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A STRATIGRAPHER'S VIEW OF THE CAROLINA SLATE BELT SOUTHCENTRAL NORTH CAROLINA

Prepared by

Gail G. Gibson Steven A. Teeter

Department of Geography & Earth Sciences

University of North Carolina at Charlotte

Charlotte, North Carolina 28223

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INTRODUCTION

The Carolina slate belt is one of several geologic provinces that comprise the southern Appalachian Piedmont. The slate belt occurs as a narrow band of relatively undeformed volcanic and volcanosedimentary facies that extend from central Georgia northeastward to central Virginia (Fig. 1). In southcentral North Carolina, the slate belt is bounded by Triassic sediments preserved in half grabens, on the east, and by the Gold Hill-Silver hill fault zone on the west. West of the fault zone lies the igneous-metamorphic complex that is the Charlotte belt. The slate belt in southcentral North Carolina has for the most part been mapped only on reconnaisance scale N.C. Geologic Map, 1958; Bert, 1981) and the slate belt units have frequently been lumped under such terms as "argillite" or "slate". In several areas, more detailed mapping has been carried out, but the stratigraphic-sedimentologic characteristics of slate belt units have not been detailed (Conley and Bain, *1965;* Sundelius and Stromquist, 1978).

The purpose of this field trip then is; to examine some of the stratigraphic-sedimentologic characteristics of the Carolina slate belt in Stanly and Montgomery counties, North Carolina. Since the area we will be looking at has undergone little metamorphism, we will dispense with such terms as "metasiltstone" or "metagraywacke" and instead speak in terms of "sands", "silts", and "clays", referring to the original sediment characteristics.

STRATIGRAPHIC TERMINOLOGY FOR THE CAROLINA SLATE BELT, ALBEMARLE AREA

The Carolina slate belt is a recognizable aggregate of volcanic, volcano-sedimentary, metamorphic, and intrusive igneous lithologie that are complexly related in time and space. Extensive lithostratigraphic correlations are essentially non-existent because of: l) the complex variability of volcanic terranes; 2) Post-depositional alterations; 3) lack of continuity of exposures; 4) interests of geologist working in the area; 5) the rather monotonous lithologies and subtle facies changes characteristic of the Albemarle Group; and 6) preconceived ideas of local and regional geology. Consequently, stratigraphic terminology for the Carolina slate belt is frequently based on broad generalizations about an area or region, or on detailed work in a relatively small area whose lithologies may not be extensive enough to allow carrying the terminology beyond that area.

In southcentral North Carolina, the pioneer stratigraphic study in the slate belt (Conley and Bain, 1965) established stratigraphic designations for the volcanic and volcanosedimentary units. Their stratigraphic column (Fig. 2) includes: the Uwharrie Formation; and the Albemarle Group, which is composed of the Tillery Formation, the McManus Formation, and the Yadkin Graywacke, which was thought to be unconformably overlain by the Tater Top Group of "volcanic" rocks. Work by Stromquist and Sundelius (1969), Stromquist, Choquette, and Sundelius (1975), and Sundelius and Stromquist (1978) north and west of the Albemarle quadrangle and the resulting stratigraphic terminology (Fig. 2) illustrates the variability of the volcanically-derived lithofacies in this part of the slate belt. Dan Milton (personal communication) recognized the interfingering relationships of the Flat Swamp volcanics, the "Badin" greenstone, and the Morrow Mountain rhyolites into the Albemarle Group and that these units are not regionally extensive.

Our work and present level of stratigraphic analysis of the slate belt units in Stanly, Montgomery, Anson, and Union counties has resulted in a modification of existing stratigraphic terminology (Fig. 3). This modification of terminology accommodates our present concept of the depositional history of the slate belt in this area. We have retained the Uwharrie, Tillery, McManus, and Yadkin at formational status, as originally defined, with the latter three units comprising the Albemarle Group. However, we have found it convenient to subdivide the McManus Formation into two members, a lower informal member - the mudstone member as described by Stromquist and Sundelius (1969), and the upper, Floyd Church Member, in the sense of Stromquist and Sundelius (1969). The volcanic unit (Flat Swamp 'volcanics') used by Stromquist and Sundelius (1969) is not present in the area we are working. Our present interpretation is that the mudstone member and the Floyd Church Member are more closely related than the Floyd Church Member and the Yadkin Graywacke, particularly in the absence of the Flat Swamp volcanic units.

One of our goals is to establish an acceptable stratigraphic nomenclature for the slate belt sequence in the Albemarle area and extend that nomenclature outward into other areas. We also recognize that the nomenclature and unit boundaries may be altered as more detailed work is undertaken on the stratigraphic implications of the Carolina slate belt.

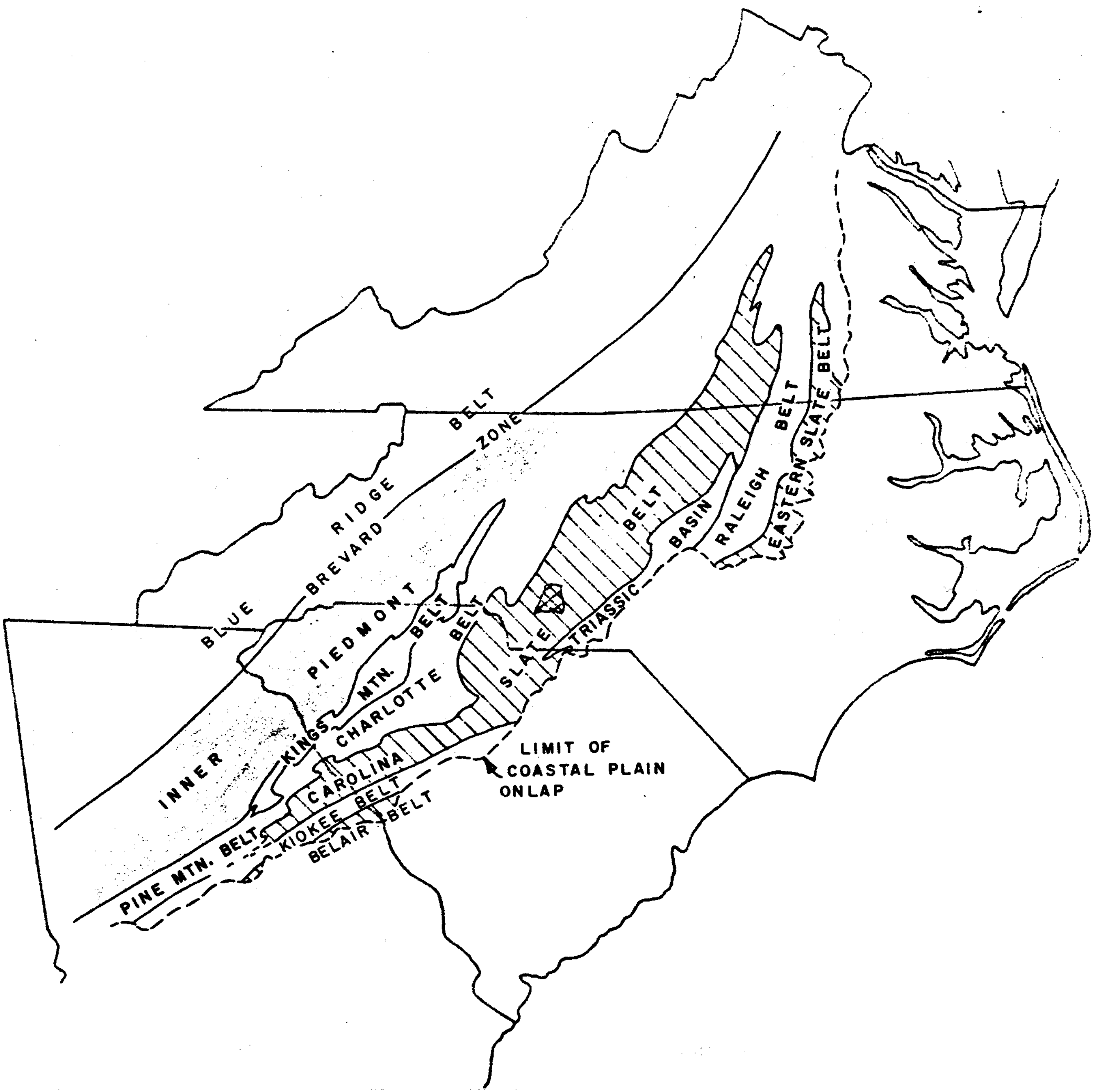

Figure 1. Carolina slate belt, its regional setting.

BRIEF DESCRIPTION OF CAROLINA SLATE BELT STRATIGRAPHIC UNITS, ALBEMARLE AREA

Although the complex of volcanic, volcanoclastic, and volcanosedimentary rocks of the Carolina slate belt in south-central North Carolina are reasonably well exposed, subtle vertical and lateral facies changes are not everywhere easily recognizable. The difficulty in recognition of stratigraphic units is related to the generally fine-grained nature of most of the slate belt sequence, lack of easily recognizable markers, rather subtle facies changes, the overall monotonous gray coloration of fresh surfaces that tends to mask lithologic variations, and weathering characteristics of the rocks.

Uwharrie Formation

The oldest mappable unit in this part of the slate belt is the Uwharrie Formation, which crops out east of the Pee Dee River on the line of ridges that are part of the Uwharrie

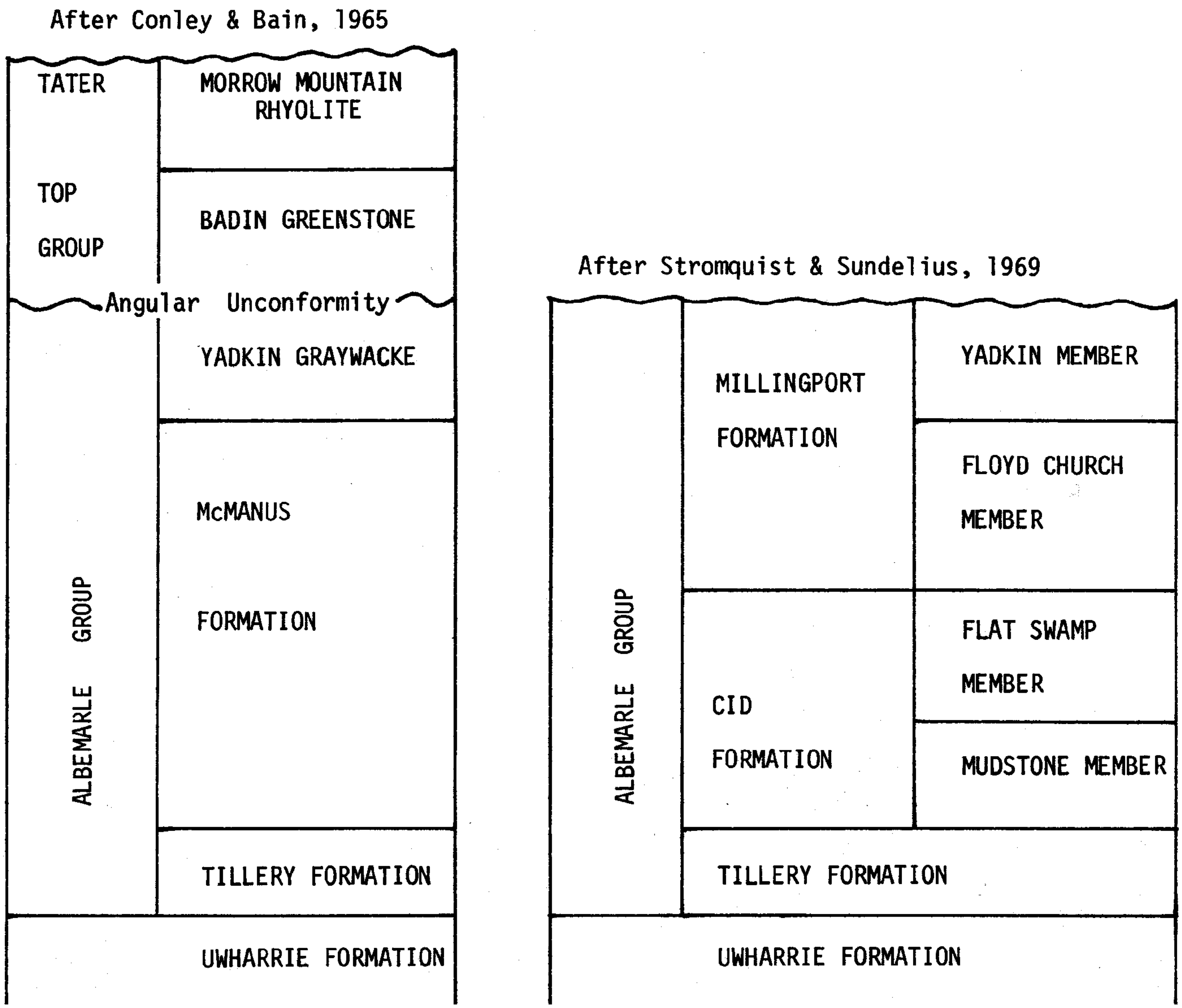

Fig. 2 Stratigraphic terminology used in the slate belt of southcentral North Carolina.

Mountains. The upper part of the Uwharrie Formation, seen on this field trip, is composed of interbedded thin- to thick-bedded felsic lithic tuffs, crystal and crystal-lithic tuffs, flow-banded rhyolites, and recrystallized volcanic mudstone, locally known as 'novaculite'. These materials are obviously of volcanic origin, but most layers in this interval exhibit characteristics of water reworked sediments. Individual layers pinch and swell, and exhibit variation in clast size from silt and clay sizes to clasts 4 cm or more in diameter. In some layers, all clasts are very well-rounded, whereas in other layers, the clasts are angular. Some layers are clast-supported conglomerates or breccias, while immediately adjacent layers are matrix-supported conglomerates or breccias. Matrix-supported lithic tuffs (tuffaceous conglomerates) dominate the uppermost Uwharrie Formation in this area. Normal graded bedding is common in sand-sized material, as is reverse grading. Small scale cross-bedding and cross lamination in fine-pebble and smaller grain sizes is fairly common and suggests a transport direction from the north-northwest. This conclusion is based on limited data. Broad, tangential cross-bedding is also common and usually has a coarser grained layer at the base of each cross-bed set.

Recognizable lithic fragments in the conglomerates and breccias include: flow-banded rhyolite; felsite; porphyritic felsite; crystal tuff, and lithic tuff. Crystals that can be easily seen include quartz and feldspar in both euhedral and anhedral shapes.

The Uwharrie Formation in this area is generally in sharp contact with the laminated muddy siltstones and sandstones of the overlying Tillery Formation. We have selected

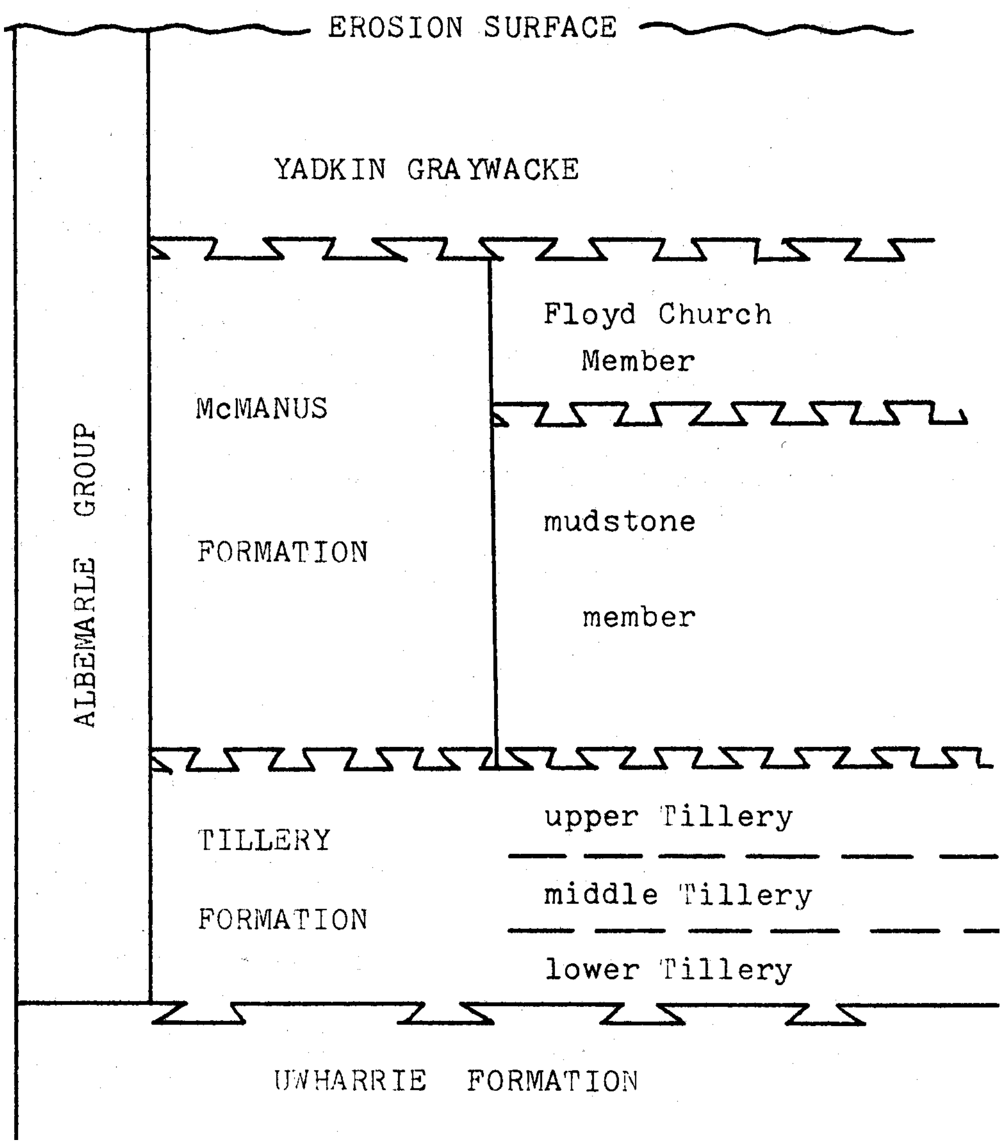

Fig. 3. Stratigraphic terminology used in present slate belt study, based on interpretation of depositional systems.

the laminated units lying directly on lithic tuffs typical of the Uwharrie as our mapping contact. This contact can be seen along SR ll5O - at mile 22.45; along SR 1146, just east of mile 23.85; and along Wood Run, where it crosses SR ll50, at mile 28.55. Along SR 109, east of the town of Uwharrie, the contact is also sharp, but the uppermost several tens of meters of the Uwharrie Formation exhibits lithologic changes that indicate gradual (?) changes in the depositional environment toward more Tillery-like conditions. This change appears to indicate waning local volcanic activity, allowing regionally prevailing depositional conditions to re-establish themselves. Elsewhere, the contact between the Uwharrie and overlying Tillery has been reported as gradational (Conley and Bain, 1965; Randazzo, 1972) and interfingering (Seiders and Wright, 1977).

No petrographic or outcrop evidence has yet been found to indicate pre-Tillery (pre-laminated units) erosion of the lithic tuffs or tuffaceous conglomerates. There does not appear to be any significant relief on the top of the tuffs, suggesting that the laminated units represent the dominant depositional environment with the volcanoclastics being added from elsewhere.

Tillery Formation

The lowest formation of the Albemarle Group is generally characterized as being rhythmically laminated to thin-bedded silty claystones (Conley and Bain, 1965) each couplet of which grades upward from silt (lighter color} to clay (darker color) sizes (Seiders and Wright, 1977). The lower contact with the underlying Uwharrie Formation is sharp, while the upper contact with the overlying McManus Formation is gradational.

Although the Tillery is generally characterized as being rhythmically bedded graded silty claystones, the lower fifty meters or so represents significantly higher energy conditions. The lower part of the Tillery Formation contains rhythmically bedded silt to fine sand laminations whose clasts are dominantly euhedral feldspar and quartz crystals, channel deposits of matrix-supported pebble-sized and larger lithic fragments and crystals cross-bedded coarse-grained sand layers, intraformational breccias whose clasts are “clay” galls, ripple-marked surfaces on medium-grained sand layers. Directional data derived from a limited number of cross-beds and ripple surfaces suggests dominant transport from the northwest, although bimodal cross bedding is present. Even in this interval, the rhythmically laminated character of the Tillery seems to dominate as the rhythmites are cut by the coarser deposits.

The middle part of the Tillery Formation is characterized by the rhythmically laminated clayey siltstones with frequent interbeds of silt, fine sand and coarse sand sizes that exhibit low-angle cross-bedding and some grading. The rhythmically laminated layers are commonly not what is considered to be normal graded bedding. Instead, the color change that suggests normal grading appears to be the result of the addition of finer grain sizes, not the loss of coarser grain sizes. This can be seen in thin sections taken from samples of Tillery at the borrow pit at the intersection of U.S. 52 and SR 1934. Dropstones are common in the rhythmites. Generally less than 2 to 3 cm in diameter, these fragments are of volcanic material and have no associations suggesting current transport into the area.

The upper part of the Tillery Formation in this area is recognized by the loss of laminated units, the addition of coarser grained siltstones, sandstones and fine-pebble conglomerates, which in turn are replaced by mudstones of the McManus Formation. Coarser clasts are readily recognizable as being of volcanic origin. This interval contains a complex of interbedded lithologies with numerous sedimentary structures indicating current deposition at various energy levels. Grain-supported fine-pebble conglomerates and breccias, matrix-supported fine-pebble breccias and conglomerates, well-sorted sandstones and siltstones, as well as 'dirty' sandstones are common. All of these textural variations are composed of angular to subrounded lithic clasts in contrast to the lithic and crystal clasts of roughly similar-appearing units at the base of the Tillery.

McManus Formation

The McManus Formation described here is that of Conley and Bain (1965) and can be divided into a lower unit and an upper unit. The lower member (mudstone member of Stromquist and Sundelius, lg69) is dominated by structureless mudstones with intermittent interbeds and interlaminations of siltstone and silty mudstones. The latter occur in layers of rhythmically laminated couplets two to three centimeters thick and appear very similar to the rhythmites of the Tillery. Massive-appearing clayey layers less than three centimeters thick are also common in this member. There is a general lack of primary and secondary sedimentary structures in this interval with the exception of discontinuous parallel laminations of siltstone around which secondary sulfides have been generated.

The upper member of the McManus Formation is the Floyd Church Member as originally described by Stromquist and Sundelius {1969). In this area, the Floyd Church Member lies directly on the mudstone member, without the intervening volcanic units named the Flat Swamp Member by Stromquist et al. (1975) in the Denton Quadrangle to the north. In this area of Stanly County, the upper member of the McManus Formation is mainly silty mudstones with up to 40 or 50 percent interbeds and interlaminations of siltstone and fine-grained sandstone. The interbeds are composed mainly of quartz grains with calcite cement and recrystallized (?) mud matrix. The sandy-silty interbeds range from less than one millimeter thick to 40 to 50 centimeters thick, are internally laminated, exhibit both normal and reverse grading, and ripple cross laminations that indicate a bimodal current direction that was generally either from the north-northwest or the south-southeast. Other sedimentary features are also common in this member, but all of which are conspicuously absent from the lower or mudstone member.

The contact between the McManus Formation and the overlying Yadkin Graywacke is gradational or interfingering in this area with mudstone becoming interbedded with medium- to fine-grained sandy units of a few millimeters to a few centimeters thick. The sandy units, characteristic of the Yadkin Graywacke, become thicker and more numerous to the eventual exclusion of the mudstone layers, as one goes up section. The sandy units in the gradational contact interval appear to be more cross laminated than similar layers higher in the Yadkin.

A fragment of a fossil with *Pteridinium*-like characteristics was recovered from bedrock near the base of this contact zone. The lithology of the bed from which the fragment was recovered is structureless mudstone characteristic of the McManus Formation.

Yadkin Graywacke

This unit is the youngest formation of the Albemarle Group and exhibits an interfingering or gradational relationship with the underlying Floyd Church Member of the McManus Formation. The Yadkin is mainly a poorly sorted, interbedded sequence of sands and silts of volcogenic origin. Interbedded in this sequence are layers of well-sorted quartzose sandstone. Sedimentary features characteristic of the

Yadkin include: ripple-cross laminations, graded bedding (normal and reverse, and that created by the addition of finer material upward); flaser, lenticular, and wavy bedding; concordant and discordant ripples; bimodal cross-laminations, which in places are in a herringbone pattern, with each cross-bed set separated from sub- and superadjacent sets by a thin layer of silt or mud. The Yadkin appears to represent the overall highest energy levels for the depositional environment of the formations of the Albemarle Group. Erosion has removed the upper part of the Yadkin.

AGE OF THE CAROLINA SLATE BELT, SOUTHCENTRAL NORTH CAROLINA

The geologic age of the Carolina slate belt in southern North Carolina continues to be a subject of discussion, especially when considering the slate belt as an exotic terrane (Secor et al., 1983) or as part of the Avalon Terrane (Williams and Hatcher, 1982). A number of radiometric dates have been determined from samples of slate belt units in southern North Carolina. These ages range from as young as 440 + 60 m.y. Pb-alpha age (White et al., 1963) to as old as 690 + 15 m.y. Rb-Sr-date (Black, 1977) The general trend of ages of slate belt rock suggested that the slate belt became younger from north to south (Kish and Black, 1982).

The discovery of metazoan fossils in the slate belt rocks of Stanly County (Gibson et al., 1984) and the recognition that these metazoans belong to the late Precambrian Ediacarian fauna indicates that the slate belt is southern North Carolina is also late Precambrian and does not become younger, at least this far south. The Ediacarian fossil, *Pteridinium*, is an element of a rather unique late Precambrian fauna; an element that has been reported only from South Australia (Glaessner and Wade, 1966); South Africa (Germs, 1972), and the Soviet Union (Fedonkin, 1981). There are no known instances in which *Pteridinium* or any of the Ediacarian fauna co-exist with Cambrian faunas.

Since the local biozone, so far defined, is the upper part of the Floyd Church Member of the McManus Formation, the age assignment for most of the Albemarle Group is late Precambrian. The interfingering nature of the contact between the McManus and Yadkin formations further suggests that the Yadkin is probably also Precambrian.

COMMENTS ON THE REGIONAL IMPLICATIONS OF EDIACARIAN FOSSILS IN THE CAROLINA SLATE BELT, ALBEMARLE AREA

The recognition of the Ediacarian fossil, *Pteridinium*, in the slate belt of southcentral North Carolina along with *Vermiforma antiqua* (Cloud et al., 1976) provides legitimate paleontologic control to this part of the slate belt, as well as paleobiogeographic control for interpreting late Precambrian paleogeography. On a more local scale, the *Pteridinium* marker now provides a correlation point that removes some of the major correlation questions in the southern slate belt; questions that were pointed out by Wright and Seiders, (1980) and Bourland and Rigby (1982).

Examination of published data on representative sections of the Avalon Terrane, from Rhode Island northward, indicates that the Avalon Terrane is composed of late Precambrian elements overlain in unconformable contact by Cambrian elements of the Terrane. The Ediacarian fossil *Pteridinium* and *Vermiforma* indicate that the slate belt in North Carolina' is part of the older elements of the Avalon Terrane and that the units from which Secor et al. (1983) described the Cambrian Atlantic Province trilobites are perhaps part of the younger Avalon Terrane elements.

On a worldwide scale, *Pteridinium* is the first diagnostic Ediacarian fossils found in the slate belt that can be used for intercontinental correlation. The correlation is at present with three additional localities -- northwestern U.S.S.R., South West Africa, and South Australia. Recently. *Pteridinium* has been discovered in the Northwest Territories of Canada (Guy Narbonne, personal communication).

DEPOSITIONAL MODEL FOR THE CAROLINA SLATE BELT, SOUTHCENTRAL NORTH CAROLINA

The Carolina slate belt has been variously interpreted as being: a product of continental rifting (Long, 1978); a part of a continental margin arc environment (Stow and Tull, 1982); a basinal sequence (Feiss, 1982) related to a volcanic island arc with rocks produced in a primitive ocean-ocean arc or on a thin transitional crustal margin; or perhaps a continental trailing margin (Feiss, l982a). In addition, scattered and sketchy data, mainly graded bedding, suggest that the volcanosedimentary units of the Albemarle Group are turbidite deposits (Milton and Reinhardt, 198O), implying a deep basinal environment.

In terms of its relationship to the ancestral North American craton, fossils recovered from the slate belt (St. Jean, 1975; Cloud, et al., 1976; Maher et al., 1981; Secor et al., 1983 and Gibson et al., 1984) indicate that the slate belt was isolated from the North American craton during the late Precambrian. This supports the terrane concept for the Appalachian Orogen as discussed by Williams and Hatcher (1982). In addition, the Ediacarian fossil *Pteridinium*, represents a shallow water organism, perhaps at or close to a beach environment (Germs, 1972; Glaessner and Wade, 1966)

The sedimentary features preserved in the slate belt of the Albemarle area also appear to indicate subaqueous and sub aerial depositional environments. The features suggest intertidal to perhaps tidal flat environments for part of the section; shallow, tidal-influenced marine conditions for another part of the section; and perhaps fan-delta filling of basin margin for the lowest part of the section.

The model we suggest, based on our work to date, is that of a shallow marine platform adjacent to an active volcanic terrane (island arc?), where the Uwharrie Formation represents subaerial and shallow submarine (fan-delta?) deposition that overwhelmed regional nearshore depositional patterns represented by the Tillery. Middle Tillery rhythmically bedded clayey siltstones may then represent tidal influenced shallow shelf deposits passing into the interfingering contact zone between Tillery and overlying McManus. This suggests transition into deeper basin environments accompanied by explosive, episodic volcanism.

The mudstone member of the McManus Formation with its massive mudstones represents quiescent shelf basin deposition, which passes upward into the Floyd Church Member. Features of the Floyd Church Member suggest shallowing, nearshore conditions with rapid deposition under tidal influence. This is capped by the Yadkin Graywacke that appears to represent shallow tidal to intertidal conditions.

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ROAD LOG -- FIRST DAY -- MORNING STOPS

The field trip road log begins at the Heart of Albemarle Motel. Buses will be boarded there and leave from that point. The route and stops can be located on the Albemarle and Frog Pond 7 ½ minute topographic sheets.

Mileage Between Points	Total Mileage	
0.0	0.0	From the Heart of Albemarle Motel, proceed north on First Street (U.S. 52) to the second traffic light, at the intersection of N.C. 73 and U.S. 52.
0.2	0.2	At intersection, **TURN LEFT** (WEST) onto West Main Street (N.C. 73).
0.1	0.3	Intersection of Depot Street with West Main Street. Continue on West Main Street.
0.2	0.5	Intersection of Carolina Avenue with West Main Street. Continue on West Main.
0.2	0.7	Intersection of N.C. 73 (on north) with West Main Street, Continue on West Main.
0.1	0.8	Intersection of Cobel Avenue (on south) with West Main Street.
0.1	0.9	“Y” intersection. **BEAR LEFT** on West Main Street (SR 1274).
0.5	1.4	West Main Street (SR 1274) crosses Long Creek.
0.5	1.9	Intersection of SR 1963 (on south) with West Main Street (SR 1274). Continue on West Main Street.
0.1	2.0	Intersection of SR 1268 (Poplin's Grove Church Road) on north, with West Main Street. Continue on West Main Street.
0.2	2.2	Intersection of College Drive (on north) with West Main Street. Hills to right on which Stanly Technical Institute is situated are held up by gabbroic intrusions in the mudstone member of the McManus Formation.
0.1	2.3	Stanly Technical Institute Industrial Center on right (north).
0.1	2.4	**STOP SIGN**. Intersection of SR 1274, SR 1274, and N.C. 24-27. **TURN RIGHT** onto Canton Road (SR 1249).
0.1	0.25	Weathered outcrop to north is clayey siltstones of the Floyd Church Member of the McManus Formation.
0.35	2.85	Crossing of Scaly Bark Creek.
0.35	3.2	Outcrop in drainage ditch on south is uppermost Floyd Church Member siltstone with sandy interbeds of Yadkin-like lithology. This is part of the gradational or interfingering contact zone between McManus and Yadkin.
0.25	3.45	Intersection of SR 1258 (on south) with SR 1249. Continue on SR 1249.
0.3	3.75	Intersection of SR 1264 (on north) with SR 1249. Continue on SR 1249.
0.4	4.15	Intersection of SR 1262 with SR 1249.
0.3	4.45	Intersection of SR 1257 (on south) with SR 1249. Continue on SR 1249.
0.2	4.65	Crossing of unnamed creek. Pass from gradational contact zone between McManus and Yadkin into Yadkin Graywacke.
0.15	4.8	Intersection of SR 1261 (on north) with SR 1249. Continue on SR 1249.
0.5	5.3	Crossing of Little Bear Creek. Float in creek is Yadkin Graywacke.
0.2	5.5	Intersection of SR 1285 (April Lane) with SR 1249. Continue on SR 1249.
0.2	5.7	Intersection of SR 1256 (on south) with SR 1249. Continue on SR 1249.
0.1	5.8	Crossroads. SR 1247 (on north) and SR 1250 on south. Continue on SR 1249.
0.2	6.0	Outcrops on north side of SR 1249 are sandy, parallel laminated and cross-laminated units of the Yadkin Graywacke.
0.05	6.05	Crossing of Ramsey Creek. Float blocks in creek bed are all Yadkin Graywacke.
0.4	6.45	Bloomington Community. Intersection of SR 1214 and SR 1249. Continue on SR 1249.
0.25	6.7	Pond on north.
0.2	6.9	Crossing of unnamed creek.
0.3	7.2	**STOP SIGN**. Intersection of SR 1134 (Millingport Road) and SR 1249. **TURN SOUT** (LEFT) onto SR 1134.
0.25	7.45	Intersection of SR 1225 (Old Mill Road) on left with SR 1134. **TURN SOUTH** (LEFT) onto SR

1225. This is a narrow, gravel road, usually with deep ditches and soft berms. Old Mill Road trends southward across the erosion surface cut into the Yadkin Graywacke.

0.8 8.25 Old Mill Road turns sharply to the right and then begins a steep downhill section toward Big Bear Creek.

0.35 8.6 **STOP #1**. Old Whitney Mill Bridge over Big Bear Creek. Weight limits as of this date are 36,000 lbs (single vehicle) and 50,000 lbs (semi).

Originally named by Conley and Bain (1965) from a type locality northeast of New London, along N.C.8, the Yadkin Graywacke is an erosional remnant of a once more extensive depositional unit that is now preserved only in the center of the New London Synclinorium. TheYadkin Graywacke has been described as being medium to very thick bedded, to possess graded bedding and south-west-dipping cross-bedding (Conley and Bain, 1965); to be composed mainly of interbedded, poorly sorted volcanic sandstone and siltstone (Stromquist and Sundelius, 1975) of about equal parts of lithic fragments, quartz grains, and feldspar clasts (Conley and Bain, 1965).

In this location, some 200 meters above the lower gradational or interfingering contact zone, the Yadkin Graywacke is thin-bedded to laminated and composed primarily of continuous and discontinuous wavy subparallel interbedded or interlaminated volcanically-derived medium- to fine-grained sandstone and siltstone. Individual layers of siltstone and sandstone are themselves complexly laminated. Lenticular bedding is also common with cross laminations readily apparent within lenses.

Normal and reverse graded bedding is present at this locality. Normal graded beds generally grade from medium sand upward to silt sizes and the reverse grading commonly terminates upward with coarse sand sizes.

Occasional, isolated, thin beds of moderately well-sorted and rounded quartz sandstone occur throughout this and higher parts of theYadkin section. In the terminology of Reineck and Singh (1975), this is coarsely interlayered bedding. These layers of medium- to coarse-grained quartz sandstone lie on irregular, intrastratal erosional surfaces and do not appear to possess internal structures.

Another obvious bedding type at this location is isolated lenticular bodies of poorly sorted, heterogeneous, coarse sand- to fine pebble-sized clasts.

The lenses range from one to 20 centimeters long and may or may not exhibit cross laminations. These lenses represent current: ripples and possess for concordant and form discordant internal structures. The lenses sit on erosional surfaces and may be covered by laminated siltstone or be partially eroded.

In addition to the isolated lenticular bodies that represent current ripples, cross-section views of laterally continuous rippled surfaces are common. These small-scale ripples generally possess form discordant internal structures, but form concordant internal structures (cross laminations) can be seen. Rippled surfaces can be found on float blocks,

The laminated layers that cover rippled surfaces contain clasts ripped up from underlying material. Similar ripped-up clasts can be found in the isolated lenses. Small-scale current cross-bedding seen in trough fill indicate multiple transport directions.

Ripple-marked bedding surfaces are exposed in the Yadkin Graywacke along Big Bear Creek. These ripples are small scale current ripples, with sinuous (undulatory), in phase crests that occasionally bifurcate. Limited data from this area suggests north-northwest to south-southeast current directions.

Ripple cross-laminations are not particularly apparent in this locality, mainly as a result of weathering. Higher in the Yadkin section, herringbone cross laminations do occur. Herringbone cross laminations (bimodal cross bedding) are indicative of opposing transport directions. In addition, the herringbone cross laminations are frequently separated by thin silt or clay layers. Examples of this can be found in float blocks along the creek.

Post-depositional sedimentary structures are not particularly-common here. Slump structures (load casts) occur where the thicker beds of quartz sand lie on silt-sized material. Packages of laminations five to ten centimeters thick exhibit recumbent and overturned folds of the bedding, a result of either current activity or slumping. There is some differential compaction of silts and very fine-grained sand laminations over isolated ripples

A number of laminations of clay and silt-sized particles exhibit textures suggestive of algal mat structures, that are readily visible in thin section.

Interpretation -- The aggregate of sedimentary features in this part of the Yadkin Graywacke suggest deposition under the influence of tidal conditions, in shallow subtidal to perhaps intertidal areas. Inter-laminations of fine and coarse material, along with coarsely layered bedding are strongly suggestive of mixed tidal flats (Reineck and Singh, 1975). Likewise, lenticular bedding with isolated lenses of current origin are characteristic of subtidal or intertidal zones. Erosion ripples of irregular amplitude and wavelength are common in this section and can he seen forming on tidal flats and in shallow subtidal zones today (Collinson and Thompson, 1982). Thin beds of moderately well-sorted and rounded quartz sand suggest proximity to an active winnowing environment, such as a shoreline, that occasionally supplied material to the depositional system. Lastly, bimodal, small-scale cross-laminations (herringbone cross bedding) with cross-bed sets separated by thin silt or clay partings provide additional support for the shallow water interpretations of the depositional environment for theYadkin Graywacke.

Continue southward on SR 1225

0.1 8.7 Abandoned quarry in trees to south, between road and creek.

0.3 9.0 Weathered exposures of Yadkin Graywacke along hillside to west.

0.3 9.3 Intersection of SR 1226. Continue on SR 1225

0.35 9.65 Weathered Yadkin Graywacke in ditch to south of road.

0.15 9.8 AT&T microwave tower visible to west, straight ahead.

0.3 10.1 **STOP SIGN**. Intersection of SR 1225 with SR 1227 (Ridgecrest Road). **TURN LEFT** and proceed south on SR 1227, on erosional surface cut into Yadkin Graywacke.

0.45 10.55 Intersection of SR 1223 (Dead end road).

0.8 11.35 Intersection of SR 1214. Continue south on SR 1227.

0.7 12.05 Crossing of Stony Run.

0.3 12.35 Weathered Yadkin Graywacke exposed to east.

0.2 12.55 Weathered Yadkin Graywacke exposed to east

0.3 12.85 Intersection of SR 1217 (Highland Road) with SR 1227. Continue on SR 1227.

0.2 13.05 Yadkin Graywacke exposed in drainage ditch to east.

0.2 13.25 **STOP SIGN.** Crossroads intersection of N.C. 24-27 and SR 1227 at community of Red Cross. Continue south (straight ahead) toward Oakboro. Route number is now SR 205.

0.7 13.95 Intersection of SR 1135 with SR 205. **TURN RIGHT** (WEST) onto SR 1135. Weathered exposures Near intersection are the Floyd Church Member of the McManus Formation.

0.3 14.25 Weathered outcrop on north side of road is mainly Yadkin lithofacies in the interfingering contact zone with the underlying McManus Formation.

0.35 14.6 Crossing of Cucumber Creek, which here flows across the lowestYadkin Graywacke.

0.3 14.9 **STOP SIGN**. Intersection of SR 1135 and SR 1134. **TURN LEFT** (EAST) onto SR 1134.

0.6 15.5 Weathered outcrops of lower Yadkin Graywacke on south side of road.

0.1 15.6 **STOP #2.** Interfingering contact or gradational contact between McManus and overlying Yadkin formations.

The contact zone is exposed for about 0.2 miles fro just west of Cucumber Creek, eastward to the top of the hill. We will examine the contact zone and reboard the busses at the top of the hill.

Variations within and between stratigraphic units in this part of the Carolina slate belt are frequently subtle, not readily visible on fresh surfaces or on intensely weathered surfaces, and are commonly covered. The exposures along SR 1134, east of Cucumber Creek, generally fit the categories of poorly exposed and weathered. However. by working eastward, fro exposures west of the creek to the top of the hill, one can see the gradational or interfingering contact relationships between the Yadkin Graywacke and the underlying McManus Formation. This contact has been variously described as conformable (Conley and Bain. 1965), gradational (Randazzo, 1972), and unconformable (Sundelius and Stromquist (1978).

We present this contact as an interfingering lithologic contact representing a gradual change in depositional environments. There is a slight westward dip to the bedding here, an as one works eastward from west of the creek, one passes from typical Yadkin into massively bedded and structureless mudstones of the upper part of the McManus Formation. There are about 40 meters of section exposed here.

West of Cucumber Creek, exposures in the low banks around the filed (and farther west) contain mediu grained 'dirty' sandstones of the Yadkin Formation. Parallel planar and cross bedding is visible. Working eastward along the drainage ditches, particularly on the south side of the road, the interfingering nature of the lithologies can be seen.

The 15 meters of section below the planar bedded sands are composed of interlaminated silt, clay, and very fine-grained sands in subparallel, discontinuous layers, Very thin beds of small scale cross laminated silts and very fine grained sands occur in this interval as do occasional layers of McManus-type mudstone. The mudstone layers generally appear to be structureless, tan-brown weathered fragments.

Still working uphill to the east, but down section below the planar bedded Yadkin lithologies, small scale cross laminations become more common as do layers of McManus-type mudstone, while discontinuous interlaminated mud, silt, and very fine-grained sand become less common. Thin layers with simple and bifurcated flaser bedding are also common in this interval.

The uppermost part of the hill to the east of Cucumber Creek is composed mainly of McManus mudstones in structureless, massive layers. A fossil fragment with characteristics of *Pteridinium* has been recovered from this interval and would appear to extend the vertical range of the genus t this position in the section.

0.4 16.0 Continue east from Cucumber Creek along SR 1134 to **STOP SIGN** at intersection of SR 1134 and SR 1131 with SR 205. **TURN SOUT** at SR 205 and proceed toward Oakboro.

0.1 16.2 To one side of the large brick building are recent quarried boulders of the lower part of the Floyd Church member of the McManus formation.

0.4 16.6 Intersection of SR 1157 (Bear Claw Road) with SR 205. Continue on SR 205.

0.3 16.9 Crossroads intersection of SR 1115 and SR 205 at Big Lick Community. Continue south on SR 205.

0.25 17.15 Intersection of SR 1111.

0.05 17.2 Oakboro Cemetery to west.

0.6 17.8 Oakboro City limits. Bedrock here is the mudstone member of the McManus Formation. Continue south on SR 205.

0.55 18.35 Stop light in Oakboro. Intersection with Second Street. Continue south on SR 205.

0.1 18.45 Intersection of SR 1975 with SR 205, just north of railroad crossing. **TURN EAST** onto St. Martin Road (SR 1975.)

1.2 19.65 Intersection of SR 1976 (East Eight Avenue) with St Martin Road (SR 1975).

0.15 19.8 Crossing of Mcleaster Creek. Exposed Floyd Church Member in creek.

0.15 19.95 Intersection of SR 1975 with SR 1968. **BEAR RIGHT** on SR 1968 (St. Martin Road).

0.1 20.05 Weathered Floyd Church Member on north.

0.15 20.2 Crossing of Stony Run.

0.1 20.3 Intersection of SR 1221 (Frog Pond Road) and SR 1968 (St. Martin Road). Continue on SR 1968. Weathered Floyd Church Member on north.

0.15 20.45 F1oyd Church Member silty mudstones crop out on north side of road.

0.15 20.6 Floyd Church Member crops out on north side of road.

0.3 20.9 Floyd Church Member in drainage ditch to south.

0.4 21.3 Crossroads intersection of SR 1970 (Hazard Road) with SR.1968. Continue on SR 1968.

0.05 21.35 Floyd Church Member crops out along road for next 0.2 miles.

0.35 21.7 Tabernacle Baptist Church at intersection of SR 1969 with SR 1968. Continue on SR 1968.

0.15 21.85 Crossing of Big Bear Creek. Bedrock is Floyd Church Member with float of Yadkin Graywacke and gabbro.

0.05 21.9 Outcrops of relatively fresh Floyd Church Member clayey siltstones and interlaminated siltstones and very fine sandstones for next 0.3 miles.

0.3 22.2 Intersection of SR 1979 (Bridgeport Road) with SR 1968. Continue on SR 1968.

0.65 22.85 Crossroads intersection of SR 1969 and SR 1968. St. Martin Lutheran Church is at intersection. Continue on SR 1968.

0.3 23.15 Crossing of Little Bear Creek. Just a few tens of meters upstream is the probable quarry site from which one of the *Pteridinium* fossils described by Gibson et al. (1984) was found. The specimen in all probability came from a small quarry site operated in the mid-18OO's as a source of building stone on the Efrid farm. The quarry site is stratigraphically in the upper part of the Floyd Church Member of the McManus Formation and effectively dates this formation as late Precambrian.

0.05 23.2 Weathered Floyd Church Member along south side of SR 1968.

0.15 23.35 “Y” intersection of SR 1968 and SR 1963. **BEAR LEFT** along SR 1963 (St. Martin Road).

0.05 23.4 Floyd Church siltstones on south.

1.4 24.8 Natural Lake Farm and lake to north of SR 1963.

0.1 24.9 Intersection of SR 1965 (Carriker Road) with SR 1963. Continue on SR 1963.

0.7 25.6 Crossing of small unnamed creek that flows eastward into Long Creek.

0.05 25.65 Abandoned state quarry in trees to north. Rock is Floyd Church Member with common sedimentary structures.

1.1 26.75 Entrance to Cedar Village Subdivision on north. **TURN LEFT** (NORTH) into subdivision. Proceed to cul-de-sac.

0.4 27.15 **STOP #3.** Abandoned quarry west of cul-de-sac.

This stop is in the lower part of the Floyd Church Member of the McManus Formation. We have chosen to retain the terminology of Conley and Bain (1965) and add to that the nomenclature of Stromquist and Sundelius (1969), something that describes most closely what is seen in this area.

The degree of weathering in this quarry reveals a variety of sedimentary structures that are characteristic of the Floyd Church Member These structures are not evident on freshly broken surfaces such as at the Carolina Solite Corporation quarry near Aquadale. Intense weathering and surface staining also obscure the sedimentary features.

This part of the Floyd Church Member is primarily a silty mudstone with complex interlaminations of fine to medium sand-size material· The interbeds or interlaminations are revealed by brownish staining along the more permeable, coarser grained layers. Similarities in clast composition, matrix, and cement between the coarser grained layers and the bulk of the unit results in a failure to see the variations on fresh surfaces. Thickness of the sandy interbeds or laminations is measured in millimeters or at most a few centimeters. A few of the sandy interbeds are 30 to 40 centimeters thick and are themselves composed of thinner layers.

Primary sedimentary features evident at this location include:

1) Planar parallel continuous and discontinuous laminations of sand within the mudstone. Many of the laminations are only a couple of millimeters thick and frequently pass laterally into mudstone, i.e. pinch out;

2) Wavy parallel continuous and discontinuous laminations frequently seen to pass into cross-laminations;

3) Repeated interlaminations and interbeds of subordinate fine and medium sand-sized material within the dominant mudstone;

4) Small scale ripple cross laminations in sandy laminae. Ripple cross laminations frequently seem to pass into wavy bedding;

5} Graded bedding (coarse to fine upward) is not common in this interval. Some grading is visible in the gray mudstone and is represented by beds less than about two centimeters thick passing upward fro medium or fine sand sizes to clay. The base of each graded interval is a slight erosional surface;

6) Reverse grading (fine to coarse upward) has been noted in this quarry but appears to be confined to layers less than two centimeters thick;

7) Lenticular bedding with connected and isolated sandy lenses within mudstone;

8) Wavy bedding (after Reineck and Singh, 1975) within zones where sand and mud layers are equally represented;

9) Flaser bedding within mudstone;

10) Ripple-drift cross-laminations;

11) Asymmetric ripples;

12) Sandstone channel deposits with mudstone ripups as basal conglomerate.

Weathering along incipient bedding cleavage and closely spaced vertical cleavage obliterates most bedding surface features in this areas of the slate belt. Secondary or soft sediment deformation features can be observed in cross section. Soft sediment deformation features present here include:

1) Flame structures or mudstone squeezed upward between loadcasts created from very thin and thin bedded sandy layers;

2) “Pseudonodules” or isolated loadcasts sandstone balls surrounded by deformed mudstone. Load balls frequently preserve deformed laminae of once continuous sandy 1ayers;

3} Sandstone “boudinage” mainly in one to two centimeter thick sandy layers, resulting from differential compaction;

4) Intervals 70 to 100 cm thick of sedimentary folding that resulted from slumping. Slump-folded intervals are bounded by flat-lying undisturbed layers. Individual layers of sandstone may also be complexly folded and/or disturbed;

5) Lack of color mottling and presence of undisturbed laminations suggests an absence of infauna; and

6) Ball-and-Pillow structures.

Synsedimentary erosional features present in the Floyd Church Member at this locality include:

l) Cut-and-fill structures and

2) Longitudinal scours (?) or ridges and furrows, that result from secondary current eddies.

Interpretation -- In this interval of the Floyd Church Member of the McManus Formation, the aggregate of sedimentary structures suggest a depositional environment that was influenced by tidal conditions, but at a lower energy level compared to the overlying Yadkin Graywacke. Features like planar parallel continuous and discontinuous laminations and wavy parallel laminations suggest tidal influenced beach, shoaling waves or tidal flats (Reineck and Singh, 1975; Collinson and Thompson, 1982); repeated interlaminations of coarser and finer layers and small scale, bimodal, ripple cross-laminations also suggest tidal influence (Reineck and Sinha, 1975); graded bedding can be turbidity current related or of shallow water origin; lenticular bedding can be related to shallow water sub- to intertidal delta front situations; and flaser bedding is related to sand and mud availability with alternating current and slack water conditions.

In addition, the presence of *Pteridinium* in this interval supports the idea of a shallow water depositional environment. *Pteridinium* from other localities (South West Africa and South Australia) are recovered from sedimentary units that are high energy deposits, mainly nearshore sand deposits. The general character of *Pteridinium* indicates that it probably would not survive transport such as generally attributed to turbidity currents, whether more proximal, higher energy currents or more distal, lower energy currents. In addition, the rather fortuitous occurrence of two specimens on a single small slab (St, Jean, 1973) argues for short to non-existent transport distances.

Mud deposition (rapid*?)* apparently dominated and the repeated interlaminations of sand could indicate energy pulses such as occur either on tidal flats or on shallow muddy tidal shelves. The small scale, bimodal cross-bedding points to tide related environments as do lenticular bedding. Load structures observed here are those characteristic of rapid mud deposition with pulses of sand, such as in turbidite deposits of tidal flat-shallow-muddy shelf environments

0.4 27.55 Return to SR 1963. **TURN LEFT** (EAST) on SR 1963.

0.3 27.85 Crossing of Scaly Bark Creek.

0.05 27.9 Floyd Church Member crops out on north side of road.

1.15 29.05 Intersection of SR 1962 with SR 1963. Continue on SR 1963.

0.5 29.55 Intersection of SR 1963 with N.C. 24-27.

End of the morning segment of the field trip. Proceed to lunch stop.

ROAD LOG -- FIRST DAY -- AFTERNOON STOPS

The afternoon segment of the first day begins at the intersection of **N.C.** 24-27 and N.C. 138. Stops on this segment of the field trip will be in the Floyd Church Member and the mudstone member of the McManus Formation and the middle and upper Tillery Formation. The stops will be in the Aquadale and Mount Gilead West 7 1/2 minute topographic quadrangles.

Mileage between points | Total mileage

0.0 0.0 Intersection of N.C. 24-27 and N.C. 138. Proceed **SOUTH** on N.C. 138.

0.5 0.5 Water standpipe on left (east).

0.3 0.8 Junction of SR 1003 with N.C. 138. Proceed south on N.C. 138.

0.4 1.2 Intersection of SR 1958 (Old Aquadale Road) and N.C. 138. **TURN RIGHT** (WEST) on SR 1958.

0.7 1.9 Outcrop of silty mudstone with interlaminations of very tine grained sandstones. Floyd Church Member of McManus Formation. Bedding attitude N. 60° W., 10° SW.

0.1 2.0 Intersection of SR 1961 (Dry Road) and SR 1956. Proceed on SR 1956.

0.15 2.15 SouthsideVolunteer Fire Department.

0.15 2.3 Weathered Floyd Church Member of 'McManus Formation.

0.25 2.55 Floyd Church Member of McManus Formation on right.

0.15 2.7 Weathered Floyd Church Member. Sedimentary features visible.

0.1 2.8 Intersection of SR 1960, Mabry Road. Continue on SR 1956.

0.45 3.25 Weathered silty mudstone of Floyd Church Member on left (east}.

0.3 3.55 “Y” intersection of SR 1957 with SR 1956. **BEAR RIGHT** (WEST} on SR 1956 (Old Aquadale Road). Outcrops at intersection are muddy siltstones with interlaminations of silt and very fine grained sandstone that are less than two millimeters thick. Floyd Church Member.

1.05 4.6 Intersection of SR 1967 (Sides Road) with SR w956. Weathered Floyd Church Member on left (east)

0.8 5.4 Exposures of clayey siltstone (Floyd Church

Member) on right (west).

0.15 5.55 "Y" intersection of SR 1954 with SR 1956. **BEAR LEFT** (SOUTHEASTWARD) on SR 1954, which is now the "Old Aquadale Road."

0.35 5.90 Bridge over Little Creek.

0.05 5.95 Weathered lower (?) Floyd Church Member. Massive, silty mudstone with distinctive interbeds three to five millimeters thick of coarse silt to fine sand and crudely laminated claystone. Coarse silt to fine sand layers overlie laminated mud.

0.05 6.0 Weathered Floyd Church Member on right (west).

0.1 6.1 Relatively fresh clayey siltstone of Floyd Church Member in driveway, to right (west).

0.2 6.3 "Y" intersection of SR 1919 (Chapel Road) with SR 1954. **BEAR RIGHT** (SOUTH} on SR 1954.

0.1 6.4 **Sharp** right hand curve.

0.05 6.45 Floyd Church Member exposed on right. Siltstone with discontinuous interlaminations of fine to very fine-grained sandstone. Small scale ripples (?) cross-laminations common.

0.5 6.95 Exposed Floyd Church Member on right (west).

0.3 7.25 Intersection of SR 1956 (Reap Road) on west with SR 1954. Continue on SR 1954.

0.2 7.45 Intersection of SR 1935 (or SR 2001) with SR 1954. **TURN LEFT** (EAST) on paved road which is SR 1935 (or SR 2001), part of the Old Aquadale Road. County road signs have SR 2001, maps have SR 1935.

0.6 8.05 Crossroads intersection of SR 1917 (Bethlehem Church Road) with SR 2001 (SR 1935 on map). Continue on SR 2001.

0.15 8.2 Entrance road to Carolina Solite Corporation quarry. **TURN RIGHT** (SOUTH) onto quarry road.

0.3 8.5 Security gate to Carolina Solite Corporation's Aquadale Quarry. Proceed to **STOP #4.**

<u>Hardhats are required to visit this quarry.</u>

Exposed here are fresh to slightly weathered outcrops of both the lower or mudstone member and the upper or Floyd Church Member of the McManus Formation. The differences between the two members can be readily seen here whereas they are generally obscured on intensely weathered surfaces.

The bottom level of the quarry, where current mining operations are taking place, is cut into the mudstone member. This unit is a massive silty mudstone that lacks the silt and fine sand interbeds characteristic of the Floyd Church Member. Frequent thin (less than three centimeters) laterally extensive layers of laminated claystone are evident as are darker color bands. These clay bands are commonly overlain by very thin layers of silt to very fine sand. On weathered surfaces, the silt and sand layers are apparent of bands of negative relief. The contact between clay and silt is sharp and does not appear to be an erosional surface.

The mudstone member does not contain sedimentary features characteristic of the upper part of the McManus Formation,. This difference is apparent after examining the exposures In the bottom of the quarry and then those on the next bench above the bottom level, which is cut mainly in the Floyd Church Member.

The upper' benches of the quarry are cut into muddy siltstones with numerous, discrete interbeds and interlaminations of silt- and sand-sized clasts. These interbeds are easily identified on slightly weathered surfaces as zones of brown coloration against the dark gray of the muddy siltstone. The coarser layers are sulfide accumulation and have abundant calcite. Primary sedimentary structures found here include:

I) Horizontal continuous and discontinuous interbeds and interlaminations of silt- to medium sand-sized clasts. Clasts within individual layers are moderately well-sorted and generally angular. The lower boundary of the silt or sand layers is an erosional surface on the underlying mudstone;

2) Broad (12 to 17 cm), low angle tangential cross beds or laminations;

3) Depositional units 15 to 40 cm thick bounded by erosional surfaces, where the basal two to five centimeters is silt and sand that grades upward into massive m mudstone;

4) Channel cut-and-fill structures with the fill material being of silt and sand sizes. Channel fill frequently laminated and channel is cut into massive mudstone or laminated horizontal silt/sand layers;

5) Isolated ripples with concordant or discordant internal structures acting as dams for later bottom transported silt and sand;

6) Coarse sand to fine pebble, discontinuous beds (channel deposits?) and

7) Continuous and discontinuous interlaminations (very fine) of mudstone and moderately well-rounded sand with calcite cement. Common layers of coarse to very coarse sand-sized clasts with calcite cement

frequently contain ripup clasts of mudstone.

Secondary sedimentary structures are not as common as seen at stop #3, but include:

l) Convolute bedding in zones generally less than 10 centimeters thick.

Interpretation -- This exposure is stratigraphically lower than that at Stop #3. Data for the interpretation of depositional environment is not as definitive as that seen at Stops #1 and #3. In the Floyd Church Member at the Solite Quarry, parallel continuous and discontinuous interlaminations of silt and sand within mudstone are present as are wavy laminations. Graded bedding is more common in the Floyd Church here than at Stop #3.

Ripple cross-laminations are generally absent in the Floyd Church Member here, as are load structures suggestive of rapid deposition followed by slumping of coarser grained layers. Slump folded intervals are present but are not as thick as at Stop #3. The general lack of slump structures suggests lower rates of deposition as compared to higher (Stop #3) in the section. There are some layers of cut-and-fill structures with coarse sand-sized and larger clasts, suggesting pulses of higher than normal energy.

One Interpretation of the Floyd Church Member here is that it represents somewhat deeper and generally quieter water (muddy shelf) with pulses of higher energy, but not high enough to create cross-bedding. The quieter water may just as well have been on a tidal flat.

The mudstone member appears to represent even quieter conditions of deposition than the overlying Floyd Church Member. Massively bedded silty mudstones are interrupted by fewer higher energy layers, each of which rests on an erosional surface. The mudstone member contains extensive layers of what could be very quiet water pelagic clays. It has been suggested (Milton, personal communication) that the Albemarle Group represents a general shallowing upward sequence. If this is the case, then beginning 'with nearshore to intertidal deposits of the Yadkin graywacke, one would pass downward into shallow shelf deposits represented by the Floyd Church Member and then into deeper shelf deposits of the mudstone member.

8.5 Return to the security gate of Carolina Solite Corporation.

0.3 8.8 Proceed along quarry entrance road to SR 2001,. **TURN RIGHT** (EAST) on SR 2001.

0.2 9.0 Crossing of unnamed creek.

0.05 9.05 Intersection of SR 2014 (Ray Bud Road) with SR 2001. Continue on SR 2001.

0.25 9.3 Crossing of unnamed creek.

0.4 9.7 Railroad crossing.

0.2 9.9 **STOP SIGN.** Intersection of SR 2001 with N.C. 138. **TURN LEFT** (EAST) on N.C. 138.

0.1 10.0 **STOP SIGN.** Intersectionof SR 1935 (Plank Road) with N.C. 138. **TURN RIGHT** (SOUTH) onto SR 1935 toward Cottonville.

0.2 10.2 Intersection of SR 1945 (Rocky River Road) with SR 1935. Continue on SR 1935.

0.5 10.7 Intersection of SR 1945 (other end) with SR 1935. Continue on SR 1935.

0.5 11.2 Intersection of SR 1943 (Old Davis Road) with SR 1935.

1.1 12.3 Intersection of SR 1942 (Aldridge Road) with SR 1935. Continue on SR 1935.

0.4 12.7 Intersection of SR 1918 (Cottonville Road) with SR 1935 (Plank Road).

0.05 12.75 Sign and store for Cottonville, and intersection of SR 1980 with SR 1935. Continue on SR 1935.

0.15 12.9 Intersection of SR 1937 (Hardy Road) with SR 1935.

Beginning here there is a significant change in the aspect of the mudstone member of the McManus Formation. Beds of sandy, tuffaceous material 20 to 40 cm thick are interbedded with the mudstone.

1.4 14.3 Weathered outcrop on east of tuffaceous mudstone with thin layers of laminated clayey siltstone. This outcrop represents the transitional contact between the mudstone member and the underlying 'Tillery Formation. This transition interval is composed of interbedded rhythmites typical of the middle part of the Tillery, massive tuffaceous siltstones and sandstones, and massively bedded mudstones of the lower McManus Formation.

0.05 14.35 Outcrop of McManus mudstones with interbedded intervals of Tillery-like siltstone rhythmites. Bedding mostly obscured by closely spaced vertical cleavage.

0.1 14.45 Intersection of SR 1934 (Mt. Zion Church Road) with SR 1935. **TURN LEFT** (EAST) onto SR 1934.

0.25 14.70 Weathered tuffaceous silty sandstone on south.

0.4 15.1 Crossing of Hardy Creek. Along the creek are excellent exposures of the mudstone lithologies characteristic of the lower McManus Formation, interbedded with thin (less than 3 cm) layers that are rhythmically bedded like those of the Tillery Formation. This outcrop is also in the transition zone from "typical" McManus.

0.3 15.4 Weathered tuffaceous sandstones and siltstones.

0.3 15.7 Intersection of SR 1937 (on north) with SR 1934.

0.15 15.85 Mt. Zion Church and cemetery on right (south).

0.2 16.05 Intersection of west end of SR 1982 (Loop Road) with SR 1934.

0.5 16.1 Outcrop on south is mainly Tillery-like rhythmically bedded clayey siltstones.

0.1 16.2 "Y" intersection of SR 1933 (Whitley Road) with SR 1934. **BEAR RIGHT** onto SR 1934.

0.7 16.9 **STOP #5.** We will examine folded tuffaceous sandy lithologies characteristic o f the upper Tillery and then walk east across the bridge and onto the east end of Loop Road and see the folded beds in a structural section.

This outcrop and the one just east of the bridge are interesting not only because of the deformation present, but because it is an opportunity to view a different facies of the Tillery Formation. The Tillery here for the most part lacks the rhythmically bedded siltstones characteristic of the middle part of the formation. Instead, this representative outcrop of the upper part of the Tillery is composed of reworked tuffaceous deposits with silt, sand, and larger sized clasts. Compositionally, this tuffaceous interval is similar to those seen in the lower part of the Tillery and represents higher energy regimes as compared to "typical" Tillery rhythmites.

We consider this to be part of the Tillery formation rather than the McManus because of the similarities of material here and at the base of the Tillery, the presence of rhythmically laminated siltstones, which become more common downsection, and the general absence of mudstones. Conley and Bain (1965) mapped some rather tight folds and intrusive relationships to the north of here. To date, we have not had the opportunity to trace this zone of folds to determine possible relationships.

0.2 17.1 Walk eastward after viewing this outcrop to see additional exposures, east of the creek.

Re-board buses at intersection of Loop Road (east end) and SR 1934. Continue east on SR 1934.

0.1 17.2 Tuffaceous sandy siltstone of upper Tillery crops out along south side of road.

0.2 17.4 Tuffaceous sandy siltstones of upper Tillery, but containing very common interbeds of rhythmically laminated siltstone. Laminated siltstone becomes more common to the east or downsection. Tillery exposed over next 0.5 miles.

0.5 17.9 Railroad crossing.

0.1 18.0 Crossing of Big Cedar Creek.

0.15 18.15 "Y" intersection. **BEAR RIGHT** on SR 1934, which is now called River View Road.

0.05 18.20 Abandoned grain mill on right. Outcrop of laminated siltstones of middle Tillery on left (north).

0.25 18.45 **STOP #6.** Rhythmically laminated siltstones of the Tillery Formation.

The rhythmically laminated clayey siltstone that is generally considered "typical" of the Tillery is composed of a lower, lighter colored portion that appears to grade upward into a darker colored portion. The grain size in thin sections so far examined from this outcrop is silt-sized with little normal grading as suggested by the color couplets. Grading here is mainly the result of the addition of finer grain sizes, in what is the darker part of a couplet, not a progressive decrease in grain size upward.

Upper and lower contacts of individual couplets are sharp, but frequently somewhat wavy. Individual couplets can easily be traced across the outcrop and there is no evidence of pinch and swell of laminations

Most couplets are less than two to four millimeters thick, but there are many examples of couplets where the lighter part is as much as 12 cm thick, The grain size in couplets with thicker lighter colored parts Is generally coarser and frequently the basal portion contains low angle tangential cross laminations of coarser material mixed with the silt. In addition, couplets with thicker lighter colored portions contain wavy, discontinuous parallel and non-parallel interlaminations of medium to fine sand-sized clasts.

Numerous intrastratal zones of deformation are present in this area. These appear to be post-depositional, pre-lithification features.

Interpretation - The Tillery has tong been considered a quiet water deposit, as suggested by the laterally extensive bedding and relatively uniform fine grain sizes in this part of the section. Reports of graded bedding (Stromquist & Sundelius, 1969) in the Tillery plus the rhythmic repetition of light and dark colored bands suggest deep water turbidite deposits, probably distal turbidites.

However, in light of depositional environments suggested for the overlying McManus and Yadkin formations, the general absence of normal graded bedding, and data from the lower Tillery, an alternative interpretation is suggested -- that of a relatively shallow water environment that was usual1y isolated from coarse sediment influx, but was still influenced by tides.

The depositional environment was one in which silt sized material was washed from a shallower platform into a slightly deeper basin. With slack water periods, such as during high and low tide stages, pelagic sediments (clays) would settle to the bottom accounting for the dark layers of finer grained sediment within the silt. Occasional pulses of higher energy and extended periods of higher energy would account for the coarser grained layers and zones of low angle tangential cross laminations.

This completes the first day's field trip. Reboard the buses and proceed east on SR 1934 to the stop sign.

0.05 18.5 **STOP SIGN.** Intersection of SR 1934 with U.S. 52. **TURN LEFT** (NORTH) and return to Albemarle.

ROAD LOG -- SECOND DAY -- MORNING

The field trip for the second day begins at the Heart of Albemarle Motel. Buses will be boarded there and leave from that point.

Mileage between points	Total Mileage	
0.0	0.0	From Heart of Albemarle Motel proceed south on U.S. 52 (First Street) to intersection of U.S. 52 and N.C. 24-27.
0.6	0.6	Intersection of U.S. 52 and N.C. 24-27. Proceed beneath underpass and **TURN LEFT** {EAST) onto N.C. 24-27.
0.2	0.8	Excavation on north (left) will be site of automotive parts house, and is being cut Into type area of McManus formation as described by Conley and Bain (1965), which here is massive, structureless silty mudstone with intermittent thin layers of laminated clay. Fresh surfaces do not reveal lithologic changes, which are subtle.
0.1	0.9	Roadcuts expose mudstone member of McManus Formation. Good exposures occur between here and intersection of N.C. 24-27 and N.C. 73, ahead.
1.6	2.5	Intersection of N.C. 73 with N.C. 24-27. **TURN RIGHT** (EAST) onto N.C. 24-27/73. Bedrock exposed around Belk store is mudstone member of McManus Formation.
0.8	3.3	Intersection of SR 1537 with N.C. 24-27/73.
0.4	3.7	Intersection of SR 1731 (on north) with N.C. 24-27/73.
0.1	3.8	Outcrop of McManus formation on north.
0.6	4.4	Mudstone member of the McManus formation crops out on south (right).
0.4	4.8	Crossroads intersection of SR 1720 with N.C. 2,3- 27/73.
0.6	5.4	Intersection of SR 1736 with N.C. 24-27/73.
0.2	5.6	Intersection of SR 1740 (West end of loop) with N.C. 24-27/73.
0.5	6.1	Intersection of SR 1818 with N.C. 24-27/73.
0.2	6.3	Mudstone member of McManus formation on south (right). Some interbeds of silty to sandy material, typical of transition into underlying Tillery Formation.
0.5	6.8	Intersection of SR 1740 (East end of loop) with N.C. 24-27/73.
0.3	7.1	Intersection of SR 1778 with N.C. 24-27/73.
0.7	7.8	Outcrop on north at top of hill exposes rhythmically laminated Tillery silty clay-stones. This outcrop was visited on the 1959 CGS field trip. In addition to the laminated silty claystones, there are tuffaceous dropstones in the easternmost part of the exposure. These angular fragments are 1 to 2 cm in diameter. A gabbro sill and crosscutting dike are also visible here.
0.3	8.1	West end of bridge over Lake Tillery.
0.2	8.3	Intersection of N.C. 24-27 and N.C. 73. **CONTINUE EASTWARD** on N.C. 24-27.
0.1	8.4	Intersection of SR 1149 (Old SR 1150) with N.C. 24-27.
0.2	8.6	Weathered laminated Tillery on north.
0.1	8.7	Crossing of Rocky Creek.
0.1	8.8	Exposures of lower Tillery laminated sandy siltstones composed of tuffaceous fragments, quartz and feldspar clasts.
0.2	9.0	Crossing of Rocky Creek.
0.2	9.2	Crossroads intersection of SR 1150 and N.C. 24-27. Continue eastward on N.C. 24 -27.
0. I	9.3	Poor exposures of sandy laminated siltstones of the Tillery. Clasts include euhedral feldspar and quartz as well as lithic fragments including reworked laminated sandy siltstones. Normal and reverse grading is seen in this material.

0.5 9.8 **STOP #7.** The outcrops in this roadcut and the small, abandoned quarry just south of the highway provide good exposures of the sedimentary features of the uppermost Uwharrie formation.

Described as "fine-grained, bedded tuffs" in the CGS 1959 guidebook, the Uwharrie formation here is primarily composed of water reworked felsic volcanic debris, and suggests repeated influxes of lithic fragments into the depositional system. Sedimentary features exposed in this roadcut include: matrix supported and clast-supported conglomerates; poorly-sorted and well-sorted intervals; layers of well-rounded clasts; layers of angular clasts; fining upward as well as coarsening upward sequences; lag deposits; small-scale cress bedding in fine-pebble and finer clast sizes; and broad, gently dipping tangential cross bed sets, frequently, with lag deposits as the base. Limited data from cross bed sets indicates several directions of transport, such as found in bedloads of streams; interbedded coarse grained and fine grained layers with thickness variation along outcrop.

Interpretation -- The aggregate of sedimentary features in this part of the Uwharrie formation suggest both sub-aerial and subaqueous (marine?) deposition, by streams on a fan-delta environment: and by waves/ currents on the submerged fan or delta front. The transition from sub-aerial to subaqueous deposition was rather rapid as laminated Tillery. sandy siltstones crop out less than one-tenth mile west of this roadcut.

The interbedded nature of the various sedimentary features of the Uwharrie suggest flux in the energy levels of the transporting medium and the mineralogy and textural immaturity of the sediments points toward rapid transport and burial.

The authors favor the fan-delta interpretation with both subaerial and subaqueous deposition from a felsic volcanic terrane. The placement and overall transportation directions for both the fan and delta components have yet to be determined.

Proceed **WEST** on N.C. 24-27, from Stop #7.

0.5 10.3 Poorly exposed laminated sandy siltstones. Clasts include both euhedral and anhedral quartz and feldspar crystals as well as lithic fragments in what was probably finely comminuted volcanic debris.

0.1 10.4 Crossroads intersection of SR 1150 and N.C. 24-27. **TURN NORTH** (RIGHT) onto SR 1150 and proceed north to the town of Uwharrie.

9.0 19.4 Intersection of SR 1150 and SR 109. Town of Uwharrie. **TURN RIGHT** (EAST) on SR 109.

0.2 19.6 **STOP #8.** This stop illustrates the transitional nature of the contact between "typical" Uwharrie and "typical" Tillery formations at this point. Walking east along the north side of SR 109, one passes from thin-bedded, tuffaceous, sandy to silty, rhythmically bedded units of the Tillery into andesitic (?) layers and then into relic crystal-lithic and lithic tuffs here considered to be upper Uwharrie. No erosion surface is apparent in this area and no lag deposits have been found. The rhythmically bedded sandy siltstones and silty sandstones are composed of clasts of volcanic origin with euhedral quartz and feldspar crystals common, and are in stratigraphic continuity with laminated clayey siltstones only a few meters upsection.

After viewing this outcrop walk east along the north side of SR 109 to view an outcrop that appears to mark the initiation of a major change in the Uwharrie volcanic-volcanoclastic depositional environment to an environment dominated by aqueous sedimentary conditions. At this outcrop, the quartz veins seem to mark the boundary between 'typical' Uwharrie and units transitional into 'typical' Tillery. Lithic and crystal-lithic tuffs characteristic of the Uwharrie formation occur to the east of the quartz veins while to the west of the quartz are units more closely resembling lithologies of the McManus formation.

The massive-appearing unit dominating this outcrop is composed of thick bedded to laminated very finely crystalline water laid tuff. Included are 4 to 6 cm thick layers of polymict conglomerates, with tuffaceous matrix. Scattered throughout this unit are isolated channel-fill

cross-bed sets that measure as much as 20 cm wide by 2 cm deep and whose attitudes suggest transport fro the north-northwest.

0.8 20.4 **STOP #9.** The outcrop on the north side of the highway' is composed primarily of flow-banded rhyolite with interbeds of lithic-crystal tuff to the west. This association appears quite commonly in the upper part of the Uwharrie formation as seen on Horse Mountain, just north of Stop #'7 and along SR 1146 About 2.3 miles southwest of here.

After viewing this outcrop, walk eastward to the trailhead parking lot of the Uwharrie formation. Just east of the parking lot entrance are outcrops of well-indurated lithic and lithic-crystal tuffs.

Reboard buses at parking area and proceed westward on SR 109, toward Uwharrie.

1.0 21.4 Intersection of SR 1150 with SR 109. **TURN LEFT** (SOUTH) onto SR 1150.

0.35 21.75 Graded area on left (east) of SR 1150 is cut into very thin-bedded to moderately well-laminated silty claystones that are 'typical' Tillery. Alternating light colored and dark colored layers exhibit some normal graded bedding, silt to clay. This is in stratigraphic continuity with the outcrops at Stop #8.

0.1 21.85 Cross Hall's Branch.

0.1 21.95 Inactive quarry in Tillery formation. The quarry is cut into moderately steeply dipping clayey siltstones and sandstones. Bedding thickness varies from thinly laminated to massive. The dominant depositional environment appears to have been such as to produce rhythmically laminated layers that were in turn cut by higher energy regimes. Higher energy deposits include: lenticular layers of coarse to fine sand sized material of vo1canic origin; a massive-appearing interval 150 to 180 cm thick that contains multiple graded layers, cross-bedding, flaser bedding, massive layers of laminated clayey siltstones, symmetrically rippled surfaces and poorly-sorted, matrix-supported fine pebble conglomerates. This sequence is in stratigraphic continuity with the outcrop at mile 20.95. Soft-sediment slump structures are apparent in the rhythmites beneath the higher energy deposits.

0.05 22.0 Intersection of SR 1152 with SR 1150.

0.2 22.2 Laminated silty claystones in drainage ditch to east.

0.25 22.45 Tillery exposed on both sides of highway.

0.4 22.85 Active Quarry. **STOP #10.**

Moderately well-laminated to very thin-bedded silt2,' clay-stones with graded bedding, both normal and that created by the addition of fines upward. Section near creek level contains a 120 cm thick massive-appearing pebble to cobble conglomeratic siltstone. The cobble conglomeratic portion is composed of rounded clasts of flow-banded rhyolite, lithic tuff, and crystal lithic tuff. The base of the 120 cm thick units contains a 30 cm thick layer of intra-formational conglomerate with oriented, rounded, elongated (less than 20 cm long) and flattened clasts of very thinly bedded siltstone. The layering of the siltstone clasts is concave upward. These clasts are interpreted to be desiccation ripups from a subaerial, nearshore (intertidal?) environment. Transport was vigorous enough to round, but not destroy the ripups. Matrix composition of this matrix-supported conglomerate is the same as that of the clasts. Bedding cleavage is common.

0.2 23.05 Moderately well-laminated clayey siltstone in drainage ditch to east.

0.1 23.15 Moderately, well-laminated, clayey siltstone in ditch to east.

0.1 23.25 Well-laminated Tillery in ditch to west. Bedding cleavage does not appear to be as common, as at Stop #10.

0.25 23.5 Well laminated Tillery to east.

0.15 23.65 Well laminated Tillery to east.

0.2 23.85 Intersection of SR 1146 and SR 1150. Continue south on SR 1150. Contact between lithic-crystal tuff of Uwharrie formation and clayey siltstones of Tillery formation is about 250 feet east of the intersection along SR 1146.

0.1 23.95 Straight ahead on skyline are Morrow Mountain (left), Sugarloaf Mountain (center), and Hattaway Mountain (right).

0.1 24.05 Cemetery to west (right).

0.2 24.25 Laminated Tillery in ditch to east.

0.1 24.35 Crossing of Dutchmans Creek. Tillery in place along creek, with float blocks of lithic tuff, crystal tuff and rhyolite.

0.4 24.75 Intersection of SR 115l with SR Il50. Continue south on SR 1150.

0.8 25.55 Gated entrance to Lake in the Pines. Tillery in road cut on west.

0.25 25.8 Gated entrance to Carolina Forest.

0.25 26.05 Tillery on both sides of the road. laminated tuffaceous clayey siltstones with thin-bedded structureless siltstones and discontinuous tuffaceous polymict fine pebble conglomerates. Conglomerates are channel fillings or stringers of higher energy bottom deposits East side of road, fissile Tillery passes downward into massive, tuffaceous conglomeratic sandstone and siltstone. Clasts in conglomerates are tuff and rhyolite, primarily.

0.45 26.5 Intersection of private road and SR 1150.

0.05 26.55 Gated, paved private road to west.

0.1 26.65 Laminated, clayey siltstone in ditch to west,

0.05 26.7 Laminated Tillery on west.

0.15 26.85 Laminated Tillery with broad, open folds.

0.15 27.0 Intersection of SR 1182 with SR 1150.

0.1 27.1 Laminated Tillery siltstones on west.

0.2 27.3 Laminated silty claystones on west.

0.1 27.4 Laminated to fissile claystone on both sides of the road.

0.1 27.5 Gated entrance to Holiday Shores on west.

0.05 27.55 Laminated Tillery on both sides of road.

0.1 27.65 STOP #11. Tillery on west. Nonlayered, matrix-supported conglomerate within laminated clayey siltstones. Conglomerate clasts are oriented and appear flattened. Clast composition includes; lithic tuff, rhyolite, laminated siltstone, and crystal-lithic tuff. This conglomeratic unit is broadly lenticular, lacks characteristic 'stream' structures and suggests a subaqueous flow

0.05 27.7 Crossing of Upper Wood Run.

0.05 27.75 Laminated Tillery claystones on east.

0.25 28.15 Logging road to east.

0.15 28.15 Logging road to east. Tillery in clearing.

0.2 28.35 Access road to west. Moderately well-laminated Tillery on both sides of SR 1150. Contact between Tillery and Uwharrie formations is just south of access road.

0.05 28.4 Uwharrie formation crops out on east side of SR 1150 as massive crystal-lithic tuff with poorly sorted clayey siltstones immediately above tuff. No evidence of tectonic contact or an erosional surface on the tuff.

0.05 28.45 Gated road to east.

0.1 28.55 Crossing of Wood Run.

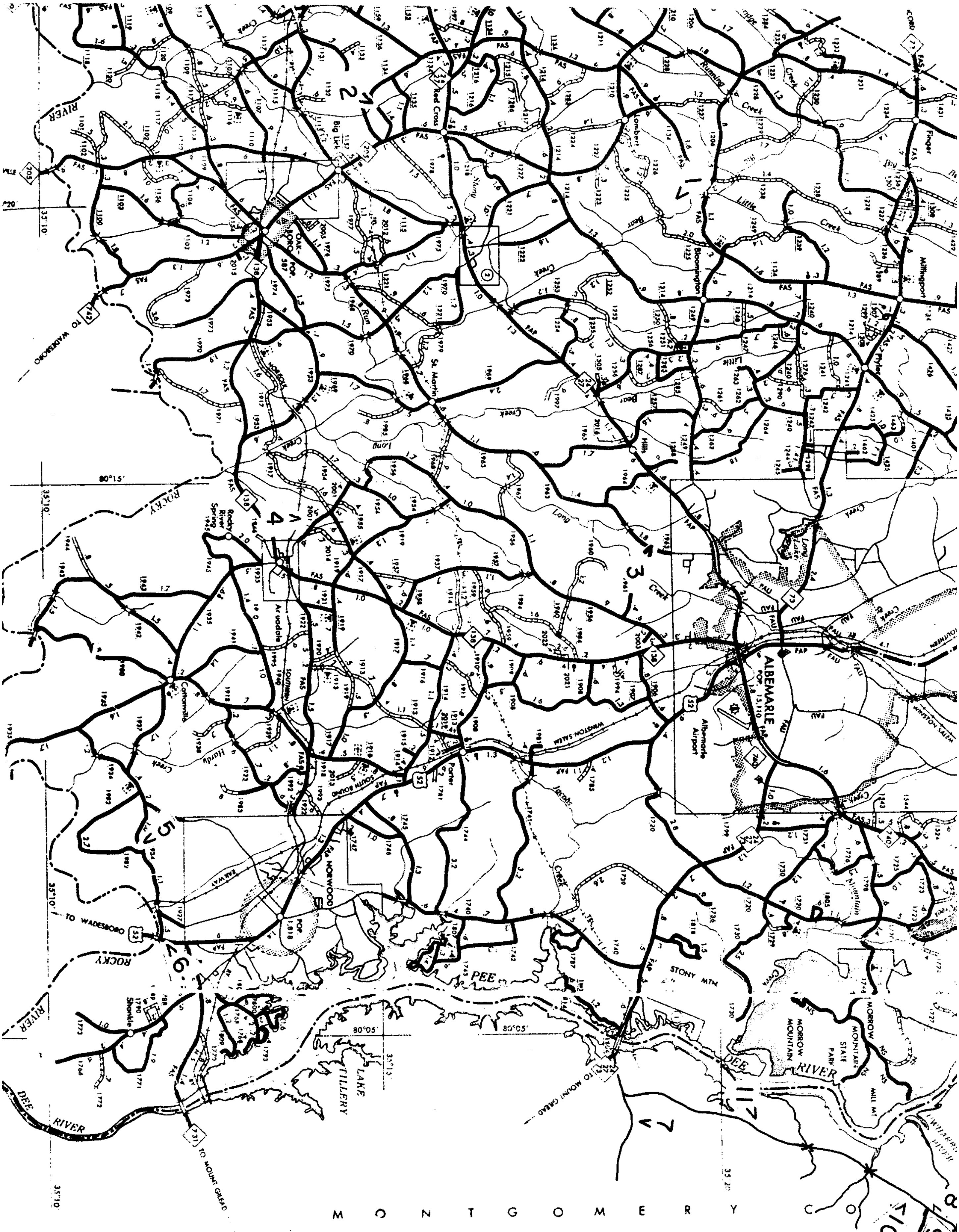
0.05 28.6 Entrance to Wood Run Campground and abandoned building. Uwharrie-Tillery contact can be seen along Wood Run to north and northeast of building. Laminated silty claystone lies concordantly on lithic-crystal tuff. Again, no evidence of erosion on contact. Within tuff is a 20 cm thick layer of finely crystalline mudstone, similar to that seen along SR 109 at Stop #8 and also present at Stop #7.

0.55 29.15 White Crest Baptist Church.

0.45 29.6 Intersection of SR 1149 with SR 1150. Laminated claystone to east.

0.2 29.8 Laminated silty claystone to east.

0.1 29.9 Intersection of SR 1150 with N.C. 24-27. **TURN WEST** (RIGHT) onto N.C.24-27 and return to Albemarle.



Red Cross
Big Lick
OAKBORO
POP. 387
Bloomington
Finger
Millingport
St. Martin
Rocky River Spring
Aquadale
Cottonville
ALBEMARLE
POP. 15,110
Albemarle Airport
Porter
NORWOOD
POP. 1,818
Shankle
STONY MTN
MORROW MOUNTAIN
MORROW MOUNTAIN STATE PARK
LAKE TILLERY
PEE DEE RIVER
ROCKY RIVER
Long Creek
Running Creek
Little Creek
Long Lake
WINSTON SALEM
SOUTHERN
TO WADESBORO
TO MOUNT GILEAD
80°15′
80°05′
35°10′
M O N T G O M E R Y C O