CAROLINA GEOLOGICAL SOCIETY

OCTOBER 24-25, 1970

Field Trip Guidebook

Stratigraphy, Sedimentology and Economic Geology of Dan River Basin, North Carolina

by

Paul A. Thayer
Dewey S. Kirstein
Roy L. Ingram

Raleigh
1970

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STRATIGRAPHY, SEDIMENTOLOGY AND ECONOMIC GEOLOGY OF DAN RIVER BASIN, NORTH CAROLINA

Paul A. Thayer
Dewy S. Kirstein
Roy L. Ingram

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FIELD TRIP ROAD LOG - FIRST DAY

Saturday, October 24, 1970

Leader: Paul A. Thayer

The Saturday field trip will assemble on the parking strip along U.S. 29 South in front of the Red Carpet Inn (also called Virdan Motor Lodge), Danville, Virginia. Participants should reach the assembly point in ample time to be in line and ready to depart at 8:00 sharp. Vehicles should have full fuel tanks before starting the trip. Total mileage for the Saturday trip is 116 miles; for Sunday it is 41 miles.

Before leaving participants should purchase tickets for Saturday lunch and the Saturday night banquet (7:30 PM at the King of the Sea Restaurant, Danville).

Because of the large number of vehicles involved in the trip **PLEASE:** 1). Keep your position in the caravan throughout each day, 2). Stay close behind the vehicle in front of you, 3). Do not turn until the vehicle behind you is in sight, and 4). Assemble promptly with the field trip leader at each stop.

Summary

The first day of the field trip consists of 9 stops at the main rock types, and is primarily concerned with stratigraphy, petrology, and sedimentology of the Dan River strata. The Index Map (Figure 1), Map of Danville (Figure 2), and Thayer's (1970) Figure 2 and Plate 1 will be very helpful for both geographic and geologic reference.

Leaving Danville, the trip will proceed southward to Stops 1, 2, and 3 near Eden, North Carolina, after which the route will continue to Stop 4, just south of Stoneville. Lunch will follow Stop 4, at the YMCA Camp near Mayodan. After lunch the route continues south to Stop 5, in Mayodan, and Stops 6 and 7, near Pine Hall in Stokes County. The route will then be retraced in part to Stops 8 and 9, the latter being just northeast of Stoneville in Rockingham County. At the conclusion of Stop 9, the caravan will return to Danville (following NC 770 most of the way) for dinner, discussions, and lodging.

Tentative Schedule

Arrive	Leave	
	8:00 AM	Red Carpet Inn, Danville, Virginia
8:30	9:15	Stop 1. Pine Hall Conglomerate and Arkose, 45 minutes
9:45	10:00	STOP 2. Eastern border fault. 15 minutes
10:20	11:00	STOP 3. King's Quarry. 40 minutes
11:30	12:00 AM	STOP 4. Stoneville Arkose. 30 minutes
12:10	1:10	LUNCH YMCA Camp near Mayodan, North Carolina. 1 hour
1:20	2:00	STOP 5. Stoneville transitional facies. 40 minutes
2:30	2:45	STOP 6. Stoneville Conglomerate. 15 minutes
3:05	3:30	STOP 7. Pine Hall Arkose. 25 minutes
4:00	4:25	STOP 8. Cow Branch Formation and dolerite dike. 25 minutes
4:45	5:00	STOP 9. Stoneville Conglomerate. 15 minutes
6:00		Red Carpet Inn, Danville, Virginia

ROAD LOG

Milage	Distance From Last Reading	Discussion
0.0	0.0	Assembly Point. Red Carpet Inn (also called Virdan Motor Lodge), Danville, Virginia. Caravan proceeds southward on US 29 South.
0.5	0.5	North Carolina state line (Caswell County).
1.55	1.05	Turn **RIGHT** on NC 700 exit ramp.
1.8	0.25	Turn right (southwest) on NC 700 W.
5.15	3.35	Rockingham County line. Continue ahead on NC 700 W.
8.75	3.6	Intersection with Rockingham County Road 1767 (Mayfield). Continue ahead on NC 700 W.
9.95	1.2	Bear left. Continue on NC 700 W.
12.55	2.6	Intersection with Rockingham County Road 1759. Bear left and continue on NC 700 W.
12.6	0.05	Turn right (north) at Happy Home United Church of Christ, on Rockingham County Road 1756.
13.1	0.5	Note discontinuous exposures of dol-

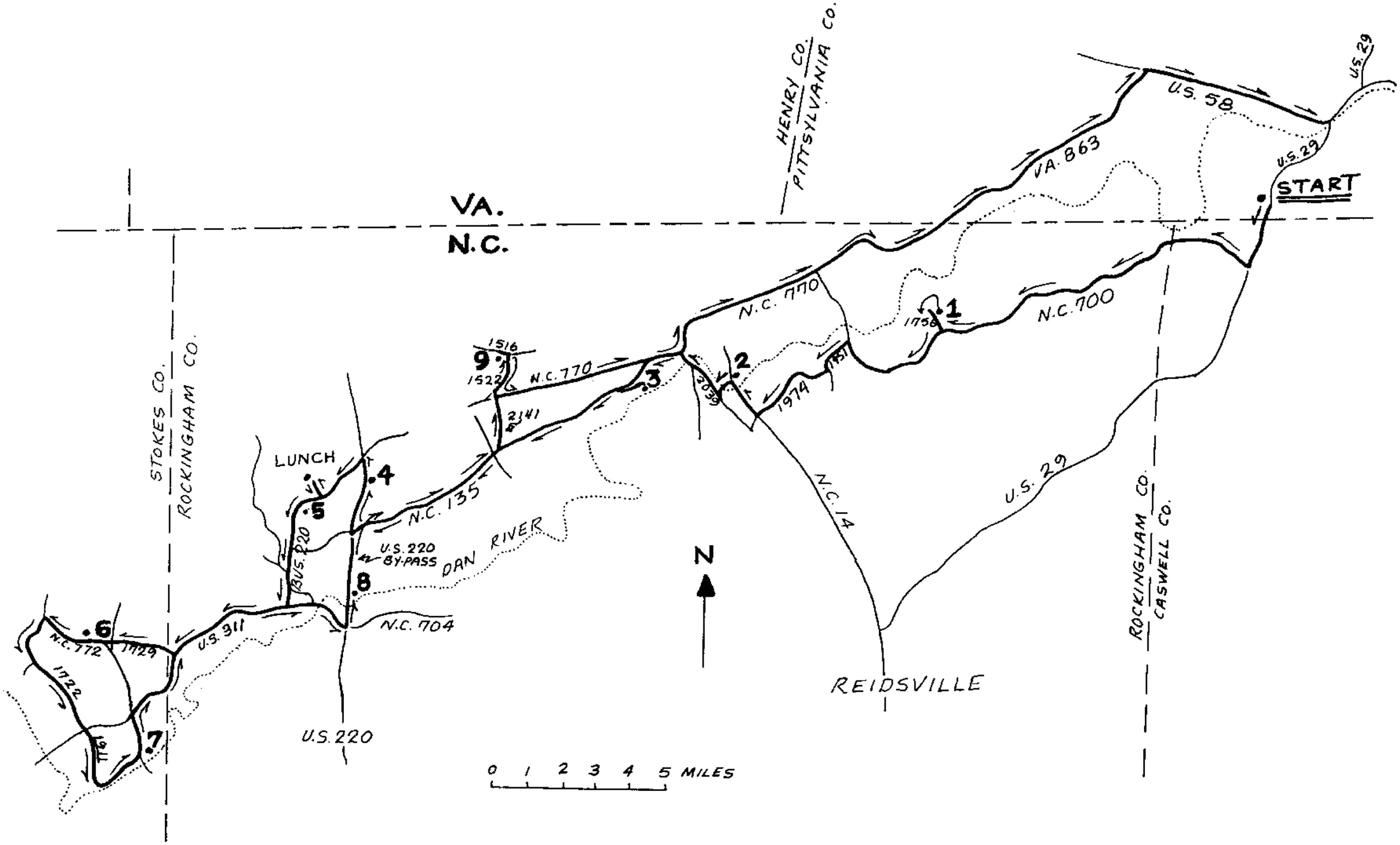

Figure 1. Route of Saturday field trip across rocks of Dan River Basin, Stokes and Rockingham Counties, North Carolina.

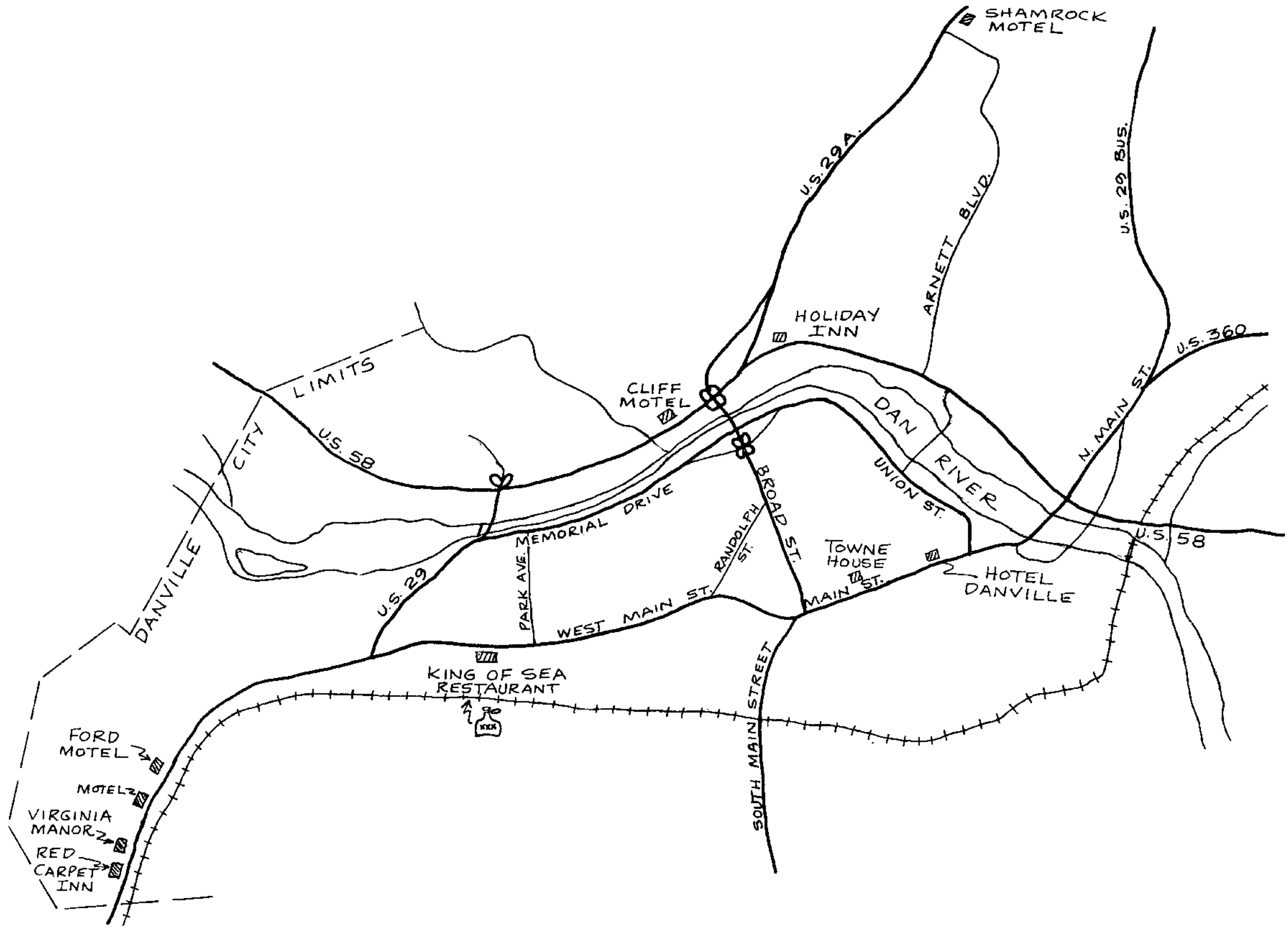

Figure 2. Sketch map of Danville, Virginia, showing main roads, motels, and King of the Sea Restaurant.

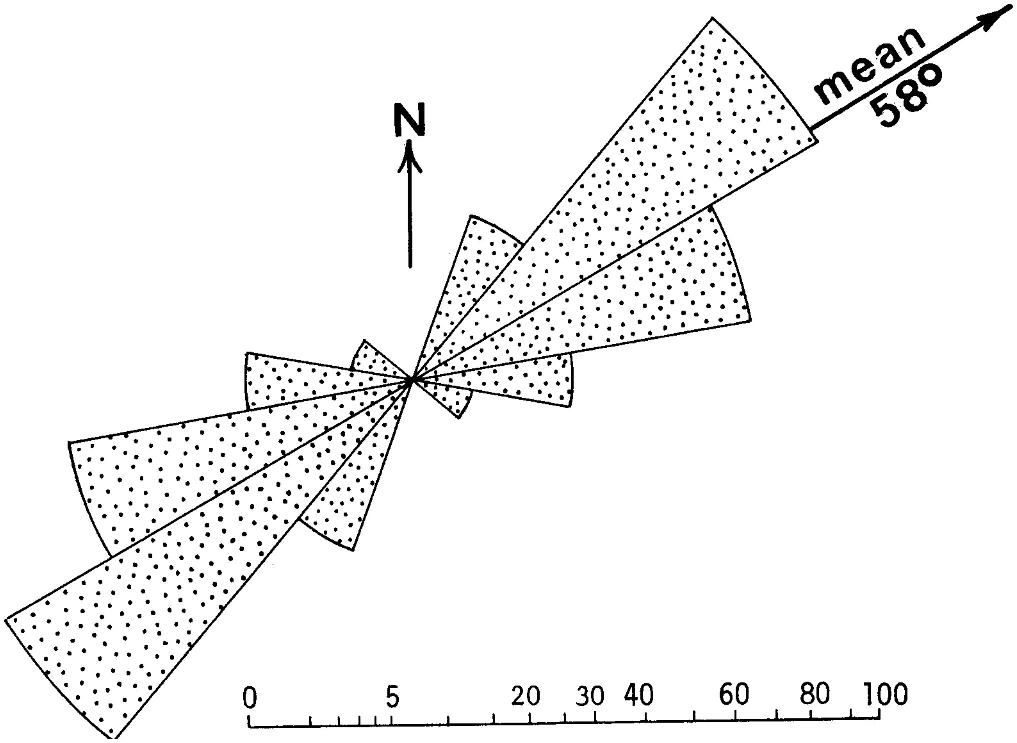

Figure 3. Equal-area circular histogram of clast, long axes from STOP 1 (Pine Hall Conglomerate).

		erite boulders along right (east) side of road from here to Stop 1. Strike of the dolerite dike is approximately parallel to the road (see Thayer, 1970, Plate 1)
13.55	0.45	Just past trailer on left (west) we are crossing approximate contact between Pine Hall Conglomerate and basement rocks. Note the abundant granule-, pebble-, and cobble-sized clasts of quartz and metavolcanic rocks along the road as soon as we have crossed into the Triassic. The contact here is believed to be a northwest-dipping, high-angle normal fault (to be seen at Stop 2).
13.65	0.1	**STOP 1**. Pine Hall Conglomerate and Sandstone Facies.

At this stop first examine the conglomerate exposure in the field 100 feet to the right (east) of the road, then traverse northward (downhill) 0.15 mile along 1756 to examine outcrops of coarse-grained plagioclase lithic arkose. The conglomerate-sandstone contact is approximately 0.1 mile down the hill.

Items (Conglomerate facies):

1. Conglomerate is approximately 800 feet thick at this locality.
2. Eastern border conglomerates, assigned to Pine Hall Formation, are restricted to the extreme northern portion of the Dan River Basin. Apparently this was a locus of major sediment infilling during initial (and subsequent?) stages of basin subsidence.
3. Pine Hall Conglomerates are very resistant to weathering; typically, they form rocky knolls or large boulder fields along the eastern basin margin.
4. Clasts are moderately sorted, rounded and well rounded, granule- to cobble-size metavolcanic rocks, believed to have been derived from the Carolina Slate Belt, approximately 25 miles to the southeast. Notable is the small percentage (+ 5%) of rounded quartz clasts.
5. Average apparent long-axis (A') orientation of 150 rod- and disc-shaped clasts greater than 16mm long from this exposure is N. 57.8× E. (Figure 3). Review of the literature (summarized by Potter and Pettijohn, 1963, p. 35-36; Johansson, 1965, Table 1; and Nilsen, 1968, p. 74-75) indicates that long axes in fluvial gravels can be either parallel or perpendicular to stream flow. Of particular relevance to the present study, however, are Krumbein's determinations that long axes of flood gravels in California are parallel to flow directions (1940, p. 668-669; 1942, p. 1386-1391). Additional evidence for a northeast flow direction comes from analysis of the orientation of blunt and tapered ends of well-aligned

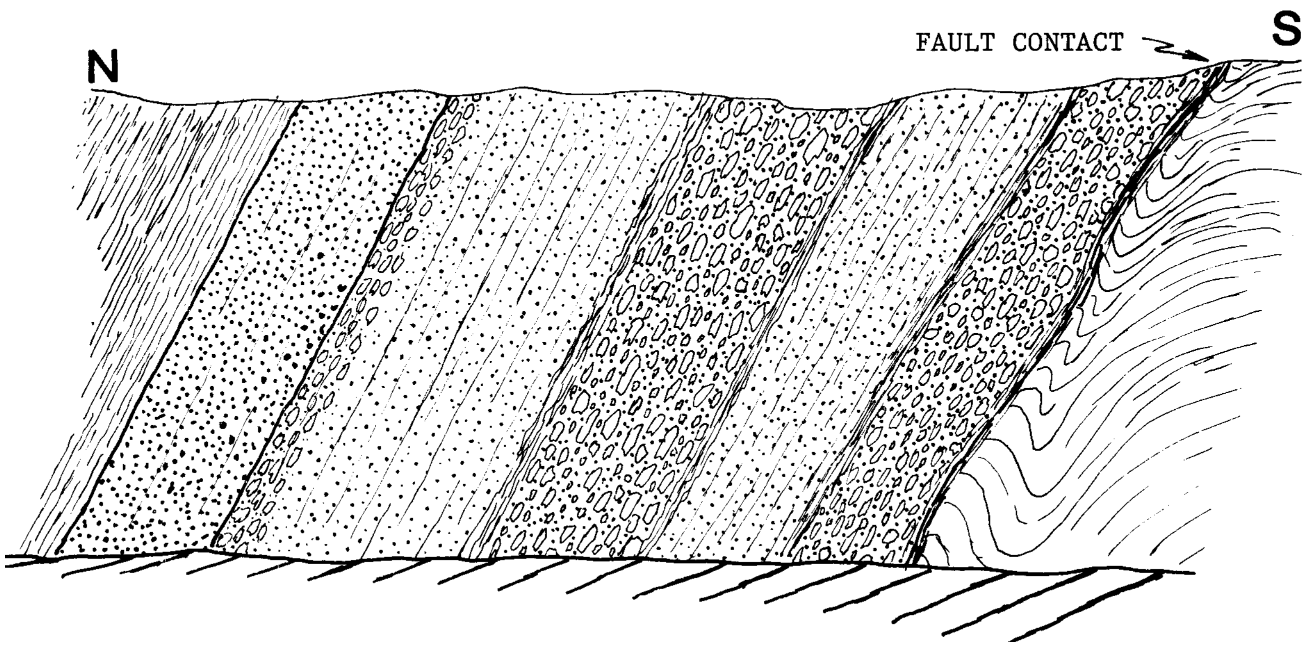

Figure 4. Sketch of weathered fault exposure along eastern basin margin seen at STOP 2.

elongate clasts. Theoretically the blunt ends should be oriented facing upcurrent. Studies of tapered elongate fossils, such as orthoceracone cephalopods and high-spired gastropods, generally confirm this relationship. Blunt ends of elongate clasts at this exposure substantiate the northeast flow direction.

6. These conglomerates are interpreted as fanglomerates that accumulated on alluvial fans adjacent to fault scarps that formed the eastern basin margin near this locality. Fine grain size, moderate sorting, and clast roundness suggest deposition by streams and/or moderate streamfloods (Allen, 1965, p. 161). The abundance of pebbles and cobbles larger than 2.5 cm indicates transport in the upper flow regime. The low proportion of silt and clay in these deposits implies deposition by high-gradient, low sinuosity streams (braided). Additional features indicative of braided stream deposition (found at nearby outcrops in this facies) include: 1). Wide range in grain size- lateral and vertical grading, 2). intra-clasts, 3). Variable bed thickness, and 4). Rare cut-and-fill (Smith, 1968, p. 285).

Items (Sandstone Facies):

1. Dip is 34× NW.
2. Gradational contact with conglomerate. Recurring lenses of conglomerate (exposed in the ditches along the east side of the road) are common within the sandstone.
3. Abundant silicified wood in drainage ditch on east side of road (approximately 750 feet downhill from conglomerate exposure). Petrified wood is abundant in sandstones of Pine Hall Formation throughout the length of the basin - it is rarely found in Stoneville sandstones or conglomerates.
4. Sets of small- and medium- scale trough cross-strata exposed in ditch approximately 900 feet downhill.
5. Pebbly, medium- to very coarse- grained, very poorly sorted immature plagioclase lithic arkose. Modal analysis of this rock yielded: common quartz, 35.2%; composite quartz, 12.9%; sutured quartz, 7.2%; twinned K-feldspar, 2.2%; untwinned K-feldspar, 4.6%; plagioclase (chiefly Na-plagioclase), 17.7%; matrix, 8.2%; micas, 1.2%; rock fragments (schist and/or phyllite, and gneiss), 2%; and pleochroic green hornblende, 8.9%.
6. The sandstones are interpreted as fluvial deposits formed in the lower flow regime. The low proportion of silt and clay suggest high-gradient, low-sinuosity streams.

Questions:

1. *What was the regional pattern of relief and drainage along the southeastern uplands?*
2. *How much detritus was brought into the basin from sources to the east?*
3. *Why are metavolcanic rock clasts so abundant in Pine Hill Conglomerates? Did the Slate Belt extend farther westward? Why didn't the adjacent gneiss-schist complex supply more coarse detritus to the subsiding trough (deep weathering?)?*
4. *Why are petrified logs so abundant in Pine Hill sandstones, yet virtually absent from Stoneville Formation? Does this imply a change in climate toward the close of Triassic time?*

5. *How far eastward did Triassic strata extend? Is the original shape and extent of the depositional basin similar to the present-day outcrop pattern?*

		Retrace route back to NC 700.
14.7	1.05	Turn right (southwest) on NC 700.
16.0	1.3	Powell's Store. Bear right and continue ahead on NC 700.
18.1	2.1	Crossing approximate fault contact between Pine Hall Conglomerate and basement rocks (chiefly biotite gneiss here).
18.2	0.1	Boog-A-Loo Dance Hall on left. Note large residual boulders of conglomerate (partially concealed by vegetation) on the south side.
18.5	0.3	Turn **LEFT** (southwest) on Rockingham County Road 1951. From here until the next reading we are traveling over Pine Hall maroon sandstones.
19.1	0.6	Crossing eastern boundary of Dan River Basin. The route from here until Stop 2 is over basement rocks (chiefly biotite gneiss).
19.7	0.6	Turn **RIGHT** (southwest) on Rockingham County Road 1974 (dirt).
20.4	0.7	Probable Indian mound in field on right (north).
22.6	2.2	Turn **RIGHT** (northwest) on NC 14.
23.5	0.9	Crossing Dan River. Note Duke Power generating plant, downstream on right. The river here flows on biotite gneiss; throughout most of the area, however, the river flows on much weaker Triassic strata.
24.0	0.5	Turn **RIGHT** (east) on dirt road leading to dirt field and park.
		STOP 2. Pine Hall Sandstone Facies and eastern border fault.

Items:

1. Quartz-feldspar biotite gneiss in fault contact with conglomerates and sandstones assigned to Pine Hall Sandstone Facies (Figure 4).
2. Estimated thickness of sandstone facies here is between 1000 and 1300 feet.
3. Normal fault dipping steeply to the northwest.
4. Shear zones marked by accumulations of red clay.
5. Steeply-dipping coarse- and very coarse-grained highly weathered (kaolinized?) arkose with abundant manganese oxides.

Questions:

1. *Is this the eastern border fault, or is it a later fault that formed basinward of the original fault now located to the southeast?*
2. *If this is the eastern border fault why are thick conglomerates lacking? Have they been faulted-out, or were they never deposited here?*
3. *Is Dan River Basin a simple half-graben with significant faulting only along the northwest margin, or a rift valley with faulting along both margins?*
4. *Why do dolerite intrusions follow north and northwest-trending fracture zones when faults such as this would have been likely conduits for rising magmas?*

		Retrace route back to NC 14, and then turn left (south). From here until milepost 25.6 we will be traveling over basement rocks (chiefly quartz-feldspar biotite gneiss).
24.2	0.2	Turn **RIGHT** (west) on Rockingha County Road 1964.
24.4	0.2	Eden Sewer works on left. (Hold your nose.)
24.6	0.2	Cross dolerite dike on left (east) just past south end of bridge.
25.0	0.4	Turn **RIGHT** (northwest) on Rockingham County Road 2039.
25.6	0.6	Crossing approximate contact between Pine Hall Sandstone and basement rocks. The contact here is believed to be an angular unconformity.
26.0	0.4	Crossing approximate Pine Hall - Cow Branch contact.
26.4	0.4	Turn **RIGHT** (north) on NC 87.
26.7	0.3	Crossing Dan River. Here the river is flowing over relatively soft Cow Branch shales. Approximate Cow Branch - Stoneville contact is drawn about 100 feet north of the north side of the bridge. From here until milepost 29.0 we will be driving over maroon mudstones with subordinate fine sandstones assigned to Stoneville Siltstone Facies.
27.0	0.03	Traffic Light. Turn **LEFT** (southwest) on NC 770.
27.0	0.03	Traffic light. Continue ahead on NC 770.
27.4	0.4	Traffic light on top of hill. Continue ahead on NC 770.
28.3	0.9	Turn **LEFT** (southwest) on NC 135.
28.8	0.5	Turn **LEFT** (south) on gravel road (Howell's Garage on opposite side of road).
29.0	0.2	Bear left at crossroads, and continue ahead. Gradational Stoneville - Cow Branch contact about 100 feet north of

here.

29.25 0.25 Bear left at crossroads and continue ahead.

29.55 0.3 **STOP 3.** King's Quarry, upper half of Cow Branch Formation. Quarry last operated in 1966 for road metal used locally in driveway and private road construction. A larger, state-owned quarry is located just to the southwest. It has been operated sporadically for a number of years, the material being used chiefly as a subbase in highway construction.

Items:

1. Dip is 30× NW. Approximate total thickness of Cow Branch in this vicinity is 800 feet.
2. Well-developed cyclic pattern (Figure 5) consisting of massive light gray and tan silty mudstones alternating with dark gray to black platy pyritic shales and carbonaceous shales (coaly in places).
   a. Coarser-grained calcitic and dolomitic massive silty mudstones average 10 feet in thickness, are brecciated (shrinkage crack casts), and usually display abundant mudcracks in their upper portions. They are rarely laminated. Instead, most of these rocks have been churned up and display mottled (bioturbated), contorted, convoluted, and disrupted fabrics. The fabrics were probably produced by 1). burrowing organisms, 2). compaction of hydroplastic muds, and 3). desiccation.

   Although variable, textures usually consist of subordinate amounts of angular silt-size grains "floating" in a dark-colored clay-size matrix. The clay-size matrix is chiefly illite (muscovite), chlorite, and ground-up detrital mineral grains, along with strongly birefringent patches of calcite and dolomite. Detrital silt-size grains are chiefly quartz, Na-plagioclase, K-feldspar, and chlorite with minor amounts of muscovite and biotite. In addition, they contain scattered patches of sparry calcite and dolomite believed to be chiefly secondary alteration products. Pyrite is ubiquitous, but not nearly as abundant as in the black platy shales.

   b. Black, platy clay shales average 6 feet in thickness. They display regular, uniformly even laminae that typically range from 0.05 to 2 mm in thickness. The laminations (varves?) are produced by 1). Color banding - alternations of black and light gray clay-size particles, and 2). Textural banding - alternations of dark gray to black clay-size particles with lighter-colored very fine silt-size carbonate-rich detrital layers. Pyrite, as framboidal aggregates, radiating rosettes, scattered cubes, and layers is very abundant in these rocks. Carbonate concretions (dolomitic) up to a foot long and parallel to bedding are common. Septaria are found locally. Fossils at this locality include estherids and ostracodes. Ripple marks are sometimes developed locally in this rock type.

   c. Black, carbonaceous (coaly in places) clay shales with abundant sulfides and carbonate concretions. These commonly develop a chalky-white sulfate bloom upon weathering. In places, macerated and whole plant debris is very common.

   A number of older geologic reports mention the occurrence of "coal" in the Dan River Basin. According to several the "coal" was used locally by blacksmiths, and during the Civil War it was supposedly mined about a quarter mile southwest of here (on the old Wade Plantation), then shipped down the Dan River on flatboats. Stone (1910) examined the "coal" deposits in the region and concluded that there were no commercially valuable beds.

   Abundant sparry calcite as veins and joint fillings in all rock types.

Interpretation:

Combinations of sedimentary structures, lithic features, and fauna indicate the Cow Branch to be largely of lacustrine origin. The cyclic patterns of sedimentation resulted fro expansion and waning that occurred during the history of the lake. The carbonaceous shales accumulated in swamps and marshy ponds during initial stages of lake filling. Laminated, pyritic platy shales were deposited under quiet water conditions (chiefly below wave-base) in an extensive lake. The mud must have been deposited in a reducing environment noxious to bottom dwellers and burrowers since delicate laminations are well preserved. Massive silty mudstones accumulated in very shallow water that periodically dried up producing mudcracks and brecciated shrinkage crack casts. The lake bottom must not have been exposed for long periods since the sediments were not oxidized. The influx of coarser-grained detritus during this phase is probably related to increased tectonic instability in the source area.

Questions:

1. *What widespread conditions were responsible for the formations of thick lacustrine facies in the Triassic basins of eastern North America (Bloomiden Fm. In Nova Scotia, Meriden Fm. In CT, Lockatong Fm. in NJ and PA, and Cumnock and Cow Branch Fms. in NC)?*
2. *What produced the central ponding in Dan River basin - growth of alluvial fans, volcanic activity (??), central subsidence, shifts in drainage patterns, or changes in climate?*
3. *What produced the cyclic arrangement - tectonics, changes in climate, or shifts in drainage patterns?*
4. *What was the climate and geography like during this*

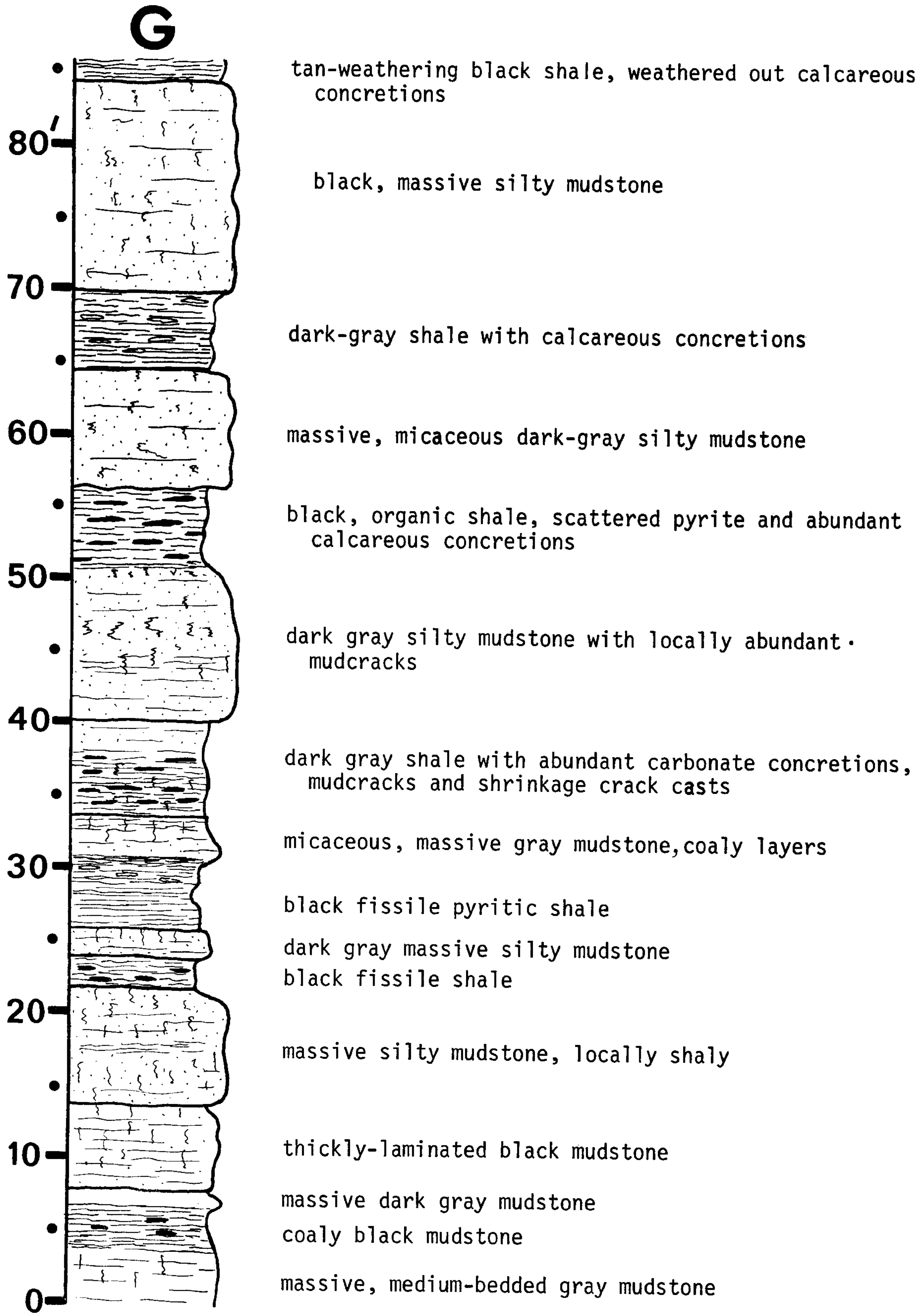

Figure 5. Stratigraphic section of Cow Branch Formation seen at STOP 3 (King's Quarry).

stage of the basin's history?

5. *Why are chemical cycles, like those of the analcime-rich Lockatong Fm. in NJ, absent (or not yet found) in the Cow Branch?*
6. *Are the abundant calcite veins found here related to hydrothermal activity or the result of diagenesis?*

		Turn around in quarry and retrace route back to NC 135.
30.35	0.8	Turn **LEFT** (southwest) on NC 135. From here until milepost 31.8 we will be traveling over maroon mudrocks with subordinate fine-grained sandstones assigned to siltstone facies of Stoneville Formation.
31.8	1.45	Crossing very approximate contact between Stoneville siltstone facies and Stoneville sandstone facies. The latter consists chiefly of medium- to coarse-grained sandstone with a subordinate proportion of mudrocks. We will be traveling on Stoneville sandstone facies from here until milepost 35.75.
32.9	1.1	Rockingham County Road 2148 on left. Continue ahead (southwest) on NC 135.
35.0	2.1	Intersection with Rockingham County Road 2145. Continue ahead (southwest) on NC 135.
35.75	0.75	Crossing approximate contact between sandstone and siltstone facies of Stoneville Formation. From here until milepost 39.1 we will be traveling upon maroon mudrocks and sandstones of Stoneville siltstone facies. Note northeast trending ridges approximately 0.5 mile to the right (north) of here until intersection with US 220 Bypass. These are held up by well-indurated lithic arkose of Stoneville sandstone facies.
36.4	0.65	Intersection with Rockingham County Road 2154. Stay on NC 135.
38.8	2.4	Turn **RIGHT** (north) on US 220 Bypass. Unnamed ridge in front of you is held up by lithic arkoses of Stoneville sandstone facies.
39.1	0.3	Approximate contact between siltstone facies and sandstone facies of Stoneville Formation. From here until milepost 45.2 we will be traveling on rocks assigned to Stoneville sandstone facies.
40.2	1.1	**STOP 4.** Sandstone facies, Stoneville Formation. Park cars on grass strip along 220 Bypass North. Cross highway and WATCH FOR CARS.

Items:

1. This is the type section of Stoneville Formation. We are located approximately in the middle of the formation in the central part of the basin; the formation here is estimated to be approximately 6000 feet thick. Dip averages 40× to the northwest. A north-northwest trending dolerite dike is located 300 feet west of here.
2. Rhythmic sandstone-siltstone alternations (Figure 6) that show an upward decrease in grain size and bed thickness (fining-upwards cycles) accompanied by a change in types of sedimentary structures.
   Ideally (Figure 7), the sequence starts with channel lag conglomerates (upper flow regime) resting on the upper scoured surface of the underlying siltstone unit. The conglomerate zone rarely exceeds 2 feet in thickness and usually averages one foot. Large-scale trough cross-stratified, coarse-grained sandstone overlies the conglomerate. This unit appears massive in the field and averages about 15 feet in thickness; variations are common, however, and some zones attain thicknesses up to 100 feet. Sets of parallel, wavy, and/or rippled laminations overlie the large-scale cross-beds. The overall thickness of the laminated zone rarely exceeds 20 feet. Sets of small-scale trough cross-stratified, medium- to very fine-grained sandstone may be present above the laminated zone, but are normally absent in most sequences. Massive, very thin- to medium- bedded reddish-colored mudstones and shales overlie the topmost sand unit. Average thickness of the mudstone cosets is 10 feet; rare cosets attain thicknesses up to 150 feet. The mudstones usually contain abundant irregular-shaped carbonate concretions.
3. A wide variety of sedimentary structures including: calcareous concretions, massive-appearing bedding, ball-and-pillow, graded bedding, wavy bedding, small- to large- scale trough cross-stratification, distorted laminations, channel-lag conglomerates, current ripple laminations, flaser bedding, and ripple-drift cross-laminations.
4. The sandstones display a wide range of textures and compositions (both depending on grain size). Coarsely grained, poorly sorted sandstones and feldspathic graywackes; finer-grained, better-sorted ones are arkoses and feldspathic subgraywackes. Modal analysis of a medium-grained sandstone yielded: common quartz, 17%; composite quartz, 6.6%; sutured quartz, 3.2%; twinned K-feldspar, 3.5%; untwinned K-feldspar, 22.2%; plagioclase, 13.8%; matrix, 26.6%; schist fragments, 1.2%; gneiss fragments, 2.0%; and others (authigenic K-feldspar, albite, and quartz overgrowths), 4%. The matrix material in these rocks is chiefly clay-size sharply angular detrital grains and abundant authigenic

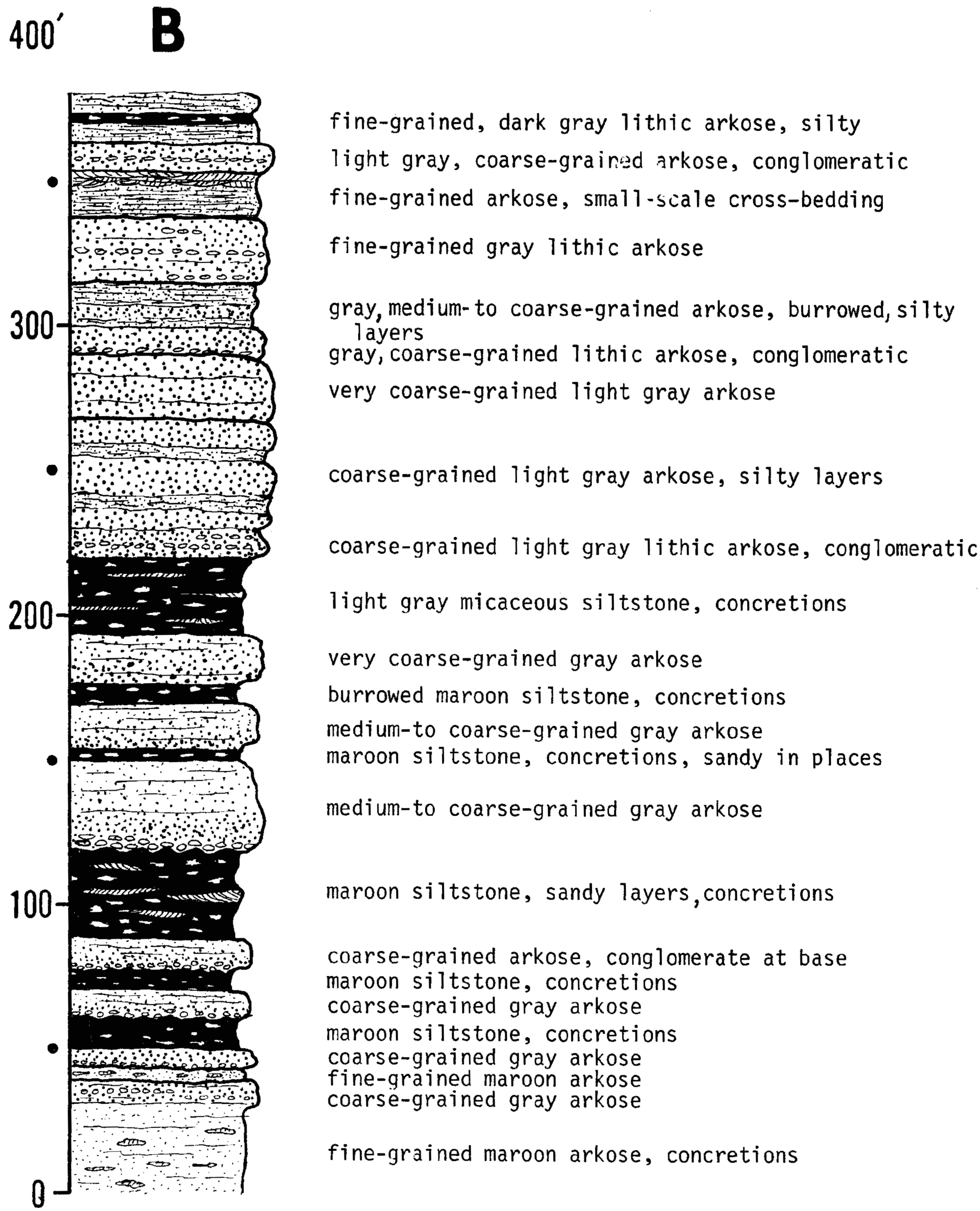

Figure 6. Stratigraphic section of Stoneville Formation along US 220 Bypass seen at STOP 4.

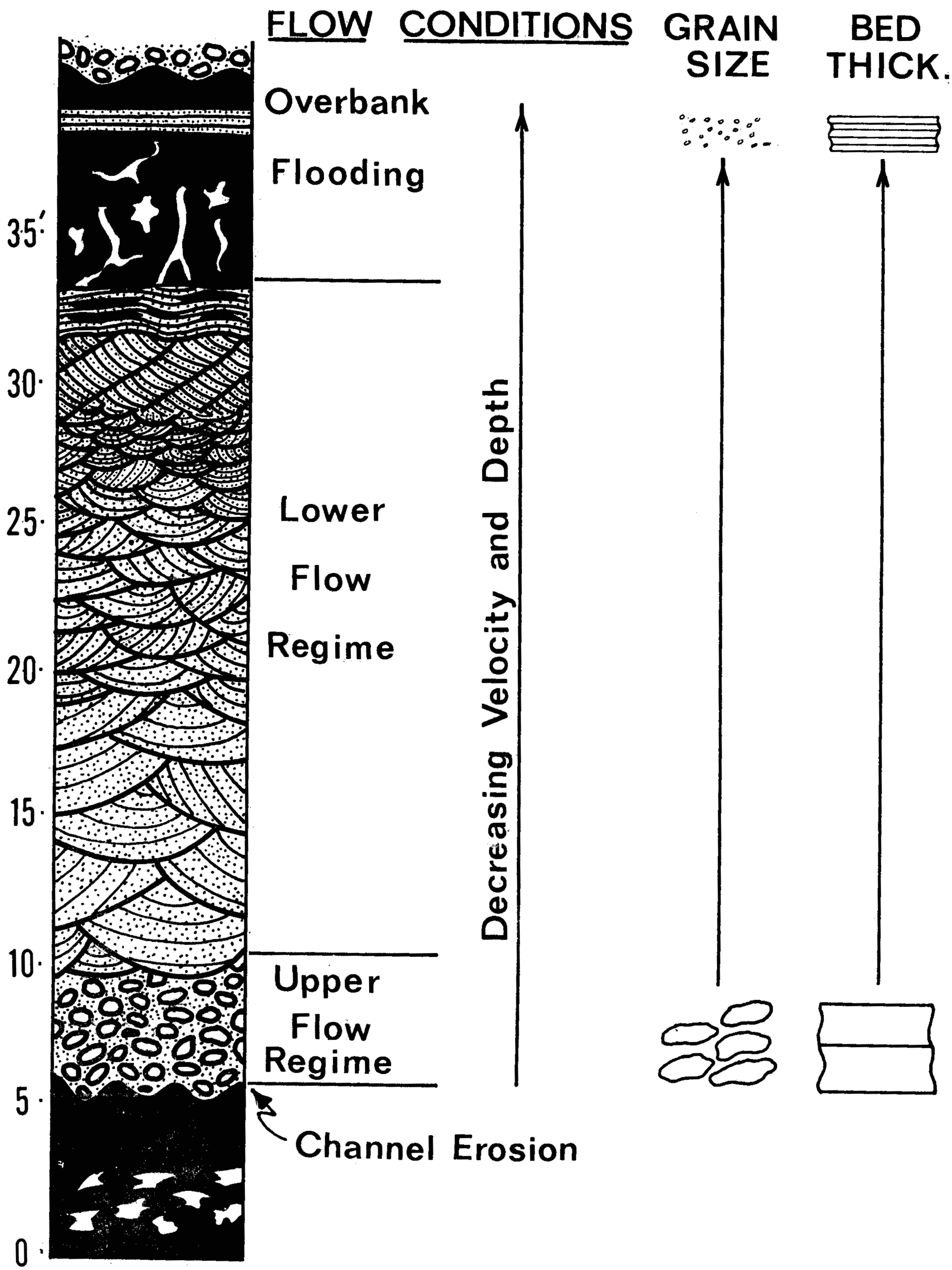

Figure 7. Ideal fining-upwards cycle in Dan River fluvial facies.

chlorite.

The superior hardness of these rocks is a consequence of: 1). A large contact index, 2). Pressure welding of detrital grains giving rise to sutured contacts, 3). Abundant authigenic overgrowths of K-feldspar, albite and quartz cementing the rock, and 4). Secondary calcite (as an alteration product) acting as a cement.

Interpretation:

Combinations of primary sedimentary structures, lithic types, and the vertical sequence developed within this facies are diagnostic of fluvial deposition.

Conglomerates resting on the upper scoured surface of the underlying mudrock units are channel-lag deposits formed in the thalweg of a stream and indicate upper flow regime. The overlying sand sequences, from coarse at the bottom to fine at the top, are lateral accretion deposits representing decreasing depth and velocity within the lower flow regime. The sequence is produced by lateral channel migration, and the subsequent progradation of the point bar with its topographically high and finer grained parts cover the coarser stream channel deposits. Massive maroon mudrocks at the top of the sequence are topstratum deposits formed by overbank flooding during channel migration.

Coarse grain size and low proportion of fine-grained material suggest high-gradient, low-sinuosity streams.

Questions:

1. *Are the drab gray colors of the sandstones the product of diagenetic reduction after burial of originally red sediment, or were they produced by reduction of red sediment in the stream channel prior to lithification?*
2. *Does the elongate, northeast-trending sandstone belt in Dan River and Danville Basin represent deposits of a major axial drainage system?*
3. *What was the source area (a) for this sediment - the west, the east, or a combination of both?*

		Continue ahead (north) on US 220 Bypass.
40.9	0.7	Turn **RIGHT** on exit ramp leading to US 220 Business.
41.1	0.2	Turn **LEFT** (southwest) on US 220 Business.
42.9	1.8	Turn **RIGHT** (west) on paved road leading to YMCA picnic grounds.
43.6	0.7	Parking lot on left. **LUNCH.** Retrace route back to US 220 Business.
44.3	0.7	Turn **RIGHT** (south) on US 220 Business.
45.0	0.7	Pull off on parking strip along the right side of US 220 Business. **BE CAREFUL OF PASSING CARS.** Walk across road, then downhill along path through woods to railroad tracks. **WATCH FOR TRAINS.** Assemble along tracks 1100 feet north of trail.
		STOP 5. Transitional deposits, Stoneville sandstone facies.

Items:

1. Located approximately 0.3 mile northeast of mapped contact with siltstone facies of Stoneville Formation. Dip is variable, but averages 30× NW.
2. Fining-upwards cycles that have a high proportion of mudstones and shales (Figure 8). The associated sandstones are generally thin, moderately sorted, and fine-grained; they display medium- and small-scale cross stratification.
3. Uniformly parallel very thin- to thick- bedding.
4. Reddish-colored mudrocks are massive-appearing, although some display uniformly parallel laminations. Many are churned up and show abundant burrows. Calcite concretions and nodular layers of fibrous calcite are very common. Some of the carbonate has weathered out, producing a honeycomb pattern in some of the beds.

   Thin sections of these rocks show poorly sorted angular silt-sized detrital grains "floating" without preferred orientation in a hematite-stained matrix. Detrital grains are chiefly quartz, K-feldspar, plagioclase, mica (mostly muscovite), and abundant opaque and heavy minerals (illite and chlorite), sericitic clay aggregates, ground-up micas, and strongly birefringent patches of carbonate.
5. Well indurated, reddish-brown arkoses are fine-grained, moderately sorted, and commonly show small-scale cross bedding and siltstone intraclasts. Modal analysis of one sample from here yielded: common quartz, 36.2%; composite quartz, 16.3%; twinned K-feldspar 1.0%; untwinned K-feldspar, 9.3%; Na-plagioclase, 18.3%; matrix, 5.3%; micas (chiefly muscovite), 8.3%; heavy minerals, 0.3%; and carbonate (as an alteration product), 5.0%. Grains are angular and display moderate pressure solution; most contacts are long and tangential. Quartz overgrowths are common on detrital quartz grains.

Interpretation:

Lithic types, combinations of primary structures, and vertical sequence are indicative of fluvial deposition.

The high proportion of mudstones along with the fine grain size of associated sandstones imply deposition in low-gradient, high-sinuosity streams. The mudrocks are flood plain deposits that accumulated adjacent to sluggish (low flow regime), meandering watercourses.

Questions:

1. Why are sandstones red-colored here, while at Stop 4, virtually all of them were drab gray-colored? Do these

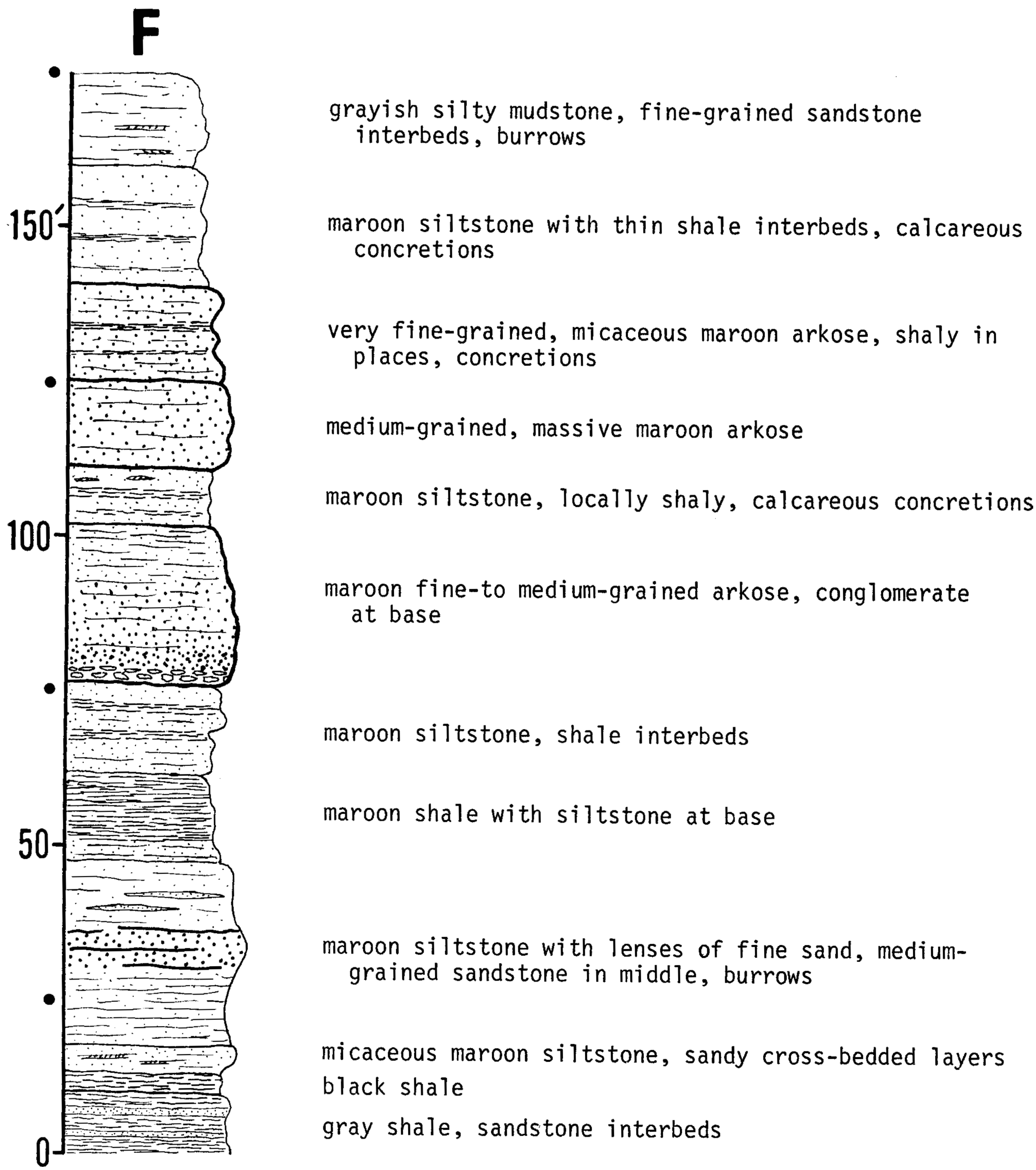

Figure 8. Stratigraphic section of Stoneville transitional facies along Norfolk and Western Railroad tracks seen at STOP 5.

colors reflect original differences in depositional environments, or are they the result of later diagenetic alteration?

2. Could the extensively burrowed reddish-brown mudstones have accumulated in an arid or semi-arid climate?
3. What is the most informative and manageable stratigraphic terminology for the gradational and intertonguing Stoneville rock units?
4. Could the carbonate "concretions" be recrystallized caliche nodules?

		Continue ahead (south) on US 220 Business.
45.2	0.2	Crossing approximate contact between Stoneville sandstone and siltstone facies.
46.0	0.8	Traffic light, Mayodan (West Main Street). Continue ahead (south) on US 220 Business.
46.1	0.1	Traffic light (Washington Street). Stay on US 220 Business.
46.3	0.2	Traffic light. Junction with NC 135; Washington Mills on left. Continue on US 220 Business.
46.55	0.25	Crossing approximate upper contact of Cow Branch tongue within siltstone facies of Stoneville Formation.
46.8	0.25	Crossing lower contact of Cow Branch lens within Stoneville Formation.
47.1	0.3	Junction with NC 704 (on right). Continue ahead (south) on US 220 Business.
47.5	0.4	Bear sharp **RIGHT** on West Main Street, Madison (just past Fuzzy's Barbecue on right).
47.75	0.25	Traffic light. Continue ahead (south) on West Main Street.
47.9	0.15	Crossing approximate Cow Branch - Stoneville contact. We will travel on Cow Branch shales from here until milepost 49.4.
48.1	0.2	Traffic light. Turn **RIGHT** (west) on US 311.
48.7	0.6	Intersection with Rockingham County Road 1138 (left). Stay on US 311. Pine Hall Brick Company plant and pits are located about 0.4 mile south of this intersection along 1138. The company uses deeply weathered shales from the basal portion of Cow Branch Formation for brick making.
49.4	0.8	Approximate Cow Branch - Stoneville contact. Until milepost 50.8 traveling on Stoneville siltstone facies.
50.8	1.4	Crossing into Cow Branch outcrop belt again.
51.3	0.5	Recross into Stoneville siltstone facies outcrop belt. We will travel on strata of this facies until milepost 53.8.
51.7	0.4	Turn **RIGHT** (northwest) on Rockingham County Road 1159 (just before Grave Baptist Church).
51.95	0.25	Stokes County Line. Road becomes Stokes County 1729. Continue ahead.
52.4	0.45	Bear left; follow Stokes County Road 1729.
53.0	0.6	Intersection with Stokes County Road 1728 (on left). Continue ahead on 1729.
53.8	0.8	Crossing into Stoneville conglomerate facies outcrop belt.
54.2	0.4	Stop sign. Continue ahead (west) on NC 772. If the day is clear Hanging Rock should be visible directly ahead in the distance.
54.85	0.65	**STOP 6.** Conglomerate facies, Stoneville Formation. Pull off on right shoulder of road and **WATCH FOR PASSING CARS.**

Items:

1. Highly weathered boulder conglomerate and associated flatbedded micaceous sandstones (both indicative of upper flow regime). Dip of sandstone is 48× West. A crude estimate of conglomerate facies thickness in this vicinity is 2500 feet.
2. Outcrop is located about 0.4 mile from the northwest border fault.
3. Conglomerate is extremely poorly sorted with a closed-work, continuous framework. Interstices between boulder-sized clasts are filled with cobble-, pebble-, granule-, and coarse sand- size rock fragments.
4. Largest clast found at this locality (east end of outcrop) is 3' 8" long!
5. Clasts are well rounded to rounded in cross-section and many are rimmed by limonitic rinds.
6. Although too weathered to determine accurately, the clasts are chiefly granite pegmatite, foliated granitic rock, quartz-feldspar gneiss, muscovite schist, and biotite gneiss with only a small percentage of quartz. Contrast the composition (and weathering characteristics) of this conglomerate with the one we saw at Stop 1.

Interpretation:

This deposit is a fanglomerate that formed adjacent to a steep highland source area. The detritus, derived from the west and northwest, probably came from sources less than a mile or so away. Extremely poor sorting and large clast size suggest deposition by violent streamfloods, and high-gradient, low-sinuosity streams. The high degree of rounding displayed by most clasts as well as the continuous framework and low proportion of silt and clay make deposition by mudflows highly improbable.

Questions:

1. *This outcrop is about 5 miles southeast of the tough quartzites now exposed in the Hanging Rock region, yet quartzite (and quartz) clasts are virtually absent in conglomerates along the western border. Were the quartzites exposed during Late Triassic time? If not, were they uncovered by later erosion, or possibly faulting? Perhaps they were exposed but drainage carried them in some other direction?*
2. *What was the climate like during deposition of these coarse conglomerates?*
3. *Does the accumulation of coarse boulder conglomerates such as these imply a unique rate of subsidence for Dan River Basin?*

		Continue ahead on NC 772 west.
55.40	0.55	Crossing western border fault (Dan River fault zone) into Inner Piedmont. The chief rock types in this vicinity are biotite and hornblende gneisses and schists.
55.9	0.5	Turn **LEFT** (south) on Stokes County Road 1722 (Hickory Fork Road).
57.6	1.7	Stokes County Road 1721 on right (west). Stay on 1722.
57.8	0.2	Crossing western border fault of Dan River Basin. From here until milepost 61.4 we will be traveling on Stoneville siltstone facies. Conglomerates and coarse-grained sandstones are notably lacking along this segment of the western border fault; they probably have been faulted out or eroded away.
60.1	2.3	Intersection with US 311. Continue straight across (south) on Stokes County Road 1911.
61.3	1.2	Bear left, downhill, and continue ahead on Stokes county Road 1911.
61.4	0.1	Cow Branch - Stoneville contact. Note small pits in weathered Cow Branch shales along right (southwest) side of road from here until next reading. The Cow Branch (as well as the uppermost Pine Hall) has been extensively excavated in this vicinity for the manufacture of bricks.
61.9	0.5	Pass through Pine Hall Brickyards. Note old-fashioned beehive kilns on left. Approximate Cow Branch - Pine Hall contact on north side of plant.
62.0	0.1	Stop sign. Cross Norfolk and Western Railroad tracks and turn **LEFT** past general store. From here until Stop 7, note weathered Pine Hall Sandstones exposed along the left side (northwest) of the road and railroad tracks. Dan River, located about 100 feet on the right follows the Triassic - Piedmont contact in this vicinity
62.5	0.5	Recross railroad tracks.
62.6	0.1	**STOP 7.** Pine Hall sandstone facies. Park as close as possible to railroad siding and assemble along railroad tracks across street (east side) fro Pine Hall Railroad Station.

Items:

1. This is the type area of Pine Hall Formation. Dip is 46× to the northwest. Thickness in this vicinity is estimated to be 1200 feet. Lower contact lies beneath alluvium of Dan River (to the east). Upper contact is gradational with Cow Branch shales and is located 0.2 mile west of here.
2. Light tan, well indurated, massively cross-bedded pebbly lithic arkose and associated flat-bedded fine-grained arkose.
3. Sandstone is texturally immature and displays moderate to poor sorting with tight grain packing (chiefly concave-convex contacts). Most grains are angular and subangular; larger grains are rounded and subrounded. Modal analysis of one coarse-grained sample from here yielded: common quartz, 35.1%; composite quartz, 15.1%; sutured quartz, 3.9%; twinned K-feldspar, 2.2%; Na-plagioclase, 17.8%; micas, 1.7%; aphanitic rock fragments, 1.2%; schist, 4.3%; gneiss, 3.5%; matrix, 10.1%; and others (chiefly pleochroic green hornblende), 2.0%.
4. Metamorphic rocks on the east side of the basin in this area include biotite gneiss, hornblende gneiss, and muscovite schist.

Interpretation:

These are interpreted as fluvial deposits formed in the lower flow regime (large-scale cross bedding). The lack of associated mudrocks (silt and clay rocks) in this facies is suggestive of high-gradient, low-sinuosity streams.

Questions:

1. *Why are conglomerates absent along the eastern border in the southern part of Dan River Basin?*
2. *What is the nature of the basal contact of this region - unconformable or fault?*

62.65	0.05	Turn **LEFT** (north) on NC 772.
62.9	0.25	Crossing Pine Hall - Cow Branch contact.
63.4	0.5	Crossing Cow Branch - Stoneville sandstone facies contact.
63.6	0.2	Contact between Stoneville sandstone and siltstone facies. From here until milepost 67.2 we will be traveling on Stoneville siltstone facies. After that we will retrace our route back to Madison on US 311.
64.1	0.50	Stop sign. Turn **RIGHT** (northeast) on US 311.
65.5	1.4	Rockingham County line. Continue ahead (northeast) on US 311.
70.2	4.7	Traffic light. Wilson Street (Madison) on left. From here until bridge over Dan River we will be traveling on Cow Branch shales and mudstones.
70.7	0.5	Traffic light. Franklin Street on left. Continue straight ahead on US 311.
70.8	0.1	Traffic light. Market Street (US 220 North Business) on left. Continue straight ahead (easterly) on US 220 South Business and NC 704 E.
71.0	0.2	Bridge over Dan River. Crossing very approximate Cow Branch - Pine Hall contact on west side of bridge. From here until milepost 71.3 we will be traveling on Pine Hall sandstones.
71.3	0.3	Crossing unconformable contact between Pine Hall sandstones and biotite gneiss. Traveling on biotite gneiss until north end of bridge over Dan River before Stop 8.
72.1	0.8	US 220 Bypass South on right. Continue ahead (east) on NC 704 and US 220 North Bypass.
72.3	0.3	Turn **LEFT** (north) on ramp leading to US 220 North Bypass. Panoramic view of Triassic lowland directly ahead
72.9	0.6	Bridge over Dan River. Crossing eastern boundary of Triassic Basin.
73.4	0.5	**STOP 8.** Cow Branch Formation and dolerite dike. (East side of highway.) Park along the shoulder of road and assemble at north end of outcrop. **WATCH FOR CARS.**

The chief purpose of this stop (Figure 9) is to illustrate the lateral continuity of Cow Branch strata. We are located approximately 11 miles southwest of Stop 3 (King's Quarry) yet the two exposures show remarkable similarity. Cow Branch strata generally, however, contain a higher proportion of black, platy clay shale and carbonaceous shale in the southern and central parts of the basin (compare Measured Sections D and G).

Items:

1. Alternating sequence of black platy carbonaceous shales and medium- to thick-bedded massive mudstones (Figure 9) that display brecciated shrinkage crack casts. Tan-weathering dolomitic concretions are very abundant in the black platy shales; septarian concretions are found locally.
2. As at Stop 3, calcite veins and joint fillings are abundant.
3. Abundant brachiopods in black platy clay shales located 460 feet north of the north end of the guard rail along the east side of the road.
4. Olivine-bearing dolerite boulders 20 feet off road in woods just opposite guard rail on north end of bridge. Modal analysis of this dike is presented in the reprint by Thayer. The dike trends N. 5× W and crosses US 220 Bypass just north of the guard rail. Hornfels is exposed in the slope on the east side of the road north of the guard rail.

Interpretation:

These rocks were deposited in lacustrine environments similar to those described at Stop 3. The greater proportion of plant-bearing, black carbonaceous shales in the southern part of the basin, however, implies deposition under shallower water conditions (shallow stagnant lakes and swamps).

Questions:

1. *Did the Cow Branch accumulate in one large, continuous lake basin, or in separate basins intermittently connected?*
2. *Is the Cow Branch at this stop synchronous with the Cow Branch seen at Stop 3?*

		Continue ahead on US 220 North Bypass.
73.5	0.1	Cow Branch - Stoneville siltstone facies contact. From here until milepost 78.5 we will be traveling over Stoneville mudstones with subordinate sandstones.
75.1	1.6	Turn **RIGHT** (north) on NC 135 exit ramp.
75.3	0.2	Yield sign. Turn right (northeast) on NC 135 (follow Eden signs). Geology along this stretch of road (until milepost 79.25) has been covered previously from milepost 35 to milepost 38.8.
79.1	3.8	Intersection with Rockingham County Road 2145. General store on northwest corner of intersection.

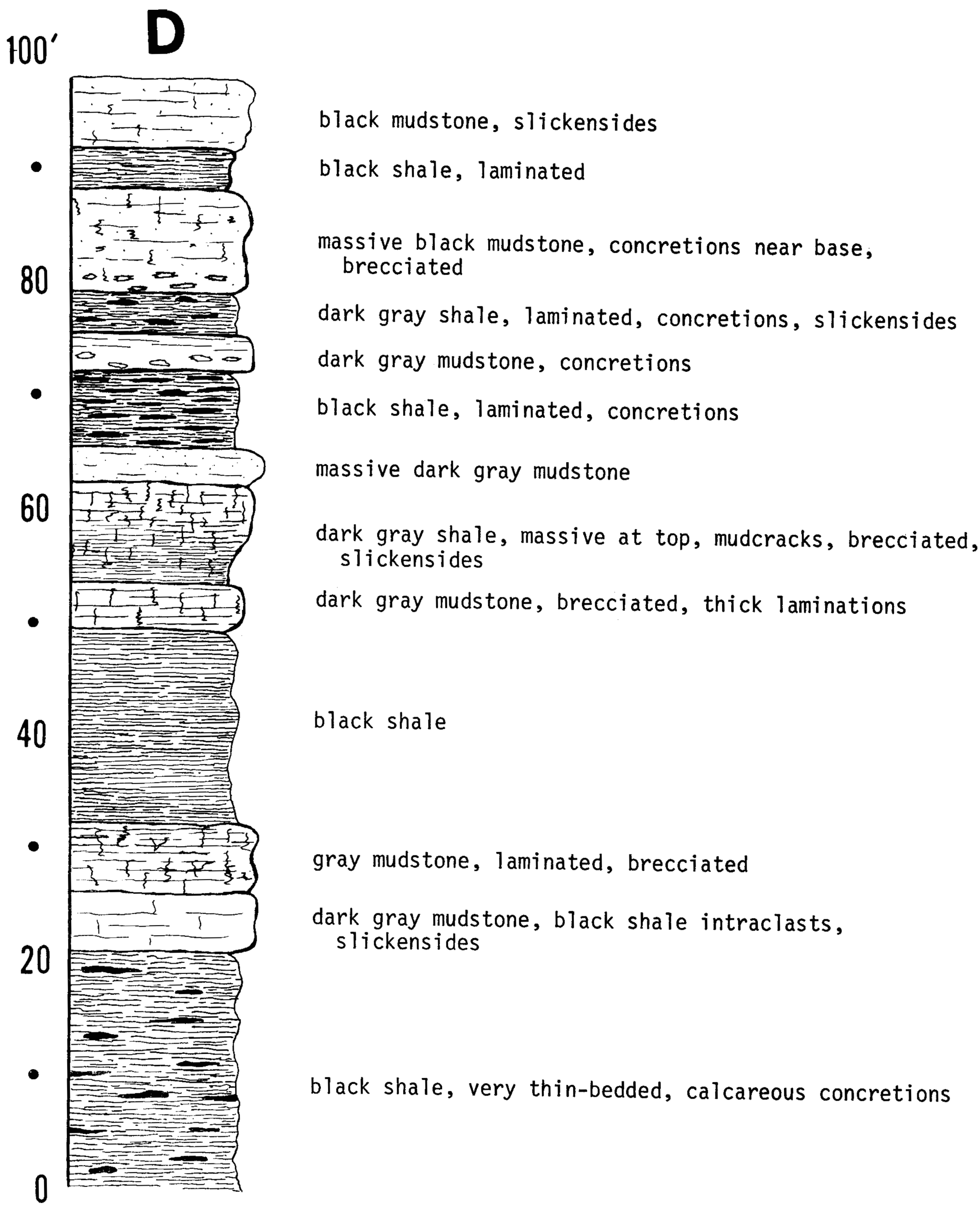

Figure 9. Stratigraphic section of Cow Branch Formation along US 220 Bypass seen at STOP 8.

79.25	0.15	Turn **LEFT** (north) on Rockingham County Road 2141. Until milepost 82.2 we will be traveling over sandstone facies of Stoneville Formation.
80.9	1.65	Intersection with NC 770. Continue across (north) on 2141.
81.1	0.2	Stop sign. Turn **RIGHT** (northeast) on Rockingham County Road 2221 (this road was formerly NC 770).
81.4	0.3	Turn **LEFT** (north) on Rockingham County Road 1522.
82.2	0.8	Crossing approximate contact between Stoneville sandstone facies and Stoneville conglomerate facies.
82.3	0.1	Turn **LEFT** in dirt driveway.
82.4	0.1	Bear right past barn (on left) and park. **STOP 9.** Fine-grained conglomerate facies, Stoneville Formation.

Items:

1. Conglomerate is approximately 650 feet thick along this segment of Dan River fault zone.
2. Exfoliation domes of feldspathic graywacke and lithic conglomerate that display sheeting and root wedging in places.
3. Approximately 350 feet away from western border fault. The adjacent metamorphic rocks in this area are hornblende gneiss and muscovite schist.
4. Maximum particle size at this locality is 8 inches. Clasts are chiefly angular to subrounded muscovite schist, hornblende gneiss, biotite gneiss, and microcline that "float" in a micaceous clayey graywacke matrix.
5. Conglomerate is heterogeneous, unsorted, and unstratified; in some ways it resembles a tillite. This rock is interpreted as a sheetflood and/or streamflood deposit that accumulated on the distal margins of an alluvial fan. An important point here (pointed out by Dunbar and Rodgers, 1957, p. 161) is that sheetfloods and violent streamfloods are not restricted to arid or semi-arid regions, but may even occur in tropical rainforests.
6. Sandstone is extremely poorly sorted, medium- to very coarse- grained feldspathic graywacke. Most grains are sharply angular with concavo-convex and sutured contacts; the contact index (number of contacts per grain) is 4.7. Modal analysis of one sample yielded: common quartz, 15.7%; composite quartz, 9.3%; sutured quartz, 4.6%; twinned K-feldspar, 5.8%; untwinned K-feldspar, 16.4%; plagioclase, 16.4%; matrix 0.5%; micas, 7.1%; gneiss fragments, 0.7%; schist fragments, 10.8%; pleochroic green hornblende, 6.6%; and others (alteration products and authigenic overgrowths on detrital quartz, hornblende and feldspar). Authigenic minerals include strongly pleochroic deep blue riebeckite, quartz, chlorite, pyrite, and albite. As yet, authigenic zeolites have not been identified in Dan River rocks. This rock has apparently undergone considerable diagenetic alteration, due to deep burial or proximity to nearby border fault.
7. Because of its superior hardness the rock was used locally for making millstones. One of these is located along the driveway in front of the house.

Questions:

1. Is the diagenetic mineral assemblage found here indicative of a particular diagenetic facies? What was the temperature, pressure (PH2O), pH-cation concentration, and Eh that favored growth of this assemblage of minerals?
2. Why are the conglomerates so fine-grained here? Does this indicate: 1). Deep weathering in the adjacent source area, 2). Low elevations in the source area, or 3). Bypassing of the coarser-grained detritus to some other part of the basin? Or, have the coarse conglomerates been faulted out, or simply been eroded away?
3. The presence of conglomerates and steeply-dipping beds have been used by numerous workers to infer faults along the margins of Triassic basins, even though in most cases the faults cannot be viewed in the field. Do these mapped contacts really represent faults, or are they simply products of later erosion? Could the border fault (or faults) at this stop actually be located west of its mapped position?

		When leaving drive north past house on left to intersection with Rockingham County Road 1516. This is the last stop of the day. The rest of the road log will lead you back to Danville and your motel.
82.6	0.1	Turn **RIGHT** (east) on Rockingha County Road 1516.
82.7	0.1	Turn **RIGHT** (south) on Rockingham County Road 1522.
83.7	1.0	Turn **RIGHT** (southwest) on Rockingham County Road 2221 (old NC 770).
84.0	0.3	Turn **LEFT** (south) on Rockingha County Road 2141.
84.2	0.2	Turn **LEFT** (northeast) on NC 770. From here until milepost 85.4 we will be traveling on sandstone facies of Stoneville Formation.
85.4	1.2	Crossing approximate contact between sandstone and siltstone facies of Stoneville Formation. Until milepost 90.6 we will be traveling on Stoneville siltstone.
88.5	3.1	Junction with NC 135 (on right). Continue ahead (northeast on NC 770).

88.7	0.2	Eden city limits. (This part of Eden was formerly called Leaksville - no wonder they changed the name!)
90.1	1.4	Traffic light in center of Eden. Stay in right lane and bear **LEFT** across intersection following NC 770 North (Boone Road).
90.5	0.4	Traffic light. Continue ahead on NC 770 North.
90.6	0.1	Crossing Cow Branch - Stoneville contact. From here until milepost 96.4 we will be traveling on Cow Branch mudrocks.
91.1	0.5	Traffic circle. Turn **RIGHT** (east) following NC 770 N. This part of Eden used to be the town of Spray - the home of J.M. Morehead.
91.2	0.1	Good exposure of steeply dipping Cow Branch shales on left (north) side of road. From here until milepost 96.4 the road follows the strike of Cow Branch Formation.
93.15	1.95	Bear left, and **STOP**. Turn **LEFT** across intersection following NC 770 N. Note the flat topography developed on Cow Branch mudrocks in this region.
94.8	1.65	Traffic light. Intersection with North Main Street, Eden (this part of Eden was formerly the town of Draper).
96.4	1.6	Bear right on NC 770 (gas station to the left). The geology from here back to Danville will be covered on the Sunday road log.
96.8	0.4	Webster Brick Company plant and pits on left (north).
99.2	2.4	Entering Virginia (Pittsylvania County). Road is now Virginia 863.
106.8	7.6	Turn **RIGHT** (east) on US 58.
111.2	4.4	Danville city limits. Continue ahead on US 58 East.
112.35	1.15	Intersection with US 29 South. *Those people staying at Red Carpet, Ford, or Virginia Motor Manor Motels turn **RIGHT** and follow Log A.

*Those people staying at Holiday Inn continue ahead on US 58 East and follow Log B.

Log A

112.35	1.15	Turn **RIGHT** (south) on US 29.
112.45	0.1	Turn **RIGHT** on bridge over Dan River.
112.75	0.3	Turn **RIGHT** (south) on US 29 South.
113.60	0.85	Turn **RIGHT** and follow US 29 South.
115.05	1.45	FORD MOTEL on right.
115.75	0.7	VIRGINIA MANOR MOTEL on right.
115.85	0.1	RED CARPET INN on right.

Log B

112.35	1.15	Intersection with US 29 South. Continue ahead (east) on US 58.
113.05	0.7	Traffic light. Intersection with 51 West. Stay on 58 East.
113.45	0.4	Traffic light. Masons Discount Store on right.
113.47	0.02	Stay in left lane. Follow US 58 East signs (to south Boston).
113.77	0.03	Turn **LEFT** on US 29 North.
113.87	0.1	HOLIDAY INN on right.

FIELD TRIP ROAD LOG - SECOND DAY

Sunday, October 25, 1970

Leaders: Paul A. Thayer, Dewey S. Kirstein

The Sunday field trip will assemble on the parking strip along US 29 North on the west side of the Holiday Inn, Danville, Virginia. Participants should reach the assembly point in ample time to be in line and ready to depart at 8:30 AM sharp.

Summary

Today's trip will proceed northward from Danville to Stop 10 along US 29 North on top of Whiteoak Mountain, Virginia. The route will then be retraced southward to Stop 11 near Leaksville Junction, Pittsylvania County, Virginia. Lunch will be served, courtesy of Solite Corporation, at the conclusion of Stop 11. Following lunch, the field trip will be over.

The map of Danville (Figure 2) and the Index Map of Sunday's trip (Figure 10) will be helpful for geographical reference.

Tentative Schedule

Arrive	Leave	
	8:30 AM	Holiday Inn, Danville, Virginia
9:00	9:40	STOP 10. Dry Fork Arkose. 40 minutes
10:40	12:00 PM	STOP 11. Cow Branch Argillite and tour of Solite Plant. 1 hour and 20 minutes
12:00	1:00	Lunch

Mileage	Distance From Last Reading	Discussion
0	0	Assemble cars facing north on west

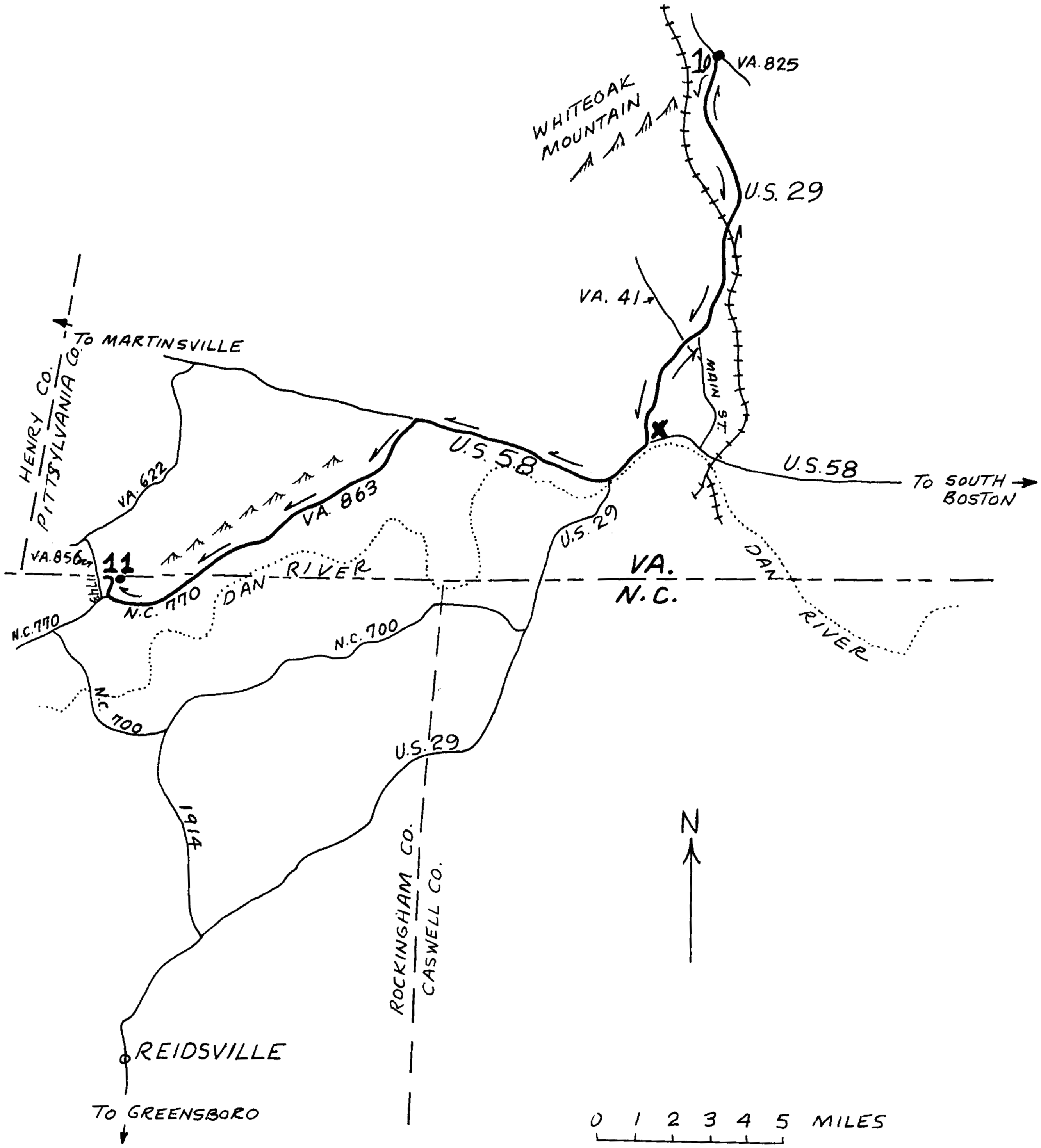

Figure 10. Route of Sunday field trip across Triassic rocks of Danville and Dan River Basins, Virginia and North Carolina.

Table 1. Stratigraphic section of Dry Fork Formation in roadcut on top of Whiteoak Mountain going north on US Highway 29, Pittsylvania County, Virginia (from Meyertons, 1963, p. 60-61)

	Dry Fork Formation, arkosic facies (1022 feet)	Thickness In Feet
49.	Conglomerate, yellow-white, sandy	38
48.	Sandstone, maroon, grades to siltstone at base	36
47.	Conglomerate, yellow, sandy, arkosic	5
46.	Sandstone, maroon, fine-grained	14
45.	Sandstone, yellow-brown, fine- to medium- grained, arkosic	17
44.	Sandstone, maroon, silty	11
43.	Conglomerate, yellow-brown, pebbly, soft, arkosic	25
42.	Siltstone, maroon, medium-hard	25
41.	Conglomerate, yellow to tan, pebbly	23
40.	Siltstone, maroon, sandy	5
39.	Sandstone, white to tan, fine-grained	20
38.	Siltstone, maroon, sandy	7
37.	Conglomerate, white to brown, pebbly	8
36.	Sandstone, maroon, silty, calcareous, hard, grades to coarse-grained, gray sandstone at base	63
35.	Conglomerate, white-yellow, pebbly, hard, with limonite specks	57
34.	Siltstone, maroon, soft	4
33.	Sandstone, tan, coarse-grained, arkosic, pebbly, speckled with limonite	41
32.	Covered	75
31.	Sandstone, maroon, fine- to coarse- grained, speckled with limonite	6
30.	Covered	12
29.	Sandstone, tan, medium-grained, speckled with limonite	17
28.	Covered	93
27.	Sandstone, brown to white, coarse- grained	14
26.	Siltstone, maroon, sandy	7
25.	Sandstone, brown to white, fine- to coarse- grained, pebbly	7
24.	Siltstone, maroon, sandy	4
23.	Sandstone, maroon to brown, fine- to coarse- grained, hard	10
22.	Sandstone, gray, coarse- grained, with quartz pebbles near base	35
21.	Siltstone, gray-green, soft, with hard maroon, silty sandstone near base	5
20.	Conglomerate, orange-brown, sandy, arkosic	4
19.	Siltstone, red, sandy	6
18.	Conglomerate, gray to maroon, pebbly, arkosic, with calcareous gray shale partings	20
17.	Sandstone, maroon, silty, calcareous, hard	22
16.	Conglomerate, gray	8
15.	Sandstone, maroon, fine- grained, arkosic, with quartz pebbles	8
14.	Sandstone, gray-green, fine- to medium- grained, slightly calcareous, silty, with thin gray-green hard shale lenses	45
13.	Conglomerate, gray to maroon, pebbly, arkosic	17
12.	Conglomerate, white to buff, pebbly, arkosic	52
11.	Siltstone, maroon, sandy	1
10.	Sandstone, gray-green, fine- grained, hard	2
9.	Sandstone, buff-red, coarse- grained, soft	18
8.	Diabase dike, coarse- grained, weathered into boulders with concentric shells	19
7.	Sandstone, black, fine- grained, hard, altered by dike	4
6.	Conglomerate, buff, pebbly, clayey, arkosic	8
5.	Sandstone, maroon to gray, medium- grained, grades into siltstone at center and conglomerate near base	13
4.	Conglomerate, yellow-brown, pebbly, arkosic, soft and weathered	49
3.	Sandstone, red, silty, hard, grades into soft siltstone at base	17
2.	Conglomerate, yellow-white, pebbly, arkosic, with gray clay in joints	11
1.	Siltstone, maroon, gray, and yellow	14

		side of Holiday Inn along right shoulder of US 29 North. **Caravan proceeds north on US 29.** Our route from here until milepost 10.9 is over unmapped gneisses of the Inner Piedmont.
0.5	0.5	Yield sign. Bear right and follow US 29 North.
3.0	2.5	Traffic light, intersection with VA 41. Continue ahead (north) on US 29.
10.0	7.0	VA 863 on left.
10.9	0.9	Crossing eastern border of Danville Triassic Basin. The large hill you are ascending is Whiteoak Mountain, a northeast-trending hogback ridge held up by lithic arkoses and feldspathic litharenites of Meyertons' Dry Fork Formation. This is the “mountain” made famous in the ballad “Wreck of the Old 97."
11.6	0.7	Top of Whiteoak Mountain. Pull off US 29 and park on dirt lot, right side of road. **STOP 10.** Coarse-grained fining-upward cycles, Dry Fork Formation. Measured section for this stop is presented in Table 1 (from Meyertons, 1963, p. 60-61). We are approximately located in the narrowest part of Dan River - Danville basin; the lithic fill across the basin here consists almost entirely of coarse-grained clastics.

Items:

1. Thick, well-indurated, coarse-grained fining-upwards cycles (Table 1), consisting of approximately 40% conglomerate, 48% sandstone, and 12% mudstone. These cycles are thicker and contain much coarser detritus than the cycles we saw at Stops 4 and 5 on Saturday.

   An ideal cycle at this stop begins with poorly sorted pebble and cobble conglomerate. This commonly rests on an erosional contact with the underlying cyclic unit.

   The conglomerate grades up into very coarse dark gray sandstone that commonly contains scattered pebbles and cobbles. Generally, the sandstone is massive-appearing, although shallow trough cross-beds are sometimes present. The coarse sandstone passes up into fine red (occasionally gray) sandstone either by a progressive decrease in grain size, or by interbedding with fine sandstone lenticles that gradually dominate the section. The top of the unit is formed by very fine-grained, usually red, massive-appearing sandstone; in a few places the top of the unit is reddish-colored massive siltstone.
2. Sedimentary features include large-scale channeling, massive bedding, channel-lag conglomerates, sandstone intraclasts, minor cross bedding, and ball-and-pillow.
3. Coarse-grained, tan pebbly arkose at east end of outcrop is speckled with limonite that is believed to be an alteration product of biotite and hornblende.
4. Wide variety of rock types that range from lithic conglomerate through maroon siltstones. Sandstone composition depends chiefly on grain size; coarse-grained pebbly sandstones are feldspathic graywackes and impure arkoses; medium- and fine- grained ones are dominantly arkoses.

   Modal analysis of one coarse-grained, very poorly sorted, gray pebbly sandstone yielded: common quartz, 24.3%; composite quartz, 15.3%; twinned K-feldspar 7.7%; untwinned K-feldspar, 9.3%; Na-plagioclase, 16.0%; schist, 0.3%; gneiss, 8.7%; micas (detrital), 2.0%; secondary carbonate, 0.3%; and matrix, 16%. The matrix in this rock has recrystallized to light green chlorite that is oxidizing in part to limonite. Rhombic calcite is a secondary alteration product of plagioclase.

   Point-count analysis of a maroon, fine-grained, poorly sorted sandstone yielded: common quartz, 30.8%; composite quartz, 15.6%; sutured quartz, 4.1%; twinned K-feldspar, 3.2%; untwinned K-feldspar, 19.4%; plagioclase, 12.7%; schist fragments, 0.3%; gneiss fragments, 1.3%; matrix, 1.6%; micas (chiefly muscovite), 3.5%; and secondary calcite and chlorite, 7.6%.

   The sandstones are typified by poor size sorting, high grain angularity, and a large contact index. Detrital grains have undergone considerable pressure welding as evidenced by sutured and concavo-convex contacts. High contact indices as well as secondary “cementation” (by calcite, chlorite, quartz and albite overgrowths) are responsible for the hardness of these rocks.

   Granule- to pebble-size conglomerates (breccias in some places) are gray-colored, poorly sorted, and contain abundant feldspar (chiefly salmon-colored microcline).

Interpretation:

Fining-upwards cycles, combinations of primary sedimentary structures, and lithic features indicate fluvial deposition. The coarse-grained cycles are thought to be the result of channel filling and migration in a braided stream environment (high gradient, low sinuosity). This interpretation is based on 1). The high proportion of coarse-grained detritus indicative of upper flow regime, 2). The low percent of overbank deposits (mudstones), 3). The wide ranges in grain size, 4). Presence of intraclasts, and 5). Variable bed thickness.

The conglomerates are interpreted as deposits of violent stream flow during periods of high discharge; coarse- and fine- grained sandstones represent channel fills formed under decreasing flow conditions. Siltstones formed under tranquil flow conditions during low discharge periods.

It is thought that these deposits occur at the edge of an alluvial fan zone that extended westward from the eastern basin margin. The large influx of coarse detritus in this part of the basin may have dammed longitudinal drainage.

Questions:

1. *What was the regional pattern of relief and drainage in this part of the basin?*
2. *What kind of provenance supplied this little-modified coarse detritus? What happened to the fine clay- and silt-size fraction?*
3. *Why are rocks of lacustrine origin lacking in this narrow part of the basin - growth of alluvial fans, or later erosion?*
4. *What is the best stratigraphic terminology for mapping and conveying relations among intertonguing units when there are no mappable key beds (Cow Branch) in this part of the basin? (The same problem of stratigraphic subdivision exists in the Durham and Wadesboro Basins where the lacustrine-swamp Cumnock Formation is absent.)*

		Pull out, cross over median, and head south on US 29 South.
19.6	8.0	Follow US 29 South Truck Route.
20.1	0.5	Traffic light. Intersection with VA 41. Continue ahead, south on US 29.
23.4	3.3	Turn **RIGHT** (west) on US 58 West.
23.6	0.2	Traffic light. Junction with VA 51. Continue ahead on US 58 West.
24.7	0.7	US 29 South exit. Continue ahead (west) on US 58 West.
29.3	4.6	Crossing southeastern border of Danville Basin. According to Meyertons (1963), Cedar Forest polymictic conglomerates unconformably overlie quartz-feldspar gneiss.
29.9	0.6	Good exposure of Dry Fork lithic arkose on right (north) side of road.
30.35	0.45	Turn **LEFT** (south) on VA 863.
30.45	0.1	Good exposures of Dry Fork sandstones on both sides of the road.
32.5	2.05	Hogback ridges on right (northwest) - Soyar Mtn., Judy Bird Mtn., and Boyd Mtn. - for the next 4 miles or so are held up by lithic arkoses and feldspathic litharenites of Meyertons' Dry fork Formation. From here until the NC state line we will be traveling on red and maroon mudrocks that Meyertons assigned to the Cascade Station member of his Leaksville Formation.
36.8	4.3	Cross railroad tracks.
38.1	1.3	NC state line. Road becomes NC 770.
40.3	2.2	Webster Brick Company clay pits on right (north). The company uses maroon claystones and shales fro the uppermost part of siltstone facies, Pine Hall Formation for its brick kilns.
40.8	0.5	Cross railroad tracks. Turn **RIGHT** immediately past tracks into Solite Corporation Plant.
		STOP 11. Cow Branch Argillite and tour of Solite production facilities.

At this stop we will 1). Examine the thick section of Cow Branch Formation exposed in two of Solite's quarries, 2). Look at cores and polished slabs of the main rock types and sedimentary structures, and 3). See how lightweight aggregate is produced.

The following discussion by Kirstein summarizes the geology and plant operations to be seen at Stop 11.

VIRGINIA SOLITE PLANT AND QUARRY

By Dewey S. Kirstein

Virginia Solite Company produces lightweight aggregate from portions of Cow Branch Formation in Dan River Basin.

Lightweight aggregate is any lithic substance that has been subjected to a state of pyroplastic expansion and which may be used in place of sand, gravel, or crushed stone in portland cement mixtures designed to form concrete with strengths either equal or superior to those found in conventional sand, gravel, and cement mixtures. In a broad sense, substances such as expanded and sintered clays, shales, slates, coal cinders, furnace slag, fly ash, pumice and scoria are lightweight aggregates. The overall advantages of lightweight aggregates over conventional aggregates are reductions in weight and superior insulating qualities. A produced aggregate, such as SOLITE, has further advantages. These are chemical inertness, uniformity, and the absence of deleterious contaminants. Lightweight concretes are now used in the manufacture of precast masonry units, bricks, floor beams, columns and partitions, roofs, and floor tiles and slabs. The lightweight aggregate industry has grown rapidly in recent years due to the increasing use of concrete materials and a decrease in the availability of industrial cinders and slag.

There are two principal types of lightweight aggregate production from raw material such as clay, shale, and slate. They are either sintered products or expanded products. Solite Corporation produces only expanded lightweight aggregates.

Rotary kiln methods, similar to these presently being used at the Leaksville Plant, are employed at all Solite plants. Figure 11 is a simplified schematic diagram of the actual process.

In the early days of Solite Corporation, the company did

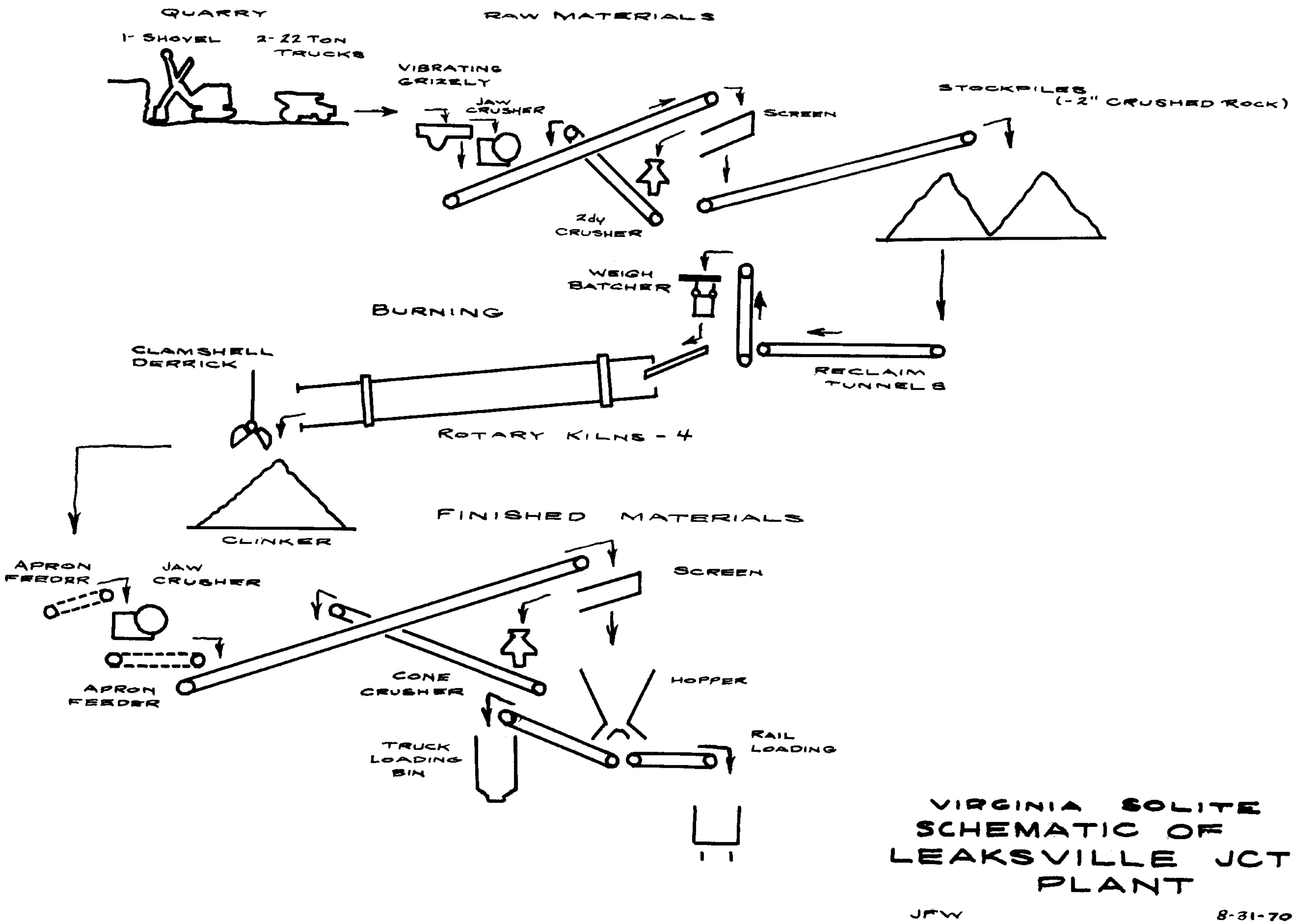

Figure 11. Simplified schematic diagram of lightweight aggregate production from raw material at Solite Corporation Plant (STOP 11).

not hire full-time geologists. Rather, the company used the services of various federal and state agencies, consultants and individuals for the purpose of locating and proving lightweight aggregate deposits. Actual construction of the Leaksville Plant started in December 1956. Its first shipment of lightweight aggregate was in June 1957. The plant began as a two-kiln operation and has been enlarged to its present size to keep up with consumer growth. Initial quarrying began just west of the plant on the creek bank near the gas line manifold. The location and development of the present operating quarry began in 1964 following the recommendation of the company geology department. The department based its recommendations on information from a large number of core drill holes, test firings of numerous core samples, and evaluation of laboratory data obtained from fired core samples.

For the most part, all rock units found within Cow Branch Formation will expand when fired; however, many of the units possess different bloating-fusing temperatures. When unfavorable units, or unfavorable combinations of units, are fired in a rotary kiln, certain problems frequently arise: the aggregate may stick to the walls of the kiln or the unit weight of the finished product may be highly variable. In an attempt to solve these problems the geology department first logged drill cores by unit quarry names (examples are provided in Tables 2, 3, and 4). The department then plotted the drill holes on cross- sections (Figure 12) and plan maps. Comparative pilot firings of various rock units mixed in given ratios were then made. When usable ratios were found, the areas that would yield the best natural quarry blend were selected from geologic maps and sections. Following this, optimum material areas were staked out, stripped of overburden, and developed under the direction of the company geology department. To date, this has been very successful in controlling production problems related to variable raw material at this plant.

GENERAL DESCRIPTION

The materials being quarried for manufacture of lightweight aggregate at Leaksville Junction are within Cow Branch Formation. In the areas studied average strike is north 40 degrees east, and dip is 30 degrees northwest. Surface outcrops are rare. However, core drill information indicates that the formation is 4700 feet thick in the proximity of the state line. Fresh rock is overlain by 1 to 10 feet of light brown silty soil that contains some clay. The soil is about 4 feet thick over the entire area. A zone of weathered rock is present beneath the soil cover; it occurs in varying shades of yellow, brown, green, gray, and black, and is referred to by many as “shale.” The weathered zone varies from a crumbly saprolite to hard, stained, slightly weathered bedrock. Thicknesses of the weathered zone vary from 1 to 12 feet but average about 5 feet.

When the need for establishing descriptive terms that could be used by management and plant personnel arose, a simple sandstone-shale classification did not appear adequate for detailed core logging and mapping purposes. Therefore, a quarry classification consisting of five easily recognizable rock units in the Cow Branch Formation occurring at Leaksville Junction was devised. These units are **arkosic argillite, calcareous argillite, massive argillite, argillite, and varved argillite.**

Arkosic argillite is a light to medium gray, coarse-grained, poorly sorted clayey sandstone. Visible mineral grains include dolomite, calcite, orthoclase, plagioclase, biotite, quartz, and pyrite. Most occurrences are cut by numerous calcite veinlets in the form of minor beds varying from 0.5 inch to 18 inches thick and separated by beds of finer grained material. This unit probably represents one percent or less of Cow Branch Formation, yet it appears to be the most resistant to weathering. In fact, it is a ridge fomer. Feldspar fragments are 3 to 5 mm in size; some are rounded and have overgrowths. Dolomite occurs as anhedral grains up to 0.15 X 0.20 mm in size. Thin dark laminae are composed of finely divided pyrite and magnetite. The variation in color is apparently related to differences in grain size. Scattered cross-cutting veinlets are filled with feldspar and dolomite. Feldspar and dolomite also act as rock-cementing agents. Composition by grain count in one specimen is: plagioclase and orthoclase feldspar, 75%; dolomite, 15%; amphibole and biotite, 5%; quartz, 2%; and pyrite and other opaque minerals, 3%.

Calcareous argillite is light to medium gray, massive, well indurated, and fine- to medium-grained. It effervesces readily with cold hydrochloric acid. Like the arkosic unit, most occurrences are cut by numerous small calcite veinlets - some of which contain what appears to be minute iron, copper, and lead sulfite minerals. Upon weathering, a light-brown rind forms on exposed rock surfaces. The unit occurs as beds, interbedded with other units, and it may be traceable for several hundred feet. However, it probably represents less than 1/10 of 1 percent of the total Cow Branch Formation.

Massive argillite is a medium to dark gray, massive, well-indurated speckled rock, having a grain size of mediu to fine sandstone. The speckled or salted appearance is caused by dissemination of calcite, dolomite, and feldspar grains in a black groundmass. Visible grains of biotite are scattered throughout. In some specimens the light colored minerals appear to have grown after deposition of the unit. The massive argillite occurs as lenses and beds, and is interbedded with other rock units. Bedding varies from a few inches to tens of feet in thickness. Along strike, some beds are continuous for hundreds of feet while others feather and pinch out abruptly. The unit probably represents 45 percent of Cow Branch Formation. It underlies most of the upland areas such as hills and ridges, even though its saprolite zone is the thickest of the five rock units.

Argillite is a dark gray to jet black, dense, fine-grained rock that breaks with conchoidal fracture. A few minor calcite veinlets are present. Only a few fine calcite or dolomite grains and minute flakes of mica can be distinguished by the unaided eye. As a rule the carbonate content of this unit is lower than adjacent units. The unit probably represents less than 5 percent of the Cow Branch Formation and its bedding may vary from a few inches to a few feet in thickness. It usually occurs adjacent to beds of varved argillite and apparently grades into varved or massive argillite. Microscopic examination reveals silt-sized particles of feldspar, biotite, muscovite, sericite, and minor amounts of chlorite and pyrite.

Varved argillite is a medium gray to black, fine-grained, hard fissile rock that has numerous layers having alternating variations in color. Some beds contain considerable organic debris - usually carbonized plant matter. Some beds contain up to 5 percent pyrite that occurs as fine crystals, radiating plates up to 0.5 inch in diameter, or as pencils and blebs 0.5 inch across and up to 3 inches long. The unit has the highest variation in carbonate content. For example, beds that contain organic debris are usually low in carbonates, probably from 1 to 5 percent, while other beds may contain as much as 50 percent carbonates. Few minerals are visible to the unaided eye other than pyrite and biotite flakes. The varved argillite unit comprises about 50 percent of Cow Branch Formation. It underlies low areas and has the thinnest soil and saprolite cover. However, in places, weathering has altered the unit to a tan, brown to black soft fissile "shale" up to a depth of 10 to 15 feet below the ground surface. Microscopic examination shows that the rock is variable in mineral composition from one layer to the next. However, it is largely composed of calcite, biotite, dolomite, sericite, chlorite, and fragments of feldspar. Most of the pyrite nodules are scattered at random throughout the rock and apparently are not related to cross-cutting veinlets that are filled with dolomite and feldspar.

SOME GENERAL CONCLUSIONS AND OBSERVATIONS:

The contact between Cow Branch Formation and Pine Hall Formation on the eastern boundary of Solite property was not encountered during drilling; the contact probably follows a small stream valley. The western contact between Cow Branch and Stoneville Formations has been cut by several drill holes. Drill results indicate that the red layers vary from a few inches to 30 feet in thickness. They are interspaced with gray to black massive and varved layers in intertonguing form.

Three early minor fault zones cut all rock units in the area. All openings in these are filled with veinlets composed of crystalline calcite, dolomite, feldspar, and minor amounts of pyrite. Several later minor fault zones and open cracks cut all rock units - some of which are clay filled. Movements along all fault zones in this area were relatively minor and displacements can be measured in terms of a few feet at most. All five rock units have apparently been altered since deposition and lithification - probably from hydrothermal solutions. This alteration has filled cracks and pore spaces with calcite, dolomite, feldspar, chlorite, and some pyrite. This alteration could be the same age as the diabase igneous dikes that cut other rocks in the region; however, no diabase dikes have been found cutting the Cow Branch Formation in this locality.

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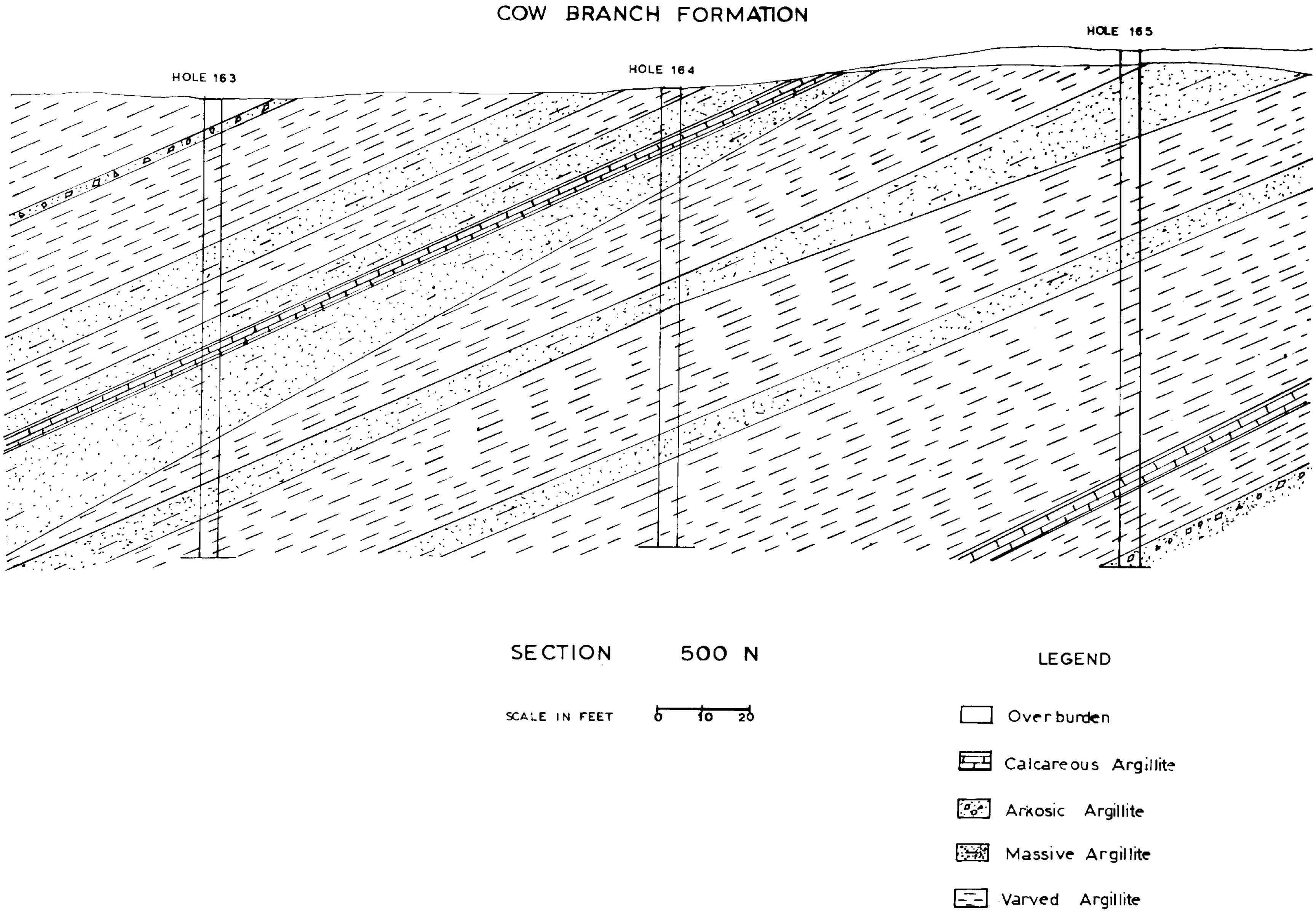

Figure 12. Cow Branch Formation.

Table 2. Virginia Solite Diamond Drill Hole Log, 10-11-65, Section ____ Offset____ Logged by D. Kirstein

Hole 142	Angle 90°
0 - 4'	Top soil and saprolite, 6 inches of core recovery
4 - 12'	Massive argillite; dark gray, broken into two inch pieces; weathered and stained along cracks; few minor beds of arkosic argillite; 3 to 5 percent carbonates, 90 percent core recovery. Zone contains a few scattered calcite veinlets.
12 - 35'	Massive argillite; dull barn red, speckled with white feldspar and carbonates. Carbonate content 3 to 5 percent.
35 - 40'	Varved argillite; medium, dark gray near typical section; few minor varvings of arkose; few films and specks of sulfides; carbonate content 20 to 25 percent
40 - 55'	Massive argillite; dark gray; contains 4 sections of arkosic argillite up to 6 inches thick; 3 to 5 percent carbonates. 1 foot varved section at 51 feet.
55 - 65'	Massive argillite; dark red; similar to that described in 12 to 35 foot section.
65 - 68'	Massive argillite; dark gray with several arkosic lenses varying from 1/2 to 1 inch thick; estimated carbonate content 3 to 5 percent.
68 - 75'	Varved argillite; medium to dark gray; a typical section contains a few blebs, pencils and layers of pyrite; estimate carbonate content 15 to 20 percent.
75 - 87'	Massive argillite; medium to dark gray; similar to section 65 to 68' except it contains arkosic lenses up to 3 inches thick; estimated carbonate content 3 to 5 percent.
87 - 90'	Massive argillite; mostly dark red; at the beginning of the section there is a gradual gradation from gray to red; estimated carbonate content 3 to 5 percent.
90 - 95'	Varved argillite; dark red with a few light red to light gray bands. It contains a few scattered hairline calcite veinlets. Note: Along bedding planes there are molds and casts of irregular shape up to 1/2 inch across; estimated carbonate content 15 to 20 percent.
95 - 100'	Massive argillite; mostly dark red; similar to that previously described; estimated carbonate content 3 to 5 percent.
	Bottomed hole at 100'. The average angle of bedding 65° from core axis.
	Note: Unless otherwise listed, core recovery 100 percent.

Table 3. Virginia Solite Diamond Drill Hole Log, 12-7-65 Section 400N Offset 750W Logged by D. Kirstein

Hole 152	Angle 90°
0 - 4'	Brown silty clay; overburden. No core recovery.
4 - 14'	Massive argillite; brown; weathered and broken; 70 percent core recovery.
14 - 31'	Massive argillite; medium to dark gray with several lenses of arkosic argillite up to 2 inches thick. 10 percent carbonate content.
31 - 43'	Varved argillite; dark gray to black with some pyrite occurring in films and blebs. 3 percent carbonate content.
43 - 47'	Calcareous argillite; light gray; its estimated carbonate content 70 percent.
47 - 50'	Massive argillite; dark gray; this zone contains a few minor arkosic lenses, 5 percent carbonates.
50 - 70'	Varved argillite; dark gray to black; contains some pyrite in films and a trace of coal. 3 percent carbonates.
70 - 74'	Massive argillite; medium to dark gray with a few minor arkosic lenses up to 1/2 inch thick. 3 to 5 percent carbonates.
74 - 121'	Varved argillite; medium gray to black with some varved highly calcareous zones and some scattered films of sulfides and traces of coal. Average carbonate content 10 percent.
	Bottomed hole at 121 feet. Average angle of bedding from core axis 60°.
	Note: Unless otherwise listed, core recovery 100 percent.

Table 4. Virginia Solite Diamond Drill Hole Log 5-27-64 Section 00 Offset 1950E Logged by D. Kirstein

Hole 125	Angle 90°
0-7'	Top soil and saprolite. No core recovery.
7 - 9'	Varved argillite; brown to black; weathered; estimated carbonate content 10 to 15 percent. 8 percent core recovery.
9 - 68'	Varved argillite; medium to dark gray; contains considerable pyrite in blebs up to 1/2 inch thick and 2 inches long. One-foot massive argillite section at 57 feet.
68 - 79'	Massive argillite; medium to dark gray; mostly very calcareous. One foot varved argillite section at 73 to 73 and 76 feet. Section contains six 1/4-inch calcite veinlets. Estimated carbonate content 40 to 50 percent.
79 - 94'	Varved argillite; medium to dark gray; it is similar to section 9 - 68'. It contains considerable pyrite in blebs and numerous scattered hairline calcite veinlets. Estimated carbonate content 20 to 25 percent. Bottomed hole at 94". The average angle of bedding is 55° from core axis. Note: This drill hole is near the mapped contact between the Pine Hall Formation and the Cow Branch Formation.