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GEOLOGY OF THE SOUTHERN BLUE RIDGE BELT

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ABSTRACT. Recent geologic mapping in the southern Blue Ridge belt, particularly in Georgia, clarifies the stratigraphy of Precambrian units, emphasizes the extensiveness of Precambrian metavolcanics, strongly supports the equivalence of Weisner-Shady and Murphy Marble belt rocks, supports the non-existence of the Cartersville Fault within the Cartersville District, casts doubt on the existence of the fault southwest of Cartersville, and reveals field relationships that are inconsistent with prevailing views of the Brevard Zone.

The Sandy Springs sequence, which crosses the Brevard Zone between Atlanta and the Georgia-Alabama line, is overthrust westward onto the Wedowee Formation and the Ashland Group, along the Chattahoochee Fault. The relative age of the sequence is uncertain, though its downward transition to metavolcanics suggests the possibility of its overlying the Ashland Group.

The Wedowee Formation underlies the Ashland Group. In the upper part of the Ashland Group are extensive metavolcanics, notably metabasalts. Some metabasalts are amygdaloidal; rarely do they show pillow structure. Associated gneisses have relict porphyritic textures. The upper Ashland Group correlates with the Ashe Formation of probable upper Precambrian age.

The synclinal Murphy Marble sequence, with the Great Smoky Group on each limb, extends from Murphy, N.C., southward through Tate, Ga., and closes out in Bartow County, where it merges with the Shady Dolomite and associated lower Cambrian sediments.

Major displacement in the Cartersville District is not along the Cartersville Fault but along the Allatoona Fault, east of the Weisner-Shady to Murphy Marble sequence transition. Southwest of Cartersville, the contact between truncated Cambro-Ordovician rocks and the Talladega Group might be an angular unconformity rather than a major fault.

The youngest stratigraphic unit is the Talladega Group, post-Early Ordovician to Devonian in age.

The Brevard Zone does not coincide everywhere with a single rock sequence. From Graphite, N.C., to Suwanee, Ga., it coincides with the Chauga River Formation, a thin carbonate member which extends with few breaks for a strike distance of 233 km. Southwest from Suwanee in Middle Georgia the Brevard Zone as generally projected is along the Sandy Springs sequence but at a small angle to it. In Douglas-Carrol-Heard Counties, Ga., the distinctive quartzites of the Sandy Springs sequence cut obliquely across the narrow zone of autoclasis which is generally regarded as the Brevard Zone, without apparent offset.

INTRODUCTION

For the last 50 years geologists have agreed, generally, on several aspects of the southern Blue Ridge belt: (1) that the Talladega Slate is the youngest of the belt's metasedimentary rocks, (2) that Weisner and Chilhowee rocks are similar and Cambrian in age, (3) that the Murphy Marble probably is equivalent to the Shady Dolomite, (4) that the Great Smoky Group is Precambrian, (5) that the Brevard Zone between Brevard, N.C., and Suwanee, Ga., is a distinct metasedimentary sequence, and (6) that the Blue Ridge belt has been affected by two or more periods of regional metamorphism.

Less accord has prevailed for other major features. The Murphy Marble belt, for example, was interpreted initially as a complex syncline (Keith, 1907b). Later it was interpreted as an anticline (Jonas, 1932, p. 240), a fenster (Stose and Stose, 1944, p. 377), and a homocline (Van Horn, 1948, p. 18-20). The synclinal interpretation, however, has recurred (Stose and Stose, 1949, p. 286-291; Furcron, 1953, p. 36; Hurst, 1955, p. 72; Fairley, 1965, p. 49) and now may be regarded as well established.

The Cartersville Fault has been recognized as a major thrust fault by many geologists (Hayes, 1901; Butts and Gildersleeve, 1948; Webb, 1958; Smith, ms; Salisbury, 1961; Hurst and Schlee, 1962), but there are still claims that the fault does not exist in the Cartersville District (Kesler, 1950; Kesler and Kesler, 1971).

The Brevard Zone, like the Murphy Marble belt, was interpreted first as a syncline (Keith, 1905, 1907a). It has been reinterpreted as a thrust fault (Jonas, 1932), a dejective zone (King, 1955); more recently, as a major strike-slip fault with right lateral displacement of at least 217 km (Reed and Bryant, 1964), a strike-slip fault with left lateral displacement (Reed, Bryant, and Meyers, 1970), and a root zone (Burchfiel and Livingston, 1967). Geologists working along the Brevard Zone in North Carolina have reported that "most rocks in the Zone are intensely sheared". Others working in Georgia have found no more evidence of shear in Brevard rocks than in associated rocks and have, in fact, traced lithologic units across the zone, without apparent displacement (Crawford and Medlin, ms).

The major interpretational differences that exist seem to arise less from contradictory observations than from differences in emphasis. For example, one group of geologists concerns itself mainly with deciphering a clear-cut stratigraphy in Piedmont rocks and gives little emphasis to faulting or "shearing", while another group describes the same rocks in terms of phyllonites, blastomylonites, nappes, and thrusts. Regional variability clearly influences the interpretational differences, along with the professional predilections of the observers.

The purpose of this paper is to present, in outline, new field data not previously utilized in a regional synthesis. Most of it pertains to the Blue Ridge belt in Georgia. Though the Blue Ridge in Alabama is being intensively studied, few of the new data for that area are available.

The new data bear importantly on (1) the stratigraphy of the Precambrian rocks, (2) the recognition of extensive metavolcanic rocks, (3) the equivalence of Weisner-Shady and Murphy Marble belt rocks, (4) the resolution of interpretational differences along the Cartersville Fault, and (5) a new look at the Brevard Zone problem.

THE SOUTHERN BLUE RIDGE BELT

The southern Blue Ridge belt (fig. 1) is 40 to 120 km wide, bounded on the west by the Great Smoky-Cartersville Fault and on the east by the Brevard Zone (King, 1955, p. 357).

When geological investigation of the region began, the subdivision of the metamorphic-igneous rocks into belts, as the Blue Ridge belt, was useful. It provided a frame of reference, focused attention first on large-scale relationships, and facilitated orderly description. Now that study of the region has progressed beyond the reconnaissance stage, however, these subdivisions are becoming less meaningful, the boundaries more arbitrary.

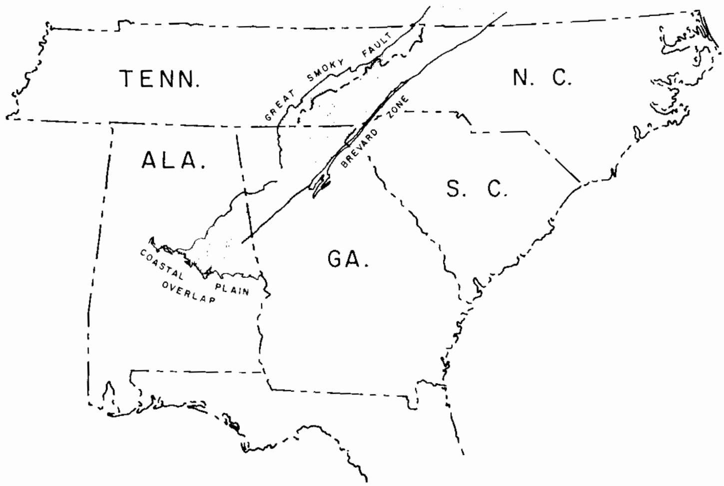

Fig. 1. Location of the Southern Blue Ridge belt.

Originally, the western boundary of the Blue Ridge belt was seen as a demarcation between sedimentary and metamorphic rocks. Though the change from one kind of rock to the other was not everywhere easy to place, it was locally distinct, and several major faults were apparent near and roughly parallel to the general trend of the change. It was natural that a first boundary would be chosen along a favorably positioned fault so as to separate Paleozoic sedimentary rocks, in which stratigraphic subdivisions already were recognized, from metamorphic and igneous rocks grouped together as a belt.

While this boundary is a good approximation on a regional scale, present knowledge shows that it can be quite arbitrary, even meaningless, within a local area. For one thing, it does not separate everywhere sedimentary from metamorphic rocks. Though metamorphic grade generally is low along the west side of the Blue Ridge belt and decreases westward, it does not end abruptly against a fault. Rather, metamorphism overlaps the Paleozoic-Precambrian contact. In Gordon County, Ga., the overlap is several kilometers, as shown by chlorite porphyroblasts, spotting, and recrystallization of micas in Cambrian shales west of the Cartersville Fault.

The boundary also fails to separate rocks of different age and lithology: Cambrian rocks occur on both sides of the boundary, in Alabama, Georgia, and Tennessee.

The eastern boundary of the Blue Ridge belt likewise fails to separate rocks on the basis of age, lithology, or structure. Relative age has not yet been established for the rocks bounding the Brevard Zone. In fact, the recent geologic mapping of Crawford and Medlin (ms) shows continuous lithologic units and fold structures crossing the Brevard zone without displacement (fig. 7).

The presently drawn boundaries of the Blue Ridge belt do not group rocks lithologically, structurally, or by age, except perhaps in a crude manner. The same can be said of other so-called "lithologic belts" of the southern Appalachians. The past practice of reasoning in terms of large ill-defined "belts" logically should diminish. The substitution of formational subdivisions and objective structural features for the early "belts" will allow sharper resolution of geological detail and a clearer understanding of the geologic history of the southern Appalachians.

GENERAL GEOLOGY

The dominant rocks, by far, are metasediments: metagraywacke, various schists, metaconglomerate, quartzite, and quartzofeldspathic gneisses. Metamorphosed carbonates are restricted in occurrence.

A few large igneous masses are exposed, as the Pinckneyville Granite in Alabama, the Corbin Granite in Georgia, the Whiteside Granite and parts of the Cranberry Gneiss in North Carolina and Tennessee.

Small ultrabasic intrusions are widely scattered. A notable concentration of them is in northeast Georgia, in Lumpkin, White, Habersham and Rabun Counties, and across western North Carolina, in Madison, Buncombe, Yancey, Mitchell, and Ashe Counties (Larrabee, 1966).

A thick sequence of metavolcanic rocks extends from central Alabama northeastward across Georgia and western North Carolina into Virginia.

The youngest stratigraphic unit is the Talladega group, post-Early Ordovician to Devonian in age (Rodgers and Shaw, 1962; Shaw, 1970). Older units are the lower Cambrian Murphy sequence, the lower Cambrian Weisner Quartzite and Chilhowee Group, the Precambrian Great Smoky Group, and the Precambrian Ashland Group. Underlying the Ashland Group is the Wedowee Formation. The Sandy Springs sequence (Higgins, 1966) is in fault contact with the Wedowee Formation and Ashland Group, and its age is unknown. The Chauga River Formation (Hatcher, 1969) extends along the Brevard Zone from Suwanee, Ga., northeastward across South Carolina at least as far as Graphite, N.C., and possibly beyond in the James River syncline.

Within the southern Blue Ridge belt more detailed lithologic mapping has been done in Georgia than in any other state. Current knowledge for Georgia is summarized in figure 2. This synthesis is based partly on Geoffrey Crickmay's summary, as published on the Geologic Map of Georgia, 1939, but mainly on the more recent work referenced by figure 3.

The general geology of the Blue Ridge belt in Alabama (fig. 5) is mainly from the Geologic Map of Alabama (Adams, Stephenson, and Cooke, 1926). On the eastern side of the State, the formational boundaries have been modified to make them compatible with the recent mapping in western Georgia. The western boundary of the Talladega group has been modified after Shaw (1970).

Talladega Group.—The type locality is Talladega Creek in Talladega County, Ala., where a thick section of phyllite and arkosic sandstone is exposed. Smith (1888) applied the name "Talladega Group" to these

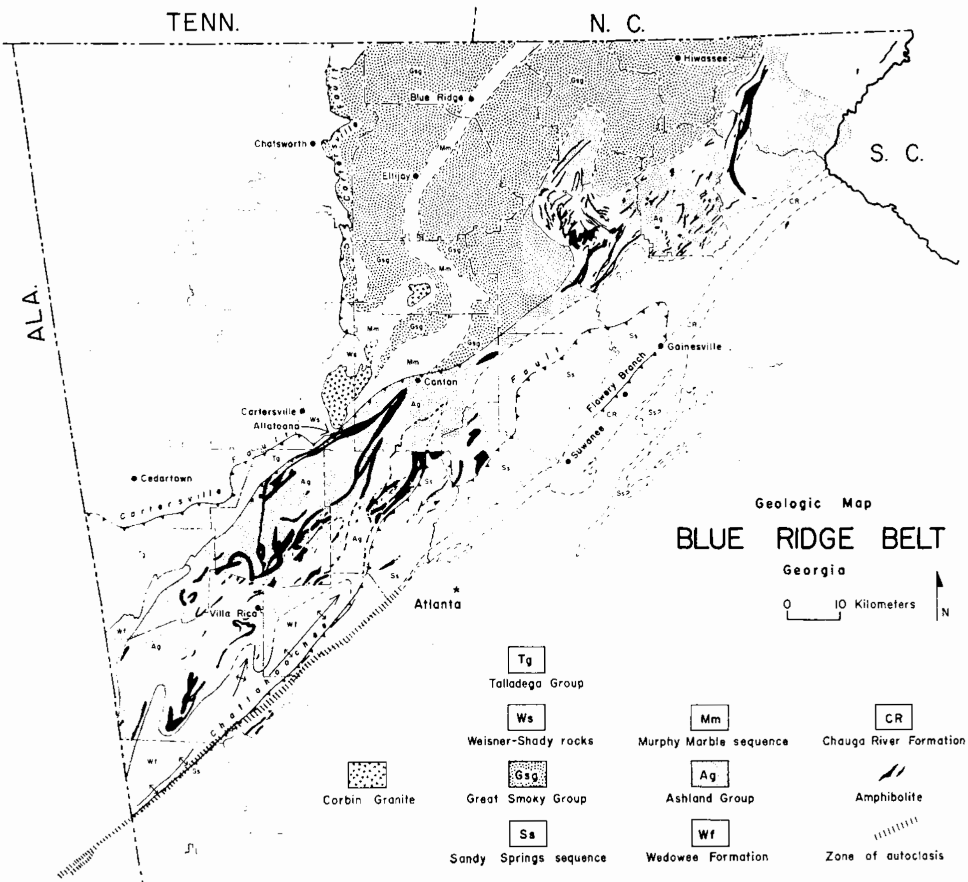

Fig. 2. Geologic map of the Blue Ridge belt in Georgia.

rocks. Prouty (1923, p. 33) referred to the same rocks as the "Talladega Phyllite or Slate". Butts (1926, p. 49) used the term "Talladega Slate" but extended it to include strata below the type Talladega in Chilton and Shelby Counties. In 1970, Shaw restricted the term essentially to the earlier usage of Smith and Prouty.

The earlier term "Talladega Group" takes precedence over "Talladega Slate" and descriptively is more appropriate.

The Talladega Group in Chilton and Shelby Counties, Ala., was deposited on an erosional surface cut into folded Cambrian and Lower Ordovician rocks (Shaw, 1970, p. 261). The Jemison Chert in the upper part of the Talladega Group in Chilton County contains Devonian fossils (Smith, 1903, p. 244-46; Butts, 1926, p. 145, 219). The Talladega Group is therefore post-Early Ordovician to Devonian in age (Rodgers and Shaw, 1962).

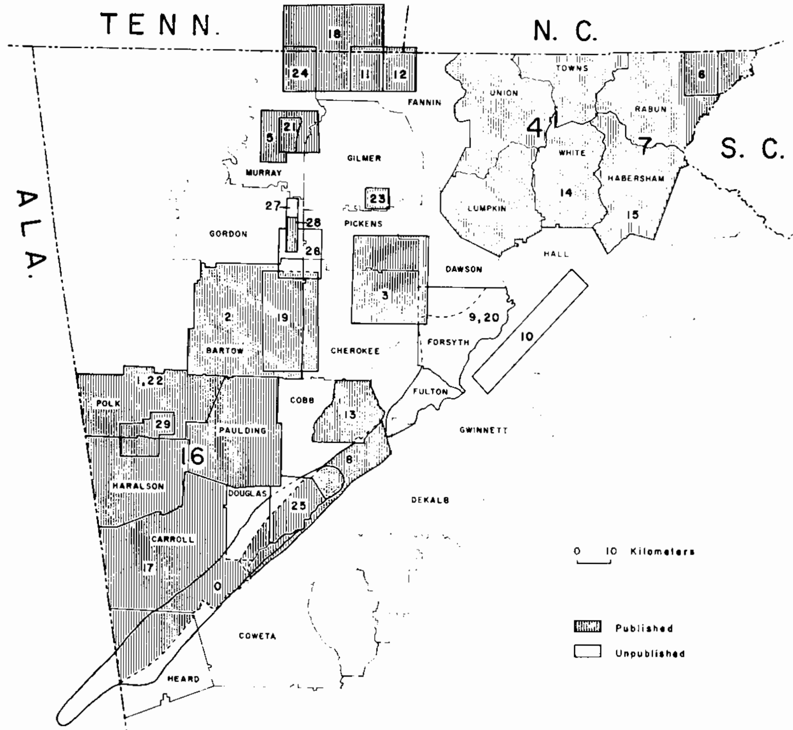

Fig. 3. Geologic references, since 1939, used in the compilation of figure 2.

West of the Talladega Group are sedimentary formations ranging from lower Cambrian to Mississippian age. The boundary between these rocks and the Talladega generally has been interpreted as a thrust fault. The southwestern portion of the boundary, possibly even most of it, might be an angular unconformity.

The faults in figure 5 are taken from the Geologic Map of Alabama (1926) which reflects the stratigraphic and structural interpretations of Butts. The revisions of Shaw (1970, p. 258-61) favor deletion of a few of the faults. Detailed study of the Talladega Group and particularly the tracing of its facies changes remains to be done and could further modify the geologic map. The large number of faults related to folding known in the Paleozoic rocks west of the Talladega belt suggest that many faults might be found in the folded Talladega rocks. Although the pre-Talladega rocks were folded prior to deposition of Talladega strata, the dominant Appalachian structures were developed later, because they involve post-Devonian strata. The recognition of so few faults might be due to the small amount of detailed mapping within the belt and to the hindrance of great thicknesses of lithologically similar rocks.

The Talladega Group consists mainly of thick phyllite and phyllite interbedded with arkosic sandstone or metagraywacke. Detailed descriptions have been published by Butts (1940), Webb (1958, p. 19-22), and Carrington (1964).

Recent work indicates that unconformities might be more important than faults in deciphering the complex stratigraphy of the Talladega belt. The Talladega Group was deposited on an erosional surface cut in folded Lower Ordovician rocks or younger rocks in Alabama. The Rockmart Slate of Middle Ordovician age, much of which is lithologically similar to the Talladega rocks, was deposited unconformably on Lower Ordovician rocks in Polk County, Ga. Above the Rockmart Slate is another unconformity.

The equivalence of the Talladega rocks as mapped in Georgia to the type Talladega in Alabama has been established by tracing units along strike (Cressler, 1970, p. 51). Stratigraphic relations within the Talladega belt, as now mapped, have not been worked out for most of the belt, nor have the less metamorphosed but lithologically similar rocks west of the Cartersville Fault(?) been studied in sufficient detail to insure that sound stratigraphic distinctions are being made. If Butt's belief (1926, p. 61) that the Talladega Group encompasses shoreward clastic deposits that accumulated during a large part of the Paleozoic Era while offshore facies were being deposited to the west is correct, then some of the confusion in delineating and relating the Talladega and associated rocks is understandable.

Murphy Marble sequence and equivalent Paleozoic formations.—All the formations overlying the Great Smoky Group and cropping out within the Murphy Marble belt compose the Murphy Marble sequence: Nantahala Slate, Tusquitee Quartzite, Brasstown Formation, Murphy Marble, and younger formations as named by Keith (1904-1907b) and modified by Hurst (1955). Good descriptions have been published by Keith (1904, 1907b), La Forge and Phalen (1913), Bayley (1928), Van Horn (1948), Hurst (1955), and Fairley (1965).

Below the Murphy Marble, which typically is dolomitic and less than 60 m thick, are 450 to 925 m of thinly bedded slates or phyllites or mica schists, interbedded quartzites, and locally conglomerate. Overlying the marble is more than 300 m of rocks that are lithologically similar but more calcareous.

The early Cambrian Weisner Quartzite, which is stratigraphically equivalent to the lower part of the Murphy Marble sequence, was named from exposures on Weisner Mountain, Cherokee County, Ala. (Hayes, 1901). It is 450 to 925 m thick, composed of shale, phyllite, slate, or sericite schist, interbedded with quartzose sandstone or quartzite (depending upon metamorphic grade) and locally conglomerate. The Shady Dolomite, conformably overlying the Weisner and stratigraphically equivalent to the middle-upper part of the Murphy Marble sequence, varies in lithology and thickness. In the Cartersville District, Ga., it is a few hundred meters thick; the lower part is gray siliceous dolomite, the middle part is sandstone and shale or sericite schist, and the upper part is gray sandy dolomite or limestone (Croft, 1963, p. FF11). At other localities, the Shady is up to 300 m thick and essentially all carbonate. Overlying the Shady is the Rome Formation, which is thin-bedded sandstone and shale, with occasional thin layers of limestone.

The equivalence of the Murphy Marble and Shady Dolomite was proposed by Keith (1907b, p. 11) and has been tentatively accepted by most subsequent workers. The equivalence of the Weisner Quartzite and the Chilhowee Group also has been widely recognized (Butts and Gildersleeve 1948; King, 1949, 1952; Rodgers, 1956; Hurst and Schlee, 1962; King, 1964, 1970). The term Chilhowee Group is derived from the "Chilhowee Sandstone" of Safford (1856; 1869) but is more clearly defined than Safford's term. The base of the Group has been placed by the U.S. Geological Survey at the base of the Cochran Formation.

The equivalence of the Murphy Marble sequence and the Weisner-Chilhowee-Shady rocks, and perhaps part of the Rome Formation, has been generally accepted for a long time. This equivalence, however, has been clouded by uncertainty about the stratigraphic relations of the Walden Creek Group. King and others interpreted this group as stratigraphically beneath the Chilhowee Group, in the upper part of the Ocoee Series (King and others, 1958, p. 951; Neuman and Nelson, 1965, p. D-63-D67), but at most exposures, as noted by King (1970, p. 39), the contacts of the Snowbird, the Walden Creek, and the Great Smoky Groups have been interpreted as fault contacts, an interpretation rendering their mutual stratigraphic relations uncertain. Possibly the importance of some of the contact faults has been overestimated. At some places, at least, total displacement along them is small, and the regular stratigraphic succession is less disrupted than first supposed.

A detailed cross section along Ocoee Gorge in southeastern Tennessee by Hurst and Schlee (1962) shows that rocks east of Sylco Creek mapped as the Walden Creek group are equivalent to the rocks of the Murphy Marble sequence. Though this conclusion opposes that of Salisbury (1961, p. 40-41), it is based on a detailed section through the excellent exposures of Ocoee Gorge and on detailed geologic maps of the Epworth and Mineral Bluff quadrangles to the east. The conclusion is supported by the geologic mapping of Hernon (1964) in the Ducktown, Isabella, and Parsimmon Creek quadrangles in Tennessee and North Carolina.

As noted by Hadley (1970, p. 251), the rocks of the Walden Creek Group in southeastern Tennessee have not been mapped or studied in detail. Sufficient work has been done, however, there and in Georgia to establish the major stratigraphic and structural relations of figure 4. The synclinal Murphy Marble sequence, with the Great Smoky Group on each limb, extends southward through Tate, Ga., and closes out in eastern Bartow County, where the Murphy sequence merges with the Shady Dolomite and associated lower Cambrian sediments. Despite the best efforts of several geologists, no one has been able to trace the Cartersville Fault satisfactorily through the Cartersville District. Kesler has insisted

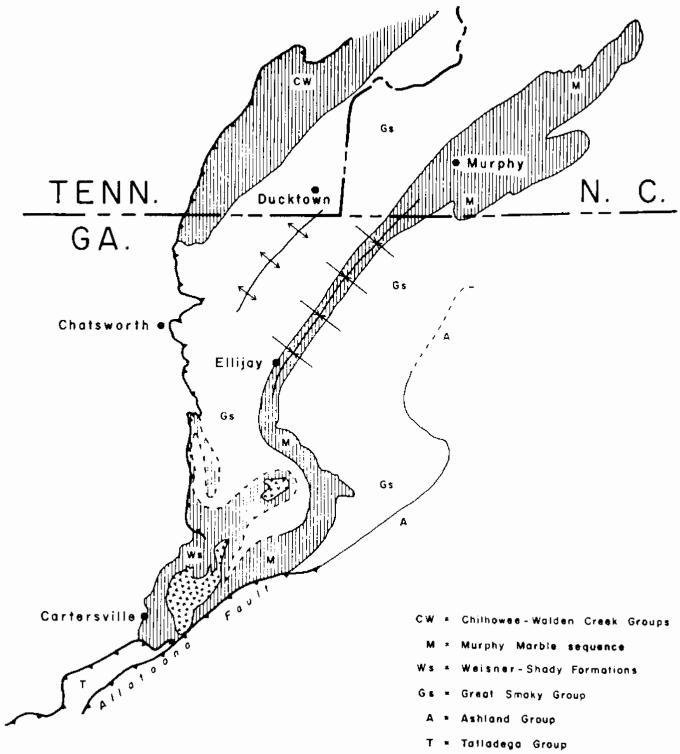

Fig. 4. Structural and stratigraphic relationships in north-central Georgia and southeast Tennessee.

that the fault does not exist (Kesler, 1950; Kesler and Kesler, 1971). A review of the work of Kesler in the Cartersville District, Smith in the Fairmount Area (ms), Croft in Bartow County (1963), Fairley in Cherokee County (1965), Hurst and Crawford in Paulding County (1969), and my own work on metamorphic isograds indicates that the eastern Bartow County Weisner-Shady rocks, which have been regionally metamorphosed, are equivalent to the Murphy sequence, as Keith long ago proposed and as subsequent workers generally have assented, and that the Cartersville Fault indeed may not exist in the Cartersville District. The equivalence of Weisner-Shady rocks and the Murphy sequence has been obscured by complex folding and faulting, a disrupted pattern of metamorphic isograds, and the Corbin Granite.

The Murphy sequence has been cut out by erosion over the anticlinorium whose axis is in the vicinity of Ducktown but reappears farther west where it has been mapped as the Walden Creek and Chilhowee Groups.

The most abundant rocks in the Weisner Quartzite, the Chilhowee Group, the Walden Creek Group, the Rome Formation, and large parts of the Talladega Group are interbedded shales and sandstones or their more metamorphosed equivalents. Similar rocks constitute a part of the Shady Dolomite. Carbonates are a part of the Rome Formation and the Walden Creek Group. As these units are presently mapped, lithologic variability within a unit may exceed the lithologic difference between two of them. In view of gross lithologic similarities, the lateral variability to be expected in any sandstone-shale-limestone sequence, the differences in metamorphic grade from one area to another, and limited detailed study, uncertainties and perhaps even errors in identifying and relating subunits of this sequence are expectable. The best clues to the main outline of the stratigraphy available at this time are the regional relationships in figure 4. These argue strongly for stratigraphic equivalence of the Weisner Quartzite, Chilhowee Group, Shady Dolomite, part of the Walden Creek Group, and the Murphy Marble sequence.

Great Smoky Group.—Stratigraphically beneath the Murphy Marble sequence, the lowermost unit of which is the Nantahala Slate, and in apparent conformity with it is the Ocoee Series which has been subdivided into the lower Snowbird Group and the upper Great Smoky Group (King and others, 1958, p. 955).

More than three-fourths of the outcrop area of the Ocoee Series, including all of the eastern, central, and southeastern parts are underlain by the Great Smoky Group (Hadley, 1970, p. 249). It is the dominant unit in the southern Blue Ridge belt.

Throughout its extent the Great Smoky Group is a remarkably homogeneous mass of coarse- to fine-grained, feldspathic metasandstone or metagraywacke, in graded beds, interbedded with dark slate or mica schist. Metavolcanic rocks are notably scarce if not absent in striking contrast with the other major stratigraphic unit of the Blue Ridge belt. The thickness of coarse-grained beds in the Great Smoky Group, the proportion of coarse-grained to fine-grained beds and overall average grain size decrease southwestward from the Great Smoky Mountains. The thickness of the group is at least 7620 m in the Great Smoky Mountains (King, 1964, p. 62) and more than 5030 m thick in Georgia (Hurst, 1955, p. 9). In the southeastern part of the Great Smoky Mountains the Great Smoky Group lies conformably on the Snowbird Group and, where that wedges out, unconformably on metamorphic and plutonic basement rocks (Hadley, 1970, p. 249).

In the Epworth and Mineral Bluff quadrangles, Georgia, a 5030-m section of the Great Smoky Group, the base of which is not exposed, has been described and subdivided into formations (Hurst, 1955).

Ashland Group.—The term Ashland Mica Schist probably originated with Henry McCalley, who studied the crystalline rocks of Alabama intermittently during 1901 to 1904, but the term was first published by Prouty (1923) from exposures near Ashland, Clay County, Ala. Adams and others (1926) continued the use of the term. On the Geologic Map of Alabama they show a band of Ashland Mica Schist extending from Elmore County through Tallapoosa and Randolph Counties to Heard County, Ga. From this point the Schist was traced northeast across Georgia to North Carolina by Crickmay (1952).

The Ashland Mica Schist and the Wedowee Formation were not clearly distinguished by Adams and others on the Geologic Map of Alabama nor by Crickmay on the Geologic Map of Georgia. Both maps are based mainly on reconnaissance work. Recent, more detailed mapping in western Georgia (Hurst and Crawford, 1969, pl. 1; Hurst and Long, 1971, pl. 1; Crawford and Medlin, ms) has clarified the stratigraphic relations of these units. What was mapped by Crickmay, Adams, and others, and earlier workers as the Ashland Mica Schist actually encompasses two distinctly different rock sequences which are better embraced by the term group rather than schist.

The upper sequence of the Ashland Group is characterized by metabasalt, metatuff, other metavolcanics, and associated metasediments, with an aggregate thickness of a few thousand meters. These constitute the only extensive metavolcanic rocks in the southern Blue Ridge belt. Some of the metabasalts are amygdaloidal; rarely they show pillow structure. Associated light-colored gneisses commonly have relict porphyritic textures which show that they are metavolcanic rocks (Hurst and Jones, 1973).

The lower part of the Ashland Group is a thick sequence of metasedimentary rocks. Garnetiferous biotite schist and siliceous, more or less graphitic muscovite schist predominate. Less abundant rock types are kyanite–quartz schist, sillimanite–quartz schist, and quartzite. Adams and others (1926) estimated the total thickness of the Ashland Group as 3048 m.

According to early interpretations the Ashland Group is older than the Wedowee Formation. More recent work indicates that the reverse relationship is correct. The detailed mapping of Crawford and Medlin in western Georgia (ms) shows the Ashland and Wedowee folded together, their contact conformable, and in each plunging fold the Ashland overlying the Wedowee (fig. 2).

What overlies the Ashland Group has not yet been established. In Alabama and western Georgia the northwest side of the Ashland-Wedowee outcrop belt is in fault contact with the Talladega Group, which is post-Early Ordovician to Devonian in age. Northeastward, in Cherokee County, Ga., the upper Ashland is in fault contact with the Murphy Marble belt and with the upper part of the Great Smoky Group. Northeast of Dawsonville, where the Ashland still bounds the Great Smoky Group, insufficient work has been done to establish the nature of the contact.

Figure 6 summarizes what is known about the distribution of the Ashland Group in the southern Blue Ridge. Its distribution is best known in Georgia, where most of the Ashland has been mapped in moderate detail. The amphibolites, mainly metabasalts, are shown in black. The bands typically are smaller where they are more accurately mapped: many of the larger masses were delineated by reconnaissance mapping and include other rock types.

The amphibolites in Alabama are copied from the 1926 Geologic Map of Alabama which shows only the Hillabee chlorite and a few of the larger amphibolite masses. Adams and others (1926) mentioned the common presence of amphibolites in other areas where they are not represented on the State map. Field reconnaissance shows that amphibolites are scattered through the Ashland outcrop belts in Alabama in much the same manner as they have been mapped in the Ashland Group in Georgia. None of the geologic mapping in progress by Thorton L. Neathery, John W. Reynolds, Denny N. Bearce, and others was available for the compilation of figure 5.

The amphibolites in North Carolina are copied from the 1958 Geologic Map of North Carolina. The outcrops appear more massive because they are generalized representations: other rock types are also within the areas shown as amphibolite. Many smaller amphibolites are not represented.

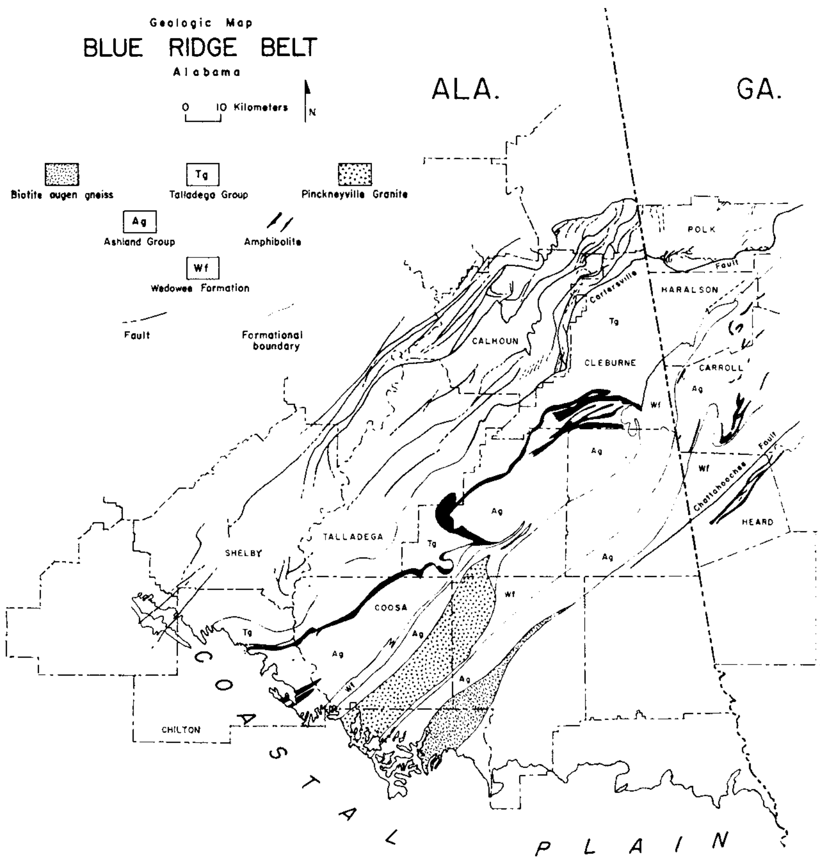

Fig. 5. Geologic map of the Blue Ridge belt in Alabama.

Despite the generalizations in figure 6, it does indicate the general distribution of amphibolites; they are rare in all the principal lithologic units except the Ashland Group and the unit described by Rankin (1970) as the Ashe Formation or the correlative Mount Rogers volcanics (Stose and Stose, 1944).

Amphibolites are common southeast of the Brevard Zone in North Carolina, South Carolina, Georgia, and Alabama. A few of these are shown in North Carolina. Others crop out extensively in the Newton-Statesville area, farther east. The amphibolites in northwestern South Carolina are from Hatcher and Griffin (1969) and Roper and Dunn (1970). The amphibolites southeast of and near the Brevard Zone in Georgia and Alabama have not been well mapped.

The lithologic distribution summarized in figure 6 strongly indicates that the Ashland Group in Alabama and Georgia is correlative with the Ashe Formation in North Carolina of probable late Precambrian age and

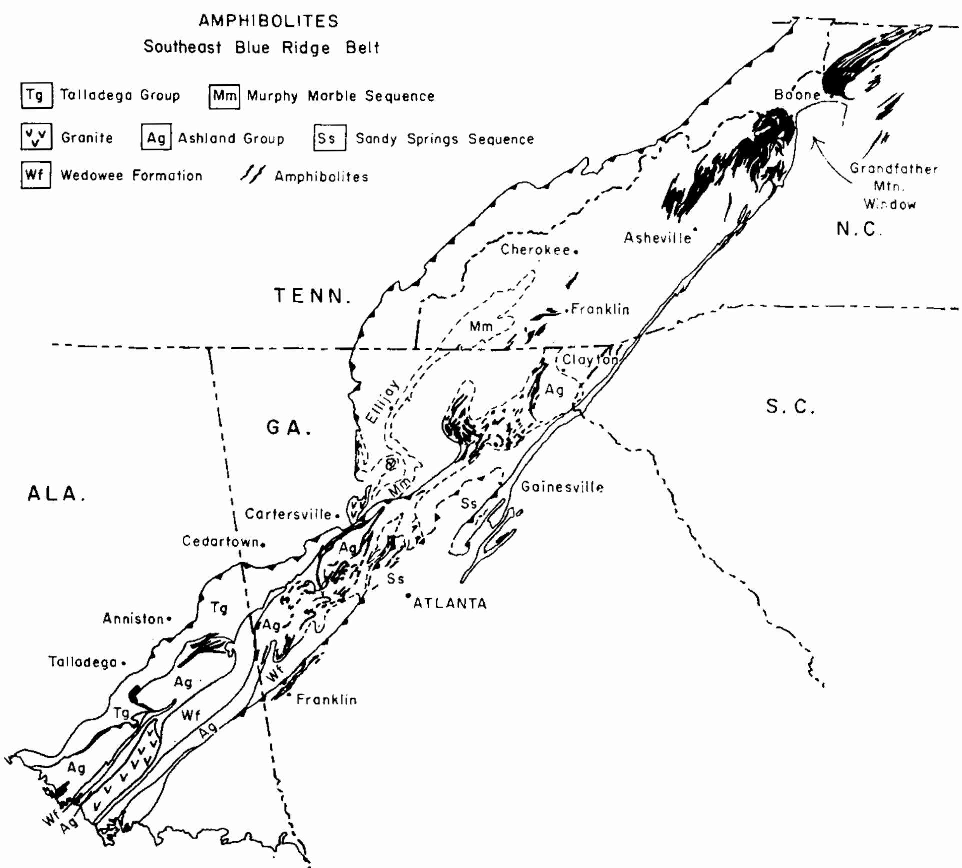

Fig. 6. Distribution of amphibolites in the Southern Blue Ridge belt.

with the Mount Rogers volcanics farther northeast. The Ashland-Ashe unit is, then, the only stratigraphic unit containing extensive metavolcanic rocks in the southern Blue Ridge belt.

One notable inference from figure 6 or figure 2 is that the Tallulah Falls metasediments belong to the lower part of the Ashland Group. The domal structure of the Tallulah Falls area is well established. A dome involving the Ashland Group would show metavolcanic rocks or associated igneous intrusives on the flanks of the dome and siliceous schists, kyanite schist, and quartzite in the central portion of the dome, as is observed in the Tallulah Falls area. Earlier attempts to correlate the Tallulah Falls quartzites with those in the Sandy Springs sequence have been unsatisfactory because (1) lithologically the two quartzite sequences are very different, and (2) one cannot be traced into the other.

Wedowee Formation.—No detailed description of the Wedowee Formation has been published. Adams and others (1926, p. 36-38) applied the term to a sequence of slate, phyllite, quartzite, and schist characterized at many places by "amorphous" graphite, as typically exposed at Wedowee, Randolph County, Ala. This outcrop belt was traced from Alabama into Georgia by Crickmay. He noted the probable existence of the southern Wedowee outcrop belt (Crickmay, 1952, p. 19), which recent mapping has delineated in Heard-Carroll-Douglas Counties, though he didn't separate it from the Ashland on the 1939 Geologic Map of Georgia.

The Wedowee Formation is characterized by graphitic phyllite or schist. Metagraywacke and micaceous quartzite are much more common than in the lower part of the Ashland Group, and garnetiferous schists generally scarce. Metavolcanic rocks, particularly amphibolite, are very scarce if not altogether absent.

The recent work in Georgia renders untenable the early views of Adams and others (1926) that the Wedowee Formation is younger than the Ashland Group and that the two units are equivalent to parts of the Talladega Group. The folds mapped by Crawford and Medlin (ms) repeatedly show the Ashland Group, which is probably late Precambrian in age, overlying the Wedowee Formation.

The gross lithologic similarity of the Wedowee Formation to the lower part of the Ashland Group and parts of the Talladega Group will hinder its delineation in the areas where it has not yet been accurately mapped. This difficulty may be magnified on the west side of the Blue Ridge belt, where metamorphic grade is low. Where garnet, staurolite, and kyanite have not formed, due to low metamorphic grade, most of the fine-grained metasediments are similar-appearing phyllites or schists whose compositional differences cannot be distinguished readily in the field.

The upper Ashland can be separated from the other units with relative ease, because it is the only stratigraphic unit containing abundant metabasalts (amphibolites) and other metavolcanic rocks. Some assistance in distinguishing the Wedowee Formation may be gained by mapping westward from eastern Alabama and western Georgia, where more than 5000 sq km of detailed mapping already has been completed.

Sandy Springs Sequence.—The Sandy Springs sequence was named by Higgins (1966) from exposures in the Sandy Springs area, Fulton County, Ga. It is the same sequence mapped earlier in Douglas County (Schepis, ms), Cobb County (Hurst, 1956b), and Forsyth County (Holland, ms).

The sequence is characterized by thinly bedded quartzites. Originally, most of them were fine- to medium-grained; some were coarse, rarely conglomeratic. Commonly they have been feldspathized and pegmatized; even where least altered they are generally micaceous. The thickness of the outcrop band varies, partly from original depositional differences but more importantly from deformation. Through faulting or shearing the quartzite band has been reduced at places to a thickness of only a few meters. At other places the thickness of the band has been increased through a succession of tight folds or imbricated fault blocks to 450 m or more. Good examples of structural thickening are Blackjack Mountain and Sweat Mountain in Cobb County. Generally the outcrop band of quartzites is 15 to 60 m thick.

In northern Cobb County, the top of the Sandy Springs sequence is paragneiss and lesser schist. Underlying the paragneiss is a quartzite zone, and beneath it is a thick sequence of schists characterized by abundant garnets (Hurst, 1970, p. 388). Below the garnetiferous mica schists is another mica schist unit up to 900 m thick in which garnets are notably less abundant and in which there are thin amphibolites. Metavolcanics increase downward.

Eastward and southeastward from central Cobb County there are two quartzite horizons. The second quartzite begins as a quartz-rich zone in the garnet–mica schists in central Cobb County and develops eastward into a continuous quartzite layer. Higgins (1968) mapped the two quartzite units, separated by aluminous schists, in southern Douglas and Cobb Counties. Holland (ms) and Murray (1972) mapped the two in Forsyth County, and Murray mapped them in north Fulton County.

Current knowledge of the areal distribution of the Sandy Springs sequence is shown in figure 7. The sequence lies south of the Brevard Zone in Heard County but crosses the Brevard Zone in Carroll and Douglas Counties (Crawford and Medlin, ms) at a low angle. It diverges from the zone northeastward in Cobb and Forsyth Counties, swings south in Hall County, and possibly recrosses the Brevard Zone between Suwanee and Gainesville.

From Heard County through Forsyth County the sequence is well mapped. The detailed maps of Crawford and Medlin (ms) in Heard and Carroll Counties show continuous quartzite bands closing around plunging folds and not offset along the zone of autoclasis, which has been called the Brevard Zone.

Most of Hall County is structurally complex. The only part of it that has been mapped is a narrow strip extending southwestward from Gainesville toward Suwanee, the portion wherein quartzites are delineated in figure 7 (ref. 10 of fig. 3). Reconnaissance north and northwest of Gainesville revealed highly deformed quartzite bands (not shown in fig. 7) which are the continuation of the quartzites in adjacent Forsyth County. The Sandy Springs sequence does not extend north or east of the Chattahoochee Fault.

South and southwest of Gainesville within the Brevard belt and east of the marble are conspicuous thinly bedded quartzites which are less deformed than those in the Sandy Springs sequence but are otherwise similar. The belts farther southeast marked Ss? contain quartzites in a metasedimentary sequence. They have been mapped in only one small area west of Talmo (Klett, ms). If these quartzites do not belong to the Sandy Springs sequence, they probably are correlative with those in the Poor Mountain sequence described by Hatcher (1969, p. 110-113) east of the Brevard Zone in northwestern South Carolina.

In Cobb County the Sandy Springs sequence is transitional downward to amphibolite and other metavolcanic rocks (Hurst, 1970, p. 388).

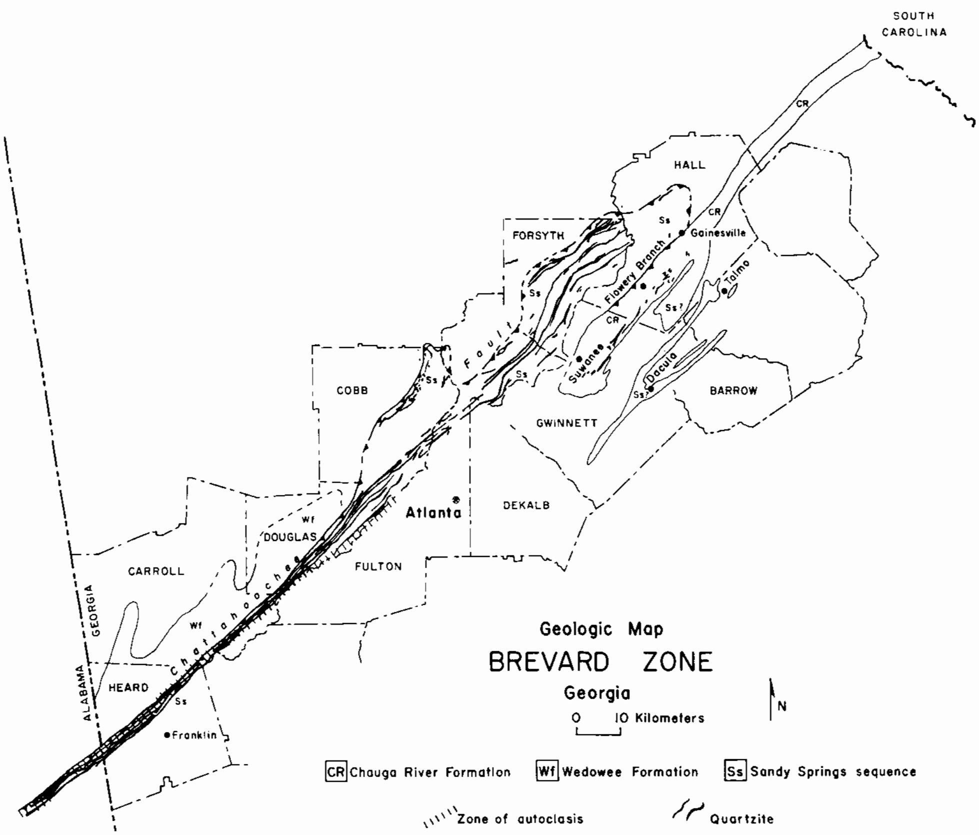

Fig. 7. Geologic map of the Brevard Zone in Georgia.

In Forsyth County the transition downward is to biotite–hornblende gneiss, quartz–mica schist, and garnetiferous amphibolite (Murray, 1972). The possibility that the lower part of the Sandy Springs sequence is equivalent to the upper part of the Ashland Group has been noted already (Hurst, 1970, p. 388-389).

Chauga River Formation.—The dolomitic marble in the Brevard Zone and the graphitic phyllites or mica schists and interbedded meta-arenites which are below and above it have been named the Chauga River Formation (Hatcher, 1969, p. 109-110) from exposures along the Chauga River, Oconee County, S.C. The thickness of the marble generally is 15 to 50 m. Hatcher estimates the thickness of the formation to be 457 to 610 m.

The Chauga River Formation extends from the vicinity of Suwanee, Gwinnett County, Ga., across South Carolina into North Carolina, a strike distance of more than 240 km. Detailed mapping has revealed that the marble occurs not in scattered small lenses within the formation, as early reports represented it, but in a remarkably continuous band, locally two bands (Holland and Hurst, ms; Hurst and Crawford, 1964; Hatcher, 1969). Along strike the marble ranges from a very siliceous dolomitic marble, even calcareous quartzite, to calcareous marble or calcareous amphibolite. Similar variations are found from bed to bed at a given locality.

The Chauga River Formation in South Carolina was correlated by Hatcher (1969) with the Poor Mountain sequence of Sloan (1907), a marble-calcareous quartzite-bearing unit east of the Brevard Zone. The quartzite-bearing units, which crop out in narrow belts in Georgia east of the Brevard Zone, in Hall, Gwinnett, and Barrow Counties, might be Chauga River-Poor Mountain equivalents or might be equivalent to the Sandy Springs sequence.

The termination of the Chauga River Formation in Gwinnett County, Ga., has not been mapped accurately. Possibly it is cut off by the southward extension of the Flowery Branch Fault (fig. 7). More likely, if the narrow bands east of the Brevard are stratigraphically equivalent to the Chauga River Formation, the termination is due to fold-closure.

Northeastward, the Chauga River Formation extends from Suwanee, Ga., in an unbroken narrow belt across South Carolina at least as far as Graphite, N.C., where it is within 20 km of Shady Dolomite exposed along the west edge of the Grandfather Mountain window, along the projected strike of the Brevard belt.

Brevard Zone.—Since Keith described the Brevard Zone in North Carolina in 1905 and interpreted it as a syncline, many others have re-examined it, extended it, reinterpreted it. Notable extremes have been achieved in both extention and reinterpretation. It has been projected southwestward to the Coastal Plain overlap in Alabama and northeastward almost to Maryland (Cloos, 1964, p. 815), a strike distance of more than 965 km. Commonly it is depicted as extending from the Coastal Plain of Alabama to the North Carolina-Virginia line, about 725 km.

The reinterpretations include a thrust fault (Jonas, 1932; King and others, 1944; Hatcher, 1971), a dejective zone (King, 1955), a strike-slip fault with right lateral displacement of at least 217 km (Reed and Bryant, 1964), a strike-slip fault with left lateral displacement (Reed, Bryant, and Meyers, 1970), and a root zone (Burchfiel and Livingston, 1967). None of the interpretations appear to be uniquely supported by the observations.

Most references stress faulting or shearing when describing the Brevard rocks. In common usage, "Brevard Zone" has come to be virtually synonymous with "Brevard Fault Zone". This is, perhaps, another example of overextension, because faulting is not everywhere more noticeable in the zone than in bounding rocks. Originally, the connotations of "Brevard rocks" or "Brevard Zone" were more stratigraphic than structural. Notably, common faulting along the zone would be compatible with any of the proposed interpretations, including Keith's original synclinal interpretation.

Characteristics that will eventually allow a unique interpretation of the Brevard Zone to be made are emerging. Recent work shows clearly that the Brevard Zone does not everywhere coincide with a single rock sequence, as some early investigators supposed. It does, however, coincide with the Chauga River Formation from Suwanee, Ga., to Graphite, N.C. In describing this narrow strip, words such as "pervasive shearing", "slicing", "phyllonite", and "blastomylonite" have been used commonly. Yet, along this narrow zone of supposed major faulting, recent work shows a carbonate layer less than 60 m thick extending with few breaks for 233 km —a characteristic easier to reconcile with folding than with faulting.

Southwest from Suwanee in middle Georgia, the Brevard Zone, as previously mapped, extends along the Sandy Springs sequence outcrop belt but at an angle to it, as might be expected of a fault zone. Yet, in Douglas-Carrol-Heard Counties the distinctive quartzites of the Sandy Springs sequence cut obliquely across the narrow zone of autoclasis, usually regarded as the Brevard Zone, without apparent offset.

In western Georgia and eastern Alabama a major fault does extend along this zone of autoclasis, separating the Wedowee Formation from the Sandy Springs sequence, for nearly 80 km. This fault, called the Chattahoochee Fault, diverges from the Brevard Zone northeastward. In Cobb County the Chattahoochee Fault separates the Ashland Group from the overthrust Sandy Springs sequence.

Figure 7 does not support the concept of a single continuous major fault along a narrow zone, as has been postulated for the Brevard Fault Zone. Also, the figure negates the possibility of a narrow lithologic zone crossing Georgia as it crosses South Carolina.

At the Georgia-South Carolina line, the Chauga River Formation is bounded on the west by the Ashland Group. In the Gainesville area it is bounded on the west by the Sandy Springs sequence. In western Hall County and northern Gwinnett County, gneisses of the metagraywacke type interbedded with schists are in fault contact with the Chauga River

Formation. These relationships do indicate major faulting along the west side of the Chauga River Formation. The Flowery Branch Fault has been mapped from the south side of Gainesville through Flowery Branch almost to Buford. Farther southwestward no mapping has been done. If a regional fault does exist along the Brevard Zone, then the Flowery Branch Fault is a part of it. Gwinnett County is a key area for detailed mapping to determine whether the Chauga River Formation terminates through folding or faulting and to delineate the southwestward course of the Flowery Branch Fault. Additional mapping in Hall County might disclose whether the Sandy Springs sequence is cut off by the Flowery Branch Fault or whether it cuts across the Brevard Zone, beneath the Chauga River Formation, and forms the narrow belts of quartzite-bearing metasediments in the Talmo-Dacula area.

Additional data are needed to establish the regional significance of faulting along the Brevard Zone. The stratigraphy characteristic of the zone in North Carolina and South Carolina appears to terminate at Suwanee, Ga.

MAJOR FAULTS

Great Smoky-Cartersville Fault.—The system of faults known as the Great Smoky-Cartersville Fault juxtaposes Cambro-Ordovician and early Cambrian rocks in Southeast Tennessee, Cambrian and Precambrian rocks in southern Murray County, Ga. It becomes ill-defined to nonexistent in eastern Bartow County, where the metamorphosed Murphy Marble sequence merges with metamorphosed lower Cambrian strata. In southern Bartow County and on to the west across Polk County, the contact between the Talladega Group and Cambro-Ordovician rocks is clearly evident, because it truncates several formations. In Alabama, likewise, the rocks in contact with the west side of the Talladega Group are highly folded and faulted Cambro-Ordovician rocks.

The usual representation of the Great Smoky-Cartersville Fault, modified in two areas, is shown in figure 6.

One modification is in the Cartersville District. There the Weisner-Shady rocks are highly deformed, as shown by the detailed map of Kesler (1950). While there are many faults, displacements along all of them must be minor, because the Weisner-Shady rocks merge eastward with equivalent rocks of the Murphy Marble sequence and are overlain westward by successively younger formations of the Paleozoic sequence. These relationships indicate that the Cartersville Fault does not extend through the Cartersville District. The major displacement is in eastern Bartow County, along the Allatoona Fault.

The other modification is in Alabama, from Talladega to the Coastal Plain overlap, where Shaw (1970) concluded that the Talladega Group overlies with angular unconformity the Cambro-Ordovician rocks west of it. If Shaw's conclusion is valid—the evidence he presents is convincing—then the basis for drawing a major fault between the two groups of rocks vanishes. Accordingly, the Cartersville Fault in figure 6 is not shown southwest of Talladega.

Shaw's conclusions that the Talladega Group is post-Early Ordovician to Devonian in age and that it was deposited on a mid-Ordovician erosional surface truncating folded and faulted Cambrian and early Ordovician strata casts some doubt on the existence of another segment of the Cartersville Fault, that between Talladega, Ala., and southern Bartow County, Ga. The principal criteria for drawing this segment of the fault have been the truncation of southerly structural trends in the lower Paleozoic formations where they are in contact with the Talladega Group and a change in metamorphic grade. However, the change in metamorphic grade is not abrupt. The Rockmart Slate, for example, north of the contact is as metamorphosed as much of the Talladega Group south of it. All the criteria so far offered as favoring the existence of this segment of the fault (for a summary, see Hurst, 1970, p. 391) lose their efficacy in the light of the following new information:

1. The post-Early Ordovician to Devonian age of the Talladega Group (Shaw, 1970) and the angular unconformity at the base of it.
2. The fact that great stratigraphic displacement in the Cartersville District is actually along the Allatoona Fault (see figs. 4 and 2).
3. The middle to upper Ordovician age of the Rockmart Slate (Cressler, 1970, p. 26-31).

Thus the rocks on both sides of the supposed Cartersville Fault west of Cartersville are not very different in age, and those south of it are younger than some of those north of it. The general geologic relations along the supposed fault as sketched by Hurst (1970, p. 391, fig. 4) are as easily explained by an angular unconformity as by a thrust fault.

Stratigraphic and structural relationships along the west side of the Blue Ridge belt appear now to be more complex than first supposed. A mid-Ordovician orogenic episode might have extensively deformed earlier rocks and might have been followed by the development of a widespread angular unconformity, on which rapidly varying clastic sediments were deposited. These characteristics plus generally poor outcrops make the interpretation of faults difficult. Certainly small- to moderate-size faults are common both within and west of the Blue Ridge belt, but the existence of a major thrust fault extending hundreds of kilometers along the west side of the belt, the Great Smoky-Cartersville Fault, is beginning to appear more like a major oversimplification. The recent work supports Kesler's claim that the Cartersville Fault does not exist in the Cartersville District and casts doubt on the existence of the Cartersville Fault west of Cartersville.

Allatoona Fault.—On the 1939 Geologic Map of Georgia, Crickmay drew a major fault between the Talladega Group and the Ashland-Wedowee rocks from the Alabama-Georgia line to central Cherokee County, Ga. From there he extended the fault northward along the east side of the Murphy Marble belt to connect with the Whitestone Fault, which La Forge and Phalen (1913) had drawn from Murphy, N. C., to Whitestone, Ga. Subsequent work has shown that the Whitestone Fault as visualized by La Forge and Phalen does not exist (Hurst, 1955; Fairley, 1965). A major fault is easy to trace in Bartow and Cherokee Counties along the west side of the Ashland Group, but instead of turning north along the Murphy Marble belt it continues northeastward toward Dawsonville.

This fault, appropriately called the Allatoona fault, has been traced from Paulding County to Dawson County (figs. 2 and 4). In Paulding County, it juxtaposes the Ashland Group of probable late Precambrian age and the Talladega Group of post-Early Ordovician age. In Bartow County it juxtaposes the Ashland Group and lower Cambrian sediments. In eastern Cherokee County it separates the Ashland Group and the Great Smoky Group. Total displacement therefore appears to decrease northeastward.

A similarly placed fault, separating the Talladega Group from the Ashland Group, has been recognized in Alabama (Bentley, 1964).

Chattatoochee Fault.—Crawford and Medlin (ms) traced a major fault from eastern Alabama along the north side of an autoclastic zone, which has been called the Brevard Zone, to Austell in Cobb County (fig. 7). From a short distance to the northeast, Hurst (1956b) traced a fault across Cobb County to Sweat Mountain, where it turns south in Fulton County. Murray (1972) deduced a fault along the north side of the Sandy Springs sequence in Forsyth County.

This fault is called the Chattahoochee Fault because it is associated with the Chattahoochee River over a large area. From Alabama to Gainesville, Ga., it is the western boundary of the Sandy Springs sequence.

Flowery Branch Fault.—From Gainesville, Ga., southeastward along the Chauga River Formation through Flowery Branch to Gwinnett County a fault has been mapped (Holland and Hurst, ms). If the postulated Brevard Fault exists, then the Flowery Branch Fault is a part of it.

METAMORPHISM

Hadley (1964) prepared histograms of nearly 300 K-Ar, Rb-Sr, and U-Pb age determinations in the Appalachian Blue Ridge and Piedmont Provinces. His histogram for the southern Appalachians shows thermal peaks at about 250 m.y., 340 to 360 m.y., 800 to 900 m.y., and scattered older ages up to 1250 m.y. More recent work indicates a cluster of ages at about 1150 m.y.

The oldest recognized period of metamorphism may be correlated with the older radiometric ages of about 1150 m.y., prior to deposition of the upper Precambrian Ocoee series (Bryant and Reed, 1970, p. 216). Most of the metamorphic features now observable correlate with a younger event that produced essentially classic Barrovian zones in the southern Blue Ridge, with the thermal gradient increasing northeasterly. A still younger metamorphism, correlating with the rocks that yield 250 m.y. ages, retrograded some older rocks in the Blue Ridge, while producing high-grade schists and migmatites in the Inner Piedmont. The most recent alteration of southern Piedmont rocks is widespread zeolitization.

Because radiometric ages are a measure of the time that has elapsed since the samples cooled sufficiently for diffusion of radiogenic products to become negligible, the apparent age of metamorphic minerals from a high-grade zone, where higher temperature delayed cooling, should be less than the apparent age of minerals that crystallized synchronously in a low-grade zone. Observation gives some support to this expectation. In the Scottish Caledonides, for example, mineral and whole rock K-Ar dates of metamorphic rocks commonly are 50 to 70 m.y. younger than the peak of regional metamorphism deduced from other evidence (Harper, 1967). In Japan, Rb-Sr and K-Ar mineral ages may be 40 to 60 m.y. younger than the metamorphic event that apparently produced them (Yamaguchi and Yangai, 1970).

These considerations led Butler (1972) to a reinterpretation of available radiometric data for the southern Appalachians, from which he concluded that the major episode of regional metamorphism in the Blue Ridge was more than 430 m.y. ago, possibly during the Taconic orogeny (450-500 m.y. ago), that the Spruce Pine pegmatites originated about 380 m.y. ago, and that the 350 and 250 m.y. events were not times of widespread recrystallization. An attempt to show a progressive age difference in relation to metamorphic grade (1972, p. 322, table 1) is suggestive but inconclusive. When the ages Butler selected are averaged by zone, the difference from biotite to sillimanite zone is about 50 m.y., comparable to the difference between radiometric age and true age reported for other areas. The dating of additional, carefully selected samples will be necessary to demonstrate whether the inner Piedmont cooled more slowly than the Blue Ridge. At present, there is no basis for supposing a lag of nearly 200 m.y. in the cooling of inner Piedmont.

An areal plot of available radiometric ages for the southeastern United States shows a well defined pattern. For micas the older ages are along the west side of the Blue Ridge belt. Eastward the ages are progressively though erratically younger toward the zone characterized by 250 m.y. ages, which extends northeast-southwest through Raleigh, N.C. and Elberton, Ga. In this zone published zircon and whole rock Rb-Sr ages range from 350 to 450 m.y., but the micas rather consistently give dates near 250 m.y. The Elebrton granite, for example, whose texture shows clearly that it has undergone thermal metamorphism, yields a zircon age of about 450 m.y. (U-Pb) and a biotite age of 245 m.y. (K-Ar). The 250 axis coincides with a zone of high-grade regional metamorphism and anatexis. Micas not only along this zone but also on its flanks, more than 45 km from the 250 m.y. axis, show 250 m.y. ages.

If the major episode of regional metamorphism in the southern Blue Ridge were Taconic, 450 to 500 m.y. ago (Butler, 1972, p. 327), then it preceded deposition of Talladega sediments, preceded and is genetically unrelated to extensive pegmatite emplacement; further, the cooling of the inner Piedmont lagged the cooling of the Blue Ridge by as much as 200 m.y. Neither consequence is tenable. The Talladega sediments, deposited on folded and faulted Cambro-Ordovician rocks, are post-Early Ordovician to Devonian in age, yet they have been subjected to regional metamorphism, the period that produced the Barrovian zones in the southern Blue Ridge. The extensive mid-Paleozoic pegmatites and granites have been shown to be confined essentially to the kyanite and sillimanite zones (Carpenter, 1970), which implies a genetic relationship. Another reason for doubting that the major period of regional metamorphism was more than 430 m.y. ago, or that the last widespread heating was 360 to 380 m.y. ago, is the occurrence of micas in the Blue Ridge and Carolina Slate belts showing the same age as micas along the high-grade 250 m.y. axis.

While the radiometric ages of metamorphic minerals may lag real age by tens of millions of years, it still appears that at least 3 periods of metamorphism, that is, times of widespread heating or recrystallization, have affected the southern Appalachians, and that at least 2 of them appreciably affected the southern Blue Ridge belt. One period was Precambrian, perhaps 1100 to 1200 m.y. ago, certainly prior to deposition of the upper Precambrian Ocoee Series. Another produced the major pattern of metamorphic zonation now observed. It affected the Talladega Group, which is post-Early Ordovician to Devonian in age (Shaw, 1970), hence must be younger. A 340 to 390 m.y. date is consistent with available information. A third thermal event was a time of anatexis along the zone that yields 250 m.y. ages. It affected not only the rocks along the 250 m.y. axis but also many rocks far from the axis, within the Blue Ridge and Carolina Slate belts.

The areal distribution of metamorphic index minerals in Tennessee, North Carolina, and Georgia is shown by figure 8. The data for Tennessee and North Carolina are from Carpenter (1970). The zones for Georgia approximate the provisional isograds compiled by Smith, Wampler, and Green (1969) but are based more on field mapping. The zones along the west side of the Blue Ridge belt were traced out in 1959 but not previously published. The other zones are based on the geologic mapping referenced in figure 3.

In North Carolina an axis of high-grade metamorphism is bounded both on the northwest and the southeast by lower grade metamorphism. This high-grade zone broadens as it extends into Georgia. The Grandfather Mountain window faults and the northern part of Cartersville Fault truncate metamorphic zones. Additional work is required to show whether isograds are truncated by the Brevard Zone or by the contact between Talladega and Cambro-Ordovician strata in Bartow and Polk Counties, Ga. The detailed mapping of metamorphic isograds might be particularly useful in distinguishing angular unconformities from major faults in Alabama and west Georgia and in demonstrating whether the Brevard Zone is a major fault zone.

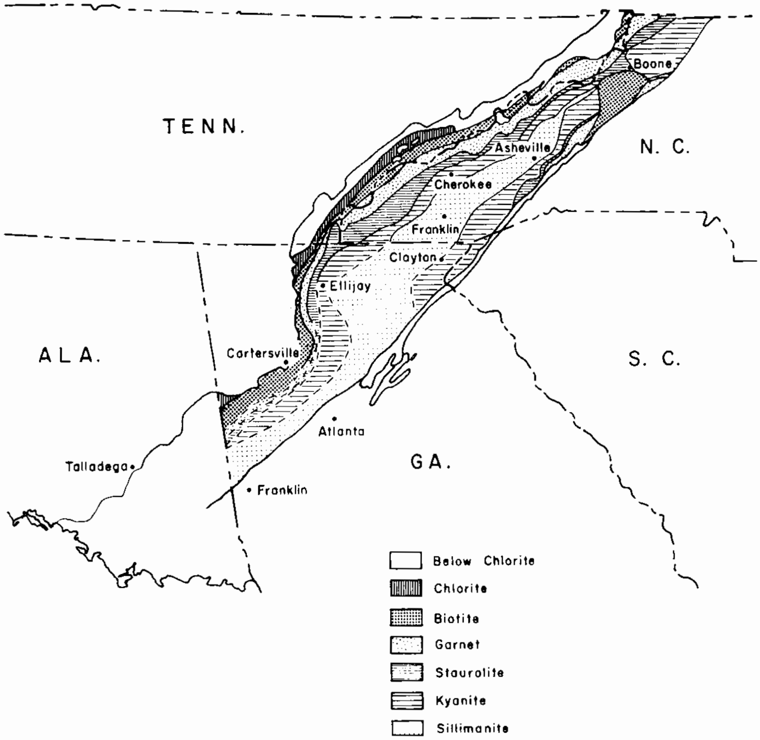

Fig. 8. Zones of regional metamorphism in Tennessee, North Carolina, and Georgia.

A review of the literature yields reports of metamorphic grade changes more numerous and chaotic than figure 8 shows. Some of them have been postulated on the presence or absence of a single mineral, even on differences in grain size, and probably will not be substantiated by further study. By taking closer account of bulk rock composition in relation to the total phase assemblage and of the retarding effect of high graphite on recrystallization (Harker, 1952, p. 224), by basing metamorphic grade on appropriate mineralogical reactions rather than less dependable criteria, and by more clearly distinguishing prograde from retrograde metamorphism, a clearer metamorphic history can be derived.

CONCLUSION

The era of reconnaissance in the southern Blue Ridge is nearly over. A good working outline of the region's geologic evolution has emerged.

Future refinements and extensions will require detailed stratigraphic studies and a clearer sequencing of the region's main evolutionary events, as times of widespread folding and faulting, igneous intrusion, metamorphism, and anatexis. Better to distinguish prograde from retrograde metamorphism, reliably to interpret relic minerals and textures, and to detect and interpret the subtle changes that connote reheating of high-temperature rocks, careful petrologic studies coupled with modern geochronologic investigations are needed. Detailed chemical studies with emphasis on the rare-earth elements are needed to distinguish the mantle-derived granitic rocks from the products of anatexis.

Past efforts to develop a temporal framework might have placed undue emphasis on the region's deformational features, many of which relate to a time of relatively recent rock strain. The manifestations of post-crystallization strain are more conspicuous than the relic evidence of earlier pre-recrystallization deformations, but they might not be more important. Rock strain and annealing recrystallization in relation to thermal metamorphism and hydrothermal alteration, as derived petrographically, offer temporal distinctions as yet hardly utilized in the southern Blue Ridge region.

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