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ENVIRONMENTS OF DEPOSITION OF THE PRICE FORMATION (LOWER MISSISSIPPIAN) IN ITS TYPE AREA, SOUTHWESTERN VIRGINIA

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ABSTRACT. The Lower Mississippian Price Formation, containing the geologically oldest commercial coals in North America, is a sequence of terrigenous sediments resulting from erosion associated with late phases of the Acadian orogeny. In a study of 15 sections in the type area of the Price in southwest central Virginia, we have recognized eight lithofacies representing the following depositional environments: (1) marine shelf, (2) prodelta slope, (3) bar and barrier, (4) barred bay, (5) mixed wash-over, (6) distributary channel, (7) delta plain, and (8) swamp. Collectively these facies constitute a well-defined regressive sequence. Marine facies occupy the lower parts of the Formation and thicken from the east to the northwest in the study area. The overlying non-marine facies have the general structure of a series of coalescing prograding deltas, and they thin from the east to the northwest and southwest. Sedimentation in the Price Formation in its type area was controlled by a large stream system which built a delta on the northeast side of the area and supplied coarse sediments to the shoreline. Longshore drift to the southwest constructed a series of bars and barriers (the Cloyd Conglomerate) which protected a shallow bay on the southwest side of the delta. As sediment supply continued from this major source, it caused shoaling and northwestward migration of the bar system. Small streams built deltas into the protected bay causing the strandline of the bay to prograde northwestward. Coal swamps formed on the resulting delta plain. A similar interaction of delta formation and longshore drift to form asymmetric deltas and protected bays is displayed in the Gulf of Venice and along the Malay Peninsula. These areas are probably similar to the tectonic deltas of the Appalachians in the upper Paleozoic.

INTRODUCTION

The Price Formation is a sequence of terrigenous sediments of Lower Mississippian age. It is at least partially correlative with the Grainger Formation in eastern Tennessee, the Waverly Group in Ohio, Kentucky, and West Virginia, and the Pocono Formation in Pennsylvania, Maryland, and northern Virginia (Weller and others, 1948). The Price Formation is unusual in that it contains the geologically oldest commercially mined coal in North America.

Marius R. Campbell (1894, 1925) named the Price Formation from exposures on Price Mountain, Montgomery County, Va. Although no type section was specified, the formation was clearly defined as having a massive conglomerate at its base and a gradational upper boundary with the predominantly red Maccrady Formation. Campbell named the basal conglomerate member the Ingles Conglomerate for small exposures on Ingles Mountain. Charles Butts (1933, 1940) determined that the conglomerate on Ingles Mountain was Silurian in age, and he renamed the Lower Mississippian conglomerate associated with the Price Formation the Cloyd Conglomerate for exposures on Cloyd Mountain, Pulaski County, Va. We use the name Maccrady for all immediately post-Price

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Formation red beds in the study area, including the Stroubles of Cooper, 1961. Byron Cooper published frequently on the Price Formation (1937, 1939, 1944, 1961, and 1963), and his works give full reviews of previous studies of the Formation.

There has been little consistency to the environmental interpretations of the Price Formation by previous workers. It has been interpreted as deltaic (Branson, 1912), wholly non-marine (Campbell, 1925), dominantly marine (Cooper, 1937), partly marine and partly non-marine (Butts, 1940), dominantly non-marine except in western belts (the "Parrott Formation") (Cooper, 1961, 1963), and a combination of density current, normal marine, and brackish water and mud-flat deposits (Walker, ms). This variety of environmental interpretations results from facies changes in a complex of poorly defined and described stratigraphic units.

This study describes the variety of depositional environments represented in the Price Formation and interprets the development of the Price Formation as a westward prograding deltaic shoreline complex.

Fifteen sections of the Price Formation in central southwestern Virginia were investigated. Their locations are shown in figure 1. Sections 2, 5 to 13, and 15 were the subject of a master's thesis at Virginia Polytechnic Institute and State University by R. D. Kreisa (ms). Sections 7 to 10, located on the southeastern slopes of Cloyd and Brush mountains, were measured and described in detail for that study. Eighty-seven thin sections were prepared, and modal and grain size analyses were performed on them. A paper on the petrography of the Price Formation is now in preparation by Mr. Kreisa. Detailed information was also available for section 3, measured by K. R. Walker (ms); section 5, measured by B. N. Cooper (1937); and section 1, measured by D. Blancher (unpub. 1972). We have reexamined these sections and have also examined eight other sections and determined the thicknesses of the major facies in them.

The terminology used in this paper is adopted from the following standard sources. Bedding and thickness terms are those defined by Ingram (1954). Roundness terms are those of Powers (1953). Grain sizes are after Wentworth (1922) and Krumbein (1934). Rock names and petrographic classification follow Folk (1968).

FACIES AND ENVIRONMENTS

The Price Formation and its northern correlative, the Pocono Formation, are a wedge of terrigenous sediments resulting from erosion during and following late phases of the Acadian orogeny. The dominant rock types of the formation are sublitharenites and litharenites. Lithofacies, isopach, and paleocurrent studies show that the direction of transport for these sediments was from the east and southeast (Pelletier, 1958; Walker, 1962; Kreisa, ms). The source terrane was dominated by sedimentary and low-grade metamorphic rocks (Kreisa, ms). The environments of deposition of the Price Formation were nearshore marine, shore-

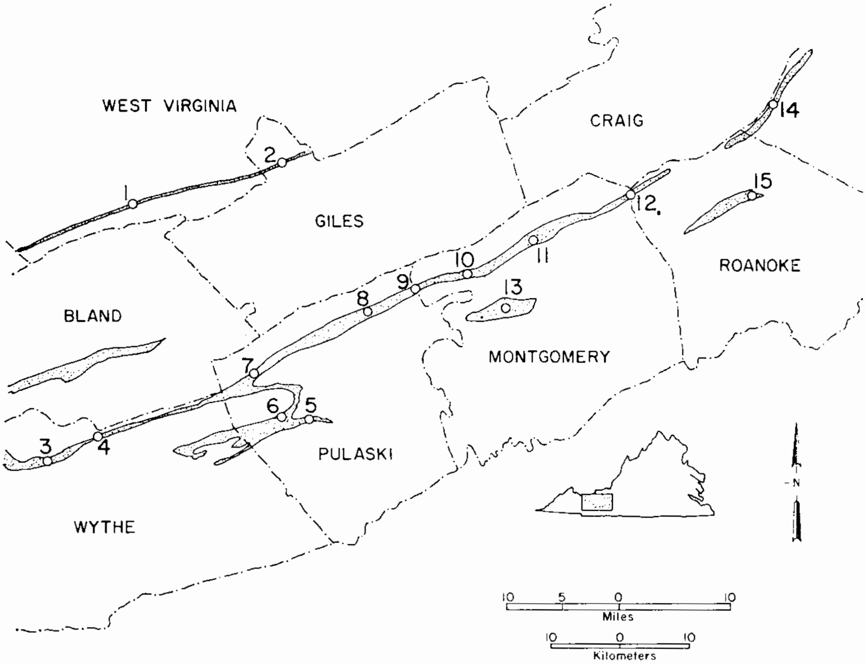

Fig. 1. Index Map with locations of studied sections of the Price Formation. Outcrop pattern of the Price Formation is shaded.

(1) Interstate 77 cut at the East River, 10.5 km (6½ miles) east of Bluefield (Mercer County), W. Va.

(2) Norfolk and Western Railroad cut on the west side of the New River, 3.2 km (2 miles) north of Narrows (Giles County), Va.

(3) U.S. Highway 52 cuts at Stony Creek, 9.5 km (6 miles) west of Wytheville (Wythe County), Va.

(4) Interstate 77 cuts through Little Walker Mountain, 9.5 km (6 miles) north of Wytheville (Wythe County), Va.

(5) U.S. Highway 11 cut at base of Draper Mountain, Pulaski (Pulaski County), Va.

(6) Virginia Route 710 cuts on Caseknife Ridge northwest of Pulaski (Pulaski County), Va.

(7) Virginia Route 738 on Little Walker Mountain, 10.5 km (6½ miles) northwest of Pulaski (Pulaski County), Va.

(8) Virginia Highway 100 on south slope of Cloyds Mountain 9.5 km (6 miles) north of Dublin (Pulaski County), Va.

(9) Norfolk and Western Railroad cuts on west side of the New River, 0.8 km (½ mile) north of Parrott (Pulaski County) Va., and supplementary exposures in the New River.

(10) State route 781 cuts in gap through Brush Mountain 13 km (8 miles) northwest of Blacksburg (Montgomery County), Va.

(11) U.S. Highway 460 cuts on south slope of Brush Mountain, 3.2 km (2 miles) north of Blacksburg (Montgomery County), Va.

(12) Single lane road on south slope of Brush Mountain, 1.6 km (1 mile) into Roanoke County, Va., from the Roanoke-Montgomery County line; 19 km (12 miles) northeast of Blacksburg, Va.

(13) Exposures on trails extending north and west from the summit of Price Mountain (Montgomery County), Va. and along State routes 643 and 657 at and east of Merrimac (Montgomery County), Va., and supplemented by sample cuttings from Kipps Anthracite Coal #1 Well (California Co.) on the summit of Price Mountain.

(14) Trail to the summit of North Mountain at the Craig County-Botetourt County line and Fire Road along Stone Coal Creek through North Mountain (Botetourt County), Va., 13 km (8 miles) west of Fincastle, Va.

(15) Fire and access roads on the east and south slopes of Fort Lewis Mountain (Roanoke County), Va., 6.5 km (4 miles) north of Salem, Va.

line complex, and deltaic. Taken collectively the facies of the Price Formation constitute a well-defined regressive sequence.

We recognize eight lithofacies in the Price Formation. These are:

1. bioturbated shales with marine fossils (marine shelf);
2. interbedded sandstones with sole markings (prodelta slope);
3. massive bedded, well rounded, and sorted quartz pebble conglomerates and interbedded quartz arenites (bar and barrier);
4. dominantly thin-bedded fine-grained sandstones and mudstones with marine fossils (barred bay);
5. thin- to thick-bedded bimodally sorted sandy conglomerates (mixed washovers);
6. medium-grained, frequently trough cross-bedded sandstones with fragmentary plant fossils (distributary channel);
7. interbedded very fine sandstones and sandy shales with some bioturbation and plant fossils (delta plain);
8. coal and carbonaceous shale (swamp).

Data on these facies are summarized in table 1.

The distribution of these facies is not uniform in the study area (figs. 1 and 2). All the facies are present in the central area (secs. 8-11). Marine facies predominate to the northwest where section 1 is exclusively marine, and deltaic and probable alluvial facies compose the entire Price Formation to the east (secs. 14 and 15). The non-marine facies are a wedge-shaped body of rock (fig. 2), thinning both southwestward and northwestward. This wedge shape is typical of a prograding deltaic sequence with basin filling starting at the thicker sections and progressing to the thinner sections. Concomitantly, the barred-bay facies above the Cloyd Conglomerate thicken toward the southwest and northwest.

Control for determination of the detailed distribution of each minor environment in the deltaic complex is not available for several reasons. Exposures of the Price Formation are limited in lateral extent because of faulting, folding, and abundant colluvial cover. Erosion has removed the Formation from large areas between outcrop belts. Most sections are rather distantly spaced at the points where roads or streams cut across the Appalachian ridges. As a consequence of the sparse control our picture of the facies pattern is rather generalized.

In the following sections, we discuss the criteria used to recognize the depositional environments present in the Price Formation. The general facies pattern that emerges provides a framework for the concluding section on the paleogeographic development of the Price Formation in its type region.

MARINE SHELF AND PRODELTA SLOPE

Interbedded shales and sandstones of facies 1 and 2 (table 1) underlie the Cloyd conglomerate (facies 3) in the central outcrop belt and also compose the entire section of the Price at section 1, the most northwestern section (figs. 1 and 2). Abundant marine fossils of at least 5 phyla (brachiopods, bryozoa, mollusca, echinodermata, "worms") demonstrate

TABLE 1

	Facies (1)	Facies (2)	Facies (3)
Environment	marine shelf	prodelta slope	bar and barrier
Characteristic Lithology	shale and sandstone	fine to medium sandstone	granule and pebble conglomerate
Composition (from thin section)	no data	no data	quartz arenite
Color	dark gray to black	medium to dark gray	light to medium gray
Bedding	thin to very thick bedded	thin to very thick bedded	medium to very thick bedded
Size in thin section (mean ϕ)	no data	no data	0.60 (1.41 to —0.49) pebbles to 70 mm
Sorting in thin sections	no data	no data	1.24 (1.06—1.61)
Rounding	no data	no data	granules and pebbles well rounded; disc-shaped pebbles common
Sedimentary Structures	bioturbation	planar cross bedding; ripple marks; graded bedding; sole marks; flutes, drag marks; shale chips (up to 70 cm in diameter); bioturbation	characteristically massive beds; planar bedding; large ripples and sand waves (to 1 m. wave length). finer grained beds: ripples, scour and fill; some poorly sorted beds especially in basal portions
Fossils	brachiopods: rhynchonellids, spiriferids crinoids; Zoophycos and other burrows varied fauna reported by Glover (ms)	brachiopods: chonetids, rhynchonellids crinoids Zoophycos	brachiopods: rhynchonellids, spiriferids bivalves: modiomorphids, pterioids comminuted plant debris fossils restricted to basal, more poorly sorted beds
No. of thin sections	none	none	4

Facies (4)	Facies (5)	Facies (6)	Facies (7)	Facies (8)
barred and inter-distributary bay	mixed "wash-over" beds	distributary channel	delta plain	swamp
mudstone and very fine to fine sandstone	sandy conglomerate	medium sandstone	interbedded sandy shale, mudstone and fine sandstone	coal and carbonaceous shale
mostly sublith-arenites, with some litharenites, and feldspathic litharenites	sublitharenites	litharenite	liatharenite	coal
light to medium-dark gray	medium gray to reddish gray	light gray to yellowish gray, white specks of micaceous rock fragments common	light gray, greenish gray to dark gray some red near top	black
thin to very thick bedded	thin to thick bedded	thin to medium bedded	thinly lami-nated to thin bedded	very thin to thick bedded
3.89 (2.73—5.04)	fine mode 3.89 (3.62—4.54) coarse mode —0.11 (0.56 to —0.75)	2.58 (1.4 —3.90)	3.71 (2.70—4.90)	— —
0.463 (0.25—0.86)	fine mode 0.56 (0.49—0.69) coarse mode 0.73 (0.52—1.01)	0.64 (0.49—0.95)	0.81 (0.57—1.15)	— —
angular to subrounded	fine mode angular to subrounded coarse mode subrounded to well rounded	angular to subrounded	angular to subrounded	— —
thin cross lami-nation, ripple marks; even bedding; calcite cemented sand pebbles (discrete horizons); shale chips; bioturbation	laterally variable hematite cement	lenticular bed-ding; large trough cross beds; high angle tabular cross beds; asymme-trical and symme-trical ripple marks; channels (to 100 m across); shale chips; fining upwards (size and bed thickness) sequences	regular, often rhythmically repeated beds; ripple marks; bioturbation	— —
brachiopods: chonetids, rhynchonellids, spiriferids, linguloids bryozoa; bivalves: modiomorphids, pteroids, gastropods crinoidea; bur-rows and trails	brachiopods including linguloids bivalves	plants: leaves, twigs, trunks (to 2 meters long) coal lenses burrows	plants: coaly partings, roots, twiggy debris	plants
19	5	21	24	none

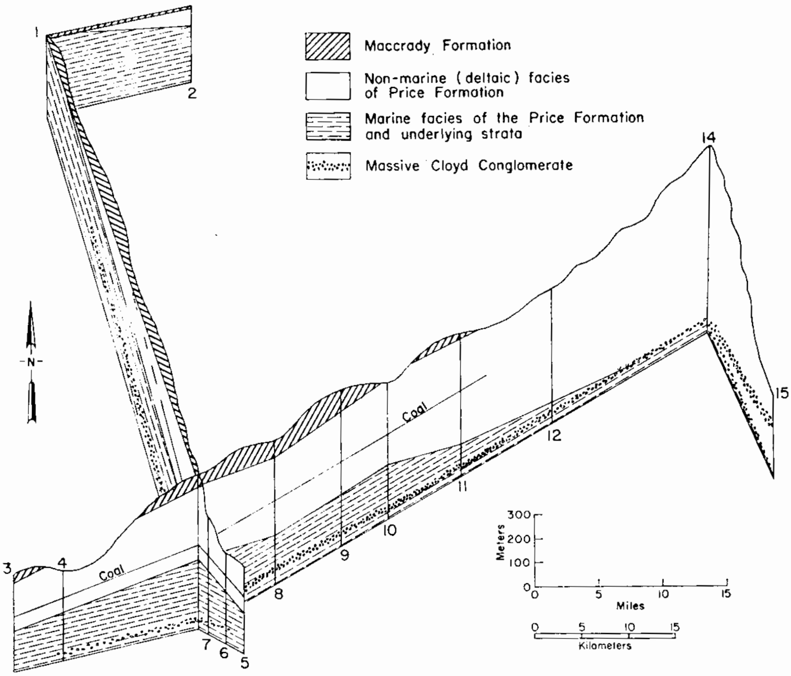

Fig. 2. Fence diagram of the Price Formation and adjacent strata.

that these beds were deposited under marine conditions. Aligned sole markings, graded bedding, and shale clasts in the sandstones indicate high-energy current deposition of the sands, probably by slump and turbidity flow down slope. The shale clasts are lithologically and paleontologically identical to the shales enclosing the sand beds. They are apparently chunks of cohesive mud ripped up as the flow of sand commenced and were then incorporated in the sand beds. Escape burrows in the sandstones also indicate rapid deposition. We believe a variety of water depths are represented by facies 1 and 2 in the central and eastern region, including local shoals which probably built up to sea level. In the northwest (sec. 1) water depths never became particularly shallow either before or during Price sedimentation. The principal reasons for this assumption are the presence of abundant *Zoophycos* throughout this section and the uniform lithologies there. *Zoophycos* and associated large horizontal burrows at this locality excellently represent the "*Zoophycos* ichnofacies" of Seilacher (1964, 1967). Despite the reservations of Osgood (1970), it is apparent that the *Zoophycos* ichnofacies is indicative of deposition offshore from the strandline and probably well below the depths where sediment is regularly disturbed by waves (Seilacher 1967; Rodriquez and Gutschick 1970; Chamberlain 1971a, b). The shales at section 1 are much darker in color, finer grained, and more massive than in the sections to the southeast. The sandstones at section 1 show conspicuous features related to deposition by turbidity flow processes. They, too, are consistently reworked by *Zoophycos*. The intermediate-depth marine features through section 1 set a limit to the northwestern extent of progradation of the shoreline during Price sedimentation. The position of facies 1 and 2 under the Price Formation and at its distal western margin fits a model of a marine shelf and prodelta slope receiving sediment both from suspension (the shales of facies 1) and by flow at the sediment surface as sands (facies 2) that were shed down the slope of a prograding delta complex during storms, floods, or other high-energy disturbances.

BAR AND BARRED BAY

The Cloyd Conglomerate (facies 3) is typical of sediment deposited in a high-energy environment. The sediments are dominantly coarse grained and well rounded. They are composed almost entirely of quartz. Even the find sands are free of the rock fragments that are common in the remainder of the Price (Kreisa, ms). The bed forms, sorting, and roundness are those expected in beach and bar deposits (see table 1). The marine fossils in the basal beds indicate marine deposition, and common disc-shaped pebbles strongly suggest that the beach environment (Dobkins and Folk, 1970) was the dominant environment in which Cloyd deposition occurred.

The even bedding, fine-grained sediment and abundant fossils of the beds overlying the Cloyd (facies 4 of table 1) indicate deposition in protected, moderately low-energy marine environments. The nature of the fauna, especially the pelecypod-linguloid brachiopod association, suggests shallow, nearshore conditions (Bretsky, 1969). Abundant chonetid brachiopods also indicate shallow water (Stevens, 1966; Calef and Hancock, in press). We interpret the environment of deposition of the marine beds above the Cloyd (facies 4) as a barred bay with the Cloyd forming the bar.

Between the bay deposits (facies 4) and the overlying deltaic facies (facies 6-8) there are commonly 7 to 25 m of shaley, even-bedded, bioturbated, and ripple-marked rocks. They lack shelly fossils but contain abundant small, shredded plant remains. The physical appearance of the beds is similar to the barred-bay deposits, including the presence of distinctive sandy conglomerates interpreted as storm washovers from a Cloyd bar (see discussion below), but the absence of shelly fossils implies a more unstable environment inhospitable to many marine animals. The stratigraphic position between unambiguously marine and stream-dominated deltaic sediments indicates that these beds are probably the strandline sediments of the sequence. They were probably deposited on shallow flats and marshes in brackish waters.

The Cloyd conglomerate developed as a shoal and bar system extending southwestward across the central part of the study area and enclosing a broad shallow bay to the southeast (see figs. 3-6). The interpretation of the Cloyd as an offshore bar complex and the overlying marine deposits as a barred bay rather than as a more conventional regressive-transgressive sequence is supported by several lines of evidence.

The fence diagram (fig. 2) shows the vertical and areal distribution of the Price Formation and related lithologies. It is significant that the Cloyd is present as a massive conglomerate in the central outcrop belt and thins and disappears to the southeast, southwest, and northwest. The marine bay deposits thin and disappear northeastward along the central belt, leaving the Cloyd beach at the marine-terrestrial boundary at the northeasternmost section (sec. 14). If the Cloyd had always been deposited at the strandline, it should have appeared at the marine-terrestrial boundary in all sections. Instead, the Cloyd is a tongue of conglomerate enclosed by marine deposits.

The source of the pebbles in the Cloyd does not seem to be from streams flowing directly across the study area from the southeast. Quartz pebbles and granules are not found in abundance in either correlative beds to the southeast (sec. 5) or in the overlying deltaic sequences at any section southwest of section 14. They do occur in non-marine beds at section 14 and in abundance at section 15 and in Pocono lithologies further to the north. It is apparent that the pebbles in the Cloyd Conglomerate were brought to the shoreline by a fluvial system located at the northeast margin of the study area near section 14 and then transported southwestward by longshore drift to form a bar complex.

The sandy conglomerates (facies 5) in the bay sediments and transitional beds also support the interpretation of the Cloyd as a bar. The size sorting of both the Cloyd and the bay sediments is unimodal (table 1). The sandy conglomerates are an exception. They are extremely bimodal often with a complete absence of grains in as many as two phi (ϕ) units in the gap separating the two modes. Invariably the finer mode is identical in size, sorting, roundness, and mineralogy to the mudstones and fine sandstones of the bay deposits (facies 4) whereas the coarse mode consists of quartz pebbles and granules petrographically and texturally identical to those in the Cloyd (table 1, facies 3; and Kreisa, ms). Textural inversions of this nature are diagnostic of storm-washover deposits (Folk, 1968). No source is apparent for these pebbles to the southeast. The sandy conglomerates persist up into the transition beds but are completely absent in the overlying deltaic deposits, as are all pebbles except in the far northeastern sections. The only plausible source for these sandy conglomerates is as storm washovers from a pebbly bar system lying northwest of the bay deposits.

The relation of the transition beds to the overlying deltaic sequence also argues for the presence of a protecting bar. These transition beds are thinly and evenly bedded, fine grained, and have no characteristics of a high-energy surf-zone deposit, yet they occur at the strand line. The marshy bay shoreline was apparently protected from strong waves and currents of the surf zone by the Cloyd offshore bar system. The transition beds include several sandy conglomerates which contain well-rounded quartz pebbles (facies 5). These pebbles were rounded in a high-energy regime unlike the environment of the transition beds and subsequently washed into this low-energy environment. These pebbles were rounded in the Cloyd surf-zone environment at the same time the transition beds were deposited along the shoreline of the protected bay.

DELTAS

The non-marine strata, which occur at the top of all sections except section 1, represent prograding deltas. The three interbedded facies (table 1, facies 6, 7, and 8) display many features that are diagnostic of deposition controlled by freshwater streams. The coarser sandstone facies (facies 6) has features, such as bedding characteristics, abundant plant fossils, and fining upward sequences of both stratification and grain size, which are associated with stream channels (Allen, 1964, 1965, 1970). The finer grained facies (facies 7) displays the stratification, grain-size, and sorting characteristics of overbank deposits. Coals (facies 8) represent accumulations of peat in fresh water swamps (Dapples and Hopkins, 1969).

In most sections these facies are interbedded, but facies 6 predominates in the lower part of the non-marine sequence and facies 7 predominates in the upper part. Coals occur at several horizons but are definitely thicker and more continuous in the middle and upper parts of the sequence. This distribution of facies is typical of deltas. Distributary sands, both as distributary mouth bars and channel sands, are located at the base and prograding edge of a delta, and fine-grained delta plain sediments, including the fresh-water peats of the upper delta plain, predominate in the upper part of a delta wedge (Morgan, 1970). The non-marine portion of the Price Formation appears to be composed of a series of coalesced deltas of various sizes. Limited exposure prevents mapping of the detailed facies relationships within any one of these deltas. However, almost all the typical features of deltas are exposed in one section or another. At several sections there are distinctive sandy sequences in the barred bay and transitional deposits (facies 4), which coarsen upward in grain size and bedding thickness. These are probably parts of distributary mouth bars. Several are well exposed at section 8. Channels as much as 100 m across are exposed at section 11. They do not show the features, such as sinuosity, normally associated with meandering alluvial channels (Allen, 1965). They are probably distributary channels which were commonly straight and shifted by crevassing rather than meander migration. The fine-grained facies (facies 7) contains exquisitely preserved, untransported plant fossils including large trunk sections and leaf-covered stems at sections 8 and 11. Distinct root structures were seen in several sections. Sheet sandstones deposited in meandering stream channels are present at sections 10 and 11. These are typical features of delta plains. The presence of coal beds is typical of upper delta-plain sedimentation in the swamps between stream channels where little terrigenous sediment accumulates.

PALEOGEOGRAPHY

The Price Formation in its type area developed as a prograding deltaic complex modified by longshore drift. The paleogeographic reconstructions (figs. 3-7) depict the migration of depositional environments through the study area.

The paleogeographic pattern in the Price seems to have been controlled by the debouchement of a large stream or small river near the northeastern margin of the region. The non-marine sections are very thick there (700 m at the incomplete section 14). The wedge of deltaic sediments thins southwestward to 400 m at section 11 (complete) and 250 m at section 3. Northwestward it decreases to 180 m at section 2 and thins to zero at section 1. Pebbles are absent in the deltaic deposits in most of the region, but they are common in the stream deposits of sections 14 and 15. Extensive beds of unsorted conglomerate with subangular to subrounded pebbles occur in the non-marine deposits of section 15. These conglomerates probably represent proximal stream deposits correlative with the well sorted conglomerates of well rounded pebbles (facies 3, the Cloyd Conglomerate) which extend southwestward from section 14. Strong longshore drift was probably responsible for moving sediment southwestward from a river mouth near section 14. It created an asymmetric delta with a barred bay on the lee side. Smaller streams built small deltas into this bay. Asymmetric deltas and barred bay systems produced by longshore drift are present in the Gulf of Venice and on the south side of the Po River Delta (Nelson, 1970) and in the Klang and Langat River Deltas of Malaysia (Coleman, Gagliano, and Smith, 1970). Interestingly, these deltas are all related to small rivers draining tectonically active areas. They are probably very good recent analogues for Appalachian Basin tectonic delta systems, such as the Price Formation.

The bay behind the shoal bar and barrier system received sediments from small fluvial sources to the southeast, and the shoreline prograded westward as small deltas were built into the bay. In this manner marine rocks in sections in the central outcrop belt were progressively overrun by non-marine strata as the strandline shifted northwestward. The barred bay sediments (facies 4) reflect this strandline migration in their thickness variation (marine facies above the Cloyd Conglomerate in fig. 2). To the east, where the strandline arrived shortly after the Cloyd bar system had developed, the bay sediments are thin (45 m at sec. 12, 80 m at sec. 11). To the southwest, where the strandline arrived only after the original area of the protected bay had been nearly completely filled, the bay sediments are thicker (250 m at sec. 7).

Figure 3 shows the area at the time the Cloyd bar system first extended into the type area at Price Mountain (sec. 13). The bar system was constructed across a preexisting shoal which was the top of a small delta system (shown on fig. 3 as a dashed line) that had formed previously in the Blacksburg area and is exposed below the Cloyd conglomerate at

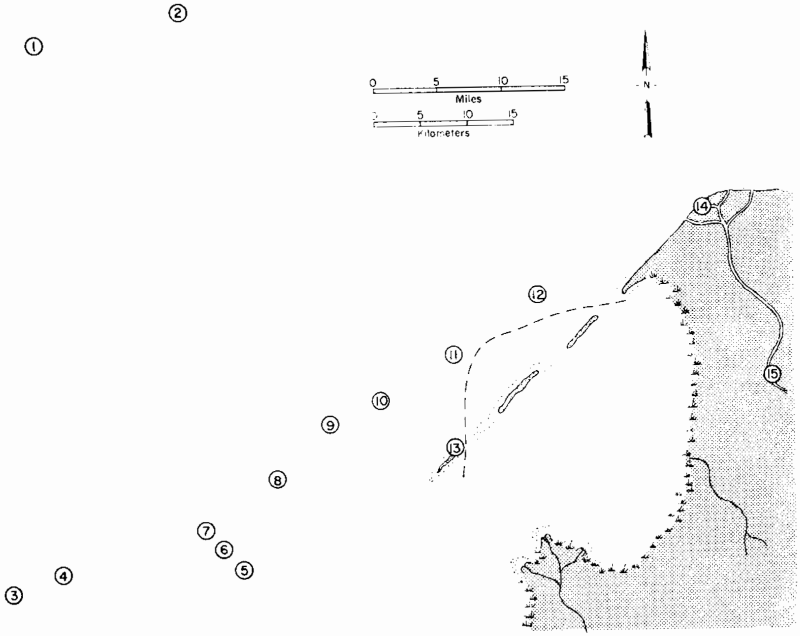

Fig. 3. Paleogeographic reconstruction of the time (T-1) of the first appearance of the Cloyd conglomerate at Price Mountain (sec. 13). This is the start of Price sedimentation at the type section. Land area shaded.

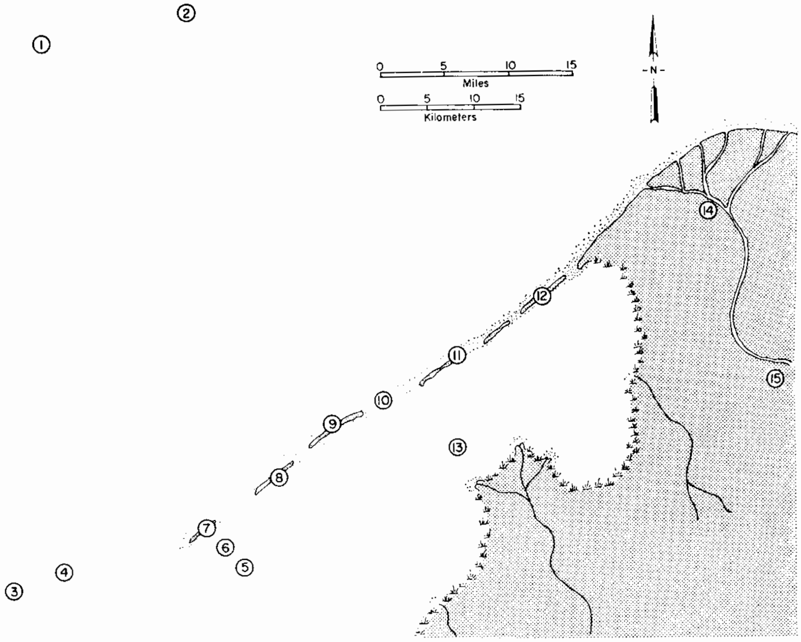

Fig. 4. Paleogeographic reconstruction of the time (T-2) when the Cloyd conglomerate was deposited in the central outcrop belt (sec. 7-12).

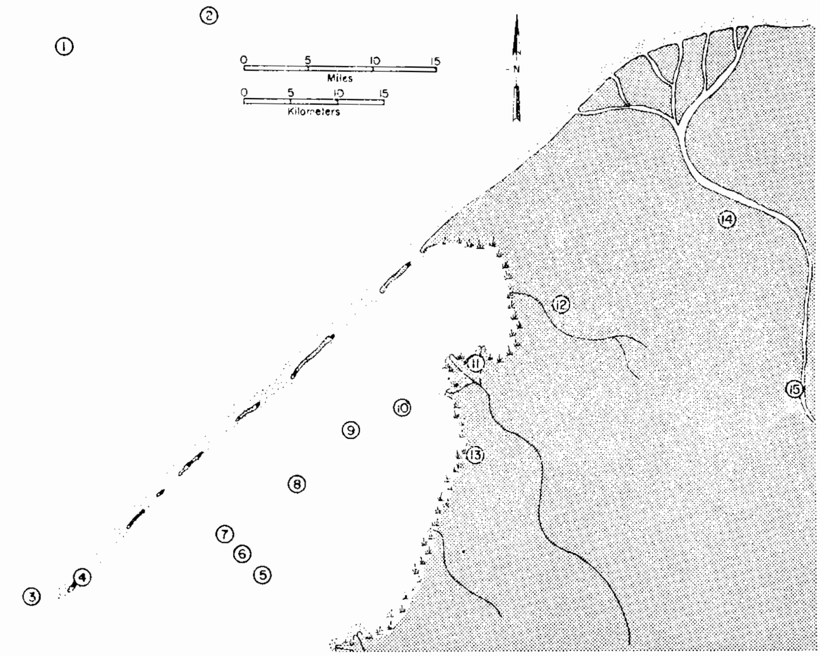

Fig. 5. Paleogeographic reconstruction of the time (T-3) when deposition of the Cloyd conglomerate occurred near Wytheville (sec. 4) and deltaic sedimentation started in the central outcrop belt (at secs. 11 and 12).

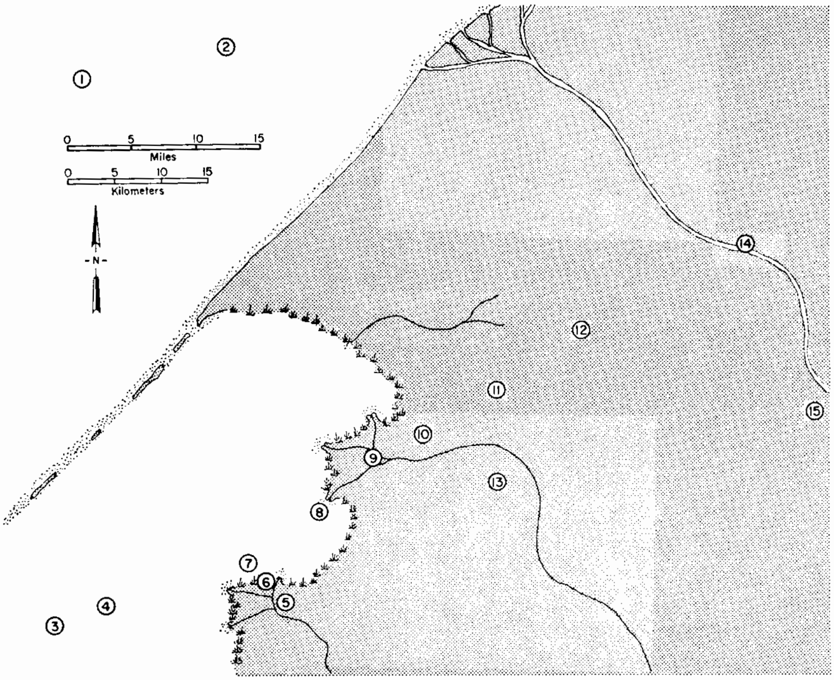

Fig. 6. Paleogeographic reconstruction of the time (T-4) when deltaic sedimentation was extending widely across the central outcrop belt.

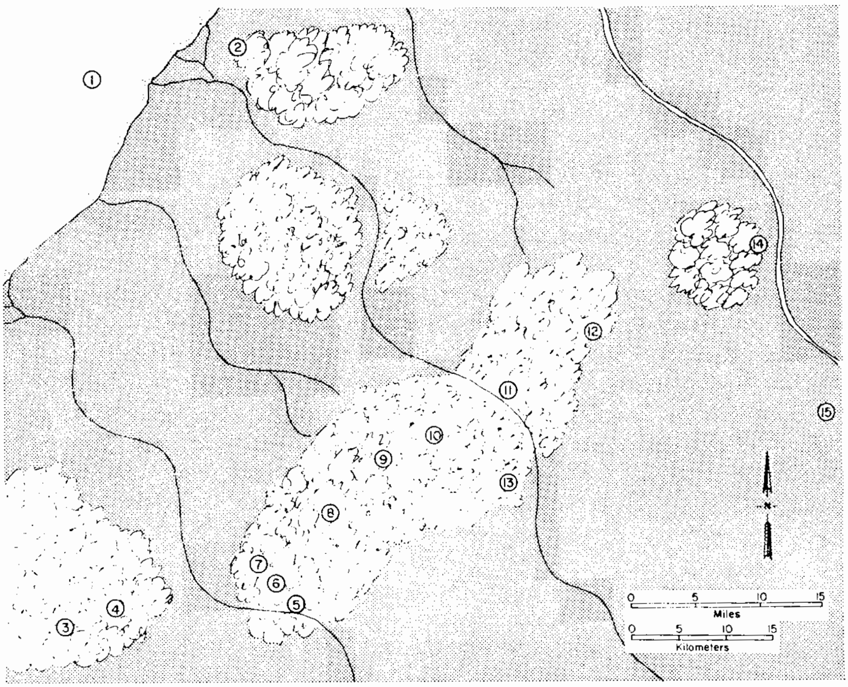

Fig. 7. Paleogeographic reconstruction of the time (T-5) of maximum northwestward progradation of the shoreline during deposition of the Price Formation in its type area. Coal swamps (pattern) were developed on the delta plain.

sections 11, 12, and 13. When first developed, the Cloyd was a discontinuous bar system now seen as lenses of conglomerate ranging from 20 cm to 2.5 m in thickness. At this early stage the conglomerates did not extend as far southwest as the Pulaski area (secs. 5-7).

Figures 4 to 6 illustrate the progressive development of the Cloyd bar and barrier system and the sequence of small-delta progradation at the bay margin. In figure 4 the Cloyd has extended to section 7 (near Pulaski) and is present as a massive unit, as much as 25 m thick, along most of the central belt of outcrops. The thinning and disappearance of the Cloyd southeast of section 7 shows that the Cloyd bar was being built from northeast to southwest by longshore drift and not directly from the southeast. The conglomerate is less than a meter thick at section 6 and is not present at section 5. In figure 5, the Cloyd bar system has prograded northwestward as the marine shelf shoaled. The Cloyd has extended southeast to the vicinity of Wytheville (sec. 4), its maximum southeastern extent at this time. It does not occur at section 3. The presence of the Cloyd bar system offshore from the central outcrop belt is indicated by the appearance in the bay sediments of the sandy conglomerate beds (facies 5) discussed on page 334 as representing mixed washover deposits. The strandline of the bay had also started to prograde westward. The strata at sections 12 and 13 are now non-marine, and the large channels seen at section 11 represent distributaries of a small delta. Figure 6 illustrates a later time when the Cloyd bar system had migrated further northwest. At this time it extended into the outcrop belt in Bland County (fig. 1). The small deltas along the shore of the bay had extended further to the west and north, prograding through more of the studied sections.

Figure 7 records the maximum extent of deltaic progradation during deposition of the Price Formation. The shoreline stabilized between Bluefield, W. Va. (near sec. 1) and Narrows, Va. (sec. 2). During the time when 180 m of deltaic sediment accumulated at Narrows, coal swamps formed at several places on the delta plain. Mineable coal is found at Wytheville, Narrows, Pulaski, and Price Mountain near Blacksburg.

The Price Formation in its type area represents a complex facies suite. The interaction of delta building and marine processes as the shoreline prograded northwestward created the facies mosaic preserved today.

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