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NOTES

GUIDE TO THE GEOLOGY OF PICKENS AND OCONEE COUNTIES, SOUTH CAROLINA -- CAROLINA GEOLOGICAL SOCIETY FIELD TRIP OCTOBER 26-27, 1963

By

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INTRODUCTION

This paper is intended to serve as an introduction to the metamorphic rock complex of the westernmost portion of South Carolina, where the Piedmont and Blue Ridge physiographic provinces merge. Generalized geologic maps, Figures 1 and 2, show the distribution of the lithologies of the two counties. Characteristics of these units are given under the next heading (Description of Rocks). A road log with commentary accompanies this paper and can be used to observe a fairly complete section of this area. The numbered STOPS are noted on Figures 1 and 2. The field work on which this guidebook is based has been carried on over the past three years by Brown in Pickens County and Cazeau in Oconee County.

GEOGRAPHY

The two counties lie largely within the Piedmont physiographic province, though the westernmost part of both form part of the Blue Ridge province. The Piedmont consists of low, rolling topography. In the southern part of these counties, the general surface is at an elevation of 700 feet. Near the northwestern boundary of the Piedmont province the surface elevation is about 1000 feet. Dissected by youthful to mature streams, the relief in the south is about 200 feet and in the north is generally 300-500 feet. Deep and protracted weathering has produced a thick saprolite cover which obscures much of the bedrock. Fresh outcrops are more often encountered, therefore, in the valleys of active streams and recent road cuts. The greater part of the field trip route will be through the Piedmont portion.

The Blue Ridge Front rises prominently to heights of 1800 feet or more, striking northeast across the western part of Oconee County a few miles west of Walhalla. The Blue Ridge Mountains will be visible in the distance from time to time during the morning. In the afternoon, the route through Oconee County will pass across the Brevard Belt into the Blue Ridge proper. In Pickens County, the augen gneiss lithology supports the highest peak in South Carolina, Sassafras Mountain, elevation 3,554 feet; and a part of the Blue Ridge Front is developed on this gneiss.

DESCRIPTION OF ROCKS

The overall geologic setting for the region is one of northeasterly striking belts or zones composed dominantly of metasedimentary and metaigneous rocks in which the dip of foliation and other structures is for the most part to the southeast. Figures 1 and 2 show outcrop areas of these major rock units.

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Biotite Gneiss

Unit bgn consists of biotite gneiss as the characteristic rock type, typically interlayered with hornblende gneiss, mica schist, and quartzite. "In fresh outcrops it is medium to dark gray, ranging from medium to coarse grained with moderately distinctive foliation developed due to the parallelism of biotite flakes. It consists chiefly of white plagioclase and quartz, with occasional garnetiferous zones. In deeply weathered outcrops the biotite gneiss has altered to a friable saprolite which may be red-brown or greenish, and contains abundant bronze-colored mica flakes.

Petrographic examination of a garnetiferous biotite gneiss from the area shows quartz 30 percent, biotite 20 percent, plagioclase (oligoclase) 25 percent, garnet 20 percent, and opaque accessories, mostly magnetite, 5 percent. The quartz contains abundant dusty inclusions, and some of the oligoclase has been sericitized. The texture is lepidoblastic." (Brown and Cazeau, In press).

Hornblende Gneiss

Hornblende gneiss (hgn) usually occurs interbedded with either biotite gneiss or mica schist and sometimes both. Unweathered specimens are generally dark gray with distinct banding caused by segregations of hornblende and the light minerals plagioclase and quartz. These rocks belong to the Roan Gneiss lithology as originally named and mapped by Keith (1903). When weathered, the hornblende gneiss is typically clayey, yellow-brown, or ochre, often retaining vestiges of the original foliation.

Mica Schist

Mica schist (ms) is found as the predominant rock type in the central part of Pickens County. Variable in composition, it consists predominantly of muscovite and biotite, quartz, $\pm$ garnet, $\pm$ sillimanite. At some places fibrous sillimanite has been altered to muscovite.

Injection Gneiss

The injection gneiss (ign) of Pickens County is a biotite gneiss characterized by discontinuous, slightly undulatory but discrete mineral laminae of quartz and feldspar. Fine-grained biotite flakes are concentrated primarily along the planes joining the bands of quartz and feldspar. Contacts for this unit are transitional with the granite gneiss (ggn) to the northwest and the biotite gneiss (bgn) and hornblende gneiss (hgn) on the southeast, and distinction is often difficult.

Granite Gneiss

Granite gneiss (ggn) in a belt to the northwest of the injection gneiss unit in Pickens County is typically a medium gray, equigranular, fine-grained foliate in which the K-spar is microcline, biotite is present in excess of muscovite, and the quartz is rod-shaped.

Injection Zone

North and west of the biotite gneiss zone in Oconee County is a complex injection zone (ign) which is equivalent to the ms, hgn, ign, and ggn of Pickens County. This zone consists of hornblende gneiss and granite gneiss with subordinate bodies of mica schist and biotite gneiss. Small quartz veins and granite dikes, both concordant and discordant, are present in this zone, and ptygmatic folding and migmatite zones are characteristic of it.

Augen Gneiss

In the northern part of Pickens County and extending across the west-central part of Oconee County is a broad belt of augen gneiss (agn) which correlates with the Henderson Granite as named by Keith (1905) in the Mount Mitchell Quadrangle, North Carolina. Southwestward along strike the augen gneiss passes from a coarse-grained phase to a fine-grained phase in which the augen, composed usually of microcline, become reduced in size or are absent.

In passing into the augen gneiss belt from the southeast, soil changes are quite evident -- from the deeper reds and browns developed in the biotite and hornblende gneisses to the light buff to yellowish sandy soils developed on the augen gneiss. In Pickens County, fine-grained phases are encountered as narrow bands within the coarse phase. The fine-grained phases are muscovitic and often mylonitized. Observations in Pickens County coincide with most of those made by Eckelman and Kulp (1956) and generally support the concept of these rocks forming the lower part of a thick metasedimentary sequence.

Brevard Belt

The Brevard belt (B) adjoins the augen gneiss zone on the northwest in Oconee County. It was named by Keith (1907) after the town of Brevard, North Carolina, and corresponds to Sloan's (1908) "Chauga Zone". The Brevard is made up of dark gray, silvery, and brown indurated schists and phyllitic schists in the south where it crosses the Tugaloo River from Georgia into South Carolina. Northward along strike scaly reddish schists become increasingly associated with the gray and brown schists. The "scaly" character of the typical Brevard has become a common means of field identification (Crickmay, 1952; John Reed, personal communication).

In addition to various schists, minor occurrences of bluish marble, amphibolite, hornblende gneiss, granite and augen gneiss are present within the Brevard belt.

The Brevard appears to be a zone of retrogressive metamorphism along which faulting has taken place periodically. Cataclastic effects are particularly evident in thin section, although the magnitude and direction of faulting are unknown. Apophyses of the Brevard extend into the augen gneiss belt in much the same way as in Georgia. In the northern part of Oconee County a body of granitic rock correlated with the Whiteside Granite of North Carolina is present (grgn west of the Brevard belt) against the northwest side of the Brevard belt. The field trip route will extend through the Brevard belt into this granite. The rather abrupt change from the Brevard to this granite is considered suggestive of shearing (Cazeau, 1961).

Mica Gneiss

A belt of mica gneiss (mgn) and allied rocks makes up the westernmost part of Oconee County and corresponds with the Blue Ridge belt of King (1955). Unfortunately the itinerary will not include this heterogeneous zone.

Westminster Pluton

In the south-central part of Oconee County a large granitic body, termed the Westminster Pluton (grgn), disrupts the belted pattern formed by the zones of biotite gneiss and injection gneiss. This body apparently has intruded and replaced part of the country rock. The field trip route will skirt the northeastern side of the pluton on the return to Clemson via Seneca.

Beverly Granite Gneiss

The Beverly Granite Gneiss (bggn), probably equivalent to the Westminster Pluton, dominates the geology of the southeastern third of Pickens County. The gneiss is generally light gray with a medium to coarse equigranular texture. A very coarse foliation is usually evident. The chief minerals are microcline, quartz, and plagioclase. Principal varietal minerals are hornblende and biotite with epidote and muscovite in minor amounts. A Sunday morning option is a trip to the Beverly quarry (Campbell Limestone Company), which is the source of most of the crushed stone in this area. Long linear bodies of biotite gneiss (including hornblende gneiss and mica schist) occur as pendants or in-folds in this mass.

GEOLOGIC HISTORY

The history of the region is complex. In broad outline we can visualize the rocks as having been formed originally as a thick series of sedimentary rocks which were later downwarped. More than one episode of regional metamorphism transformed the rocks into metasediments with accompanying mobilization and injection. Metamorphism and replacement apparently occurred during and after the emplacement of the Westminster Pluton. King (1955) and others attributed an Early Paleozoic age to these rocks, and this has been supported by lead-alpha ages of zircons (Overstreet, et al, 1961).

Continuous erosion, perhaps since the end of the Paleozoic, has taken place, so that the rocks now exposed at the surface represent the deeper portions of the original metamorphic complex.

There is little doubt that regional metamorphism, folding, faulting, intrusion, and replacement occurred concurrently much of the time. Events cannot be categorized into a discrete chronology.

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ROAD LOG

Mileage	Distance	Explanation
0.0	-	Clemson House. Form line heading west on Clemson House drive in front of the hotel.
0.1	0.1	Bear right at traffic light onto College Ave. (S.C. 133)
0.9	0.8	Traffic light. Junction S.C. 133 and U.S. 123. Continue on S.C. 133 under Southern Railway underpass.
2.1	1.2	Note thin-bedded metasediments in cut. Hornblende gneiss and biotite gneiss are cut and injected by felsic material.
2.6	0.5	Turn to left on unnumbered blacktop road, immediately after crossing Twelve Mile Creek.
2.7	0.1	STOP 1. This cut illustrates the general nature of the exposures in this section of the Piedmont — highly weathered, saprolitic, to moderately fresh rock.

Mileage	Distance	Explanation
		Lithologies exposed here are common for this area and show a distinctly layered habit which becomes more prominent on weathering. Hornblende gneiss predominates. It is cut by small veins and dikes and felsic injections parallel with the foliation, which gives the normally mafic hornblende gneiss a granitized appearance. Regionally atypical, this cut is within a northwest-trending structure which shows highly contorted foliation, drag (?) folds, and minor recumbent folding. Foliation here approximates N. 20°W. with predominant NE dip.
2.95	0.15	Felsic biotite gneiss.
4.0	1.05	Right turn on unnumbered black top road.
4.4	0.4	Intersection; turn left on S.C. 133.
6.2	1.8	SLOW DOWN - Note mica schist lithology in road cut opposite "Field Rock" house. Between here and Stop 2 there is a conspicuous absence of outcrops. This seems most typical of the schist zone.
9.6	3.4	STOP 2. Schist outcrops are scarce along this route but this one serves as a fair representation of them. At this point, we have reached the sillimanite facies of the mica schist zone. The schist here is a garnetiferous sillimanite-mica schist. King (1955) reports that Overstreet regards the sillimanite-garnet zone of the Inner Piedmont belt to be the climax of regional metamorphism in the crystalline Appalachians. (Note Six Mile Mountain in the distance.)
10.2	0.6	Center of the town of Six Mile, S. C.
10.6	0.4	Bear left at the fork; leave S.C. 133 on County Road 45.
11.5	0.9	Note the 2 ft. bed of quartzite overlying schist in the road cut on the right.
12.8	1.3	Junction; turn left on S.C. 183.
14.0	1.2	Turn right on County Road 157 to Nimmons Bridge.

Mileage	Distance	Explanation
16.7	2.7	STOP 3. Large area of rock exposed in Mile Creek downstream from the bridge. Light and dark banded and contorted felsic hornblende gneiss. General foliation is N. 10°W., 21° NE. A quartz-feldspar pegmatite, slightly weathered in relief, may be seen to strike approximately N. 85°W. and dip nearly vertically. Three joint sets are prominent: (a) N. 45°E. 77° NW (b) N. 45°W. vertical (c) N-S "healed" joint This appears to be a small area of locally mobilized rock, where the common hornblende gneiss (mafic) has been highly feldspathized. Incomplete reaction and mobility are believed represented in the migmatite zones composed of hornblende gneiss and highly felsic rock which enclose this mass.
18.0	1.3	SLOW DOWN - Note weathered migmatite in road cut.
18.8	0.8	At this point we are essentially through the injection-migmatized border zone and into the injection biotite gneiss.
20.4	1.6	Turn to left on County Road 32. (At Farm house with Gulf gasoline pump at the garage.)
21.2	0.8	Stop sign; bear left and continue.
22.0	0.8	Sharp curve to the right with abrupt change from felsic biotite gneiss into mafic hornblende gneiss. At the bottom of the steep grade, note change in soil color from reds to light tan or yellow. This reflects the composition of the granite gneiss parent. We pass through this quickly and back into the hornblende gneiss.
23.5	1.5	BUMP at this bridge is bad. Proceed slowly.
23.7	0.2	Felsic pegmatite conspicuously cuts highly fractured hornblende schists. Both are highly weathered, the schist showing a slabby, wood-like appearance.
24.1	0.4	Contact zone; hornblende gneiss and granite gneiss.

Mileage	Distance	Explanation
24.2	0.1	TURN right on County Road 32 toward Pickens, S.C. Going up the grade, note prominent outcrops on left side of the road. The speroidal type weathering differs remarkably from the slabby nature of the meta-sedimentary sequence.
25.7	1.5	STOP 4. Junction of County Roads 74 and 32. Two-mica granite gneiss, medium gray, equigranular, fine-medium grained with definite foliation. Biotite normally exceeds muscovite. The K-spar is microcline. Foliation is emphasized on weathered surfaces. Quartz often is rod-shaped in the plane of foliation. At this locality foliation is about N. 30°E. 40°SE. A prominent joint set is N. 70°W. and vertical. This unit is very similar to a fine grained phase of the augen gneiss.
26.6	0.9	Contact; granite gneiss and hornblende schist.
26.9	0.3	STOP 5. Contact; hornblende gneiss-augen gneiss. This is one of the most clearly exposed contacts in the county, and the persistence of the line denoting it on the map is probably the most accurate because of the distinctive composition and textural variation of the contiguous rocks. Note the polka-dot weathering character of the biotite augen gneiss. Typically the augen are microcline. The hornblende schist is folded rather tightly and overturned southward. These rocks conform to the regional setting in that they strike northeastward and dip southeastward. The augen gneiss is the thickest unit exposed in Pickens County. We will remain in it to the lunch stop at Camp Jocassee.
27.9	1.0	Junction, S.C. 11 and County Road 74. Bear left.
31.3	3.4	Leave S.C. 11, continue straight ahead on County Road 199.
31.5	0.2	LUNCH STOP - CAMP JOCASSEE This camp is situated about on the boundary of the Piedmont and Blue Ridge physiographic provinces. The elevation of the camp grounds is about 800'. The peak of Doublespring Mountain, immediately to the northwest, ascends to about 2,100' elevation. Musterground Mountain, one mile north of Doublespring Mountain, culminates at about 2,300'. To the southwest is McKinneys Mountain at about 2,000'.

Mileage	Distance	Explanation
		This girls' summer camp on the flood plain of the Whitewater River is owned by Mrs. Morris Brown of Walhalla, S. C. Drainage of the water lines to prevent damage to the system during the winter months prevents the normal operation of the toilet facilities at this time.
31.7	0.2	Return to S. C. 11. Turn right to Salem. Route 11 between Camp Jocassee and Salem traverses the augen gneiss belt along strike. Most of the road cuts exhibit buff-colored, indurated fine grained augen gneiss. This gneiss is granitoid in appearance, but displays fine textural banding due to the alternation in grain size of quartz and feldspar. Note general dip of foliation to the southeast.
39.0	7.3	Salem, S. C. Turn right (North) on County Road 171.
40.4	1.4	SLOW DOWN - Exposure on right, north of Salem. "Brevard Schist" present here exhibits "fish scale" character upon weathering. We are still outside of the Brevard belt proper; this exposure is part of a small apophysis. Between this point and the Brevard belt, note the alternation from "Brevard Schist" to augen gneiss and back into "Brevard Schist."
41.5	1.1	STOP 6. "Brevard Schist" - amphibolite. Toward the top of the hill the "Brevard Schist" is exposed, displaying the typical "fish-scale" appearance in weathering. Prominent outcrop of limy amphibolite is exposed on either side of the road. Note the intricate flowage of thin bands of calcite in the dark amphibolite. This area is part of a major apophysis four to five miles in length which parallels the Brevard belt proper. These units strike N. 12°E. and dip southeast between 20° and 30°. The rocks here resemble the "Poor Mountain" sequence west of Walhalla.
44.1	2.6	STOP 7. Prominent exposure of "Brevard Schist" within Brevard belt, again showing the scaly character. The rocks here strike N. 55°E. and dip 30° to 35° SE. (Use loop pull-off, routes 57 and 171.)
		STOP 7a. (optional). Whiteside Granite. Note rapid change in passing from the Brevard belt into the granite. What we consider here to be Whiteside Granite does not represent typical Whiteside as found in North Carolina.

Mileage	Distance	Explanation
		The rocks here appear to be more closely allied to the augen gneiss southeast of the Brevard belt. Note the more gentle dip of the foliation as compared with the "Brevard Schist."
52.4	8.3	STOP 8 - Whitewater Falls. Pause to appreciate the scenery. Whitewater Falls was a major stopover for Indian hunting parties before the coming of the white man's civilization.
74.7	22.3	Return through Salem to S.C. 11. Continue on S.C. 11 to County Road 40.
76.3	1.6	STOP 9. Junction of County Roads 40 and 16. Injected hornblende gneiss. The hornblende gneiss here has been extensively replaced by granite but still retains the general texture and gneiss character of unaltered hornblende gneiss.
84.3	8.0	Junction: County Road 16 and U.S. 76-123. Turn left (east) on U.S. 76-123.
87.0	2.7	STOP 10. Biotite gneiss. On dual highway between Seneca and Clemson just before Hunnicutt's Trailer Court. The biotite gneiss displays a distinct gneissic banding, is well indurated, and is injected in places. Thin bands of garnets are often found in the biotite gneiss.
91.9	4.9	CLEMSON HOUSE.
		End of Saturday trip.

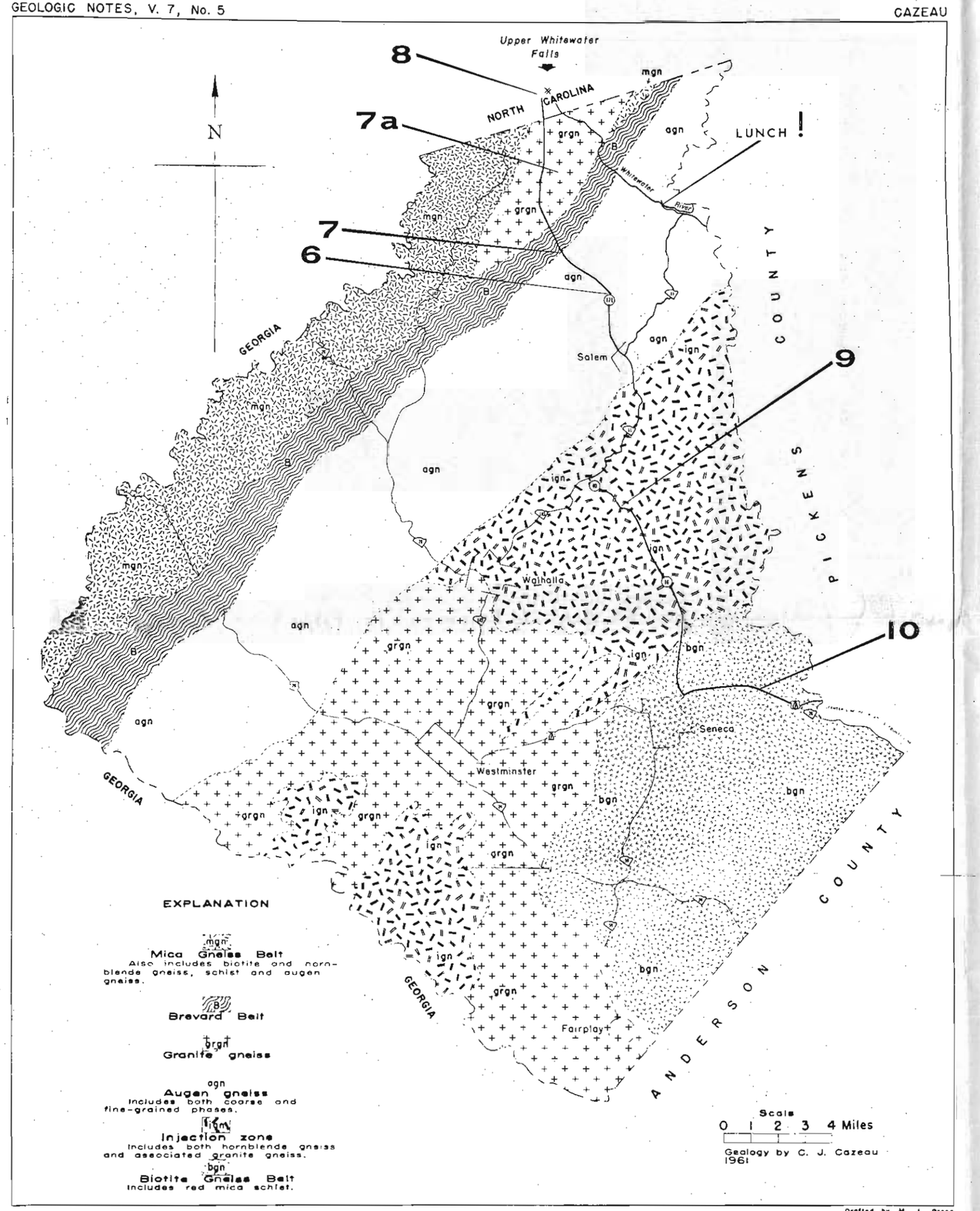

Fig. 2. Generalized geologic map of Oconee County, South Carolina.

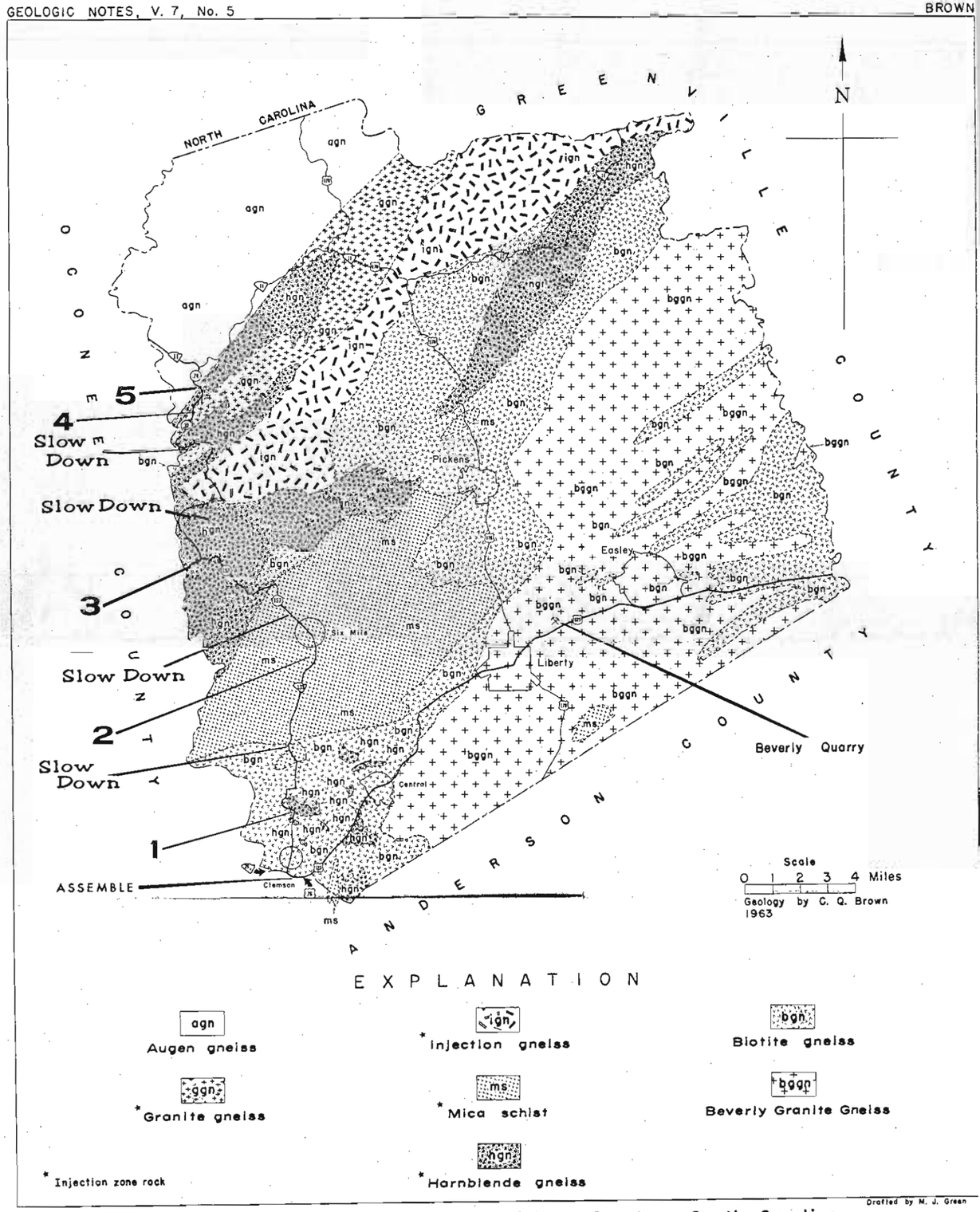

Fig. 1. Generalized geologic map of Pickens County, South Carolina.