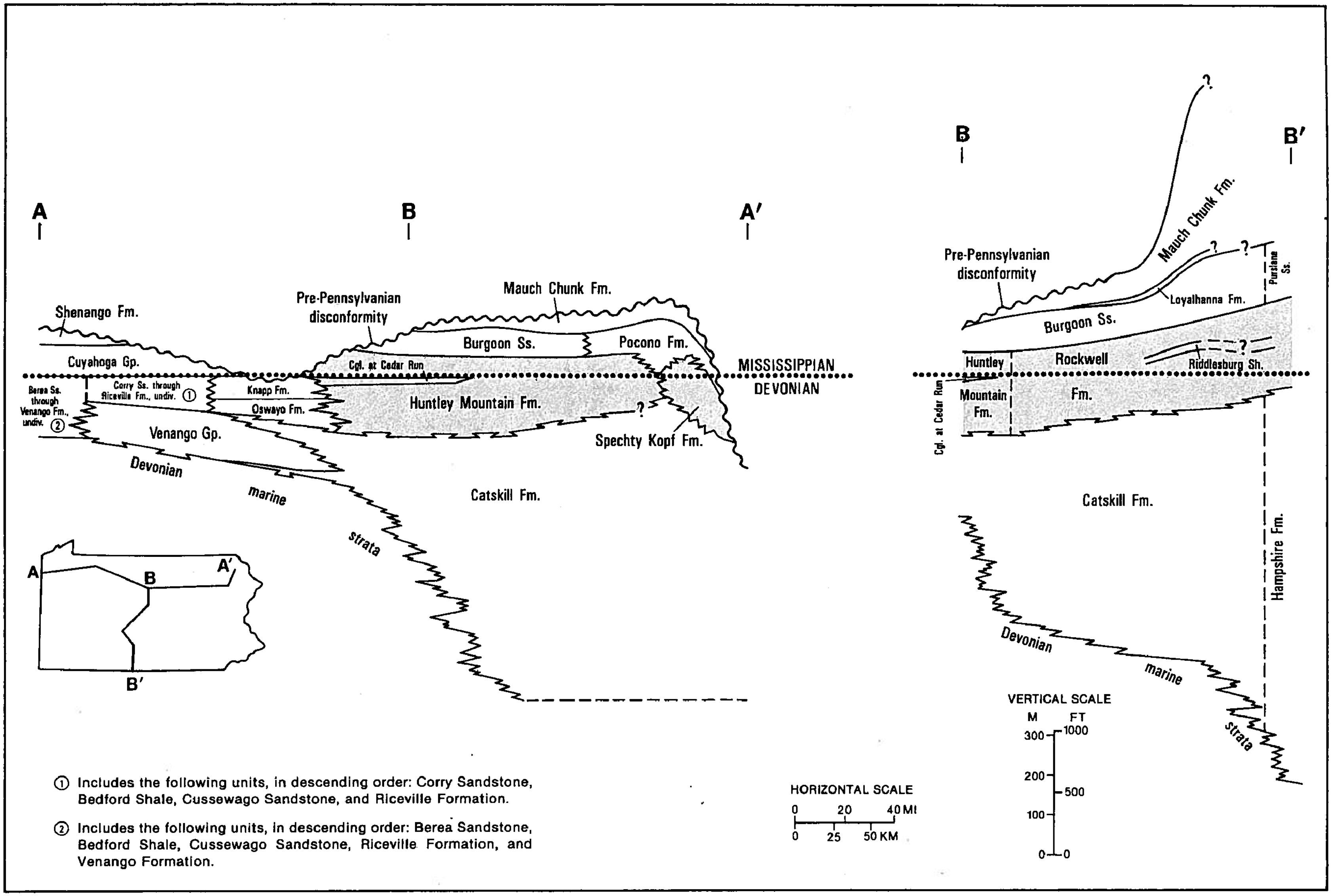

Figure 8-1. Lithostratigraphic cross sections showing the relationships among the Devonian-Mississippian transition formations (colored), overlying and underlying formations, and Mississippian and Upper Devonian marine units of northwestern Pennsylvania.

CHAPTER 8 DEVONIAN-MISSISSIPPIAN TRANSITION

THOMAS M. BERG
Ohio Department of Natural Resources
Division of Geological Survey
4383 Fountain Square Drive
Columbus, OH 43224

INTRODUCTION

In central and eastern Pennsylvania, a variable and little-understood stratigraphic succession exists as a transition between underlying strata clearly defined as the Catskill Formation and the overlying Pocono Formation or Burgoon Sandstone (Figure 8–1). At different localities, this transition comprises the Spechty Kopf, Huntley Mountain, and Rockwell Formations (Figure 8–2). The boundary between the Devonian and Mississippian Systems occurs within these transitional formations, but its exact position is as yet undefined.

The development of a biostratigraphic framework that clearly defines the Devonian-Mississippian systemic boundary has been slow because geologic mapping and stratigraphic correlation in the Upper Devonian and Lower Mississippian have proceeded mostly within a lithostratigraphic framework, the interpretation of which has been evolving. The development of stratigraphic nomenclature in this succession has followed a course of mixed lithostratigraphic, chronostratigraphic, and biostratigraphic thinking. Gutschick and Moreman (1967) summarized paleontologic research on the Devonian-Mississippian boundary of the United States. Edmunds and others (1979) presented a brief overview of Mississippian biostratigraphy in Pennsylvania.

The marine stratigraphic succession embracing the systemic boundary in the northwestern part of the state (Figure 8–1) is fairly well known and has been examined by a number of workers during the twentieth century (Caster, 1934; Holland, 1958; Sass, 1960; de Witt, 1970; Dodge, 1992; Harper, 1993). The systemic boundary is now placed at the base of the Cuyahoga Group in western Pennsylvania. Laird (1941) examined the systemic boundary in the southwestern Pennsylvania inliers, and Reger (1927) and Girty (1928) reported on Carboniferous marine fossils in the "Pocono" Formation of the Broad Top area. Although Read and Mamay (1964) provided a framework for upper Paleozoic floral assemblages in the United States, there is presently no agreement

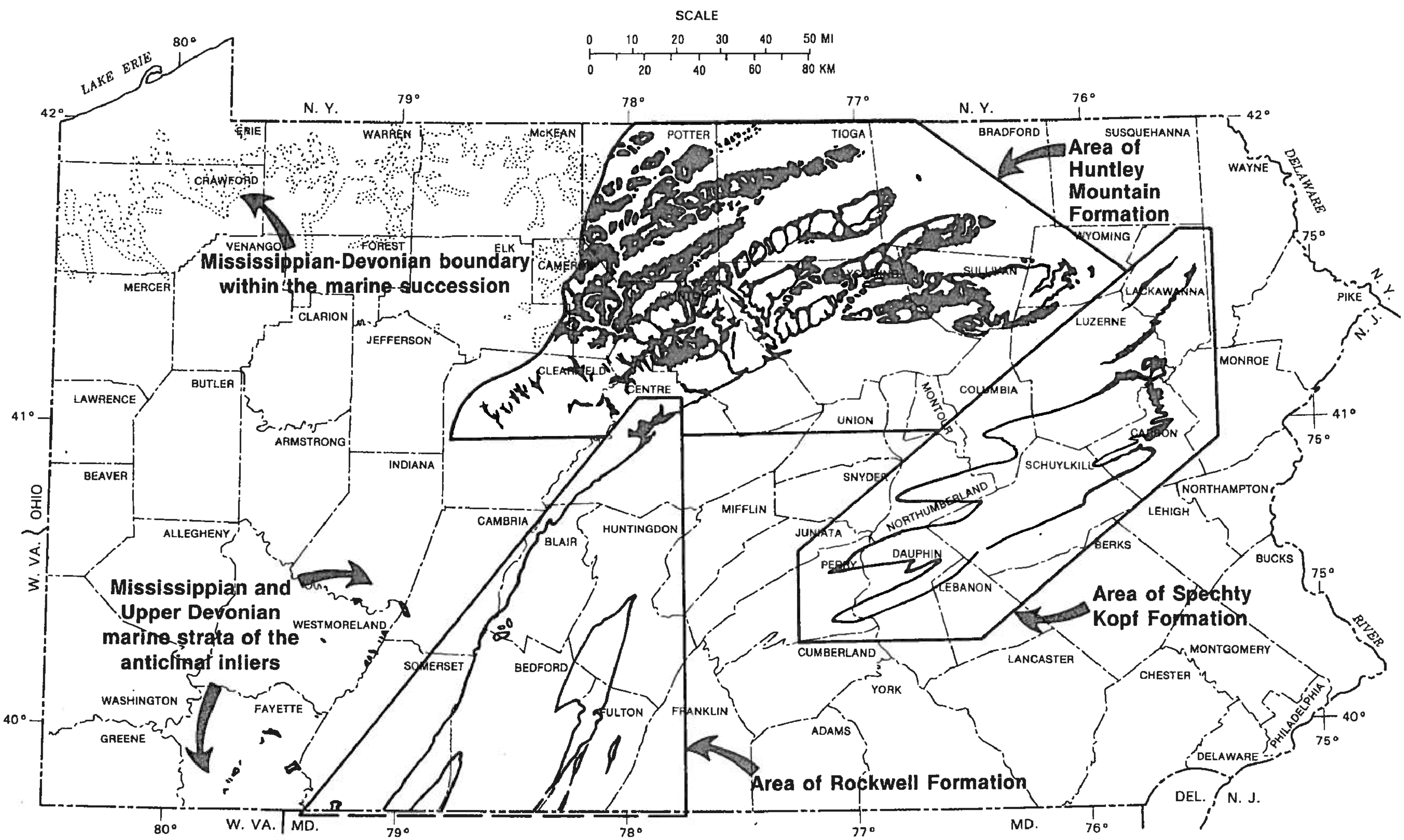

Figure 8-2. Areas in Pennsylvania where the Spechty Kopf, Huntley Mountain, and Rockwell Formations have been mapped (modified from Berg and others, 1980). The position of the boundary between Mississippian and Devonian strata of northwestern Pennsylvania is shown by the dotted line.

as to the exact position of the systemic boundary in the nonmarine, post-Catskill succession of north-central and eastern Pennsylvania.

Berg and Edmunds (1979) reviewed past usage of the name "Pocono," explaining that it was applied in a chronostratigraphic sense well beyond the borders of Pennsylvania. The "Catskill-Pocono" boundary became almost synonymous with "Devonian-Mississippian," and the name "Pocono" was geographically extended to rock sequences having no similarity whatsoever to the fluvial sandstones and conglomerates that fringe the anthracite fields and make up the Pocono Formation. As the mapping of Pennsylvania progressed, the name "Pocono" was applied to all the rocks between the red Catskill and Mauch Chunk Formations. The name was also extended to the western part of the state, even into areas where the bounding red-bed formations are not seen. Thus, the name was applied to the entire marine succession between the basal Pennsylvanian disconformity and the presumed Devonian-Mississippian boundary.

Where the red Catskill Formation grades westward to the marine Venango Group, a succession of marine siliciclastic rocks intervenes between the top of the Venango and what was considered to be the Devonian-Mississippian boundary by earlier workers who placed that systemic boundary at the base of the Cussewago Sandstone or Knapp Formation. This marine succession is called the Riceville Formation (sub-Cussewago) or Oswayo Formation (sub-Knapp). The "Oswayo," a New York stratigraphic term, was projected far eastward (Gray and others, 1960), mostly on the basis of interval, into north-central and central Pennsylvania and applied to nonmarine strata between a presumed Devonian-Mississippian boundary and Catskill red beds.

The 1980 state geologic map (Berg and others, 1980) shows three separate, distinct, and dominantly nonmarine formations that embrace the Devonian-Mississippian systemic boundary: the Spechty Kopf, Huntley Mountain, and Rockwell (Figures 8–1 and 8–2). The general paleogeographic setting at the time of deposition of these three formations is shown in Figure 8–3.

SPECHTY KOPF FORMATION

Trexler and others (1962) designated the dominantly gray and olive-gray beds below the Pocono Formation in the western part of the Southern Anthracite field the Spechty Kopf Member of the Catskill Formation. Sevon (1969b) included equivalent

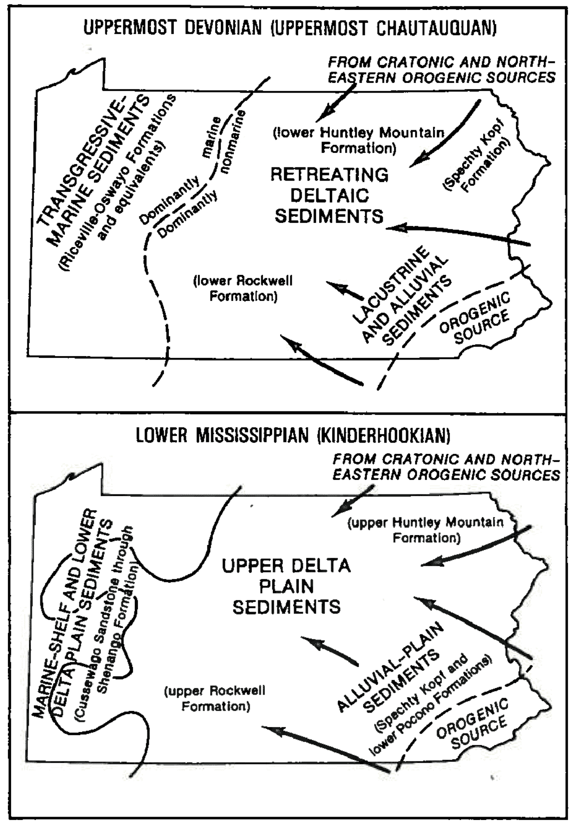

Figure 8–3. Paleogeographic maps showing generalized sedimentary environments during deposition of Devonian-Mississippian transition formations.

rocks in northeastern Pennsylvania as components of the Pocono Formation. The Spechty Kopf was raised to formation rank by Epstein and others (1974) and includes both of the aforementioned groups of rocks.

Over most of its outcrop belt in Pennsylvania, the Spechty Kopf Formation is dominantly sandstone (Figure 8–4). Other components include siltstone, shale, conglomerate, polymictic diamictite, pebbly mudstone, laminite, and coal. The sandstone, siltstone, and shale are mostly medium gray to olive gray, but yellowish-gray, brownish-gray, and some grayish-red colors occur. Most of the sandstones are trough crossbedded, but some planar bedding is present. An interesting, but genetically enigmatic, aspect of part of the Spechty Kopf is the widespread occurrence of an ordered vertical sequence (elements A, B, C, and D of Figure 8–4) in the lower and middle parts of the formation. Polymictic diamictite, pebbly mudstone, laminite, and planar-bedded sandstone occur as a laterally restricted, but recurring, stratigraphic succession (Sevon and Berg, 1986). These

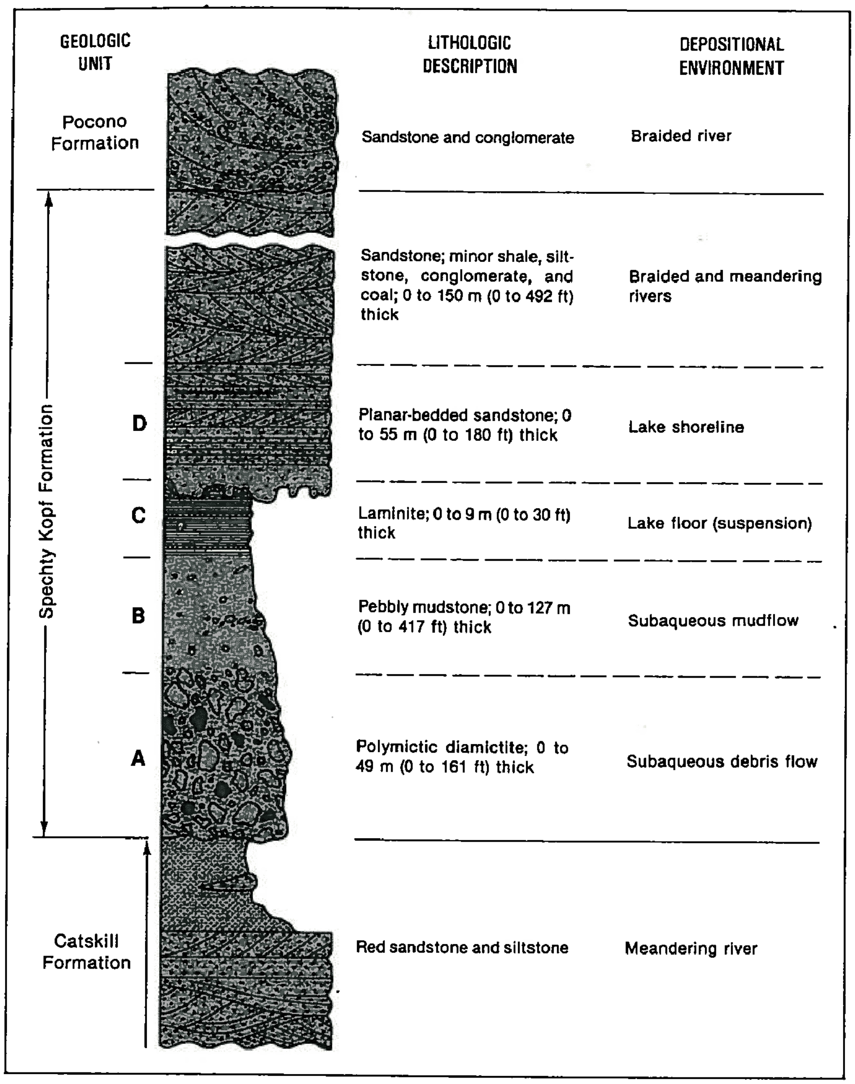

Figure 8–4. Generalized stratigraphic column showing the character of the Spechty Kopf Formation and inferred depositional environments. The colored arrow marks a fining-upward cycle in the Catskill Formation.

four elements are not present in every exposed section, but the vertical order appears to persist. The mostly nonsorted polymictic diamictites contain igneous, meta-igneous, and metasedimentary clasts, which suggests the sudden exposure of a widely polygenetic source area that was swiftly eroded. The derived sediments were rapidly transported to localized but isochronic nonmarine basins and probably represent a major event of considerable importance near the end of the Devonian. Whether that event was tectonic, climatic, or extraterrestrial is as yet undetermined.

The Spechty Kopf is separated from the underlying Catskill Formation by a disconformity, and it may be separated from the overlying Pocono Formation by a disconformity (Wood and others, 1969; Epstein and others, 1974; Edmunds and others, 1979). The formation commonly ranges up to 390 m (1,280 ft) in thickness, but it is locally absent. Thickness ranges of individual components within the Spechty Kopf are given in Figure 8–4. Wood and others (1969) reported a maximum thickness of about 730 m (2,400 ft) near the type area in northern Dauphin County. Variations in overall thickness are probably due in part to the locations of multiple sediment-input systems (Sevon, 1985a). Variations in thickness of polymictic diamictite, pebbly mudstone, laminite, and planar-bedded sandstone are due to the configuration of the eroded upper surface of the Catskill alluvial plain, which subsided to form localized lake basins (Sevon and Berg, 1986).

Marine fossils have not been found in the Spechty Kopf Formation, even though many primary sedimentary structures, such as symmetric ripples, flutes, and tool marks, in the laminites and planar-bedded sandstones are identical to structures found in offshore marine deposits or tidal flats. Some burrows have been observed (Sevon, 1969b) but are not known to be marine. The primary structures are considered to be the result of deposition in ephemeral lakes. No nonmarine invertebrate fossils have been recorded. Plant fossils have been found, and thin coal beds have been observed. Wood and others (1969) reported *Adiantites* from the Spechty Kopf, supporting an Early Mississippian age for part of the formation. For the most part, Spechty Kopf sandstones, siltstones, conglomerates, and shales were deposited in fluvial systems, either braided or meandering. The unusual succession at the base of the formation has been interpreted by Sevon and Berg (1986) to be the result of deposition in ephemeral lakes formed on the surface of the defunct Catskill alluvial plain. The polymictic diamictite and pebbly mudstone are unique in the upper Paleozoic of Pennsylvania and, as previously mentioned, probably represent a major event near the end of the Devonian. In context with the overlying laminites and planar-bedded sandstones, subaqueous debris flows and/or mudflows are likely agents of deposition (Figure 8–4). The laminite is interpreted as an offshore lacustrine facies where fine mud was deposited from suspension. Occasional "dropped in" pebbles, granules, and sand grains hint at debris-laden floating ice, but the equatorial climate of the Late Devonian (Ettensohn, 1985) casts considerable doubt on the possibility of ice floating on the ephemeral lakes. The origin of the dropped-in clasts in the laminites remains a mystery. The clean, planar-bedded sandstones most likely resulted from deposition on lake beaches or offshore lacustrine bars. The red siltstones and shales and the thin coals interbedded in the overlying Spechty Kopf fluvial sequence are interpreted as interfluve overbank and swamp deposits.

HUNTLEY MOUNTAIN FORMATION

The succession comprising the transition in north-central Pennsylvania (Figures 8-1 and 8-2) was named the Huntley Mountain Formation by Berg and Edmunds (1979). It is transitional from the Catskill Formation to the Burgoon Sandstone and was formerly mapped as a "lower part" of the Pocono Formation, plus the underlying Oswayo Formation. The Burgoon Sandstone is the homotaxial equivalent of the Pocono Formation of northeastern Pennsylvania.

The major rock type (Figure 8-5) of the Huntley Mountain Formation is greenish-gray to olive-gray, fine-grained, slabby to flaggy sandstone (Berg and Edmunds, 1979). Clearly a transition, sandstones in the lower half of the Huntley Mountain bear a close similarity to those of the underlying Catskill Formation, whereas sandstones in the upper half of the formation are similar in some respects to the overlying Burgoon sandstones. Minor lithologic components include red, gray, and olive siltstone and shale, intraformational and extraformational conglomerate, and pisolith beds. Sandstones display gentle trough crossbedding (Figure 8-6) and planar bedding. Siltstone and shale units are par-

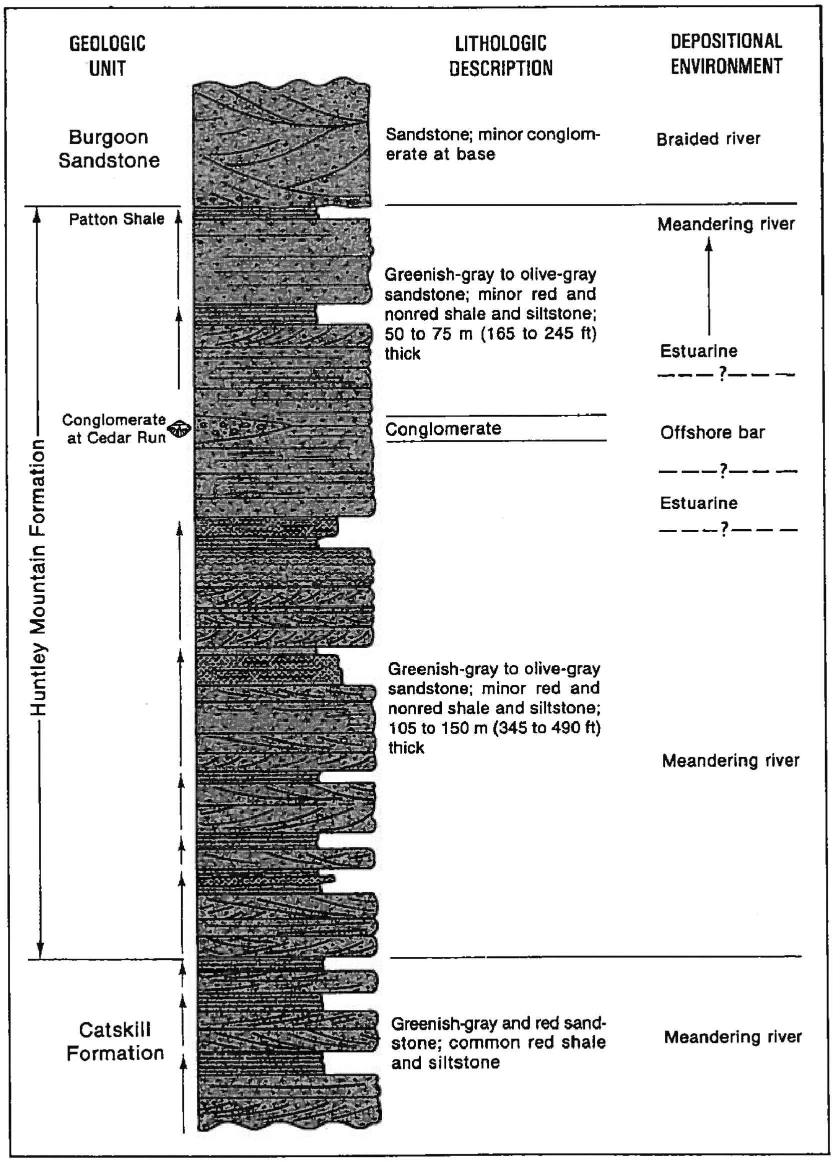

Figure 8–5. Generalized stratigraphic column showing the character of the Huntley Mountain Formation and inferred depositional environments. The colored arrows mark fining-upward cycles.

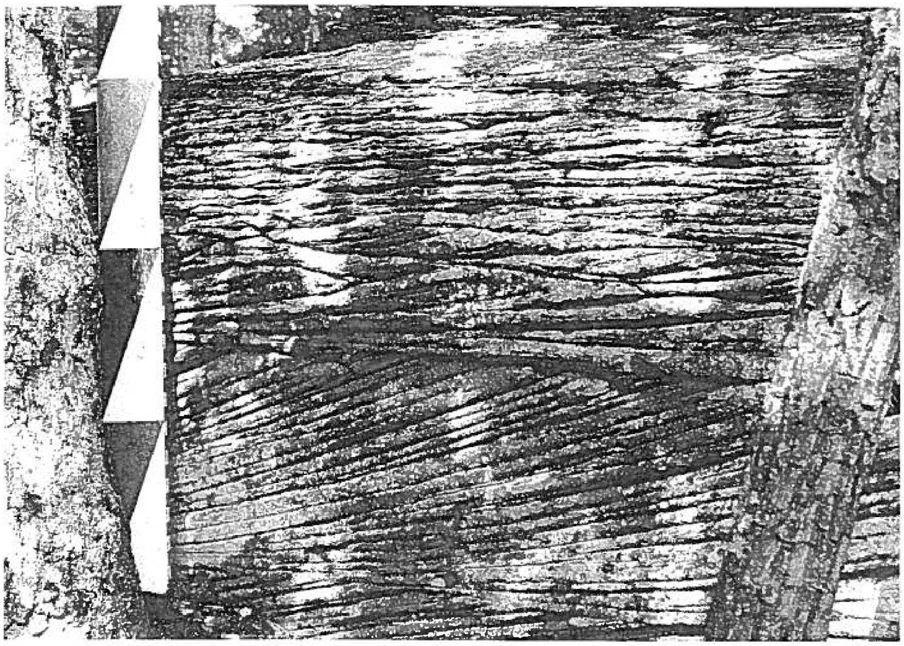

Figure 8–6. Outcrop of crossbedded sandstone in the lower part of the Huntley Mountain Formation at the type section in Lycoming County, near Waterville. The scale is marked in feet.

allel bedded and ripple bedded. The intraformational conglomerates are composed mainly of reworked lithic clasts, concentrated at the base of fining-upward cycles. One extensive, but thin, extraformational conglomerate within the upper half of the Huntley Mountain Formation, called the "conglomerate at Cedar Run" by Colton (1963), occurs over much of the western extent of the formation.

Like the underlying Catskill Formation, the Huntley Mountain Formation is characterized by fining-upward fluvial cycles (Figure 8–7). The cycles average about 17.5 m (57 ft) in thickness, but some exceed 30 m (100 ft). In general, the coarser grained lower members of the Huntley Mountain cycles are thicker than those of the Catskill, and the finer grained upper members are thinner than the equivalent members of the Catskill cycles (Berg and Edmunds, 1979). The overlying Burgoon Sandstone lacks fining-upward cycles.

The Huntley Mountain Formation ranges from 150 to 215 m (490 to 705 ft) in thickness. No systematic analysis of regional thickness changes has been made. In the northernmost part of the outcrop area, the Huntley Mountain appears to thicken to about 300 m (985 ft), possibly at the expense of the overlying Burgoon Sandstone (Edmunds and others, 1979), but such a relationship is speculative. In contrast to the Spechty Kopf-Catskill boundary, no disconformity exists at the base of the Huntley Mountain Formation. Criteria for separating the formation from the underlying "main body" of Catskill red beds were given by Berg and Edmunds (1979). The upper contact with the Burgoon is conformable and relatively clear, because the medium-grained, buff sandstones of the Burgoon contrast well with the fine-grained, greenish-gray sandstones of the Huntley Mountain.

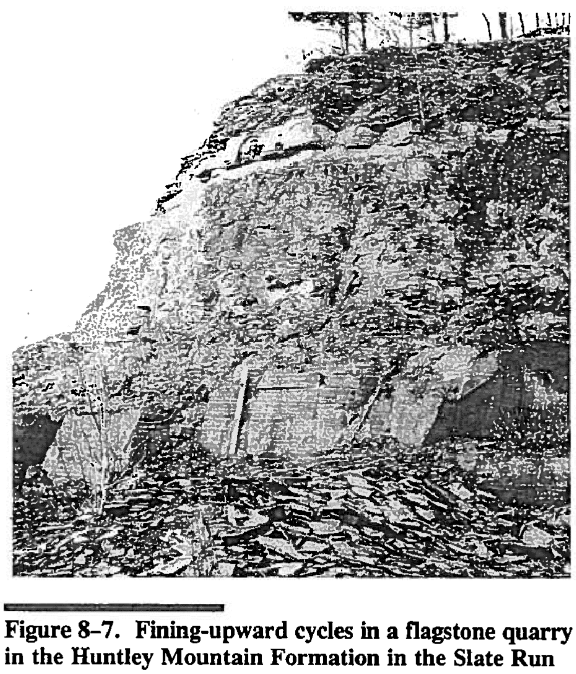

Figure 8–7. Fining-upward cycles in a flagstone quarry in the Huntley Mountain Formation in the Slate Run area, western Lycoming County. Planar-bedded sandstone is overlain by red siltstone that grades upward into olive-colored claystone just below the basal sandstone of the succeeding cycle (near the upper third of the highwall). The scale is 5 feet in length.

Fossil plants and some nonmarine invertebrates occur in the Huntley Mountain Formation (Berg and Edmunds, 1979). Marine invertebrates in the conglomerate at Cedar Run testify to a rapid marine transgression punctuating a large part of the area of this dominantly fluvial formation. Fossil brachiopods in this conglomerate appear to be Early Mississippian (Berg and Edmunds, 1979).

Fining-upward cycles, trough crossbedding, fossil plants, and sparse fossil freshwater invertebrates all indicate a fluvial environment of deposition for most of the Huntley Mountain Formation. The conglomerate at Cedar Run marks a very rapid transgression across the fluvial plain; beds just above and below this conglomerate may be estuarine or tidal-flat deposits. More lower-delta-plain and marginal-marine deposits may be expected in the region where the Huntley Mountain Formation grades westward into the Shenango-through-Oswayo succession (Figure 8–1). The Catskill Formation cycles in north-central Pennsylvania are inferred to be meandering-river deposits, whereas the Burgoon Sandstone is interpreted to be a braided-river deposit. The Huntley Mountain cycles are interpreted to be meandering-river deposits, but they were deposited by rivers that apparently carried a greater sand load than the Catskill rivers (Berg and Edmunds, 1979). Overbank deposits apparently had less time to stabilize, and channel stability was lower. A braided-river depositional system was probably approached late in Huntley Mountain time, just prior to deposition of the Burgoon Sandstone.

ROCKWELL FORMATION

The Rockwell Formation was named by Stose and Swartz (1912), who considered it to be the lower part of the "Pocono group." They named the rocks above the Rockwell the Purslane Sandstone. De Witt (1969) and Berg and Edmunds (1979) correlated the Purslane with the Burgoon Sandstone. The term "Rockwell" was first used on the 1980 state geologic map (Berg and others, 1980) to include the sequence between the Catskill red beds and the Burgoon Sandstone (Figures 8–1 and 8–2). The best exposure of the Rockwell Formation is at a very large roadcut in Maryland, close to the Pennsylvania border, where U.S. Route 40 passes through Sideling Hill. This exposure has been described and interpreted by Bjerstedt (1986) and should be considered the prime reference section.

As currently mapped, the Rockwell Formation is fairly heterolithic (Figure 8–8). Berg, Dodge, and Lentz (1986) suggested that a large part of what has been mapped as Rockwell may be more closely allied to the more marine Mississippian strata below the Burgoon as exposed to the west at Conemaugh Gorge (Fettke and Bayles, 1945; Kaktins, Uldis, 1986) than to the Rockwell at Sideling Hill in Maryland.

The following generalizations can be made about the Rockwell in Pennsylvania. The lower quarter of the formation is predominantly sandstone. Reger (1927) called this interval "Berea," an overextension of an Ohio name. The middle of the Rockwell is a mixture of interbedded sandstone, siltstone, and shale, which is mostly olive gray or greenish gray, but some red beds are present. There are also brownish-gray to grayish-black shale intervals in the middle of the formation, including the marine, fossiliferous Riddlesburg Shale of Reger (1927). Other thin marine zones occur within the middle of the Rockwell. The upper quarter of the formation is sandy and shaly and contains the "Patton" red shale. There are fining-upward cycles in the Rockwell (Dodge and Berg, 1986), but the extent of that sedimentary pattern in the formation is not fully established. A number of relatively thin coals occur in the Rockwell in southern Bedford County, Fulton County, and in Maryland and West Virginia (Bjerstedt, 1986). In Fulton County, eastern Bedford County, and along Sideling Hill in Maryland, a polymictic diamictite (Figure 8–9) occurs at the base of the Rockwell (Sevon, 1979a, b; Bjerstedt, 1986). Relatively thin, calcareous, intraformational conglomerates containing nodules and pisoliths occur within the formation where fining-upward cycles are demonstrable.

The contact between the Catskill and the Rockwell is sharp and conformable. A minor disconformity may be interpreted where the diamictite occurs at the base of the Rockwell. The contact between the Rockwell and the overlying Burgoon Sandstone is also sharp and conformable, although the textural contrast between the two formations has led some workers to speculate that a minor disconformity may be present.

The Rockwell Formation is up to 315 m (1,035 ft) thick in the Broad Top region (Butts, 1945). At Horseshoe Curve, it is 180 m (590 ft) thick. Bjerstedt (1986) measured 191 m (627 ft) of Rockwell at Sideling Hill in Maryland. Terriere (1951) reported approximately 125 m (410 ft) at the Allegheny Front in Bedford County.

Multiple, contrasting depositional environments are represented by the Rockwell Formation (Figure 8–8). The predominant type of deposition appears to have been in fluvial systems, primarily high-sinuosity meandering rivers. However, deposition in marginal-

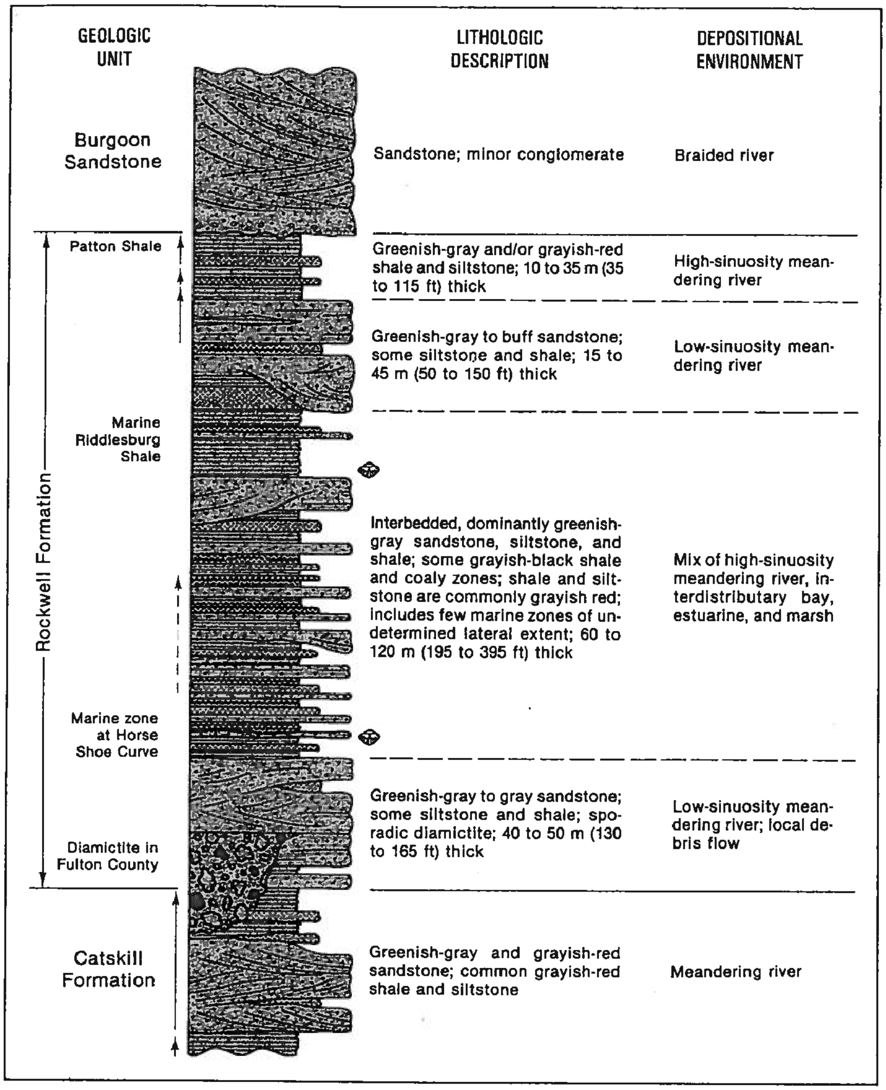

Figure 8-8. Generalized stratigraphic column showing the character of the Rockwell Formation and inferred depositional environments. The colored arrows mark fining-upward cycles; the dashed arrow indicates that the interval contains some fining-upward cycles.

marine environments, including estuaries and interdistributary bays, also occurred. The coarser, sandier portions of the Rockwell, particularly the lower and upper quarters, represent deposition in low-sinuosity meandering rivers. The thin coals resulted from the development of sporadic marshes during Rockwell time. The diamictites near the base of the Rockwell resulted from deposition by debris flows in a standing body of water, either marginal-marine or lacustrine.

PROBLEMS AND FUTURE RESEARCH

Although there are some obvious similarities among the Spechty Kopf, Huntley Mountain, and Rockwell Formations, contrasts exist that give rise to questions that can only be answered by further research and analysis. For example, the Huntley Mountain and Spechty Kopf occur in close temporal and geographic proximity to each other. Why are there no diamictites or apparent lacustrine deposits in the Huntley Mountain? The Rockwell Formation has diamictites in south-central Pennsylvania and adjacent Maryland. Are they related genetically to the diamictites of the Spechty Kopf? Were there extensive lacustrine environments during Spechty Kopf deposition? Why is clear evidence of marine deposition lacking in the Spechty Kopf? Additional work will be required to relate the geologic events that gave rise to all aspects of the three formations that comprise the Devonian-Mississippian transition in Pennsylvania.

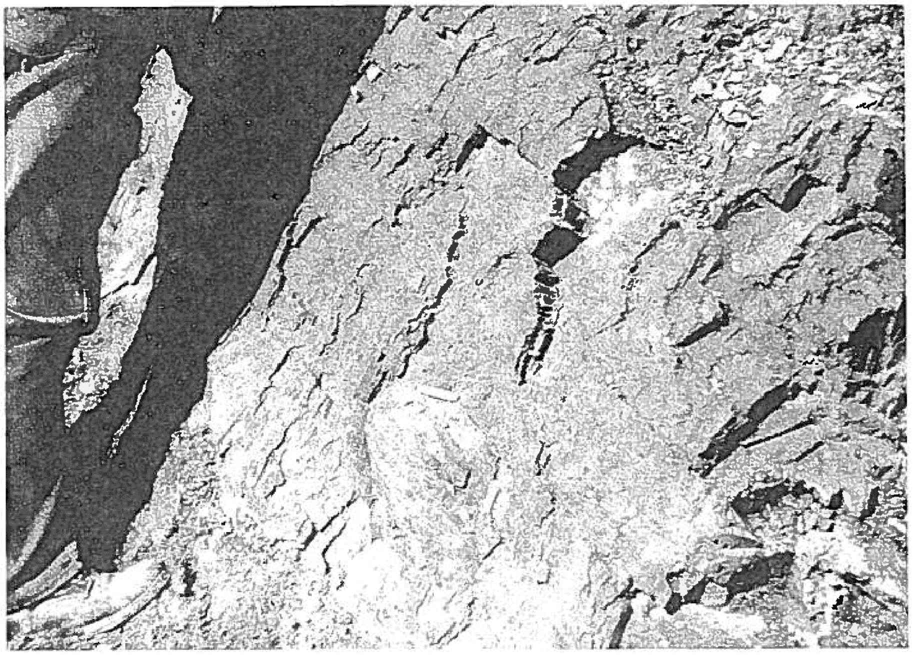

Figure 8–9. Polymictic diamictite in the lower part of the Rockwell Formation, exposed along the westbound lane of Interstate Route 70 in Bedford County, just west of the Bedford-Fulton County line. Note the abundant small pebbles in the mudstone matrix and the large clast (27 by 12 cm [11 by 5 in.]) just below the penknife. Photograph by J. A. Harper.

The western limits of the Rockwell and Huntley Mountain Formations are poorly understood, and considerable stratigraphic analysis will be necessary to relate these two formations to the well-established Devonian-Mississippian succession of western and northwestern Pennsylvania. New stratigraphic units will probably have to be established. The stratigraphic framework used by Schiner and Kimmel (1972) in northwestern Pennsylvania includes, in descending order, the Shenango Formation, the Cuyahoga Group, the Berea and Corry Sandstones, the Bedford Shale, the Cussewago Sandstone, and the Riceville Formation (Figure 8–1). Except for the Bedford Shale and the Cussewago Sandstone, Schiner and Kimmel's framework was extended into Warren County during reconnaissance mapping by the author during 1987 and 1988. The interval of mixed marine siliciclastic rocks between the Corry Sandstone and the Riceville Formation remains unnamed (Dodge, 1992). In eastern Warren County, the succession includes the Oswayo Formation and the overlying Knapp Formation, but that framework has not been extended eastward into McKean County. More detailed work needs to be done, including core drilling through the entire Mississippian and into the Venango or Catskill Formation. The relationships among the Rockwell Formation, the Lower Mississippian rocks exposed in Conemaugh Gorge, and the subsurface "Murrysville sand" of southwestern Pennsylvania need to be worked out in detail.

RECOMMENDED FOR FURTHER READING

Berg, T. M., and Edmunds, W. E. (1979), *The Huntley Mountain Formation: Catskill-to-Burgoon transition in north-central Pennsylvania,* Pennsylvania Geological Survey, 4th ser., Information Circular 83, 80 p.

Bjerstedt, T. W. (1986), *Regional stratigraphy and sedimentology of the Lower Mississippian Rockwell Formation and Purslane Sandstone based on the new Sideling Hill road cut, Maryland,* Southeastern Geology, v. 27, p. 69–94.

Caster, K. E. (1934), *The stratigraphy and paleontology of northwestern Pennsylvania—Part 1, Stratigraphy,* Bulletins of American Paleontology, v. 21, no. 71, 185 p.

Colton, G. W. (1963), *Devonian and Mississippian correlations in part of north-central Pennsylvania—a report of progress,* in Shepps, V. C., ed., *Symposium on Middle and Upper Devonian stratigraphy of Pennsylvania and adjacent states,* Pennsylvania Geological Survey, 4th ser., General Geology Report 39, p. 115–125.

Edmunds, W. E., Berg, T. M., Sevon, W. D., and others (1979), *The Mississippian and Pennsylvanian (Carboniferous) Systems in the United States—Pennsylvania and New York,* U.S. Geological Survey Professional Paper 1110-B, p. B1–B33.

Schiner, G. R., and Kimmel, G. E. (1972), *Mississippian stratigraphy of northwestern Pennsylvania,* U.S. Geological Survey Bulletin 1331-A, 27 p.

Sevon, W. D. (1969), *The Pocono Formation in northeastern Pennsylvania,* Annual Field Conference of Pennsylvania Geologists, 34th, Hazleton, Pa., Guidebook, 129 p.

Wood, G. H., Jr., Trexler, J. P., and Kehn, T. M. (1969), *Geology of the west-central part of the Southern Anthracite field and adjoining areas, Pennsylvania,* U.S. Geological Survey Professional Paper 602, 150 p.