POLYTECTONIC EVOLUTION OF THE BREVARD ZONE

PAUL J. ROPER* and PHILIP S. JUSTUS**

ABSTRACT. A number of structural and lithologic features have been found to be remarkably constant along the 600-km (375-mile) length of the Brevard Zone from Virginia to Alabama. However, several structural, geophysical, and petrologic differences do exist, which suggest that the Brevard Zone can be divided into northern, middle, and southern portions.

Two independent studies, one in the middle segment and the other along the transition between the middle and northern portions of the Brevard Zone, have led to similar conclusions concerning the geologic development of this structure. Both studies indicate that the geometry of the Brevard Zone is characterized by superposed overturned to isoclinal folding, which is associated with polymetamorphism that accompanied both deformations.

Most theories about the Brevard Zone are limited to a tectonic model of only one major genetic type and generally characterize this structure as some type of fold or fault or combination of these that formed contemporaneously. We propose that the Brevard Zone is polygenetic in origin and has been involved in much of the tectonic development of the southern Appalachians during the Paleozoic era. The first phase of Brevard evolution involved sedimentation along a continental margin. The second phase is associated with two major periods of deformation. The first period of deformation occurred during the Taconic orogeny when Brevard lithologies were deformed in a detachment zone adjacent to the Inner Piedmont (infrastructure). This tectonism may have been the result of an island arc-island arc collision. The second period of deformation and metamorphism occurred during the Acadian disturbance, which probably reflects the initial stage of collision between North America and Africa. This tectonism was less intense than the first and marks the culmination of a series of tectonic events that formed the Brevard fold belt. Phase three began during the late Paleozoic when the Blue Ridge and the western portion of the Inner Piedmont were thrust westward together as a single sheet. Decoupling of these geologic belts during this interval commenced a new style of deformation along the Brevard Zone which is characterized by faulting rather than folding. This phase of tectonism initiated the formation of the present-day Brevard fault zone. Late normal faulting may be superimposed along parts of the northern half of the Brevard Zone but is only of local importance.

INTRODUCTION

In the past few years much interest has been devoted to the Brevard Zone, which is one of the most controversial structures in the southern Appalachians. It was first recognized by Keith (1905, 1907) as a narrow band of graphite schist which he named Brevard Schist, from exposures near Brevard, N.C. He interpreted the Brevard Zone as an isoclinal syncline. Later Jonas (1932), during a reconnaissance for the 1932 geologic map of the United States, realized that these rocks were sheared and retrogressively metamorphosed. These interpretations led to a dual characterization of the Brevard Zone. The first, as proposed by Keith (1905), may be referred to as the “Brevard fold belt”, whereas the other view, which had its origins with Jonas (1932), is that the Brevard is a “fault zone”. These two aspects of the Brevard Zone are often misunderstood or ignored.

The purpose of this paper is to emphasize the importance of a polytectonic model as applied to the origin and development of the Brevard

* Department of Geology, Lafayette College, Easton, Pennsylvania 18042
** Department of Earth Sciences, Fairleigh Dickinson University, Madison, New Jersey 07940
Zone. The authors believe that such an approach can best reconcile the fold belt and fault zone enigma and is most consistent with known regional, structural, and petrographic information about the zone. This will be done by reviewing pertinent information about the Brevard Zone as well as by analyzing the results from two independent investigations of this structure.

The study areas are in North and South Carolina and are approximately 290 km (180 miles) apart. The first investigation was made by Roper and Dunn (1970a, b) in the Tamasssee, Satolah, and Cashiers quadrangles in northwestern South Carolina (fig. 1). The second study was made by Justus (ms) along a 48 km (30 mile) stretch of the Brevard Zone, which includes the transition between the middle and northern portions of this zone (fig. 1).

Most of the observations presented from the study areas were first reported by Roper and Dunn (1970a, b) in South Carolina. The study by Justus (ms) in North Carolina found many of the same structural and petrological trends, thereby reinforcing their regional significance. Other investigations made along the Brevard Zone have at least in part reached similar conclusions regarding the structural configuration and style of deformation to those proposed by Roper and Dunn (1970a, b). The results of these investigations provide additional credibility for

![Regional map showing location of study areas in the Brevard Zone. Map also shows northern, middle, and southern portions of the Brevard and its relationship to other lithologic belts. (Modified after Reed and Bryant, 1964, fig. 1; Butler and Dunn, 1968, fig. 8; and Stirewalt, ms, fig. 33.)](image-url)
interpreting the Brevard Zone in light of a polytectonic model as suggested by Dunn, Butler, and Justus (1968).

**Extent and regional relationships.**—At the present time, the Brevard Zone is recognized as a continuous belt of cataclastic rocks, approximately 1.6 to 6 km (1-4) miles wide, which roughly parallels about 600 km (375 miles) of the southeastern side of the crystalline Blue Ridge Province in the southern Appalachians, from about Horseshoe Bend, Ala., to at least the North Carolina-Virginia border (fig. 1). At the north end the Brevard trends into another type of structure, whereas its southern terminus is covered by sediments that obscure structural relationships that might otherwise indicate a continuation of the Brevard Zone. Jonas (1932, fig. 1, p. 238-241) correlated the Martic overthrust in Virginia with the Brevard Zone on grounds of lithologic similarity and stratigraphic continuity. However, this correlation generally has not been accepted, primarily because of the regional relationships between these two zones. The Martic Line, according to Wise (1970, p. 817), separates Cambro-Ordovician miogeosynclinal sedimentary rocks on the northwest from Precambrian through early Paleozoic eugeosynclinal schists on the southeast. The Brevard Zone, on the other hand, is confined to crystalline rocks of the Inner Piedmont and Blue Ridge physiographic provinces. Recent mapping near the northern end of the Brevard Zone suggests that it may continue into either the James River synclinorium (?) (Reed and Bryant, 1964; Butler and Dunn, 1968) or the Bowens Creek fault, which borders the northwestern side of a large nappe in the Piedmont (Conley and Henika, 1970; Conley, Henika, and Algor, 1971; Rankin and others, 1971).

The extent of the Brevard Zone is also questioned along its southwestern terminus. Hatcher (1972, p. 2748) suggested that the major Brevard faulting terminates in Tallapoosa County where the main cataclastic zone disappears. However, in this region Bentley and Neatherly (1970, p. 1, 3, 41-43) suggest from field relationships and tectonic style that cataclastic rocks in the Brevard Zone southwest of Opelika, Ala., bifurcate, bend to the east, and seem to become continuous with the Wacoocchee belt (Pine Mountain belt). Griffin (1970a, p. 112) proposed that the Kings Mountain belt in south Carolina probably extends into Georgia and Alabama as the Wacoocchee belt of Hewett and Crickmay (1937, p. 12). To the north, the Kings Mountain belt is shown on the geologic map of North Carolina (North Carolina Dept. Conserv. Devel., 1958) and figure 1 to extend northeastward to Statesville, N.C. Furthermore, Jonas (1932, fig. 1) proposed that the Kings Mountain belt can be traced from Statesville into Virginia. Its western border is a fault contact (Jonas, 1932, fig. 1; Griffin, 1970, p. 109, 111; 1971, p. 880). Jonas (1932, fig. 1) also shows that the western border of the Pine Mountain belt is bordered by a fault zone. The exact nature of the southern terminus of the Brevard Zone and the Pine Mountain-Wacoochee-Kings Mountain belt is not well understood at this time, because much of this area is covered by coastal...
Plain sedimentary rocks. However, if these zones should prove to be continuous and correlative, then the tectonics associated with the Brevard Zone in the southern Appalachians may be much more extensive than previously recognized.

Reed and others (1961) noted that no rocks on one side of the Brevard Zone have been found on the other side of the sheared zone. Reed and Bryant (1964) observed that the remarkably straight trend of the Brevard is independent of the salients and recesses of the Appalachian folds and thrust faults in the Valley and Ridge northwest of the Blue Ridge. They also noted that no rocks of Precambrian age have been found east of the Brevard. To be sure, Glover and others (1971, p. 313) have shown from U-Pb dating that some of the oldest gneisses in the Charlotte belt and the Carolina Slate Belt are late Precambrian, but these rocks are probably younger than the basement rocks of the Blue Ridge. On the other hand, Espenshade and Rankin (1970, p. 207) and Conley, Henika, and Algor (1971, p. 530) from structural relationships suggest that the Sauratown Mountain anticlinorium is composed of true Precambrian basement, and Rankin and others (1971, p. 343) and Rankin (1972, p. 525) support this conclusion from field mapping as well as two lead/lead ages of 1192 m.y. determined from zircons in granite gneiss taken from the core of Sauratown Mountains anticlinorium. Whether or not this date reflects a maximum or minimum age for the core of the Sauratown Mountains anticlinorium is uncertain, because it is not known whether the zircons are primary or detrital. Thus, the age of these rocks is not absolutely certain at this time. More recently, Odom, Kish and Leggo (1979) have reported a “basement” age, determined by U-Pb analysis on zircons, of at least 1 b.y. from charnockite rocks in the Pine Mountain block of the southern Georgia Piedmont.

King (1955) suggested that the Brevard Zone marks the southeastern border of the Blue Ridge geologic belt and separates it from the Inner Piedmont belt to the southeast. However, King (1955) and Reed and Bryant (1964) showed that it is only an approximate boundary between the Blue Ridge and Piedmont physiographic provinces, because for 240 km (150 miles) southwest of Toccoa, Ga. (fig. 1), near the southwestern end of the topographic Blue Ridge, the Brevard is entirely within the Piedmont Province. Furthermore, the Brevard Zone extends into the Blue Ridge physiographic province for about 145 km (90 miles) near Old Fort, N.C. A similar situation exists in northwestern South Carolina where the Brevard Zone is also known to cut across the Blue Ridge front (Roper and Dunn, 1970b).

The Brevard Zone seems to act as a structural barrier to Triassic diabase dikes, in that they do not extend beyond the zone. Lester and Allen (1950) have shown that only two diabase dikes in Georgia extend across the Brevard Zone. Reed and Bryant (1964) and Bryant and Reed (1970) have shown that one diabase dike does cut across the Brevard for a short distance in the vicinity of Grandfather Mountain Window, N.C.
Polytectonic evolution of the Brevard Zone

Stratigraphy.—Shufflebarger (1961), Hurst and Crawford (1964), Livingston (1966), Cazeau (1967), Burchfiel and Livingston (1968), Dunn, Budel, and Justus (1968), and Hatcher (1969a, b) have suggested that a stratigraphic sequence exists in the Brevard Zone; however, Hatcher (1970) presented the most convincing evidence that a mappable lithologic sequence may exist in the Brevard. He calls Brevard lithologies in South Carolina the Chauga River Group and divided them into an upper and lower group as indicated below.

Upper  
Brevard phyllite and metagraywacke
Lower  
Brevard carbonate
button muscovite–chlorite phyllite
graphitic phyllite

Most of his units can be recognized throughout South Carolina, northeastern Georgia, and southwestern North Carolina. Thus, Hatcher (1971) suggests that the same or very similar lithologies are found in the Brevard Zone throughout most of its length. He estimated that this sequence is about 457 m (1500 ft) thick and is stratigraphically equivalent to the Poor Mountain belt described by Sloan (1908). The Brevard Zone mapped by Roper and Dunn (1970b) in the Tamasee quadrangle is equivalent to the Brevard and Poor Mountain belts described by Hatcher (1970).

We recognize the rock units that Hatcher (1970) proposed for this part of the Brevard Zone. However, his stratigraphic model has some notable limitations, which suggest that it should be recognized as a lithologic sequence rather than a true stratigraphy. First, no top or bottom criteria or index fossils are preserved in any of the rocks in the Brevard Zone or Poor Mountain belt. Therefore, it is not possible to determine age relationships, or whether beds are right-side-up or overturned. Secondly, correlation between units is impaired because of poor outcrop control due to dense vegetation, deep weathering, faulting, and thickening and attenuation resulting from multiple folding. Third, Hatcher's stratigraphic model has not been rigorously tested in other parts of the Brevard. Thus, it is conceivable that his stratigraphic model may be oversimplified or not be representative of the whole zone. Fourth, Roper (1972) has shown that the “button” or “fish-scale” texture in the phyllonitic schist, one of the most characteristic lithologies in the Brevard Zone is produced in mica-rich rocks by multiple deformation. Therefore, it is a deformational texture imprinted on rocks of similar composition and does not have to be restricted to a particular formation. Rast (1968) has also shown that some mappable units in fault zones in the British Caladonides are actually a product of deformation rather than being a typical rock formation.

Characteristics and subdivisions of the Brevard Zone.—A number of structural and lithologic features are remarkably similar along most of the Brevard Zone. These features characterize the belt and are sum-
marized as follows: (1) With local exceptions, schistosity and gneissic foliation dip 20° to 60° to the southeast. (2) At least two phases of folding have been recognized in these rocks, and at least the first phase is isoclinal and sheared-out. (3) Slip cleavage is common except locally where it may be intensely sheared-out. (4) The most prominent lineations are sub-horizontal and are parallel to minor fold axes. (5) At least one, and commonly both, sides of the Brevard Zone are fault contacts. (6) The Brevard has been intensely sheared except for small lenses of less deformed rock. (7) The most common rock types in the Brevard include: white-mica-chlorite-graphite ± garnet phyllonite or schist, marble, amphibolite, cataclastic gneiss, and (or) blastomylonite. (8) Carbonates, quartzites, and persistent graphite content suggest that these lithologies are metasedimentary in origin. (9) Texturally, a "button", "fish-scale", or "curly" structure is found in the phyllonitic schists throughout the Brevard. (10) The lithologies are polymetamorphic and have been subjected to at least one prograde phase that thermally reached at least the garnet zone conditions, followed by at least one retrograde phase to lower greenschist facies of regional metamorphism.

Although the Brevard is generally uniform with respect to the characteristics discussed above, there are some notable differences. The northeastern and southwestern ends of the Brevard show structural, geophysical, and some petrological changes that are not found in the middle of the zone.

The northern segment (fig. 1) extends from approximately Ferguson, N.C. to the North Carolina-Virginia state line. In this area, the Brevard Zone widens to 16 km (10 miles) near Elkin, N.C. Brevard lithologies bifurcate into two zones northeast of Elkin, where they trend into the James River synclinorium (Reed and Bryant, 1964, p. 1178; Butler and Dunn, 1968; Dunn, Butler, and Justus, 1968 (fig. 2). The Brevard rocks in the northwestern branch, according to Butler and Dunn (1968, p. 37), have been folded but have not undergone significant retrogression and shearing since regional metamorphism. However, Conley and Henika (1970), Conley, Henika, and Algor (1971), Rankin and others (1971)

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Fig. 2. Schematic geologic map showing northern end of Brevard Zone in North Carolina. Map illustrates Brevard fold and fault zone and the relationship between the Brevard fault zone with the Stony Ridge fault and Dan River Triassic basin. (Modified after Butler and Dunn, 1968.)
suggest that this zone continues into Virginia as the Bowens Creek fault. In the eastern zone faulting is superimposed on Brevard rocks. Shearing in this eastern zone continues into Virginia where it is known as the Ridgeway fault (Conley and Henika, 1970; Conley, Henika, and Algor, 1971). However, Butler and Dunn (1968) have shown that shearing in this belt in Stokes County, N.C., also diverges farther to the east as right-lateral separations that form the Stony Ridge fault zone (fig. 2). Thus, the northern portion of the Brevard Zone can be divided into a fold and a fault zone, which are no longer continuous, except in the easternmost branch.

Watkins, Kline, and Cooley (1969) from gravity profiles of part of the middle and northern segment suggest that the northern segment is more dense than adjacent belts and broadens at depth. Their studies also indicate that at its northern end the zone is inclined more steeply to the southeast than it is southwest of Ferguson. Thus, the zone southwest of Ferguson is gravitationally distinct from the segment northeast of Ferguson. This study also indicates that the bifurcated Brevard Zone northwest of the Sauratown Mountains is convergent at depth and may be an asymmetric synform with a southeastward-dipping axial plane. These results appear to be consistent with conclusions made by Butler and Dunn (1968) and Justus (ms) from field mapping in that area.

The boundary for the southern part of the Brevard Zone is tentatively located approximately at Horseshoe Bend, Ala. (fig. 1). Bentley and Neathery (1970) have shown that south of Horseshoe Bend, Ala., the Brevard Zone bifurcates into the Abanda fault to the north and the Katy Creek fault to the south. The central shear zone between these faults disappears and relatively unsheared rocks of the Jackson Gap Group (Brevard fold zone) occupy the zone between the faults. Thus, the dual character of the Brevard Zone is also revealed at the southern end of this structure.

The Jackson Gap Group is predominantly retrogressed to the greenschist facies. However, Bentley and Neathery (1970) reported several small localities in this group that were in the amphibolite facies with sillimanite as one of the index minerals. This high-temperature index mineral is unique to the southwestern half of the Brevard in Alabama and Georgia.

The middle portion of the Brevard Zone (fig. 1) is characterized by most of the structural and lithologic features previously discussed. The Brevard fault and fold zones are superimposed on each other throughout much of this region. However, Medlin and others (1972) have shown in southwestern Georgia that the Brevard fault zone cuts across Brevard and adjacent lithologies and structures with no apparent offset of folds. Therefore, at least the last phases of faulting, here as at both termini of the Brevard Zone, are post-folding.

Hurst (1970, p. 389) reports that sillimanite schists occur locally in the Brevard. Hurst (1972, oral commun.) believes that Gainesville, Ga.,
is probably the approximate northeastern limit of sillimanite in the Brevard Zone in Georgia. Sillimanite has not been reported in the Brevard northeast of Gainesville by any investigation, although staurolite and kyanite are common index minerals throughout much of the Brevard.

STRUCTURAL AND METAMORPHIC HISTORY

Relationship of foliation to folding and metamorphism.—The following relationships between foliation, folding, and metamorphism have been observed in both study areas. The first period of folding ($F_1$) produced isoclinal folds with axial-plane schistosity ($S_1$) that formed during contemporaneous ($M_1$) metamorphism. $S_1$ is presumed to be parallel to strongly transposed sedimentary bedding ($S_o$). The second deformation ($F_2$) produced an axial-plane cleavage, expressed as a schistosity ($S_{2a}$) that crystallized during the second metamorphism ($M_2$) in some areas and as slip-cleavage ($S_{2b}$) in others.

Folding in the Brevard Zone.—Folding in the phyllonitic schists of the Brevard Zone is rarely seen in the mesoscopic scale because of deep weathering, intense shearing, and dense vegetation. However, Justus (ms) and Roper (1971, 1972) have shown that microfold structures are quite common in thin section. Microstructures indicate that the $F_1$ deformation formed sheared-out isoclinal folds. They also indicate that coaxial $F_2$ folds are overturned to isoclinal and often sheared-out. Roper and Dunn (1970b) and Justus (ms) have also shown that both $S_1$ schistosity and mesoscopic $F_2$ isoclinal folds exist in the phyllonitic schists in the Brevard Zone. Stirewalt and Dunn (1973) presented mesoscopic and megascopic evidence that $F_1$ and $F_2$ folds are approximately coaxial. Assuming that these structural features hold true on a larger scale in other regions, then these observations can be used to interpret the structural geometry of the Brevard Zone in the central segment.

In northwestern South Carolina extrapolation of structural styles of deformation from the micro- and mesoscopic scales to the macroscopic scale centers about a very distinctive lithology characterized as cataclastic gneiss. The mineralogical composition of this rock suggests that it is probably Henderson gneiss and is not to be confused with Hatcher's (1971) cataclastic mortar gneiss. The cataclastic gneiss is resistant to weathering and forms two low topographic ridges within the phyllonitic schist of the Brevard Zone in the Tamassee quadrangle (fig. 3). Both cataclastic gneiss bodies, underlying the low ridges, appear to be conformable in contact with the phyllonitic schist, and the rock units in both belts dip gently at approximately the same angle to the southeast. The western belt consists of irregular discontinuous sheared-out lenses; whereas the southeastern belt is continuous through the map area.

Livingston (ms) mapped the Reid quadrangle to the northeast in North Carolina (fig. 3) and recognized two belts of cataclastic gneisses, which he called mylonitic augen gneiss, that dip to the southeast. The two belts mapped by Livingston (ms) merge together in the eastern part
of the Reid quadrangle in North Carolina and continue as a single belt of cataclastic gneiss farther to the northeast through the Estatoe Gap and Rosman quadrangles. The two parallel belts of cataclastic gneiss in Livingston's map area in North Carolina are in the same structural position and lie directly along strike from the two parallel cataclastic belts in the Tamassee quadrangle. Hatcher and Griffin (1969), and Hatcher and Acker (in preparation) have shown that both belts continue across the northwestern portion of the Salem quadrangle (fig. 3) as discontinuous lenses. Livingston (1972, written commun.) traced these two zones by reconnaissance mapping into the southern portion of the Reid quadrangle in South Carolina. It is believed that the two belts of cataclastic gneiss in the Tamassee quadrangle are correlative with those in North Carolina. Assuming this correlation is correct, then the cataclastic gneiss that lies within the phyllonitic schists provide marker hori-

![Diagram](image)

**Fig. 3.** Map showing distribution of cataclastic gneiss and structural geometry of the Brevard Zone in North and South Carolina.
zones that may be used to outline large-scale regional structures within the Brevard Zone. This outcrop pattern coincides with a large overturned isocline mapped by Griffin and Hatcher (1969). We concur with their interpretation and suggest by extrapolation from micro- and mesoscopic structures (Roper and Dunn, 1970b; and Roper, 1971, 1972) that the fold is a coaxially refolded isocline.

Roper (ms) and Roper and Dunn (1970a, b) first proposed that the Brevard Zone is characterized by coaxially refolded and sheared-out isoclines. Since then other studies have also reported two periods of tight or isoclinal folding in the Brevard Zone; such as, Bendle and Neathery (1970), R. E. Lemmon (1972, written commun.), Bryant and Reed (1970), and Justus (ms). Justus and Lemmon, cited above, have also recognized that F₁ and F₂ folds are approximately coaxial.

Field mapping and thin sections from along the western and eastern margins of the phyllonitic schists and the west side of the eastern cataclastic gneiss belt (fig. 3) reveal zones of intense shearing and mylonitization. Roper and Dunn (1970b, p. 48) have interpreted these zones as thrust faults. Dips along the western edge of the Brevard Zone in the foliated mylonites are relatively steep (50-60 deg) in places. However, the angle of dip in the phyllonitic schists to the southeast decreases very rapidly to about 10 to 20 degrees. This suggests that these faults flatten out at depth and to the southeast and acted as planes along which the rock layers have been thrust from the southeast to the northwest as a series of tectonic slides. These features support our interpretation that the structural geometry of the Brevard Zone in northwestern South Carolina and southwestern North Carolina is a tightly refolded and sheared-out synform and antiform.

Thus, two periods of approximately coaxial sheared-out isoclinal folding have been recognized in each of the three major divisions of the Brevard. Therefore it is believed that these structures constitute one of the most important structural features that characterize the Brevard Zone.

Relationship of metamorphism to folding.—Most of the original rocks in the Brevard Zone are believed to be sedimentary. This is indicated by the abundant distribution of graphite in the phyllonitic schists, marbles and quartzites, and the possible stratigraphic sequence in this zone. Hatcher (1970, p. 973) has postulated that amphibolites in the Brevard are probably impure calcareous sediment rather than mafic flows. It is also conceivable that these sediments could be partially volcanic in origin, the source being volcanic ash derived from either the late Precambrian Grandfather Mountain volcanics or the Mt. Rogers volcanics (Rankin and others, 1969; Rankin, 1970), or the newly developing Slatebelt island arc in the late Precambrian or early Paleozoic (Butler and Ragland, 1969; Glover, 1971). Some time after these sediments were deposited, they were folded during the F₁ deformation into isoclinal folds that transposed bedding when they became sheared-out.
Roper and Dunn (1971, 1973, and in press) have shown that a genetic relationship exists between folding and metamorphism in the Brevard Zone in South Carolina. They have shown that the $F_1$ deformation was accompanied by metamorphism $M_1$, which recrystallized these sediments in an axial-plane schistosity. The progressive phase of this metamorphism ($M_{1a}$) attained the amphibolite facies of regional metamorphism. This is indicated by rotated porphyroblasts and relics of metamorphic index minerals such as garnet, kyanite or sillimanite, and andesine that formed contemporaneously with $S_1$ schistosity. Similar index minerals of the amphibolite facies also have been reported by other workers in the Brevard Zone and include: sillimanite in Alabama by Bentley and Neathery (1970, p. 23-24), staurolite and sillimanite by Hurst (1970, p. 389), and kyanite and staurolite by Crawford and Medlin (1971, p. 306) and Medlin and Crawford (1971, p. 331-332), in Georgia. In North Carolina, Keith (1905, p. 8) found kyanite in the Brevard Zone in the Mount Mitchell quadrangle, and Reed and Bryant (1964, p. 1181, 1183), Butler and Dunn (1968, p. 43), and Lemmon (1971, oral commun.) have found staurolite or staurolite and kyanite in the Brevard in North Carolina. Thus, metamorphic index minerals that characterize the amphibolite facies of regional metamorphism have been found at least locally along the entire length of the Brevard Zone. Furthermore, we believe that the index minerals reported by these workers probably formed during the $M_1$ metamorphism because they are usually reported as relict minerals, and $M_1$ is the highest temperature and best preserved metamorphic event in these rocks. Roper and Dunn (1971, 1973, and in press) have also shown from relict textures and foliations that intense cataclasis and dislocation metamorphism ($M_{1b}$) was caused by shearing-out of $F_1$ folds as well as retrograde metamorphism ($M_{1c}$).

Roper and Dunn (1971, 1973, and in press) recognized, from cross-cutting foliations, porphyroblasts, and spatial relationships in the Brevard Zone, a second metamorphic event ($M_2$) that is associated with $F_2$ folding. $M_2$ metamorphism partially recrystallized $M_{1a}$ assemblages and was less intense than $M_1$, only attaining the greenschist-amphibolite transition facies of regional metamorphism. Clear, euhedral, and nonrotated second-generation garnets suggest that the environment of formation was relatively static as compared with $M_1$, or that these porphyroblasts crystallized during the last stages of folding. Roper and Dunn (1971, 1973, and in press), by similar methods, have shown that additional dislocation metamorphism ($M_{2a}$) and retrogressive metamorphism ($M_{2c}$) also accompanied the $F_2$ deformation.

Roper and Dunn (1971, 1973, and in press) have also recognized a third retrogressive event ($M_3$), which in places is superimposed upon $M_1$ and $M_2$. The distribution of this metamorphism along the Brevard Zone is not accurately known. However, it appears to occur along parts of the Brevard that parallel the Blue Ridge front.
The work by Justus (ms) suggests a similar relationship between folding and polyphase metamorphism in North Carolina. He reported that metamorphism $M_1$ accompanied the $F_1$ deformation. This is indicated by schistosity forming an axial-plane cleavage, and by snowball garnets that formed syntectonically with the $F_1$ deformation. Thus, the progressive phase ($M_{1a}$) of regional metamorphism attained at least the garnet isograd and indicates that temperatures reached at least the green-schist-amphibolite transition facies of regional metamorphism. He also noted that dislocation and retrogressive metamorphism are common throughout these rocks, resulting from shearing due either to faulting or to shearing-out of folds, or to both. At least some of this metamorphism is probably related to more than one period of folding or faulting. Annealing recrystallization and a second generation of garnet growth suggests either post-kinematic crystallization or a second period of progressive metamorphism ($M_{2a}$), which could be related to the $F_2$ deformation. The structural and metamorphic relationships in this part of the Brevard Zone, though not worked out in detail, suggest polymetamorphism. Such relationships indicate a striking resemblance to those previously described in South Carolina and suggest that polyphase metamorphism is probably related to both $F_1$ and $F_2$ deformations.

Chronology of tectonic events.—The age of sedimentary rocks in the Brevard Zone is debatable. However, Crickmay (1952), Reed and Bryant (1964), Livingston (ms), Hatcher (1970), and Conley, Henika, and Algor (1971) propose that Brevard lithologies are probably related to the Ocoee or Lynchburg series or slightly younger and, therefore, are late Precambrian or possibly early Cambrian in age.

Polymetamorphism associated with each period of folding indicates that both periods of folding are characterized by progressive and retrogressive metamorphism suggesting that these events are separated in time, rather than being phases of one larger event. Furthermore, if the deformations occurred during separate orogenic periods as postulated, then radiogenic ages determined from many localities in the Brevard Zone should indicate this relationship by showing that metamorphic events occurred over a long span of time, as well as by a clustering of ages about major episodes of tectonism. Such a relationship appears to exist, as indicated by Stonebraker and Harker (1973) who have determined more than 150 K–Ar mica ages ranging from 1075 to 250 m.y. from nine traverses across the Brevard Zone from Tallapoosa County, Ala., to Stokes County, N.C.

If the assumption is held that the Brevard Zone is composed of late Precambrian or Cambrian rocks, then these orogenic events are probably confined to the Paleozoic era. Furthermore, the Mt. Airy Granodiorite (Late Devonian) cuts across the Brevard in Surry County, N.C. (Butler and Dunn, 1968, p. 40) (fig. 2) and is younger than both $F_1$ and $F_2$ (Butler and Dunn, 1968, p. 46). Odom and Fullagar (1970) reported a Devonian whole-rock Rb/Sr age on mylonite from the Brevard near Ros-
man, N.C. Both these dates are minimum ages and indicate that $F_2$ and $M_2$ are probably Devonian in age and may be a manifestation of the Acadian orogeny in the southern Appalachians. $F_1$ and $M_1$ are believed to be of Ordovician or Ordovician-Silurian age, as suggested by Butler (1972, p. 331), and probably represent a southern expression of the Taconic orogeny. K–Ar mica ages determined by Stonebraker and Harker (1973), which have ages ranging between 420 to 410 m.y., provide additional credibility for such an interpretation.

Thus, we conclude that the two periods of deformation that include folding and related polyepisodic metamorphism culminated by late Devonian time. Faulting during these orogenic episodes was related to shearing-out of $F_1$ and $F_2$ folds, which produced much of the cataclastic textures and dislocation metamorphism in these rocks. We refer to that portion of the Brevard Zone that experienced both periods of folding and related polymetamorphism as the Brevard fold belt.

Portions of the Brevard fold belt that have not been subjected to later intense faulting are well documented only in the northwestern branch of the northern portion of the Brevard Zone as indicated by Butler and Dunn (1968) (fig. 2). However, other segments along the Brevard may also be included in this category. They include portions of the Brevard Zone, mentioned earlier in this text, which are located entirely within the Blue Ridge physiographic province in North Carolina and part of South Carolina. Furthermore, unsheared rocks of the Jackson Gap Group described by Bentley and Neathery (1970) in the southern terminus of the Brevard also seem to fit this category. Finally, Medlin and others (1972) have shown that late faulting related to the Brevard Zone in southwestern Georgia is not restricted to a stratigraphic zone but instead cuts across adjacent structures. Thus, original Brevard lithologies may locally not have been affected by late faulting and could be considered as part of the Brevard fold belt in this area.

Late Paleozoic faulting along the Brevard Zone has been suggested by Reed and Bryant (1964), Reed, Bryant, and Myers (1970), Bryant and Reed (1969, 1970), and Hatcher (1970, 1971, 1972). Higgins (1966, 1968) has shown that the Brevard cuts the Ben Hill granite (Palmetto granite) in Georgia, that was dated by Pinson and others (1957, p. 1781) as being $282 \pm 14$ m.y. from Rb/Sr ages on biotite. Wampler, Neathery, and Bentley (1971) report a K–Ar whole rock age of 300 m.y. from mylonites in the Brevard Zone in Alabama. Finally, Stonebraker and Harker (1973) determined several K–Ar mica ages in the Brevard which range between 320 to 280 m.y. and 230 to 240 m.y. Thus, late Paleozoic activity characterized by faulting seems to be continuous throughout the rest of the Paleozoic.

Reed and Bryant (1964) presented evidence suggesting that faulting ceased along the Brevard Zone during the Triassic. This is indicated by Triassic (?) diabase dikes which cut across the Brevard in North Carolina and Georgia (Reed and Bryant, 1964; Lester and Allen, 1950). However,
the map by Bryant and Reed (1970) shows a Triassic dike cutting the Brevard Zone but does not give dip angles of the dike. Their map does show the dike following a very straight trend, for at least 29 km (13 miles), with no deflections as it crosses large valleys, indicating that the dip must be nearly vertical. Thus, if post-Triassic dip-slip movement occurred along the Brevard Zone it would not displace the fault. Butler and Dunn (1968) have also shown that the Brevard is genetically related to the Stony Ridge fault, which trends into the border fault of the Dan River Triassic basin, suggesting that late faulting, at least along the Brevard's northern terminus, may be Triassic in age. However, Stonebraker and Harker (1973) presented evidence in this region from K-Ar mica ages, mentioned earlier, that suggests this faulting may be late Permian rather than Triassic in age. Roper and Dunn (1971, and in press) have suggested that at least part of this event may be related to the opening of the Atlantic Ocean and rifting of the North American and African continents. We refer to that aspect of the Brevard's evolution that was affected by late Paleozoic-Triassic faulting, which is superimposed upon earlier deformations, as the Brevard fault zone.

It is also worth noting that White (1950) postulated that the Brevard Zone may be related to the formation of the Blue Ridge front during the Triassic and Tertiary. Conley and Drummond (1965) suggested that mylonites were formed along the Brevard during the Tertiary by reactivation of earlier and genetically related Triassic faults. Recent earthquake activity along the zone reported by MacCarthy (1957) and MacCarthy and Sinha (1958) suggests that it still may be an active zone.

**Summary of Brevard Zone in the Carolinas.**—Structural and petrographic studies in North and South Carolina suggests that the Brevard Zone is characterized by the following relationships:

1. The Brevard Zone has experienced at least two periods of folding, which are approximately coaxial.
2. F1 is isoclinal, and F2 is overturned to isoclinal.
3. At least the first period of folding is sheared-out, and in South Carolina the second period of folding also produced sheared-out folds. The second period of folding appears to be less intense than the first.
4. The first metamorphism (M1) accompanied the F1 deformation. It is characterized by progressive metamorphism (M1a) that attained the amphibolite grade and was followed by dislocation metamorphism (M1b) and retrogressive metamorphism (M1c) (Roper and Dunn, 1973, in press).
5. The second metamorphism (M2) is associated with the second deformation (F2). It is characterized by progressive metamorphism (M2a) that was somewhat less than M1a but still attained the garnet grade, and it was also followed by dislocation metamorphism (M2b) and retrogressive metamorphism (M2c) (Roper and Dunn, in press).
6. It is believed that each period of folding and metamorphism is related to a major orogenic event. At the present time we associate \( F_1, M_1 \) with the Taconic orogeny (Ordovician-Silurian) and \( F_2, M_2 \) with the Acadian orogeny during the Devonian (Roper and Dunn, in press).

7. Cataclastic textures caused by shearing in the Brevard Zone are related to three separate events. The first two events are associated with shearing-out of folds during \( F_1 \) and \( F_2 \) deformations. The third event is much later and is related to late Paleozoic thrusting and Triassic (?) normal faulting (Roper and Dunn, in press).

THEORIES OF ORIGIN

Many ideas have been expressed concerning the structural geometry and tectonic origin of the Brevard Zone. A history of thought on this subject is outlined in the following order. The Brevard Zone has been considered to be:

1. An isoclinal syncline downfolded into Archean basement (Keith, 1905, 1907).
2. An overthrust fault related to the Martic overthrust (Jonas, 1932).
3. A syncline thrust faulted continuously along the southeast side in Georgia (Stose and Smith, 1939).
4. A normal fault coincident with the Blue Ridge front (White, 1950).
5. A dejective zone (King, 1955).
7. A right-lateral strike-slip fault zone (Reed and Bryant, 1964).
10. A left-lateral strike-slip fault zone with a thrust component (Reed, Bryant, and Myers, 1969; Conley and Henika, 1970).
11. A contact of a Caledonide-like Abscherungszone (Griffin, 1969a).
14. A zone of coaxially refolded and sheared-out isoclines (Roper, ms; Roper and Dunn, 1970b).
15. Simultaneously, the root zone of the Blue Ridge thrust sheet and a left-lateral strike-slip fault zone between oppressed subcontinental blocks (Reed, Bryant, and Myers, 1970; Bryant and Reed, 1970).
16. A bifurcated thrust fault or a refolded thrust (Bentley and Neathery, 1970).
17. A major fold complicated by trough faulting (Hurst, 1970).
20. A zone that experienced two periods of sheared-out isoclinal folding with accompanying polyphase metamorphism with late Paleozoic faulting superimposed upon earlier fold structures (Roper and Dunn, in press).

Most theories for the origin of the Brevard Zone rely on some mechanism of normal or thrust faulting or folding or some combination of these methods. However, one school of thought, supported mainly by Reed and others (1961); Reed and Bryant (1964); Reed, Bryant, and Myers (1970); Bryant and Reed (1969, 1970) suggest that the Brevard Zone is characterized by significant strike-slip movement. In recent years this view has been seriously challenged by Livingston (ms, p. 86-93), Dunn, Butler, and Justus (1968), Hatcher (1969b, p. 133-134; 1971, p. 189), Rodgers (1970, p. 184) and Stirewalt and Dunn (1973). A complete discussion concerning this controversy is beyond the scope of this paper. However, we would like to add that many of the papers listed by Reed and Bryant have recognized direct evidence for multiple deformation and polymetamorphism in the Brevard Zone.

Most theories about the Brevard Zone are limited to a tectonic structure of one genetic type and are usually shortlived, because they cannot account for many of the complexities that are associated with this structure. We propose that the Brevard Zone must be characterized as a polytectonic feature. This view was first expressed by Dunn, Butler, and Justus (1968) and Butler (1973); however, they did not attempt to explain it.

The polygenetic features observed in the Brevard Zone suggest that it has been involved in much of the Phanerozoic evolution of the southern Appalachians. Thus, in order to characterize this structure, it is necessary to evaluate the role that it played in the evolution of the southern Appalachians with respect to other related belts such as the Blue Ridge, the Inner Piedmont, and possibly the Kings Mountain belt. Until such relationships are more comprehensively understood, the polygenetic and tectonic significance of the Brevard Zone can only be speculated upon. However, speculation can be worthwhile if it stimulates controversy or new ideas. It is with this attitude that we offer our tentative interpretation of the evolution of the Brevard Zone.

TEC TONIC SYNTHESIS

We propose that the geologic history of the Brevard Zone can be characterized by three major phases of development. The first phase is related to the environment of deposition of Brevard lithologies, which lasted from the late Precambrian to early Ordovician. The second phase
is associated with two periods of tectonism involving sheared-out isoclinal folding and accompanying polyepisodic metamorphism. The first and most intense diastrophic movements probably are related to the Taconic orogeny. The later tectonic event, which culminated at the end of the Devonian, may be related to the Acadian orogeny. The completion of phase II resulted in the formation of the Brevard fold belt as it is defined in this text. The third phase of Brevard evolution is related to late faulting, which commenced during the later half of the Paleozoic era, and is superimposed along much, although not all, of the Brevard fold belt. Originally this shearing was probably related to thrust faulting, but later during the Triassic it may have changed locally to normal faulting along parts of the Brevard Zone being associated with relaxing compressional stresses.

Phase I.—The generalized tectonic setting for the first phase of development of the Brevard Zone, between the late Precambrian and early Ordovician, is illustrated in figure 4 and is similar to Hatcher’s (1972) phase 1 model of the evolution of the southern Appalachians. This geologic environment is characterized by a shallow unstable continental margin of the Atlantic type with an island arc similar to that described by Dewey and Bird (1970, p. 2641). We agree with Hatcher (1972) that the Slate-belt island arc, as well as another coexisting island arc paralleling the northern Appalachians, represented the leading edge of the North American block, which was overriding oceanic crust during this time. Similar volcanic and metavolcanic rocks described by Arnould, Aymé, and Guillaume (1959) and Sougy (1962) in the Mauritanides in west Africa may indicate another island arc off the coast of that continent. Presumably, this drifting of the North American and African continents was related to the closing of a proto-Atlantic Ocean in the early Paleozoic.

The stratigraphic sequence described by Hatcher (1969, 1970) and rock types such as graphite phyllonitic schist, marble, and amphibolite suggest that Brevard lithologies are volcanic and sedimentary in origin and compatible with the type of sediment that would be likely to form along a continental margin as depicted in figure 4. No accurate estimate

![Fig. 4. Schematic diagram illustrating environment of deposition of Brevard lithologies during late Precambrian or early Paleozoic.](image-url)
of the thickness of this sedimentary pile is feasible, but the long period of sedimentation (late Precambrian to Ordovician) and the location along the continental margin suggests that the volume was considerable.

**Phase II.**—Phase II in the evolution of the Brevard Zone is illustrated in figures 5 and 6. We agree with Hatcher (1972) that the present structural pattern of the Piedmont emerged at this time, which included the formation of the infrastructure of Wegmann (1935), or the Unterbau of Haller (1956), or the mobile core of Dewey and Bird (1970). These structures have been equated by Griffin (1970a, b) with the migmatitic Inner Piedmont. Butler (1972) and Hatcher (1972) have shown that the

![Taconic Tectonism Diagram](image)

Fig. 5. Schematic diagram illustrating environment of \( F_1 \) and \( M_1 \) tectonism of Brevard lithologies within the detachment zone during the Taconic orogeny. This orogenesis may be the product of an island arc-island arc collision resulting in the eastern part of the Blue Ridge, Piedmont, and Slate Belt island arc (not included in diagram) being accreted onto the North American continent. Plutonism not illustrated in diagram.

![Acadian Tectonism Diagram](image)

Fig. 6. Schematic diagram illustrating reactivation of Brevard detachment zone producing \( F_2 \) folding and \( M_2 \) metamorphism during Devonian tectonism. Plutonism not illustrated in diagram.
Polytectonic evolution of the Brevard Zone

Inner Piedmont and at least the eastern part of the Blue Ridge belt experienced intense deformation and metamorphism, which we interpret as F₁ and M₁, during the middle to late Ordovician, and possibly the early Silurian. Hess (1939), Rodgers (1971), Butler (1972), and Roper and Dunn (in press) indicate that the Taconic orogeny was probably the most intense tectonic event to affect the crystalline rocks of the southern Appalachians.

The authors agree with Griffin (1971) that Brevard lithologies represent sediments higher up in the sedimentary pile that were not migmatized during formation of the infrastructure, and are structurally equivalent to the transition or detachment zone of Wegmann (1935) or Abscherungszone of Haller (1956). Furthermore, Roper and Dunn (in press) have shown that M₁ metamorphism of Brevard lithologies is about the same grade (kyanite to possibly sillimanite grade of amphibolite facies) as Blue Ridge and Inner Piedmont rocks adjacent to it. The most significant difference between Brevard rocks and the infrastructure of the Inner Piedmont is the more intense shearing and lack of migmatization in the former. Thus, the first tectonic phase in the evolution of the Brevard Zone was probably the sole of the detachment zone between infrastructure and the overlying transition zone, a tectonic environment compatible with F₁ sheared-out isoclinal folding and M₁ polyphase metamorphism.

Hatcher (1972) postulates that the heat responsible for mobilization of the basement and superjacent sedimentary rocks was generated along a subduction zone that originated east of the Slate-belt volcanic arc. He also indicates that the Atlantic-type continental margin with an island arc became transformed into a Cordilleran-type coast during the Ordovician and Silurian, a change related to the deformation of Piedmont and Blue Ridge sediments. However, Hatcher (1972) provides no explanation for the transformation of the southeastern North American coast to a Cordilleran-type of continental margin, or the cessation of volcanic activity in the Slate belt during the late Ordovician. We suggest, as an alternate possibility, that an island arc-island arc or a continent-island arc collision may have occurred during this time between North America and Africa (depending on whether or not an island arc existed off the west coast of Africa during the early Paleozoic), culminating in the accretion of the Piedmont belt and Slate-belt volcanic arc onto the North American continent. Evidence supporting this interpretation is suggested by Williams (1969) and Whittington and Hughes (1972) who have noted the progressive increase in similarity of brachiopod and trilobite assemblages in the northern Appalachians and Caledonian orogen through the Ordovician. This trend toward a cosmopolitan fauna climaxes in the late Ordovician, suggesting that pre-existing barriers to migration between these areas were removed during this period of time. According to Whittington and Hughes (1972) this faunal convergence is
interpreted as being related to the closing of an early proto-Atlantic ocean during the Ordovician period.

The second episode of tectonism associated with the evolution of the Brevard Zone is illustrated in figure 6 and presumably was related to the Acadian orogeny. The second deformation produced overturned to isoclinal F₂ folds and M₂ polyphase metamorphism. The timing of this event is based upon radiogenic dates of Devonian age by Long, Kulp, and Eckelman (1959) on the Mt. Airy Granodiorite which cuts across F₁ and F₂ folds (Butler and Dunn, 1968) in the Brevard Zone, as well as a similar age determined from mylonites by Odom and Fullager (1970) in this structure.

The effects of this orogeny reactivated the infrastructure and transition zone. The nature of this tectonism is best described by what we propose is a type of continental plate tectonics, whereby accreted continental plates such as the Inner Piedmont are redeformed by open folding in the middle, and tightly refolded and sheared along the margins or along planes of weakness within the plate. This interpretation implies that original planes of shearing are reused and would enhance the development of a wide zone of cataclasis, such as characterizes the Brevard Zone. Redeformation of accreted plates and their boundaries apparently did not produce as intense deformation and metamorphism as the first orogeny, which formed the major geologic provinces of the southern crystalline Appalachians.

Hatcher (1972) postulates that this tectonic activity marks the initial stages of collision between North America and Africa, which continued throughout the remainder of the Paleozoic. Earlier, Bird and Dewey (1970) postulated from their tectonic model of the northern Appalachians that North America and Africa collided at this time resulting in the Acadian orogeny.

Fig. 7. Schematic diagram illustrating the Blue Ridge and western Inner Piedmont being thrust over the Valley and Ridge province together as a continuous sheet during the late Paleozoic. Decoupling of the Blue Ridge from the Inner Piedmont occurred along parts of the Brevard Zone during this tectonism, commencing the first stage of development of the Brevard fault zone. Plutonism not illustrated in diagram.
Hatcher's views correspond most closely to the plate tectonic model we proposed earlier. From our model, we would predict that the Silurian and part of the Devonian were relatively quiet tectonic periods which involved the closing of marginal seas that existed between the deactivated island-arcs and the North American and African continents. Constriction of these marginal seas would facilitate migration of benthonic marine fauna allowing a cosmopolitan distribution of such organisms over wide areas. Evidence supporting this view is presented by Johnson (1971), Holland (1971), House (1971), and Ager (1971), who have noted the pronounced cosmopolitan fauna in the Appalachians and other parts of the world during this span of time.

This view has the advantage of accounting for the somewhat less intense tectonic effects noted for the second deformation. The initial impact of colliding island arcs or continent-island arc during the Taconic orogeny explains both the intense deformation and metamorphism experienced during this diastrophism. Unconsolidated sediments are easily deformed, and resulting metamorphism from compressional forces recrystallized large portions of this material into metamorphic rock. M3 polymetamorphic phases suggest a long and complex history which is compatible with such an event. The recrystallized metasediments of the Piedmont would then act as a more resistant buttress against a second collision in the Devonian between the North American and African continents. Thus, the most intense deformation of the newly accreted continental margin would be along older planes of weakness within these continental margin plates.

Phase III.—The tectonic history of the Brevard Zone according to our model experienced a different type of tectonic activity after the Devonian, which is characterized by faulting and retrogression rather than folding and polyepisodic metamorphism. As noted earlier in the text, radiogenic dates suggest a long history of movement along the Brevard Zone which began early in the Carboniferous and culminated in the late Permian.

Hatcher (1972) proposes that thrusting of the Blue Ridge belt over the Valley and Ridge physiographic province during the Alleghanian orogeny required compressional stresses of the same order of magnitude as the Mid-Paleozoic event, resulting in a final closing of the Atlantic and collision between southeastern North America and Africa. We agree with this interpretation but hasten to add that the Alleghanian orogeny during the Permian probably marks the culmination of the collision between North America and Africa. We postulate that the initial collision between North America and Africa involved some plastic deformation of the continental margins, which eventually transmitted this strain to shear along planes of weakness within the continental margin plates. However, retrogression related to late shearing along the Brevard Zone does not appear to be of great intensity, suggesting that this faulting, which is believed to be characterized by thrusting, served primarily to decouple
the Inner Piedmont belt from the Blue Ridge belt rather than being manifested as a major thrusting event, as suggested by Reed and Bryant (1964), Bryant and Reed (1970), Bryant, Reed, and Myers (1970), and Hatcher (1971) (1972). Therefore, we propose that the thrusting of the Blue Ridge over the Valley and Ridge physiographic province during the late Paleozoic was accomplished by one large sheet or plate which included the Inner Piedmont. The extent of this overthrusting probably coincides approximately with the western edge of the Inner Piedmont infrastructure which slightly overlies the eastern edge of the Valley and Ridge Province. The formation of the Brevard fault zone discussed earlier in this paper commenced with shearing associated with this decoupling event which began in the early Carboniferous.

Later, perhaps during the late Permian or early Triassic, rifting of the Pangea supercontinent caused extensional faulting throughout much of the Piedmont. The Brevard Zone seems to delineate the approximate western boundary of this tensional faulting in much of the southern Appalachians. Thus, locally thrusting may have changed to normal faulting during this time along parts of the Brevard, being associated with relaxing compressional stresses. The most likely place where such normal faulting may be superimposed on the Brevard would be along its eastern branch in the northern end of the Brevard. Here Butler and Dunn (1968) have shown that the Stony Ridge en echelon faults connect with the border fault of the Dan River Triassic basin to the north and also intersect the Brevard Zone to the southwest. Stonebraker and Harker (1973) suggest from K-Ar mica ages that this faulting may be late Permian in age. Late Permian or Triassic normal faulting might also be anticipated along portions of the Brevard that parallel the Blue Ridge front as shown in figure 8 and locally may enhance the topographic relief of that contact as suggested by White (1950). However, these localities constitute only a small portion of the total length of the Brevard Zone. Therefore, although we acknowledge that this type of faulting may have

Fig. 8. Schematic diagram illustrating the last major tectonic movements along the Brevard Zone which are postulated as normal faulting near the eastern edge of the underlying Valley and Ridge province where late Paleozoic overthrusting originated. This faulting may have begun in the late Permian or early Triassic and locally may enhance the relief of the Blue Ridge front. The fault zone is superimposed upon the fold zone in this illustration.
occurred along parts of the Brevard, we do not mean to imply that it played a significant role in the development of the Brevard Zone.

Interpretation of these events in terms of plate tectonic theory is convenient for F₁, M₁, F₂, M₂, and possibly M₃. Simplified global plate-tectonic models, as they exist today, provide a stimulating perspective from which to interpret regional geology, but the analogies attached to such models are still speculative and controversial as witnessed by the differences in interpretation proposed by Bird and Dewey (1970) and Hatcher (1972) and the views expressed in this paper.

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