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ROAD LOG OF THE

CHATHAM, RANDOLPH AND ORANGE COUNTY

AREAS, NORTH CAROLINA

FIELD TRIP GUIDEBOOK

RALEIGH, 1964

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METAVOLCANIC AND METASEDIMENTARY ROCKS IN CHATHAM AND RANDOLPH COUNTIES, NORTH CAROLINA[1]

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1.Publication authorized by the Director, U.S. Geological Survey

INTRODUCTION

Recent reconnaissance geologic mapping in Chatham, Orange, Durham, Randolph and Person Counties as part of a ground water study by the U.S. Geological Survey has demonstrated that the gross stratigraphy of Moore County and of the Albemarle quadrangle (Stanley County) is also applicable to the above counties. Recognition of a traceable graywacke-argillite association has contributed much to an increased understanding of the stratigraphy, structure and origin of the rocks of the Carolina Slate Belt.

The field trip into Chatham and Randolph Counties includes a few representative outcrops of the graywacke suite. No microscopic petrology has been done by the author, thus all rock names are based on megascopic examinations.

The author wishes to express his appreciation to all those people who have helped in the preparation of this guidebook article. Particular thanks go to James F. Conley for his suggestions and guidance during the original mapping, to E.O. Floyd for drafting of the geologic map, and to Stephen G. Conrad for critical review. The thin section and hand specimen descriptions following stops 3, 4 and 5 were furnished by James Robert Butler, Assistant Professor, University of North Carolina.

GENERAL GEOLOGY

Low-rank metasedimentary and metavolcanic rocks of the Carolina Slate Belt are exposed in a northeast trending zone extending from central Georgia to south-central Virginia. In Piedmont North Carolina this zone as shown on the North Carolina state map is about 70 miles wide near the Virginia state line, narrowing to 50 miles wide at the South Carolina state line. The Slate Belt is overlapped to the east by Coastal Plain sediments and is in contact to the west with igneous and high-rank metamorphic rocks belonging in part to the Charlotte belt. In the central part of the Slate Belt rocks of Triassic age are exposed in a graben-like structure called the Deep River Triassic basin. East of Raleigh the Slate Belt has been intruded by a large granitic pluton which has metamorphosed the surrounding country rock into gneisses and schists. Smaller plutonic intrusives ranging in composition from granite to grabbro are scattered throughout the Slate Belt. Rock types of the Slate Belt include felsic and mafic, lithic and crystal tuffs, welded flow tuffs, flows, argillites, slates, phyllites, volcanic breccias or agglomerates, graywacke sandstones and conglomerates, thin limestone beds, and almost every conceivable gradation between each rock type.

Structural elements within the Slate Belt have a pronounced northeast-southwest lineation. Some of the largest of these is the Troy anticlinorium in Randolph and Montgomery Counties and the Virgilinia synclinorium in Person County. The intensity of folding increases eastward fro Troy anticlinorium. In eastern Randolph County and in most of Chatham County the rocks are tightly compressed into northeast trending asymmetrical folds whose axial planes usually dip steeply to the northwest. Argillite has been converted into slate and phyllite in most places.

Most rocks of the Slate Belt show effects of low-rank metamorphism. The greenschist facies of the chlorite grade is usually attained. Locally the grade is higher where the rocks are sheared or where intruded by plutonic rocks. The Slate Belt rocks constitute a stratigraphic succession which is a minimum of 30,000 feet thick.

The oldest rocks thus far recognized in the Slate Belt are a sequence of predominantly subaerially deposited felsic pyroclastic rocks (Uwharrie Formation) which are best exposed and least metamorphosed along the axis of the Troy anticlinorium in the Uwharrie Mountains (Figure 1). The Uwharrie Formation crops out in a belt along the axis of the Troy anticlinorium and reappears in the areas of anticlinal folds along the western border of the Slate Belt in Union County, in central Orange County, in Durham County northwest of the Triassic basin and in southeastern Person County. The lower contact of the Uwharrie Formation has not been recognized. The Uwharrie Formation is overlain by finely laminated, usually graded bedded, low-rank metasedimentary rocks in the area west and southwest of the Troy anticlinorium. Elsewhere, in the Slate Belt, the Uwharrie is overlain by sequence of water-laid andesitic tuffs, which contains interbeds of conglomerate, graywacke, greenstone, argillaceous beds, and mafic flows.

The water-laid sequence east and northeast of the Troy anticlinorium (Efland Formation) consisting of andesitic tuffs with interbedded greenstones, conglomerates, graywackes, and flows occurs only east of the Troy positive area and is traceable from northern Moore County to northern Person County. It conformably overlies the Uwharrie Formation and grades upward into rhythmic-bedded slates of the overlying formation.

In some places the contact between the Efland Formation and the overlying laminated argillite or slate (Tillery Formation) is marked by very distinctive conglomerate beds. The conglomerate generally has a graywacke matrix and usually grades into graywacke sandstone. The graywacke conglomerate is not to be confused with tuffaceous lithic conglomerates and lithic breccias of which there are several in the Efland Formation.

The best exposures of this conglomerate are found in eastern Person County and in western Chatham County. One of these exposures is at the roadcut at Denny Store in Person County. The Denny Conglomerate Member of the Efland formation is present at the upper contact at most localities in Person County. In Chatham County the conglomerate is exposed intermittently from 4 miles northeast of Siler City westward to Staley and south and south-eastward along the contact to the county line due south of Pittsboro (Figure 1).

The prominent pebble lithology in the Denny Member is quartzite. Pebbles of acid volcanics, feldspathic quartzites, quartz-hornblende gneisses, and jasper (?) or red rhyolite are also present. Individual pebbles are well to sub-rounded and vary in size from 7 mm. to over 15 cm. Spericity and sorting are low.

The Uwharrie Formation west and southwest of the Troy anticlinorium and the Eland Formation east and northeast of the anticlinorium are overlain by water-laid pyroclastic and sedimentary rocks (Tillery Formation). At the type locality the Tillery Formation essentially is a finely laminated metashale exhibiting graded bedding. West of the Troy anticlinorium the formation has been metamorphosed into argillite showing well developed bedding-lane cleavage and poor axial-plane cleavage. Exceptions to this can be found where the formation is in contact with igneous rocks of the Charlotte belt and has been metamorphosed to a higher grade. East and northeast of the Troy anticlinorium the Tillery Formation has been regionally metamorphosed into slate. Metamorphic grade gradually increases to the east so that in southern Wake County the Tillery is represented by phyllites and phylonites.

East and northeast of the Troy anticlinorium the basal part of the Tillery Formation contains graywacke and greenstone beds which grade upward into laminated slate. On the northeast side of the anticlinorium the Tillery is thickest along the Person-Granville County border (Virgilina synclinorium). In Person County and along the Chatham-Randolph County line the Tillery grades upward into greenstone flows and lithic breccias. West of the Troy anticlinorium in the Albemarle quadrangle the graywacke beds are much less numerous and the basal greenstones are absent.

The association of graywacke sandstone, rhythmic argillites and graywacke conglomerates with volcanics in other parts of the world is well documented. The following excerpt from Pettijohn, 1957, page 617 illustrates the point:

> "Inasmuch as the graywacke rhythmites are characteristic only of the excessively thick and deformed sections, they are a product of geosynclinal sedimentation. They accumulated rapidly and without interruption in a comparatively dee-water (1000 to 5000 feet) marine environment. The sediments consist of waste products of a high land mass inasmuch as they are texturally and mineralogically very immature. They were derived both from low-rank metamorphic and crystalline terranes—in part fro strata earlier deposited in the same geosyncline. They follow the euxinic or silled-basin stage and precede the paralic stage in the normal geosynclinal cycle. In the deeper, shorter-lived eugeosynclines they are associated with pillow lavas and tuffs.
>
> Thick sections of this facies are very common. Most of the Archean sections in the Temiskaming province of the Canadian shield are graywackes, slates, ferruginous cherts, and greenstones (Pettijohn, 1943). The later Precambrian (Tyler, Michigamme) of northern Michigan consists of graywackes and slates plus basic volcanics. The Rensselaer graywacke (Ordovician?) of New York is a graywacke-slate complex with some volcanics (Balk, 1953). The Lower Paleozoic of the Caledonian geosyncline is thus characterized (Jones, 1938), as is the Carboniferous of the Armorican geosyncline of southern England and Wales and the Harz mountain district of Germany. This suite characterizes the Franciscan (Jurassic?) of California, the Eocene of the Olympic Mountains of Washington and much of the Alpine Tertiary (Baily, 1936). Essentially the same assemblage, with fewer or no volcanics characterized the Carboniferous of the Ouachita and Marathon mountains."

The metasedimentary rocks of the Carolina geosyncline are indeed associated with greenstones (although no evidence has been seen that would indicate that they are spilitic and pillowed), with thin limestone beds, with low-grade iron formations, and with conglomerates. All are more or less typical of other major eugeosynclines.

ROAD LOG

SATURDAY FIELD TRIP

Mileage

0.0 **Eden Rock Motel.** The assembly point for the field trip is 3.0 miles southwest of U.S. 15-501.

3.0 Assembly Point – access road for Amoco service station and antique shop just south of Straw Valley pottery house.

4.5 Bifurcation of bypass 15-501 and business 15-501.

6.8 Junction U.S. 15-501 with N.C. 54 at overpass. Continue straight ahead on U.S. 15-501 bypass.

9.2 Junction U.S. 15-501-54 bypass with business 15-501. Bear right, turn left on business 15-501 toward Pittsboro.

9.4 Outcrop of bedded volcanic-sedimentary rock on left side of road across bridge.

19.5 Junction of C.R. 1713 leading into Bynum. Continue straight ahead on U.S. 15-501.

20.6 Bridge over Haw River.

25.3 Pittsboro. Intersection of U.S. 15-501 and U.S. 64. Bear right around traffic circle on U.S. 64 west.

25.8 Junction U.S. 64 with N.C. 87. Continues straight ahead on U.S. 64.

32.0 Junction C.R. 1561 with U.S. 64 at J.V. Clark dairy farm. Turn right on C.R. 1561.

32.9 **STOP 1:** Outcrop of graywacke suite consisting of laminated, tuffaceous metashales, graywacke sandstones, conglomerates and "greenstones". The rocks exposed here are tentatively assigned to the Tillery Formation. The structure appears to be a small anticline which is plunging to the west and is faulted along its axial plane. The attitude of bedding on the southeast flank is approximately N85E 30-75SE. The axial plane of this fold is overturned to the northwest. The principal cleavage dips 55 degrees to the northwest and strikes N50E. The lamina in the metashales are accentuated by an opaque mineral which is probably magnetite. Note the penecontemporaneous slump structure in the beds in the southeast section of this exposure. The sheared graywacke conglomerate and sandstone appear to contain angular quartz, altered feldspar, mica, magnetite and epidote? The graywacke conglomerate contains very flattened volcanic (?) cobbles ranging up to 8 inches in length. "Greenstones" in the northern one-half of the exposure appear to have large fragments or bombs weathering out. Compare this with the less weathered outcrop in the ditch in the extreme northwest end of the roadcut. After stop continue straight ahead on county road.

34.7 **STOP 2:** Typical piedmont outcrop is "good" state of preservation. Graywacke sandstones exposed 100 yards back up the hill are similar to those exposed at Stop 1. Poorly defined sandstone beds indicate that the bedding strikes N80E and dips nearly vertically. The principal cleavage is N40E70NW. The main purpose of this stop is to verify the presence of a graywacke conglomerate or volcanic agglomerate, after which we will move promptly to the next stop.

34.8 Junction C.R. 1561 with C.R. 1346. Turn left on C.R. 1346.

35.3 **STOP 3:** Outcrop of siliceous, devitrified metashale and graywacke. Where unweathered the laminated metashale is a light blue green and breaks and looks like rhyolite. It weathers to ocherous buffs and lavenders which accentuate the fine bedding. (42 laminae were counted in one 3/8 inch space.) The coarser grained graywacke beds show interlocking feldspar and quartz grains and disseminated magnetite. This outcrop is assigned to the Tillery Formation. After stop continue straight ahead on C.R. 1346. The following description is by J.R. Butler:

Silicified argillite (No. NC-43)

Hand Specimens:[1] The rock is made up of greenish gray and dark greenish gray layers ranging in thickness from about two cm. To less than one mm. Weathered surfaces are grayish yellow. Most of the original grains were probably silt size or smaller, but a few of the layers contain grains as large as medium-sand size. Some of the layers are graded. The rock is hard and brittle, with little bedding-plane fissility and breaks with a sub-conchoidal fracture. Small faults with a displacement of a few inches or less are common.

Thin Section: Most of the rock has a discernible clastic texture modified by the extensive recrystallization. The original clasts have been almost completely replaced by aggregates of minerals typical of greenschist facies of metamorphism. Major constituents are epidote, chlorite, sericite, feldspar, quartz, and turbid opaque minerals. The term sericite as used here includes white micas such as muscovite and phengite that cannot be differentiated in thin section. The relict clastic texture is retained best in the coarsest layers. In these layers, outlines of subangular to subrounded clasts are to 0.5 mm. across. The clasts were mainly plagioclase crystals and lithic fragments, with a small percentage of quartz crystals.

The hard, flinty nature of the rock is thought to be caused by addition of silica, perhaps during metamorphism. Many of the argillites in this region are relatively soft and have not undergone silicification.

The silicified argillite is a metasedimentary rock, possibly containing tuffaceous material of dacitic or

1.Collected from similar rock type near Terrells 3 ½ miles northeast of this stop.

andesitic composition.

36.8 Junction C.R. 1346 with C.R. 1506. Turn right on C.R. 1506.

38.1 **Stop 4:** Large float boulder containing subangular fragments and rounded pebbles and cobbles. Lithologies include felsites showing flow banding or bedding, crystal and crystal-vitric tuffs, and granite (?) in a matrix of mafic volcanic debris. Fragments are slightly flattened by original compaction, welding, or dynamic metamorphism to give the rock a rude foliation. The attitude of the outcrop and its cleavage can be seen in those rocks in place in the woods on either side of the road. The poor sorting, accidental cobbles, and difference in roundness may indicate that this rock is the product of a mudflow (lahar) or nueee ardente. The rock type exposed here is assigned to the Efland Formation. The following description is by J.R. Butler:

Volcanic breccia (No. NC-45)

Hand Specimen: A hand specimen from one of the boulders at this stop has an overall greenish gray color and is composed of unsorted clasts up to three cm. across. The shape of the clasts is related to size; the larger clasts generally are rounded or subrounded and the smaller ones tend to be more angular. Most of the clasts are aphanitic lithic fragments of chemical composition not far from that of the bulk sample. White feldspar clasts about one mm. long are common in the groundmass.

Thin Section: The thin section has clastic particles of a wide range of sizes in a turbid groundmass. The larger clasts are lithic particles of fine-grained, plagioclase-rich volcanic rocks, probably of dacitic or andesitic composition. The smaller particles are lithic fragments and angular to subangular crystal clasts of plagioclase and quartz. The major constituents are plagioclase, epidote, chlorite, quartz, calcite, green biotite (?), sericite, and opaque minerals. Plagioclase clasts retain sharp outlines and are slightly altered. Optical determinations indicate that most of the plagioclase is calcic oligoclase. Any dark minerals such as pyroxenes or amphiboles in the original rock have been completely changed by metamorphism, but plagioclase and quartz show little evidence of metamorphic recrystallization. The biotite (?) is pleochroic from pale greenish yellow to dusky yellowish green and its birefringence is about 0.040; it may be stilpnomelane rather than biotite.

38.3 Junction C.R. 1506 with C.R. 1557. Continue straight ahead on C.R. 1506.

38.6 Turn around in T-intersection of farm road and county road, retrace route for 0.1 or 0.2 mile, park on right shoulder, and pull emergency brake (steep hill).

38.7 **STOP 5:** Outcrop of basalt (/) flow. Flow banding is quite evident around cognate blocks. Flows increase in number and in total percentage of the stratigraphic column as you go northwest from this point (down stratigraphically) the flow exposed here is assigned to the Efland Formation. J.R. Butler has furnished the following description:

Volcanic flow? (No. NC-44)

Hand Specimen: At this stop, a hard, brittle, aphanitic rock with faint layering and a distinct cleavage is exposed. The rock is medium bluish gray on fresh surfaces and scattered cleavage faces of small feldspar crystals can be seen.

Thin Section: The texture is microporhyritic, with euhedral to subhedral feldspar crystals 0.5 to 1.5 mm. long in a very fine-grained matrix. Recognizable minerals in the matrix include plagioclase, quartz, sericite, epidote, and calcite. Extinction angles and optic sign on several of the larger plagioclase crystals indicate that they are calcic oligoclase. The matrix has a faint layered structure, which could be flow layering. The nature of the layering and the presence of euhedral to subhedral crystals of fairly uniform size support the interpretation that the unit is a volcanic flow.

39.0 Junction C.R. 1506 and C.R. 1557. Turn right on C.R. 1557 toward Silk Hope.

42.3 Silk Hope. Junction of C.R. 1557 with C.R. 1003. Turn left on C.R. 1003.

47.2 Junction C.R. 1003 with U.S. 64. Turn right on U.S. 64.

47.5 Bedded sedimentary sequence crops out at this point.

49.2 Junction U.S. 64 with old U.S. 64. Bear left through traffic island into Siler City.

50.3 Junction old U.S. 64 (C.R. 1107) with U.S. 421. This is a 10 minute rest stop. The caravan will reassemble 0.3 mile straight ahead on the west side of the railroad tracks.

50.6 Assembly point. Continue straight ahead on C.R. 1107.

51.7 Junction C.R. 1116 with 1107. Turn left up hill on C.R. 1116. Watch out for lady driver at top of hill!

52.8 Junction C.R. 1116 with C.R. 1119. Turn right 0.2 mile, turn right on C.R. 1121. Park cars.

53.1 Lunch stop.

53.1 **STOP 6.** Unweathered outcrop of graywacke conglomerate and sandstones of the Tiller Formation. Attitude of the bedding is N80W30-45SW. Coarser conglomerate is exposed at Stop 6A.

STOP 6A: Outcrop of a coarse graywacke conglomerate and graywacke sandstone. Attitude of the bedding at this outcrop is N75E65SE. Pebbles and cobbles from these two outcrops indicate the source was from metamorphic and volcanic terranes. Pebbles from here and elsewhere include such lithologies as: quartzite, phyllite, slate, chert (?), red rhyolite or jasper, vein (?) quartz, and various aphanitic flow rocks. More than one-half of the recognizable pebbles here were quartzite. Sizes of individual cobbles range up to 6 inches in diameter. Bedded argillaceous rock is exposed in the northeast bank of this roadcut.

53.8 Junction of C.R. 1121 with C.R. 1120. Turn right on C.R. 1120.

54.7 Junction of C.R. 1120 with unmarked intersection (C.R. 1100) turn right 0.2 mile. Junction (C.R. 1100) with old U.S. 64 (1107).

54.9 Junction of C.R. 1100 with C.R. 1107. Turn left.

56.8 Junction of C.R. 1107 with U.S. 64. Turn left.

59.3 Junction of U.S. 64 with C.R. 2474. Turn right.

60.5 Outcrop of sheared conglomerate.

61.3 **STOP 7:** Outcrop of weathered graywacke conglomerate associated with an altered, fine-grained graywacke siltstone or tuff. There is a possible increase in quartzite pebbles in this outcrop, although this may just be an expression of the degree of weathering. We will pause here only long enough to verify the presence of the conglomerate.

61.5 **STOP 7A:** Outcrop of rhythmically bedded argillite (slate) and graywacke sandstones. Although weathered, this outcrop illustrates very well the more typical development of this suite, especially of that exposed in eastern Person County and northern Orange and Durham Counties – that is, the Virgilina facies. The section here is normal. Bedding attitude is N80W 50-70SW. The best developed cleavage is N70E 80NW. There is a poorly developed bedding-plane cleavage present. The conglomerate exposed at Stop 7 crops out also about 0.1 mile south just across the bridge. Granodiorite is exposed at the top of the hill to the south. Junction of C.R. 2474 and C.R. 2469. Turn left (south on C.R. 2469.

62.9 Outcrop of a quartz monzonite (?) batholith.

64.1 Junction of C.R. 2469, U.S. 64 and C.R. 2628. Continue straight ahead across intersection on C.R. 2628.

67.4 Parks Crossroads. Continue straight ahead on C.R. 2628.

69.6 Junction C.R. 2628 with N.C. 22 and 42. Turn left on N.C. 22-42.

72.0 Coleridge. Junction of N.C. 22-42 with C.R. 1005. Turn left on C.R. 1005.

72.6 Triangular intersection of C.R. 1005 with C.R. 2640. Continue straight ahead on C.R. 1005. Don't bear left.

76.9 Weathered outcrop of conglomerate in roadcut at junction of C.R. 1005 and 1148. The conglomerate is exposed intermittently for the next mile. Continue through intersection.

77.7 Junction of C.R. 1005 with C.R. 1151. Bear left on 1005.

81.6 Junction of C.R. 1005 with C.R. 1006. Turn left on C.R. 1006.

82.2 Weathered outcrop of conglomerate in right-hand bank.

82.9 Junction of C.R. 1006 with C.R. 1134. Turn right on C.R. 1134 toward Mt. Vernon Springs (Ore Hill). Note increased evidence of hydrothermal activity.

86.2 Junction of C.R. 1134 with U.S. 421. Continue straight across highway on C.R. 2118. Be careful! This is a bad intersection.

86.4 Junction of C.R. 2118 with C.R. 2119. Turn right on C.R. 2119.

87.5 Junction of C.R. 2119 with 2109. Continue straight ahead on C.R. 2119.

88.4 Outcrop of graywacke conglomerate in left bank.

89.2 Junction C.R. 2119 with C.R. 2120. Turn left on C.R. 2120. Bedded argillite (slate) and graywacke are exposed between this intersection and the bridge.

90.5 Junction of C.R. 2120 with C.R. 2170. Continue left around bend 0.1 mile then turn right up narrow dead-end road (C.R. 2173).

91.0 **STOP 8:** Johnson's Farm. Turn cars around and park in road headed west. Outcrop of iron-rich volcanic rock, low-grade iron ore (hematite), and a quartz dike containing hematite crystals. The original rock appears to have been a volcanic agglomerate. The association of lean iron-bearing sediments with volcanics and rocks of the graywacke suite is well established in other parts of the world. They are not unknown to the Carolina "slate belt" (McCauley, 1961). This area (Ore Hill) has a long history of iron-ore smelting. The following is taken from Kerr and Hanna (1893):

> "Ore Hill Mine.—The most noted locality in Chatham County is known as Ore Hill.
> The accompanying plate (plate V) shows the topography and general relations, and approximately the situations of the veins, which are numerous and lie at various angles with the meridian and with the horizon.

The rock is a talco-quartzose slate, knotted and toughened with much tremolite. The ore is limonite, with the exception of one vein near the top and back of the hill, which is hematite, partly specular, and much resembles the Evans ore.

The abundance of the scattered fragments would seem to indicate a vein of considerable extent. Most of the veins had been opened, but had subsequently fallen in, and accurate measurements could not be taken when the mine was visited. Still it was easy to see that two or three of them were very large – 10 to 15 feet and upwards. The ore is spongy, porous, scoriaceous, botryoidal, mammillary, stalacitic, tabular, and of many other fantastic forms. The workmen state that there were large cavities (Vugs) in some parts of the veins. The analyses here given are of samples from the 90 foot shaft, nearest the hematite vein, and may be considered as fairly representative:

Hematite from Ore Hill

Silica	(30)	(31)
Alumina	1.42	3.79
Sesquioxide of iron	82.02	83.69
Peroxide of iron		0.11
Lime	1.19	
Magnesia	0.11	
Phosphoric acid (anhydride)		trace
Sulfuric acid (anhydride)		0.77
Water	15.26	
	100.	
Metallic iron	57.26	58.67
Sulphur		0.33
Phosphorus		trace

The first of these (30) was made by Dr. T.M. Chatard, for Prof. F.A. Genth, and the second (31) by Mr. Hanna.

This ore was worked on a considerable scale during the American Revolution, and again during the late civil war; and the iron is reported to have been of good quality. It is obviously an ore very readily smelted.

The present of the hematite vein and the proximity of the ball ore, which was successfully used as a flux in the last working of the furnace, furnish admirable conditions for advantageous iron manufacture."

The writer understands little about the genesis of low-grade iron ores and iron-rich sediments. However, it seems reasonable that iron-rich sediments could be beneficiated by hydrothermal solutions.

91.5 Junction of road to Johnson's farm (C.R. 2173) with C.R. 2120. Turn left short distance, then left on Rive's Chapel road (C.R. 2170).

93.1 Junction of C.R. 2170 with C.R. 2175. Turn left.

95.9 Junction of C.R. 2175 with N.C.902. Turn right.

97.0 Junction of N.C. 902 wit C.R. 2187. Turn left opposite Meronies Methodist Church.

98.6 **STOP 9:** Outcrop of volcanic agglomerate. Lapilli sized fragments are sheared and flattened along a N50E direction (conformable to regional trend). Gross lithology of constituents is considerable different from those of the graywacke conglomerates seen earlier today. The rock appears to consist entirely of volcanic debris which weather very nearly the same rate. Note especially that there are no quartz or quartzite pebbles protruding from the weathered surface. Clasts range up to 2 inches in width and are greatly flattened in a paste of sericite and epidote. Note that there is no bedding, and no apparent sorting, thus this rock may qualify as a flow tuff. Continue straight ahead after stop.

100.6 Junction C.R. 2187 with C.R. 1010. Turn left towards Pittsboro.

111.0 Pittsboro. Junction of C.R. 1010 with N.C. 87 and U.S. 64. Turn right.

111.6 Pittsboro traffic circle. Junction of U.S. 64 with U.S. 15 and 501. Take U.S. 15-501 north to Durham and the Eden Rock Motel.

136.9 Eden Rock Motel.

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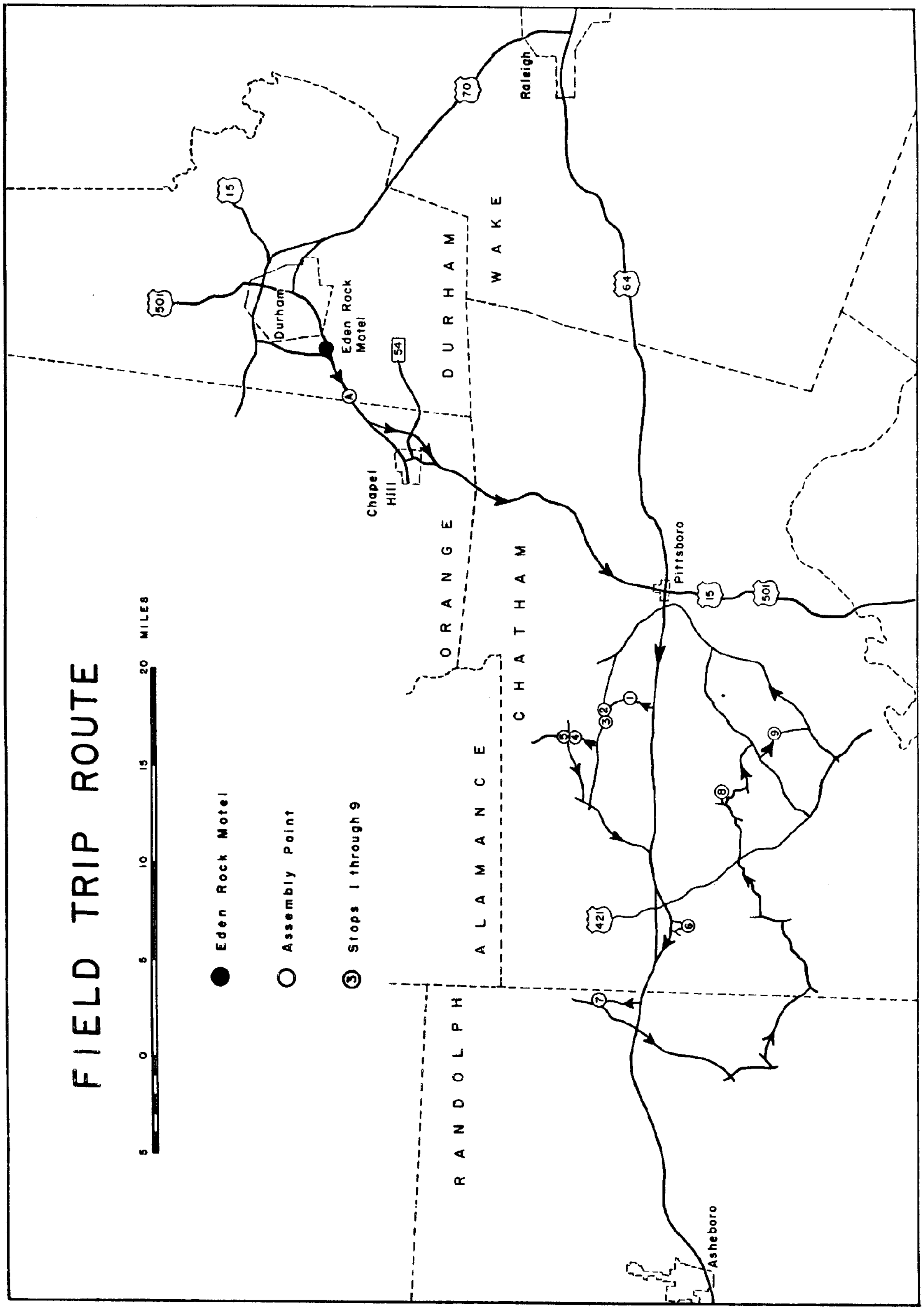
FIELD TRIP ROUTE
Eden Rock Motel
Assembly Point
Stops 1 through 9
5 0 5 10 15 20 MILES
Durham
Eden Rock Motel
Chapel Hill
Raleigh
Pittsboro
Asheboro
ORANGE
DURHAM
WAKE
ALAMANCE
CHATHAM
RANDOLPH
501
15
70
54
64
421

Ross, C.S., and Smith, R.L., 1961, Ash-Flow Tuffs: Their Origin Geologic Relations and Identifications: U.S. Geol. Survey Prof. Paper 366, 81 pp.

Stuckey, J.L., and Conrad, S.G., 1958, Explanatory Text for Geologic Map of North Carolina: North Carolina Div. of Min. Res., Bull. 71, 51 pp.

ROAD LOG

SUNDAY FIELD TRIP

Mileage

0.0 **Assembly point** – Duke Motor Lodge Office, located on U.S. 15-501business adjacent to the Howard Johnson Restaurant.

0.05 Turn right onto U.S. 15-501 business and drive southwest for.35 of a mile.

0.4 Turn left off U.S. 15-501 business onto U.S. 15-501 N. bypass and continue on U.S. 15-501N. for 5.1 miles.

5.5 Turn off U.S. 15-501N. onto right clover leaf to U.S. 70 business; immediately turn left on U.S. 70W and continue on U.S. 70W for 4.5 miles to county road 1567 located at the John Deere, Durham Farm Equipment Company, Inc.

10.0 Turn right onto county road 1567 and continue for 2.25 miles to intersection with county road 1569.

12.25 Turn left onto county road 1569 and drive 1.25 miles on unpaved road to Eno River. (Note: Please park cars to far right of road for lead cars making exit.) Outcrops are approximately 500 feet upstream.

STOP 1: (Leader: W.F. Wilson)

Tuff Breccia Unit

The breccia is part of a larger tuffaceous unit with a general strike of approximately N46E. At its widest point, the unit is a little over one mile wide and can be traced for over ten miles along strike.

In outcrop, the tuff breccia is a medium bluish grey to dark greenish grey unit in which the lithic clasts are generally darker than the matrix.

The lithic clasts appear to comprise approximately 35 to 40 percent of the rock and range in size from less than one-half inch to over one foot in diameter. The smaller clasts are generally angular and the larger clasts (over one inch) are subangular to subrounded. Both are pre-existent rocks of volcanic origin of three main types; crystal tuffs, crystal lithic tuffs and flows.

Interbedded within the tuff breccia is a dark greenish grey crystal lithic tuff. The tuff possesses a speckled appearance due largely to the greenish white feldspar crystals clasts which are altering to epidote and chlorite and also in part to lithic clasts that are for the most part darker than the matrix.

The lithic clasts are predominantly angular to subangular, are cryptocrystalline and are less than one-eight inch in diameter. The crystal clasts in hand specimen appear to be subrounded to rounded. However, in thin section, due to low-rank regional metamorphism, they appear highly altered to epidote and chlorite and the periphery of the crystals are ragged.

Thin section analyses of the tuff further revealed the major constituents to be plagioclase quartz, chlorite and epidote with minor amounts of sericite, calcite and opaque minerals.

13.50 Turn around and return to intersection of county roads 1567 and 1569. Turn left on paved road 1567 and drive 3.75 miles to intersection of county roads 1567 and 1002. St. Marys Church is located on the northeastern corner of the intersection.

17.25 Turn left onto county road 1002 and travel 1.7 miles to unpaved road at Mt. View Farm, owner J.R. Weaver.

18.95 Turn left off county road 1002 onto unpaved road leading to Bacon Quarry. Drive 0.2 to a mile to bifurcation. Continue on left fork for 0.8 of a mile to Bacon Quarry. (Note: Follow lead car around circle in counter clockwise pattern for parking and easy exit.)

19.95 **STOP 2:** (Leader: E.P. Allen) Bacon Quarry.

The Bacon Quarry is located approximately 4.3 miles northeast of Hillsboro in a quartz diorite body that has intruded mafic metavolcanic rocks. Crushed stone is produced here by the North Carolina State Highway Commission for use in road maintenance work throughout Orange County.

Bacon Quarry is roughly rectangular bench type excavation situated just below the crest of a hill that rises approximately 100 feet above the surrounding terrain. This 350 by 250 foot quarry is developed in the western margin of the intrusive and its length parallels the northeast-southwest trend of the main quartz diorite body. In the western corner of the quarry the rock face reaches its maximum height of almost 50 feet above the quarry floor. Overburden ranges from zero to 20 feet thick with an average of 10 feet of red, drab-orange, and yellow clayey soil.

In the area of Bacon Quarry the quartz diorite body is one mile wide. It has been traced by outcrop and float one mile to the northeast and two miles to the southwest. The intrusive is a medium to dark gray fine to coarse-grained granitic textured rock that appears to vary considerably in mineral composition throughout its extent. Most of the quartz diorite exposed in the quarry contains light greenish gray and pinkish-gray feldspar and clear quartz in a granitic texture, generously sprinkled with mafic minerals. Thin section observation reveals the dark patches of mafic minerals to be composed of chlorite, epidote and black opaque minerals with occasional spots of calcite and sericite. Small bundles of fibrous actinolite are often conspicuous adjacent to the hornfels.

Innumerable mafic metavolcanic xenoliths make up approximately 20 percent of the rock that has been recently quarried. The xenoliths range from less than one inch to as much as 15 feet in maximum dimension with two-inch to two-foot sizes being most common. A majority of the xenoliths are still subangular to only slightly rounded with a sharp line of contact with the igneous intrusvie thus indicating a poor assimilatory power for the quartz diorite.

Excellent examples of contact metamorphism are exhibited by many of the metavolcanic xenoliths. A green-gray colored albite-hornfels facies occurs in the inner portion of the zoned aureols of most xenoliths and grades outward into the dark gray perimeter of hornblende-hornfels facies that comes into direct contact with the quartz diorite. Because of the low to moderate temperature of this contact metamorphism, recrystallization is imperfect and the paragenesis is partially obscured by the relic minerals from the albite-epidote-hornfels facies persisting in the hornblende-hornfels facies. Both facies correspond to moderate pressure. Indicative of the xenoliths' original mafic volcanic composition is the albite-epidote-hornfels facies' basic mineral assemblage of albite-epidote-actinolite-chlorite-quartz-opaques and minor amounts of calcite.

Much epidote occurs throughout the rock in Bacon Quarry as widely disseminated fine particles and veins. Veins of calcite up to several inches in thickness are also quite common. The most prominent joint planes observed in the quarry are N35W 80SW and N35E 88 degrees NW.

Follow lead car 1 mile back to county road 1002.

20.95 Turn left on county road 1002 and drive 3.65 miles to U.S. 70 bypass around Hillsboro.

24.60 Turn right onto U.S. 70 bypass and drive 3.0 miles on U.S. 70 bypass past the highway truck weight station.

27.60 Turn left off U.S. 70 onto county road 1161 and drive 0.1 of a mile to gate on right leading to Duke Quarry.

27.70 Drive 0.3 of a mile down the quarry road to the fork and follow the right fork 0.55 of a mile to the second fork. Keep right, continue to follow the lead car for.15 of a mile around the circle at the bottom of the quarry.

STOP 3: (Leader: J. Robert Butler) Duke Quarry.

Stone from the quarry was used in the construction of Duke University. The rock is a phyllite with well-developed slaty cleavage. The color is mainly medium to dark bluish gray. The orientation of the cleavage is about N. 35 degrees E, 70 degrees NW. Cleavage is parallel to bedding in the quarry.

There is considerable variation in composition and structures of the phyllite across strike. The most prominent unit in the quarry is a dark bluish gray rock in a unit as much as 30 feet thick. Quarrying operations were mainly in this unit of darker phyllite. A series of pits opened northeast of the quarry follow the unit. According to George Bain (personal communication, 1964), this unit can be traced southwest and northeast of Duke quarry for a total distance of 12 miles. Part of the phyllite was derived from a coarse-grained clastic rock, probably volcanic breccia. Some of the clasts have been strongly deformed and appear as thin lenses in sections cut perpendicular to the cleavage. In such sections, the ratio of maximum length of the lenses (measured in the plane of cleavage) to thickness (measured perpendicular to the cleavage) is commonly as much as 8:1. Some layers are less strongly deformed and the ratio is 2:1 or less.

George Bain's interpretation of the structure is that Duke quarry lies on the northwestern flank of an anticline with its axis trending northeastward through Hillsboro (personal communication, 1964). The rocks are therefore progressively younger from southeast to northwest through the quarry.

Axes of minor folds, relationship of cleavage and bedding, and outcrop patterns in the Carolina a slate belt in Orange County indicate a series of northeast-trending folds that have horizontal or gently plunging axes. The slaty cleavage apparently is parallel to the axial planes of the folds. At some outcrops of the phyllite derived from volcanic breccia, the deformed clasts are elongated in the plane of cleavage rather than the bedding plane; therefore, the deformation is mainly a metamorphic feature.

Bedding is well exposed in the northern end of the quarry. Some of the individual layers in the dark colored phyllite unit are more than five feet thick. There are several layers of deformed breccia interbedded with laminated rock made up of silt- or sand-size particles. Some layers several inches thick are very rich in chloritoid.

So far, neither chemical nor X-ray data have been obtained for the Duke quarry phyllite, but a more detailed study is in progress. The following discussion is based on examination of seven thin sections from the quarry

The texture is lepidoblastic and the major minerals are quartz, sericite, chlorite, opaque minerals, and chloritoid. (The name sericite as used here refers to the group of optically similar white micas including muscovite, paragonite, and phengite. X-ray methods are necessary to differentiate members of the group.) The average grain size is less than 0.05 mm, but some of the porphyroblastic chloritoid crystals are about one mm. in longest dimension. The deformed clasts appear in thin section as streaks and lenticular aggregates of extremely small grains. Color of the dark gray phyllite is due mainly to the high percentage of opaque minerals, which apparently are most hematite.

The Duke quarry phyllite was derived from argillite, tuff or tuffaceous sandstone, and volcanic breccia. Occurrence of laminated argillites suggests marine deposition. Recognizable clasts appear to be mostly derived from fine-grained or glassy volcanic rocks, but deformation and recrystallization are so intensive that identification is uncertain. There is insufficient evidence to determine if the volcanic material was deposited directly by igneous action or if it was reworked by sedimentary processes. Presence of lava flows and very coarse breccias in Orange County suggest that the volcanic centers were relatively near.

Folding and metamorphism, presumably contemporaneous, produced northeast-trending, locally isoclinal folds with an axial plane cleavage, and mineral assemblages of the greenschist facies. Evidence obtained so far indicates that there was only one major episode of deformation and metamorphism.

28.70 Retrace route 1.0 mile back to county road 1161 and turn left. Drive 0.1 of a mile to U.S. 70. For those departing, take U.S. 70 west to Greensboro, or U.S. 70 east to Hillsboro and Durham.

NOTES