The Appalachian basin—its depositional sequences and their geologic relationships,* in Fisher, G. W., and others, eds., *Studies of Appalachian geology: central and southern,* Figure 16, p. 27, copyright © 1970 by Interscience Publishers, reprinted by permission of John Wiley & Sons, Inc.). Contour intervals are 500 feet (dashed colored lines) and 1,000 feet (solid colored lines). The heavy solid colored line represents the boundary of Colton's study area. The heavy dashed colored line represents the outer limit of outcrop of Upper Ordovician clastic rocks.

Siliciclastic-association rocks are of Late Ordovician age except in the Hamburg klippe and Piedmont Lowland, where they extend to Early Ordovician age (Figure 5-6). The maximum thickness of rocks in this association is developed in eastern and east-central Pennsylvania (Figure 5-10), and paleocurrents indicate westward and northwestward dispersal (Figure 5-11). Deposition was continuous west and northwest of Harrisburg and was terminated by Late Ordovician uplift and erosion that resulted in the Taconian unconformity in eastern and southeastern Pennsylvania (Figure 5-6).

The siliciclastic association contains two distinct groups of rocks: graywacke-shale flysch and sandstone-conglomerate molasse.

Graywacke-Shale

Pelagic shale and distal turbidites characterize the Martinsburg Formation, the lowest unit of the association. The graywacke sandstones exhibit graded bedding, load casts, and slump breccias. Larger scale features, such as channel fills and lag conglomerates, suggest channelized flow on submarine fans. Graptolites, trilobites, and trace fossils, in addition to the sedimentologic features, point to deposition in deep water.

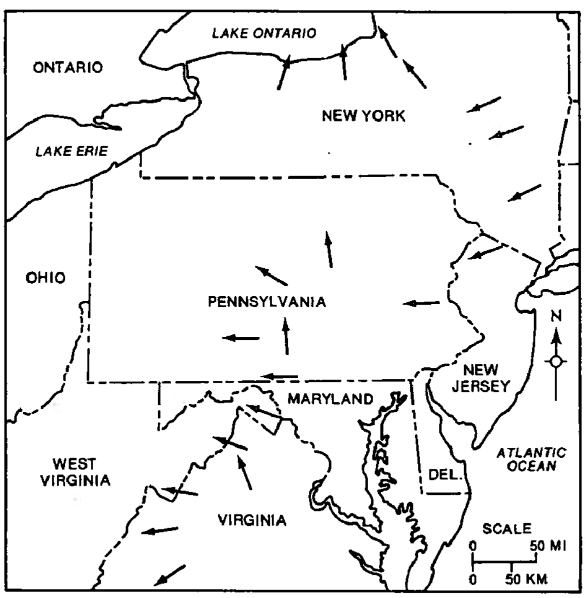

Figure 5-11. Generalized paleocurrent trends for rocks of the siliciclastic association in the central Appalachians. Black arrows, Juniata (Queenston in New York) and Bald Eagle (Oswego in New York) Formations; colored arrows, Martinsburg (Utica in New York) Formation. Data are from McBride (1962), Yeakel (1962), Zerrahn (1978), and Thompson (unpublished data).

In the Great Valley west of Harrisburg, the Martinsburg shows vertical facies changes consistent with progressive basin filling. The lowest facies comprises 1,500 to 2,000 feet of graptolitic, calcareous pelagic shale with significant limestones but few sandstones. Above them lie fan/channel turbidites and flysch that become thicker, coarser grained, and nearer source upward. The highest facies contains massive, fine-grained, crossbedded, bioturbated sandstones containing wave-generated sedimentary structures and shallow-water faunas. These are interpreted to represent shallow-shelf deposition above wave base.

In the eastern Great Valley, the Martinsburg has been subdivided. Stose (1930) defined two members: a lower shale and an upper sandstone. This has been supported by Wright and Stephens (1978). Behre (1927) recognized three members: a lower shale (Bushkill Member), a middle sandstone (Ramseyburg Member), and an upper shale (Pen Argyl Member). More recent detailed mapping in the area (for example, that of Lyttle and others, 1986) supports the three-member interpretation.

In Lehigh and Berks Counties, Middle Ordovician rocks (the New Tripoli and Shochary Formations), which are thrust on the Martinsburg, comprise 10,000 feet of shale and calcareous turbidites (Lash and others, 1984). These rocks and their sedimentary characteristics are similar to those of the Reedsville Formation in central Pennsylvania (Lyttle and Drake, 1979).

Allochthonous siliciclastic rocks within the Hamburg klippe include pelagic red shale-chert sequences, graywacke-shale turbidites, and conglomerates of the Windsor Township Formation. In Lebanon County, the Windsor Township contains basaltic and andesitic igneous rocks, the Jonestown volcanics. The Windsor Township is thrust over the Shochary, New Tripoli, and Martinsburg Formations.

In the Piedmont Lowland in northern Lancaster County, Lower and Middle Ordovician shale of the Cocalico Formation is thrust over rocks of the limestone association.

In central Pennsylvania, rocks overlying the limestone association include gray calcareous shales of the Coburn Formation, graptolitic black shales of the Antes Formation, and interbedded shale, sandstone, and minor limestone of the Reedsville Formation (facies A in Figure 5-12). These sandstones are crossbedded and fossiliferous (Figure 5-13) and were probably deposited in shallow water above wave base (Conrad,

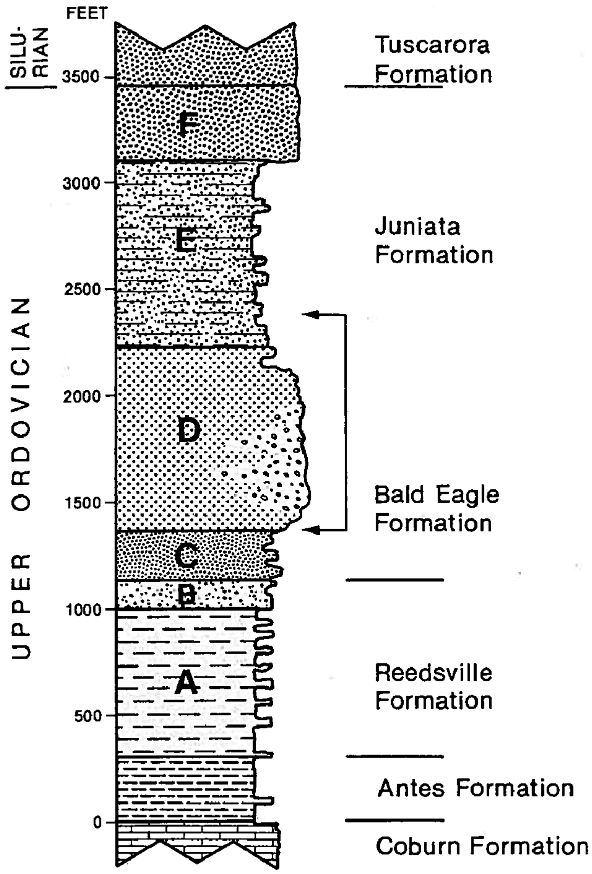

Figure 5-12. Schematic columnar section showing the stratigraphic nomenclature and the mappable lithofacies of the siliciclastic association in central Pennsylvania. The bracket indicates the stratigraphic range over which the color boundary between the gray Bald Eagle Formation and the red Juniata Formation fluctuates.

1985). The sandstones become thicker, burrowed, and more abundant upward (facies B in Figure 5-12).

Sandstone-Conglomerate

Strata overlying the Reedsville comprise nonfossiliferous sandstones, conglomerates, and mudstones of the Bald Eagle and Juniata Formations (Figure 5-6). Directly above the Reedsville lie marginal-marine, nonfossiliferous gray sandstones and minor shale (facies C in Figure 5-12; Horowitz, 1966; Thompson, 1970b). These are overlain by up to 1,200 feet of nonmarine, gray and red, crossbedded sandstone and conglomerate (Figure 5-14; facies D in Figure 5-12), the Lost Run conglomerate of Swartz (1955). These rocks are interpreted to be deposits of west-flowing, low-sinuosity streams on distal alluvial fans (Figures 5-15 and 5-16; Thompson, 1970b) and are the classical evidence for the Taconian orogeny in the central Appalachians.

The rocks of facies D are overlain by up to 1,000 feet of crossbedded red sandstone and burrowed, mud-cracked, red and gray mudstone (facies E in Figure 5-12) on which a paleosol developed (Feakes and Retallack, 1988). These rocks occur as fining-upward sequences (Figure 5-17) and were deposited in high-sinuosity meandering streams. They are locally overlain by red to gray sandstone and minor shale (facies F in Figure 5-12), which are transitional into overlying Silurian rocks (Thompson, 1970b).

The Bald Eagle-Juniata formation boundary is normally placed at the upward color change from

Figure 5-13. Interbedded sandstone, shale, and limestone of the Reedsville Formation (facies A) along Interstate Route 80, Milesburg Gap, Centre County. Sandstones (both light and dark) are lenticular, crossbedded, and hummocky bedded, have erosional upper surfaces, and in some places are size graded. The thick, light-colored bed at the left is fossiliferous limestone. Tops face left; the width of the outcrop is about 20 feet.

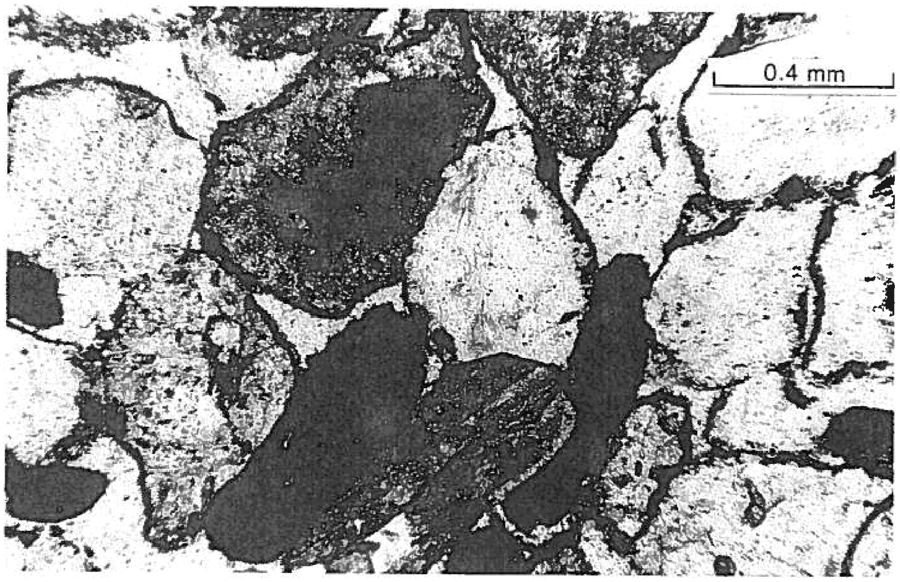

Figure 5-14. Photomicrograph of coarse-grained subgraywacke sandstone of the Juniata Formation (facies D) from an outcrop in East Waterford Gap, Juniata County. Note lithic-fragment grains, deformed and hematitized shale-clast grains, iron oxide grain coatings, and silica cement. Plane-polarized light.

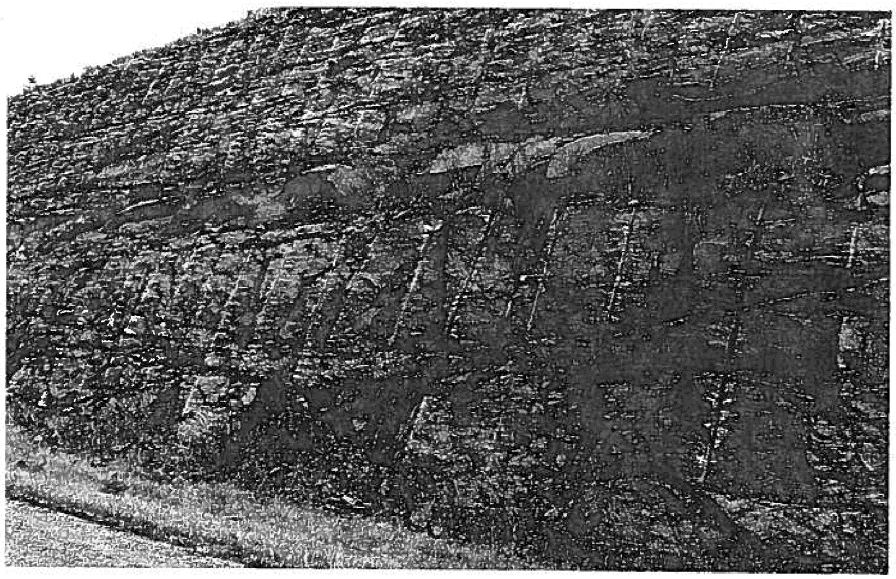

Figure 5-15. Coarse-grained sandstone of the Juniata Formation (facies D) along Interstate Route 80, Loganton, Clinton County. Note the lack of interbedded shale and the prevalence of shallow-channel bedforms. The width of the outcrop is about 75 feet.

gray to red. That position varies locally by as much as 1,100 feet (Figure 5-12) and is probably of diagenetic rather than solely depositional origin (Thompson, 1970a). The Ordovician-Silurian boundary in central and western Pennsylvania is placed at the color change from red to white at the top of the Juniata. It, too, could be diagenetically controlled and may not have time (or age) significance.

Figure 5-18 shows a schematic restored cross section through the Taconian clastic wedge. The coarse clastic rocks (facies D) are confined to central Pennsylvania; they thin to both the northwest and the southeast. These rocks become coarser grained to the southeast and pinch out above an unconformity atop the Martinsburg Formation. The pinching out marks the hingeline of the foreland basin.

STRATIGRAPHIC AND TECTONIC EVOLUTION

The principal components in the Ordovician evolution of eastern North America are illustrated in Figure 5-19. The carbonate platform of the Appalachian basin probably lay on the western margin of a small ocean basin, the eastern margin of which probably bordered a microcontinent. Subduction was initiated

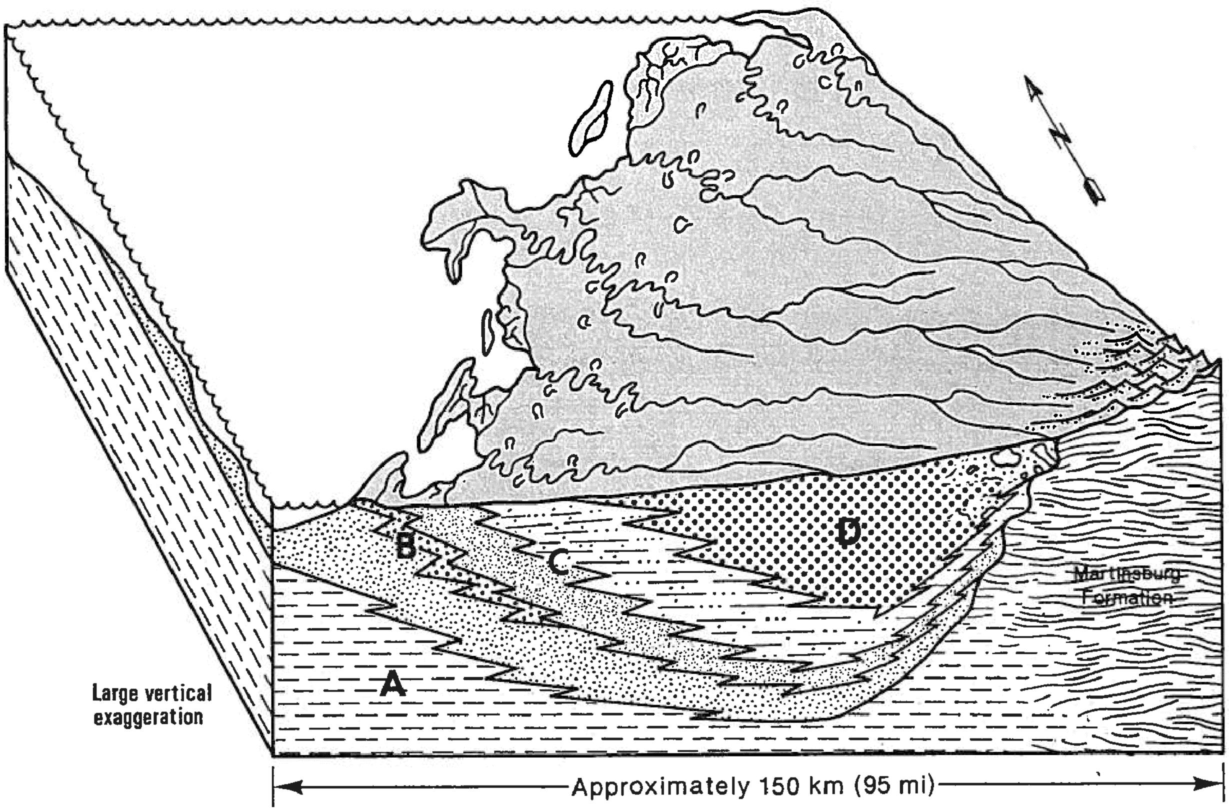

Figure 5-16. Inferred distribution of nearshore-marine and continental paleoenvironments during the marine regression associated with the early phases of deposition of the Taconian clastic wedge in central and eastern Pennsylvania (modified from Thompson, 1970b). Letters A through D refer to lithofacies defined in Figure 5-12.

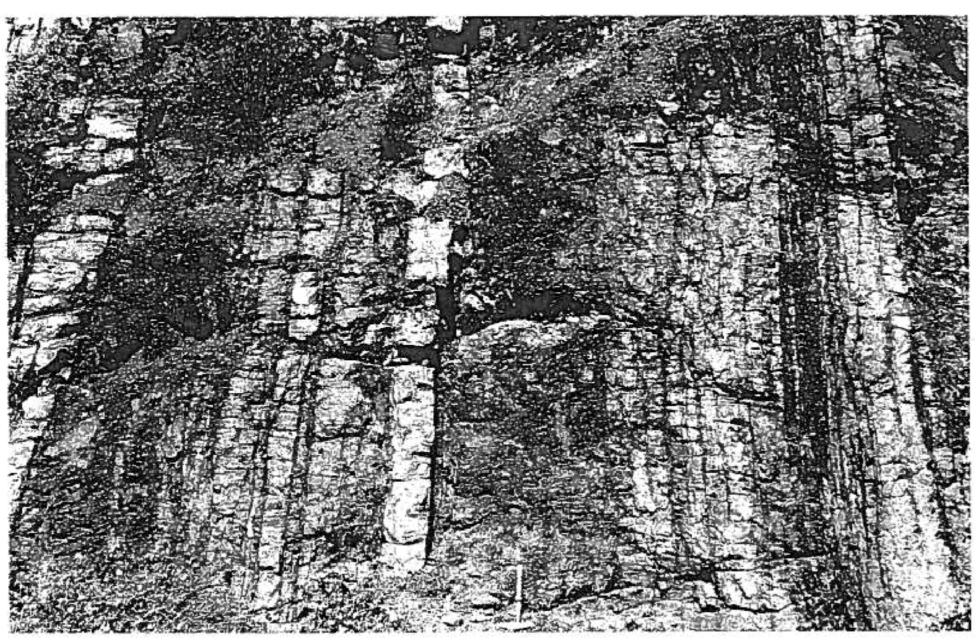

Figure 5-17. Interbedded sandstone and shale of the Juniata Formation (facies E) along the Pennsylvania Turnpike, Tussey Mountain, Bedford, Bedford County, showing two complete fining-upward sequences and the base of a third. These rocks in south-central Pennsylvania contain higher shale-to-sandstone ratios than equivalent rocks in central Pennsylvania. Tops face left.

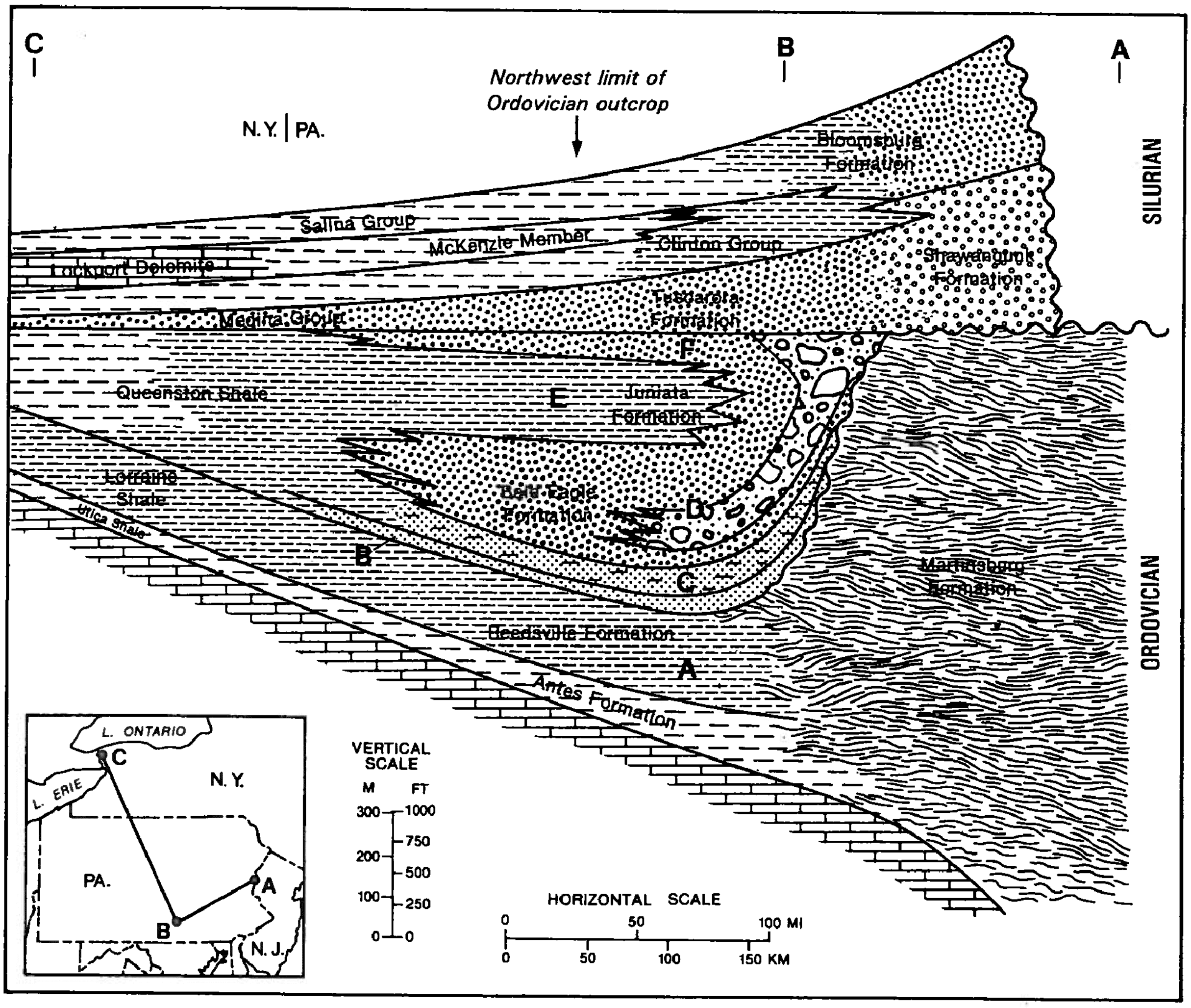

Figure 5–18. Schematic stratigraphic cross section through the Taconian clastic wedge, showing northwestward thinning of all units and southeastward coarsening and pinching out of the Bald Eagle and Juniata Formations (from Thompson and Sevon, 1982). Letters refer to lithofacies defined in Figure 5–12. Compare with Figure 5–3. Arrow marks the position of the Allegheny Front. Not palinspastic.

along this eastern margin during Middle Ordovician time, bringing about the eventual closing of the basin. The closing brought the carbonate platform partially beneath an east-dipping subduction complex along the eastern margin, giving rise to the Taconian orogeny.

The post-Knox unconformity records a widespread emergence of the eastern Laurentian craton in early Middle Ordovician time. It may represent erosion atop the peripheral bulge of flexed lithosphere that rose in response to coeval thrust loading of the craton margin to the east (Lash and Drake, 1984; Quinlan and Beaumont, 1984; Stanley and Ratcliffe, 1985). The unconformity is probably slightly older in eastern Pennsylvania than it is in central Pennsylvania.

The distribution of facies shown in Figure 5–6 reflects the general westward migration of limestone- and siliciclastic-association deposition throughout Ordovician time, as the Appalachian basin evolved from passive margin to foreland basin in response to Taconian orogenic uplift. Creation of an accretionary prism began in easternmost Pennsylvania in Late Cambrian to Middle Ordovician time (Lash and Drake, 1984, Figure 34) as subduction was initiated. The sialic material above the subduction zone probably constituted a microcontinent of rifted North American crust.

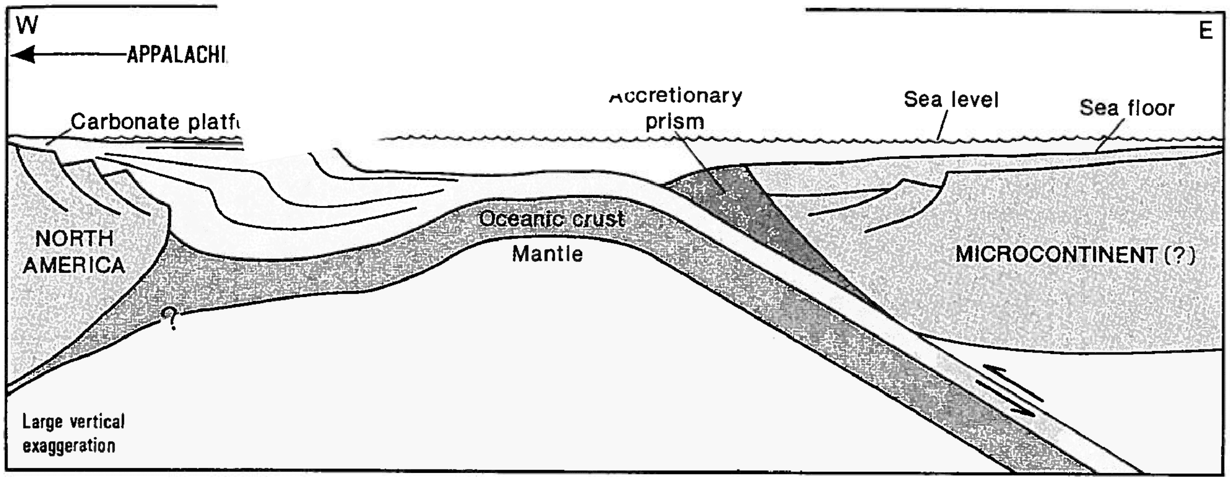

Figure 5-19. Schematic illustration of the major components of early Taconian orogenesis in the central Appalachians.

During closure of the oceanic basin in early Late Ordovician time, accretionary-prism slices (the Hamburg klippe) were emplaced atop the carbonate-platform sequence.

The thrusting created a tectonic highland (the Taconian mountains?) above the thrusts and led to the development of a foreland basin on the site of the former carbonate platform. Sediment for the Martinsburg, Bald Eagle, and Juniata Formations was derived primarily from this tectonic highland (Figure 5-16) and, later, from cannibalized sediment from the new eastern margin of the basin (Figures 5-18 and 5-20). The intensity of deformation decreased westward, and relations became conformable in central Pennsylvania.

Figure 5-20 shows, schematically, three stages in the evolution of the foreland basin. Early deposition in this basin included pelagic clay and distal turbidites of the Martinsburg Formation (Figure 5-20A).

Thickness and paleocurrent data (Figures 5-3 and 5-11) indicate a major post-Martinsburg depocenter in east-central Pennsylvania, in which terrigenous sediment was transported generally northwest in marginal-marine and fluvial depositional regimes during a regional marine regression (Figures 5-20B and 5-16). The conglomerates (facies D, Figure 5-12) reflect maximum regional stream gradients, which, in turn, reflect maximum uplift (Figure 5-16). The low-grade metamorphic, metavolcanic, and sedimentary-rock pebbles in the conglomerate suggest derivation from structurally high parts of the orogen (Leon, 1985).

Following maximum uplift, in late Late Ordovician time, regional paleoslope decreased, and low-gradient, floodplain-dominated fluvial facies of the middle Juniata Formation (facies E in Figure 5-12) became widespread in western Pennsylvània (Figure 5-20C). These more distal facies transgressed eastward into central Pennsylvania (Figure 5-18), where they passed upstream into more proximal, braided-stream sandstones of latest Ordovician and Silurian age.

In central Pennsylvania, the transition to Silurian deposition is continuous and records the encroachment of marine environments eastward across the Juniata land surface (Cotter, 1983a). In eastern Pennsylvania, Silurian continental rocks lie unconformably atop the eroded Martinsburg and Hamburg klippe sequences (Figures 5-6 and 5-18).

PROBLEMS AND FUTURE RESEARCH

The following topics, among many others, deserve further investigation:

1. Stratigraphic relations between the Antes-Reedsville sequence in central Pennsylvania and the New Tripoli-Shochary sequence in eastern Pennsylvania.
2. Stratigraphic relations between the Antes-Reedsville sequence and the Martinsburg Formation. This will involve an evaluation of the structural significance of Blue Moun-

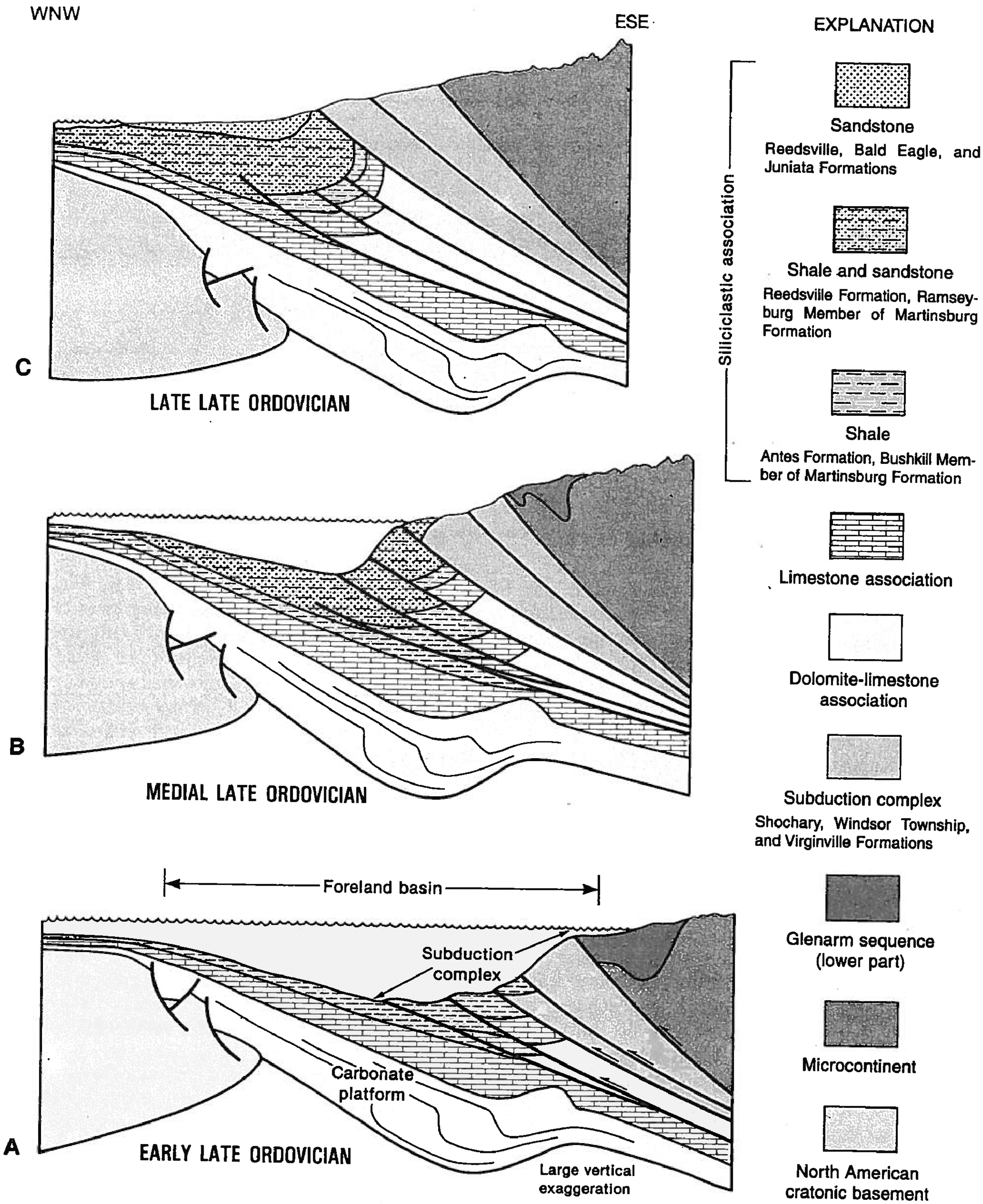

Figure 5-20. Schematic illustration of the inferred stages of the evolution of the Taconian foreland basin and clastic wedge from deep-water marine clay deposition (A), represented by the Antes and Martinsburg Formations, to the continental sand and gravel deposition of the Bald Eagle and Juniata Formations (C). For earlier stages, see Lash and Drake (1984, Figure 34).

tain and the possibility of a major décollement there.

3. The origin of the color boundaries of the Juniata Formation, and the time-stratigraphic significance of the Ordovician-Silurian boundary in central Pennsylvania.
4. The sedimentologic and/or stratigraphic expression of the Late Ordovician glacioeustatic lowering of sea level documented elsewhere in the world.
5. Evaluation of synchrony of tectonism on either side of the Martic Line.

RECOMMENDED FOR FURTHER READING

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