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GEORGIA GEOLOGIC SURVEY

GEOLOGIC REPORT 6

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ABSTRACT

Analysis of structural and stratigraphic trends in the Floyd synclinorium in northwestern Georgia, combined with published information regarding the subsurface in the Valley and Ridge Province in Alabama and Tennessee, indicate that down-to-the-basin basement faults, reactivated during the Paleozoic in Alabama, extend into the subsurface of northwestern Georgia but may not extend to any significant degree into Tennessee. These basement faults, which influenced depositional and structural patterns in Alabama, had comparable influence in Georgia. Two main orientations of basement faults are postulated, one in a NNE direction parallel with main Valley and Ridge structures, and the other in an ENE direction which determined location and geometry of cross folds and faults.

INTRODUCTION

Literature dealing with the structure and stratigraphy of the southern Appalachians indicates that most or all of the major basement faults in the subsurface of the Valley and Ridge Province in Alabama die out northeastward along the structural trend in northwestern Georgia. Coincident with the northeastward diminution of basement faulting are other structural and stratigraphic changes. The Floyd synclinorium, in northwestern Georgia, lies along the trend of the Alabama basement structures. The purpose of this paper is to review the main changes along and across the Floyd synclinorium (Fig. 1) and to make interpretations regarding basement influence on structural and stratigraphic relationships in northwestern Georgia.

REGIONAL STRUCTURAL FEATURES

Basement Faults

In his analysis of a seismic profile for east-central Tennessee, between the Kingston and Saltville thrusts, Harris (1976) indicated that the basement-sedimentary cover contact has little relief and that basement is not involved in deformation of the sedimentary cover. He interpreted apparent broad warps of the basement and overlying sedimentary sequence in the profile as probable "acoustically produced pull-ups related to the contrasts in relative velocities of energy impulses in different rock units" (Harris, 1976, p. 381). Likewise, Woodward (1985, p. 44-51) depicted no basement faults in his series of

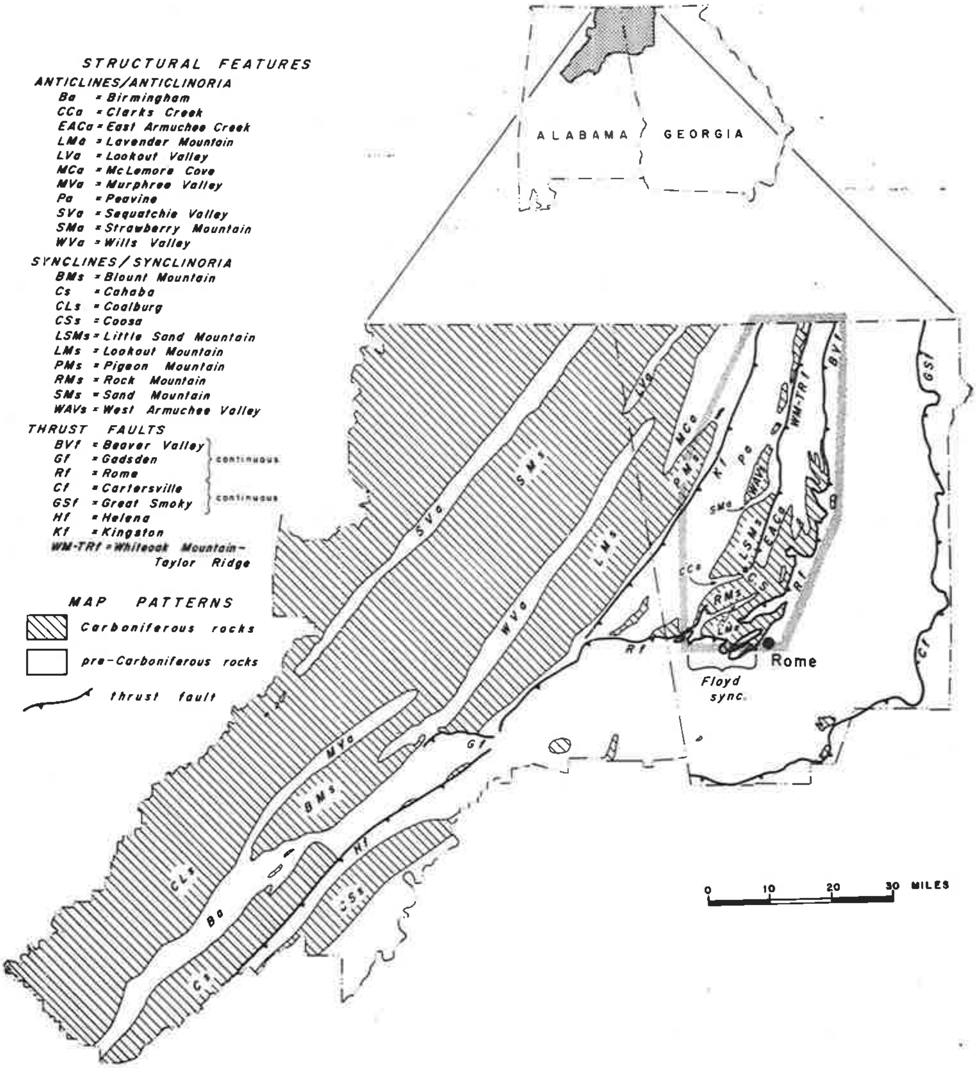


Figure 1. Main structural features and distribution of Paleozoic rocks in northeastern Alabama and northwestern Georgia (from Butts *in* Adams, and others, 1926, and Lawton, Marsalis, and others, 1976, respectively). The Floyd synclinorium (indicated by bracket) comprises areas of Carboniferous rocks between the Peavine anticlinorium (Pa) and the Rome fault (Rf). Location of Crystal Springs (C.S.) Georgia, at the south terminus of the Whiteoak Mountain-Taylor Ridge fault is shown. Area involved in Fig. 2 is outlined by stippled border.

balanced cross sections across eastern Tennessee.

By contrast, Thomas (1982) and Kaygi and others (1983), suggested that sedimentary history and structural style in the Valley and Ridge in Alabama were controlled by basement faults with as much as 10,000 feet of displacement. They related the basement faulting to Precambrian rifting of the North American continental margin as suggested by Thomas (1977).

Thomas' (1985, p. 54-61) balanced cross sections indicate between 9,800 and 13,125 ft of relief between rocks under the trend encompassing the Lookout Mountain, Blount Mountain and Coalburg synclines (northwestern domain of Thomas) and basement rocks beneath the structural trend comprising the southern extension of the Floyd synclinorium (beneath the Rome thrust sheet) and the Coosa and Cahaba synclinoria (central domain of Thomas). According to Thomas' cross sections, displacements on the down-to-the-southeast faults decrease toward the northeast from 13,125 ft below the west limb of the Cahaba syncline to 11,500 ft underneath the west limb of the Coosa syncline to 9,800 ft beneath the Rome fault east of the Lookout Mountain syncline, about 17 miles southwest of the Georgia State line. If this zone of northeastward diminishing down-to-the-southeast faulting extends northeastward into Georgia, but does not continue into Tennessee, then Georgia contains the passage from Alabama structural styles into those characteristic of eastern Tennessee.

Rome Fault

The Rome fault (Fig. 1) was named by Hayes (1891) for its passage through Rome, Georgia. In that area, the fault is a very low angle thrust, and the trace is markedly sinuous. Preservation of the thrust in synclinal structures suggests that folding followed emplacement of the hanging wall (Hayes, 1891; Butts, 1948). North of Rome, the sinuosity diminishes to just north of Hill City, Georgia, 26 miles NNE of Rome, where the fault is more or less parallel with regional folds, and its easterly dip steepens to more than 35 degrees (Butts, 1948; Woodward, 1985). The fault continues into Tennessee as the Beaver Valley fault (Woodward, 1985) which, according to Rodgers (1970), is part of the Saltville fault system.

At Rome, the Rome fault turns westward for a distance of 30 miles (Fig. 1), crossing into Alabama and cutting diagonally across regional strike. It then turns southwestward and trends parallel with the front of Lookout Mountain for 22 miles. Agreement, however, has not been reached as to what happens to the fault from that point westward and southwestward (Butts *in* Adams and others, 1926; Causey, 1961; Rodgers, 1970; Thomas, 1985; Chowns, 1986).

The combination of the westward turning of the Rome fault trace, the apparent cutting across and apparent overriding of regional structural trends, the marked southward and southwestward change in dip, and the apparent infolding of the overthrust rocks have been variously interpreted. Hayes (1891) and Butts (1948) regarded the Rome overthrust mass as having been originally relatively flat and much more extensive, and that later infolding of the thrust sheet coupled with subsequent erosion resulted in the present outcrop patterns. Cressler (1970, 1974) drew similar conclusions. In his analysis of Appalachian tectonics, Rodgers (1970) pointed to the relationships between the Rome fault and its continuation into southeastern Tennessee as the Saltville fault system. He concluded that the recess formed by westward turning of the Rome fault in the Rome area corresponds to a deep depression and that the faults of the Saltville system converge upward into the Rome fault which constitutes a "ceiling". Boyer and Elliot (1982) suggested that such relationships indicate an oblique section through a duplex roofed by the Rome fault.

Whiteoak Mountain-Taylor Ridge Fault

The Whiteoak Mountain-Taylor Ridge fault (Figs. 1, 2) is the southernmost segment of the Clinchport thrust fault which can be traced 380 miles from Virginia through Tennessee to the vicinity of Crystal Springs, Georgia (Fig. 1), located about 10 miles north of Rome (Harris, 1965). In Tennessee, the fault has one of the largest stratigraphic throws in the Valley and Ridge Province, but, beginning about 40 miles north of the Georgia State line, the stratigraphic displacement gradually diminishes southwestward along the trace (Rodgers, 1970) to Crystal Springs. Rich (1982, 1986) and Chowns (1986) discussed evidence related to southward extension of the fault, but whether or not the fault does indeed extend south and southwest beyond Crystal Springs has not been established. Exposures of the fault zone at Crystal Springs suggest that the fault may die out in a zone bringing Fort Payne Chert against Fort Payne Chert. Disturbed zones, as defined by Pohn and Purdy (1982), are present along the north limbs of the Clarks Creek and Lavender Mountain anticlines (Figs. 1, 2). The west limb of the East Armuchee Creek anticline is probably such a disturbed zone, and Crawford (1983) reported a disturbed zone on the southeast side of the Little Sand Mountain syncline just north of Crystal Springs. It may be that the disturbed zones constitute a transfer zone (Dahlstrom, 1969) in response to arcuation of the structural trend just north of the Rome fault.

Oblique Anticlines in the Floyd Synclinorium

The Floyd synclinorium is an irregular structure which narrows north of the West Armuchee Valley syncline into a culmination that continues along Taylor Ridge and Whiteoak Mountain into southeastern Tennessee. South of West Armuchee Valley, the synclinorium widens southwest to where it disappears beneath the Rome thrust sheet west of Rome. The structure is divided into east and west parts by the N-S trending Whiteoak Mountain-Taylor Ridge fault (Figs. 1, 2). The eastern part includes Rock Mountain and synclinal lobes to the northeast that are between the East Armuchee Creek anticline and the Rome fault. The western part includes the Little Sand Mountain and West Armuchee Valley synclines; deformation in this part of the synclinorium increases toward the Whiteoak Mountain-Taylor Ridge fault (Morris, 1987). In a north-south direction, the Floyd synclinorium is broken by three narrow obliquely trending anticlines: Strawberry Mountain, Clarks Creek, and Lavender Mountain, which trend at angles of 40, 58, and 48 degrees (average 49 degrees), respectively, to the main structural trend (Figs.

FIGURE 2 ON REVERSE

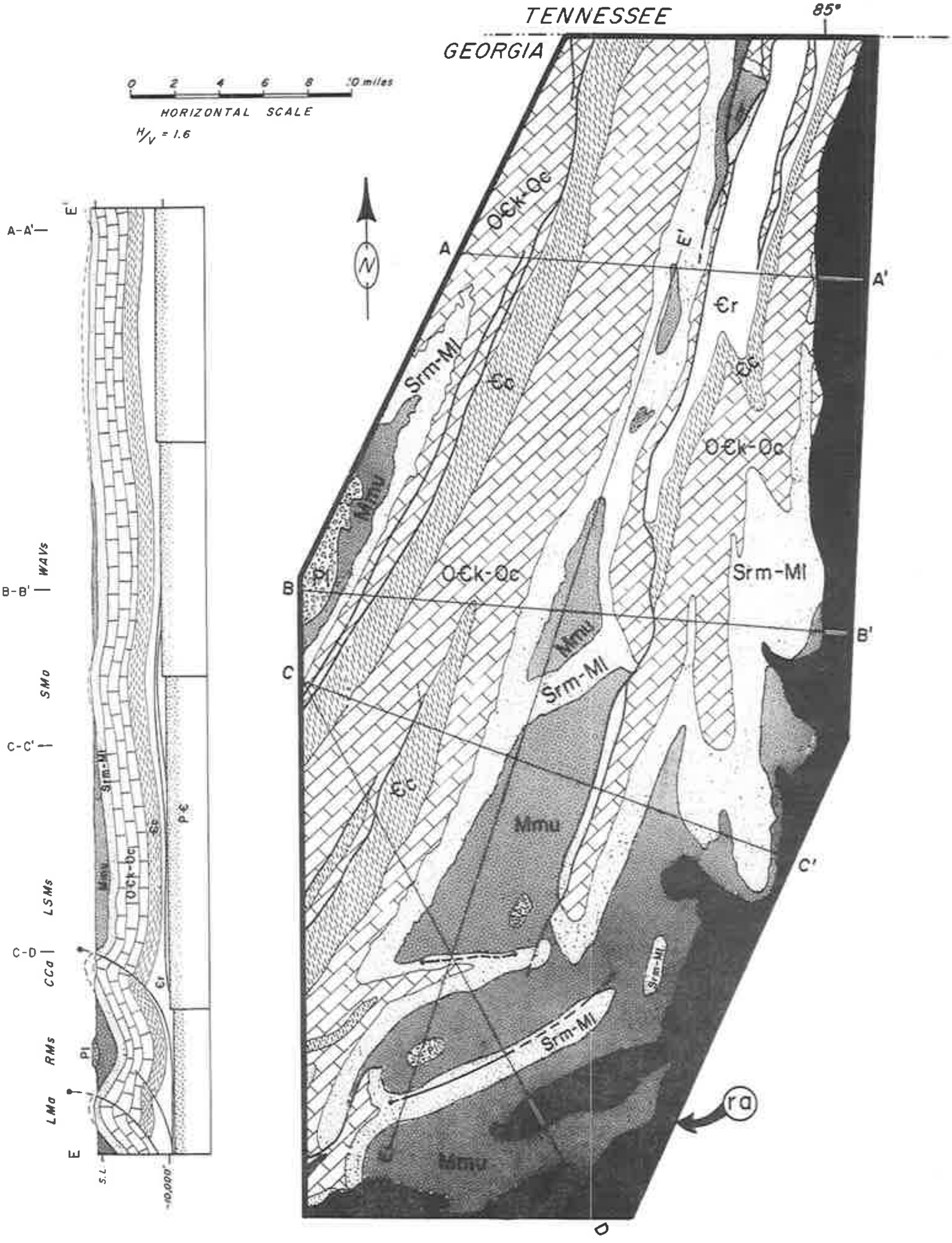
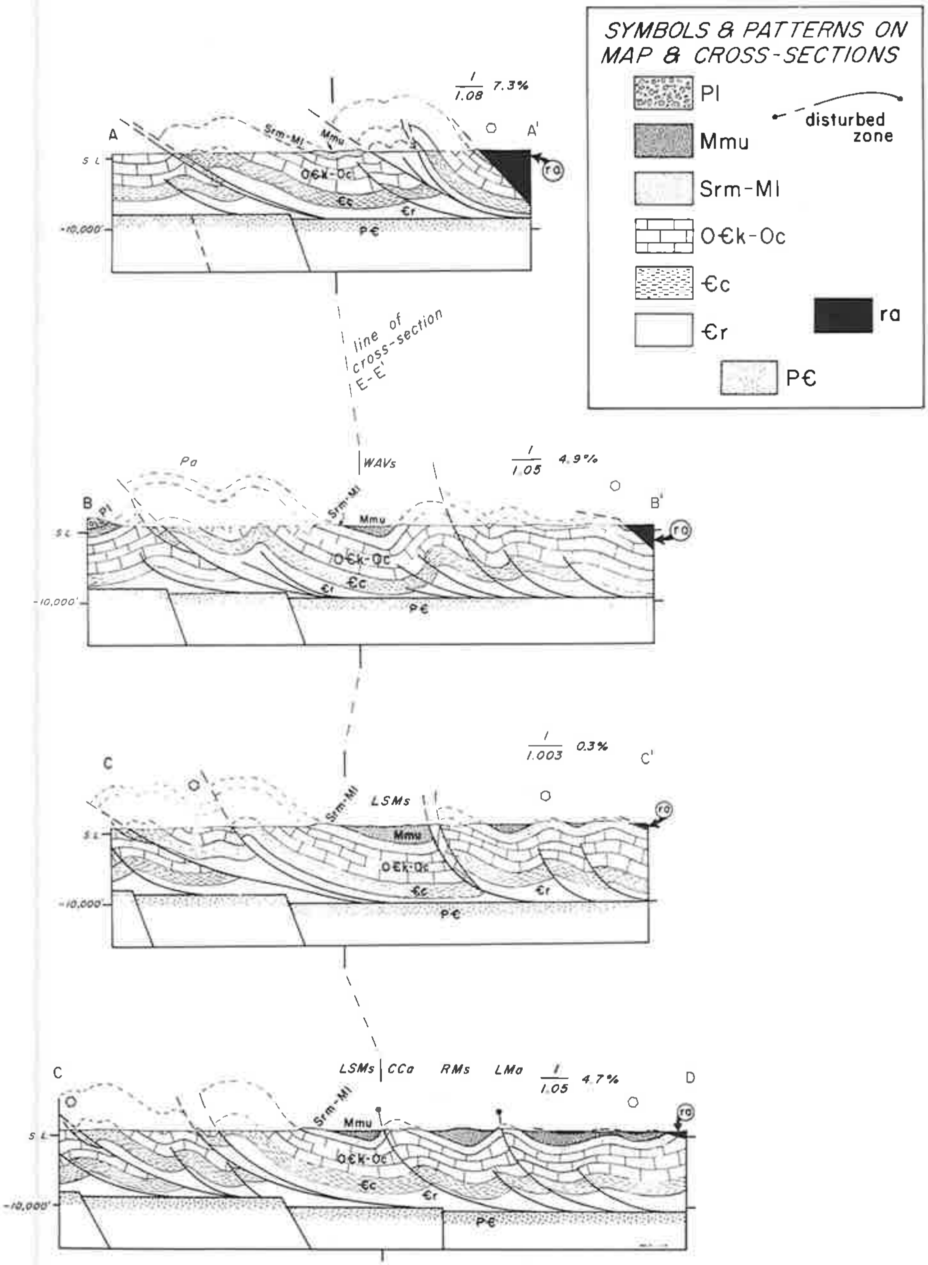


Figure 2. Generalized map and structure sections of the Floyd synclinorium and surrounding area (see Note on Cross Sections at end of paper). Map generalized and modified from Cressler (1963, 1964a, 1964b, 1970, 1974) and Lawton, Marsalis, and others (1976). Location of area is shown in Fig. 1. Anticlines indicated on cross sections: Pa = Peavine; CCa = Clarks Creek; LMa = Lavender Mountain; SMa = Strawberry Mountain. Synclines indicated: WAVs = West Armuchee Valley; LSMs = Little Sand Mountain; RMs = Rock Mountain.



Explanation of symbols and patterns: P€ = Precambrian basement rocks, €r = Rome Formation, €c = Conasauga Group, O€K-Oc = Knox and Chickamauga Groups, Srm-Ml = Red Mountain and Fort Payne Formations, Mmu = Middle and Upper Mississippian rocks, Pl = Pennsylvanian rocks, ra = Rome allochthon.

1, 2). The anticlines and broader synclinal structures making up the synclinorium are reminiscent of large kink-band folds (Faill, 1973).

Rising Fawn Cross-Strike Structural Discontinuity

Much of the southern portion of the Floyd synclinorium (Fig. 1) lies within the Rising Fawn cross-strike structural discontinuity (Thomas, 1982, 1985). This SE trending zone extends as a narrow band about 10 miles wide, across the structural grain of the Valley and Ridge region in Georgia. It encompasses the ENE striking Strawberry Mountain and Clarks Creek anticlines and the intervening Little Sand Mountain syncline and corresponds to the zone of strongest westward arcuation of Appalachian trends in Georgia.

Wheeler and others (1979) described the nature of cross-strike structural discontinuities (CSDs) in some detail. They indicated that CSDs are fundamental to thrust belts and that they correspond to "...map-scale structural lineaments or alignments, at high angles to regional strikes, and best recognized as disruptions in strikeparallel structural or geomorphic patterns." (Wheeler and others, 1979, p. 194). They (Wheeler and others, 1979, p. 196) further stated, "Basement (suballochthon rock and structure) may or may not be involved in any given CSD. Basement involvement can be active, the basement becoming part of the final CSD, or it can be passive, the older inactive basement structures influencing formation of structures in an allochthon passing overhead."

In a study of the Bangor Limestone in Georgia, I (Rich, 1986) interpreted the oblique anticlinal structures in the Floyd synclinorium segment of the Rising Fawn CSD as having formed in response to reactivation of transform fault segments that were originally part of the rift and transform system that, according to Thomas (1977), developed along the North American continental margin in late Precambrian time. In addition, I indicated that, if the reactivation of basement faults involved right lateral movements, then couples of force would have been produced, which could have generated cross folding in the overlying sedimentary cover. These interpretations were in keeping with the view of Thomas (1982) who noted that CSDs in the southern Appalachians may represent progradation of deformation upward from reactivated basement faults into an overlying detached cover sequence. Coleman (1986, 1988) also considered the Rising Fawn CSD as a long-lasting feature, ranging from Precambrian to Recent. His findings indicated that at various times the zone exerted influence over depositional facies, economic deposits, decollement thrusting, ductile folding, and erosional patterns.

STRATIGRAPHIC TRENDS

East-West Facies and Thickness Changes

Northwest of the Peavine anticlinorium, along Lookout Mountain, the post-Fort Payne Mississippian sequence is about 1150 ft thick and is almost exclusively of shallow water origin. In the Floyd synclinorium, the sequence ranges from 2000 to 2670 ft and probably was deposited under conditions of lower energy and greater depth (Rich, 1982, 1986; Algeo, 1985). Coarsening upward terrigenous sequences in the Upper Mississippian-Lower Pennsylvanian interval in the synclinorium indicate periodic overlap from an unknown terrigenous source to the east and southeast. The marked changes in Paleozoic stratigraphy across the Peavine anticlinorium can, in part at least, be explained by reactivation of steep down-to-southeast basement faults which controlled the sedimentary framework (Rich, 1986).

North-South Facies and Thickness Changes

Thomas (1979, Fig. 4) and Rich (1986, Figs. 4, 5) showed that there is significant thickening of Mississippian rocks from north to south along the Floyd synclinorium. Moreover, Thomas (1979, p. H13, Fig. 8C) noted the likelihood that depositional strike crosses present structural strike along the western segment of the synclinorium about 30 to 40 miles north of Rome. These relationships suggest the possibility that down-to-the-SSE basement faults were reactivated during late Paleozoic time, and that they exerted a control over thickness and facies trends.

DISCUSSION AND INTERPRETATIONS

Down-to-the-southeast basement fault trends documented for the Alabama Valley and Ridge belt (Kaygi and others, 1983; Thomas, 1985) in all likelihood continue into northwestern Georgia (Figs. 2, 3). This idea is supported by projecting the Alabama trends into Georgia and by the stratigraphic contrasts on either side of the Peavine anticlinorium. Evidence thus far is lacking that basement faults with large displacements played a comparable role in Paleozoic thrust fault development in the Valley and Ridge Province in Tennessee. It may be that the "pull-ups: cited by Harris (1976) represent, in part at least, some degree of basement relief below the regional decollement in that area.

Southward plunge of hanging wall folds along the east side of the Whiteoak Mountain-Taylor Ridge fault, beginning a short distance north of the Georgia-Tennessee line, and the concomitant decrease in stratigraphic displacement southward along the fault suggest a possible depression of the basement along the axis of the Floyd synclinorium which is divided into east and west segments by the fault. In addition, north to south facies and thickness trends in the Mississippian System lend credence to the idea that reactivated basement, perhaps down-to-the-south, influenced the depositional framework along the Floyd synclinorium. Thus two directions of basement fault trends are postulated, one more or less parallel with main Valley and Ridge structures and one oblique to main structural grain.

Bearing these ideas in mind, and in the absence of seismic reflection data, the following are the main interpretations derived from the analysis of regional structural and stratigraphic trends:

1. In the southern Appalachians, steep basement faults, produced during late Precambrian rifting of the North American continental margin, were reactivated intermittently during the Paleozoic. These faults played a significant role in the Mississippian

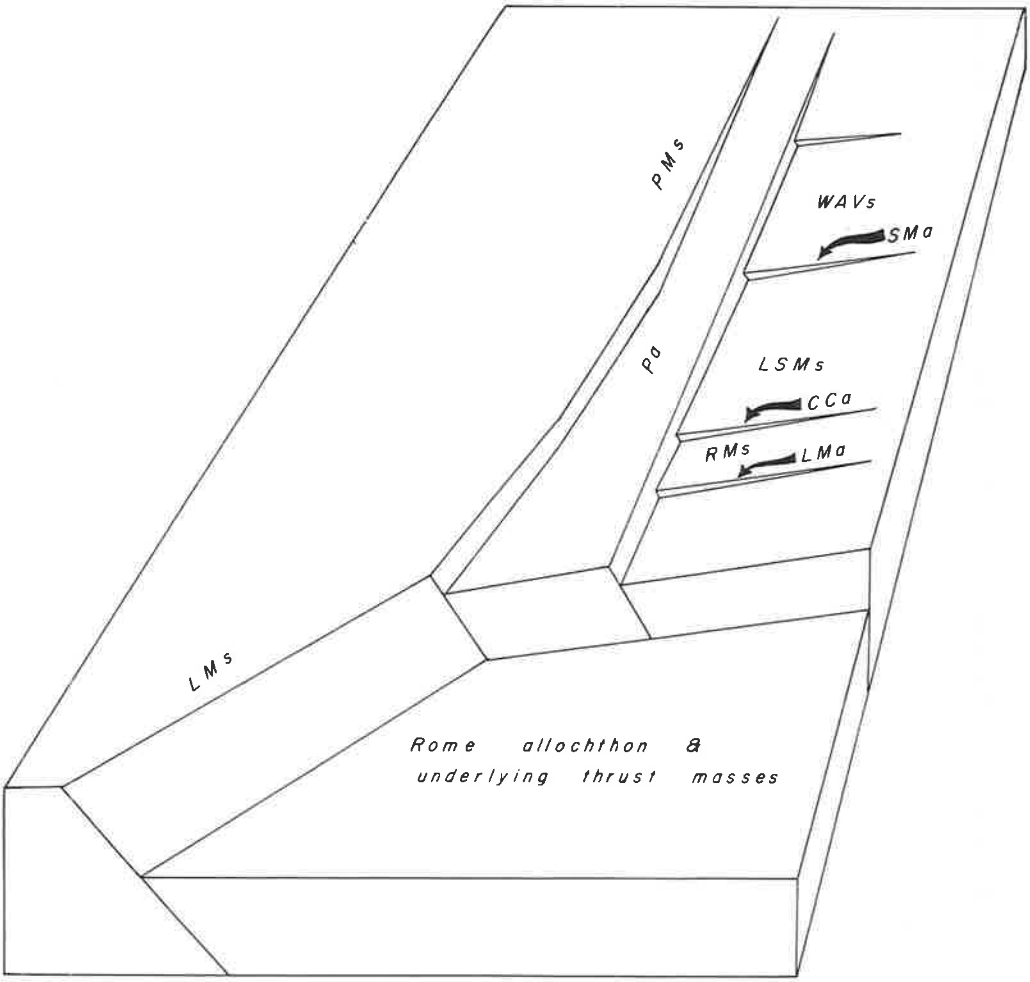


Figure 3. Hypothetical basement configuration in and around the Floyd synclinorium to show relationship to surficial structures. Displacements are generalized and are meant only to show approximate positions of postulated faults. Along right side of block is toward the NNE. Cross faults, which may have right lateral components that are not shown here, are presumed to be at an angle of about 50 degrees to the longitudinal ones. Positions of surficial structures (Fig. 1) relative to the postulated basement structures are indicated. Synclines: LMs = Lookout Mountain; PMs = Pigeon Mountain; WAVs = West Armuchee Valley; LSMs = Little Sand Mountain; RMs = Rock Mountain. Anticlines: Pa = Peavine; SMa = Strawberry Mountain; CCa = Clarks Creek; LMa = Lavender Mountain.

sedimentary framework and in influencing the locations and geometry of folds and thrust faults produced during the Alleghany orogeny.

2. Trends of surface structures and facies/thickness belts suggest that there are two main orientations of steep basement faults in the northwest Georgia area (Fig. 3). One, mostly down to the southeast, strikes in a NNE direction more or less parallel with main Valley and Ridge trend. The other is in an ENE direction, down mostly to the south, but with a possible right lateral component. The lateral component is suggested by the change in direction in the Floyd synclinorium of the predominant NNE trends in Alabama and Tennessee. ENE structures, postulated to be surface manifestations of basement faults, include the tight anticlinal structures oblique to the main axis of the western segment of the Floyd synclinorium. Such a bi-directional configuration of steep faults intersecting at oblique angles is known along passive continental margins that have undergone progressive rifting (Boillot and others, 1979; Courtillot, 1982).
3. The relationship between the postulated ENE faults noted above and the SE trending Rising Fawn CSD is unknown. It is probable that basement structures played a significant role in development of that CSD (Rich, 1986; Coleman, 1988). Regional orientation of the Rising Fawn CSD and evidence of lateral movement along its trend (Coleman, 1988) suggest the possibility that the fault underlying the Rising Fawn CSD originated as a transform segment along the late Precambrian continental margin (Rich, 1986). The ENE faults would then represent an en echelon set oblique to that transform segment.
4. The Whiteoak Mountain-Taylor Ridge fault probably dies out at Crystal Springs as was originally mapped by Butts (1948), and horizontal displacement probably shifted to a belt of "disturbed zones" in the recess within the Floyd synclinorium. This belt acted as a "transfer zone" (Dahlstrom, 1969), and it is likely that this zone continues southwestward beneath the Rome fault and somehow links up with the northeastern extension of the Helena fault of Alabama. Chowns (1986) and Rich (1986) presented evidence for the equivalence of the Helena and Whiteoak Mountain-Taylor Ridge (Clinchport) faults. If the Helena and Whiteoak Mountain-Taylor Ridge faults are linked by a transfer zone, then a case can be made that early down-to-the-southeast basement faults were a major causal factor in producing thrust slices that extended longitudinally over great distances along the Appalachian trend as relatively continuous tectonostratigraphic packages. Shifts in direction of the thrust sheets would then bear a relation to shifts in trends of the underlying basement blocks.
5. The Rome fault in its type area is, as Rodgers (1970) pointed out, indicative of a fairly deep depression. I interpret the northern boundary of this depression to be a down-to-the-SSE fault oblique to main Valley and Ridge structural trend in the area (SE corner of Fig. 3). It is further postulated that the basement fault controlling Rome thrust configuration more or less parallels basement faults beneath the Clarks Creek and Lavender Mountain anticlines. It should be noted that the Rome fault probably developed in a tectonic setting much like that of the Pulaski thrust of Virginia with which it bears a striking similarity,

especially for the area between Pulaski and Roanoke (Rodgers, 1970).

6. Major thrusting was, in large part, an uphill process directed over reactivated basement uplifts; duplex formation, if it occurred, may have been induced partly by buttressing affect of such basement features.

NOTE ON CROSS SECTIONS

The structure sections in Fig. 2 were not constructed according to prescribed balancing techniques (Woodward and others, 1985) and no depth to detachment calculations were made. However, checking of degree of balance was achieved to some extent by comparing the length of the Ꞓc/Ꞓr contact with the length of the Srm-Ml/OꞒk-Oc contact in each of the four cross sections to the right of the map and by determining the ratios and percentage differences. Thus at the top right of each of those cross sections, the fractional number represents the ratio between the length of the Srm-Ml/OꞒk-Oc contact to the consistently greater length of the Ꞓc/Ꞓr contact. The percentage number refers to the percentage difference between those lengths. Length measurements were made on the original drawing (before reduction scale of 1" = 2.05 miles) with an Altek AC908M Super Micro Digitizer having an accuracy to .005 inches. In sections A-A' and B-B', measurements were made from the left (west) sides to perpendiculars to bedding near the right (east) sides as represented in skyward projections by the open hexagons. In structure sections C-C' and C-D, the length of contact measurements were made between axial surfaces on the left (northwest) sides (represented skyward by open hexagons) and axial surfaces near the right (southeast) sides which, where projected skyward, would intersect the open hexagons. Establishing of such reference lines at axial surfaces assumes no interbed slip along the hinges (Dahlstrom, 1969; Woodward and others, 1985).

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