GEOLOGY OF THE GREATER ATLANTA REGION

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Department of Natural Resources
Environmental Protection Division
Georgia Geologic Survey

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Cover and title page photo: Atlanta skyline looking west from Glen Iris overpass on Boulevard, May 1984.

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ABSTRACT

The oldest rocks present in the Greater Atlanta Region (i.e., Corbin Gneiss Complex) are exposed in the crest of the Salem Church anticlinorium, a major northeast trending fold in the Blue Ridge portion of the study area. Nonconformably overlying these 1 b.y.-old Grenville gneisses are metasedimentary rocks of the Pinelog and Wilhite Formations. These two formations are interpreted as lithostratigraphic equivalents of units within the late Precambrian Snowbird and Walden Creek Groups of the Ocoee Supergroup. Stratigraphically above the Wilhite Formation is a metamorphosed clastic sequence that is interpreted as a lithostratigraphic equivalent of the Great Smoky Group as defined to the northeast of the study area. Rocks of the Murphy belt group are exposed in the Murphy synclinorium conformably above the Great Smoky Group. The Murphy belt group is composed predominantly of a metamorphosed succession of clastic rocks and also includes the Murphy Marble. The Murphy belt group does not extend southwest of the Murphy synclinorium east of Cartersville; however, rocks of the Great Smoky Group trend around the reentrant in the Cartersville fault into what is referred to as the Talladega belt. Units of the Talladega belt in this area are at least partially equivalent to the Ocoee Supergroup and therefore are late Precambrian in age.

Lithologic units of the Blue Ridge are separated from the rocks of the northern Piedmont by the Allatoona fault. The northern Piedmont can be divided into two major lithologic units, New Georgia and Sandy Springs Groups. The New Georgia Group is interpreted to contain the oldest units in this portion of the northern Piedmont and is characterized by a metamorphosed sequence of predominantly felsic and mafic volcanic and plutonic lithologies. The Sandy Springs Group is interpreted to conformably overlie the New Georgia Group and is composed dominantly of interlayered metavolcanic and metasedimentary rocks with a decreasing metavolcanic component upward in the stratigraphic sequence. Eastern and western belts of the Sandy Springs Group are separated by the Chattahoochee fault, a major tectonic boundary in the northern Piedmont.

Northern Piedmont rocks are separated from similar lithologies and stratigraphic sequences in the southern Piedmont by the Brevard fault zone. In the Greater Atlanta Regional Map area, the Brevard zone is a zone of early ductile and late, brittle shearing that is interpreted to have formed, at least in part, as a result of high strain along the axial zone of a large F_1 isocline. No major vertical displacement is apparent along this segment of the Brevard zone.

South of the Brevard fault zone, units defined as Atlanta Group by previous workers are interpreted in this report to be exposed in a large-scale synformal anticline. The Atlanta Group is characterized by metamorphosed sedimentary and volcanic rocks that have many similarities to lithologies north of the Brevard zone. Possible correlations between the Atlanta Group and the New Georgia and Sandy Springs Groups are presented in this report.

Paleozoic plutonic rocks present within the Greater Atlanta Regional Map area are divided into three major categories based upon chemical composition, depth of intrusion and time of intrusion relative to Paleozoic metamorphism. Earliest (category 1) intrusions were emplaced at shallow levels coincident with volcanism, are concordant to the regional trend, and are characterized by dacitic subvolcanic plutons and volcanics. Category 2 plutons were intruded syntectonically, at an intermediate level in the crust, and are characterized by moderately high concentrations of potassium, nearly concordant contacts with the country rocks and a lack of any association with volcanism. Both category 1 and 2 plutons have a metamorphic overprint. The final category of Paleozoic intrusive rocks present in the study area is dominantly granitic in composition, lacks a metamorphic overprint, is discordant to the regional trend and does not have a volcanic component. Plutons of category 3 are known to occur only south of the Brevard fault zone.

Two major regional progressive metamorphic events and seven deformational events have been recognized in the study area. The earliest deformation and metamorphism recognized occurred during the Grenville orogeny (approximately 1,000 m.y. ago) and is reflected only in basement gneisses of the Blue Ridge. The second metamorphic event is interpreted to have occurred approximately 365 m.y. ago and was associated with a major episode of isoclinal recumbent folding (F_1). Axial planar foliation (S_1) associated with this fold event represents the dominant planar feature in crystalline rocks of the area. Folds related to this deformation have not been recognized within the Valley and Ridge west of the Cartersville fault, partially supporting the existence of the fault east of Cartersville. F_2 folding postdated Paleozoic metamorphism and is responsible for the geometry of outcrop patterns in the Greater Atlanta Region. Subsequent folding events (F_3 and F_4) interfere with earlier fold patterns and complicate outcrop patterns of map units.

Twenty-eight commodities have been mined or prospected within the boundaries of the Greater Atlanta Regional Map. Of these various commodities only barite, ocher, sand, granite (dimension stone and crushed), limestone, structural clays, and marble are still being mined. Areas of extensive mining and (or) prospecting include the limestone, bauxite, and shale deposits of Floyd and Polk Counties; barite, ocher, iron and manganese deposits of the Cartersville district; volcanogenic massive sulfide and gold deposits in the northern Piedmont; and crushed and dimension stone from quarries in the Stone Mountain, Panola, Palmetto, and Ben Hill Granites and Lithonia Gneiss south of the Brevard fault zone and in the Austell, Sand Hill, Kennesaw and Dallas gneisses north of the Brevard zone.

ACKNOWLEDGEMENTS

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INTRODUCTION

Purpose and Methods

This report presents results of the Greater Atlanta Regional Map project, an effort to develop a comprehensive geologic data base for the rapidly growing Atlanta metropolitan area. The primary objective of the Atlanta Regional Map project was to provide a compilation and synthesis of existing and newly derived geologic information for the Greater Atlanta Regional Map area for use by private industry, the general public, and the geological community. A secondary objective of this project was to compile a single-source listing and map of mines and prospects in the Atlanta area primarily for use by the mineral industry. When aspects of mapping related to the Greater Atlanta Regional Map project generated interest from within the mineral exploration community, the economic part of the project was expanded to include a detailed examination of the origin of base and precious metal deposits in the Atlanta area.

The base used for the above-mentioned compilations is the map of the Greater Atlanta Region. The Atlanta map was the first of a new series of 1:100,000 scale topographic maps produced by the U.S. Geological Survey. Unlike 1:100,000 scale maps that followed it, the Greater Atlanta Regional Map was not in the 1° of longitude format. The Greater Atlanta Regional Map encompasses 1 degree, 30 minutes longitude and 1 degree of latitude and is centered on the city of Atlanta (Fig. 1). Ninety-six 7.5-minute quadrangles are contained within the boundaries of the Greater Atlanta Regional Map (Fig. 1) as are portions of three major geologic provinces (i.e., Valley and Ridge, Blue Ridge, and Piedmont).

To produce a geologic map of an area as large as that contained within the Greater Atlanta Regional Map requires an enormous amount of time and money. For that reason, existing geologic literature was reviewed in an effort to find suitable geologic mapping for compilation. Some information used in compilation of the geologic map of the study area (Plate I) was available as open-file maps at the Georgia Geologic Survey. Geologic information also was available from various hydrologic reports and nearly all of the Valley and Ridge portion of the Greater Atlanta Regional Map was compiled from these hydrologic maps.

At the start of this project much of the Blue Ridge and Piedmont contained within the boundaries of the Greater Atlanta Regional Map lacked adequate geologic mapping. A major task of the Greater Atlanta Region project was to provide mapping for these areas. In a cooperative effort, members of the Georgia Geologic Survey, U.S. Geological Survey and the University System of Georgia performed detailed and reconnaissance geologic mapping on 7.5-minute base maps. Detailed mapping generally was reserved for those areas that were exceedingly complex structurally or were of potential economic significance. Detailed petrographic studies were limited to the formal definition of specific lithologic units. Many of these petrographic studies were included in derivative reports and investigations. Chemical analyses of rocks were restricted to selected units. Most of the analytical work reported in this investigation was performed in laboratories of the Georgia Geologic Survey and U.S. Geological Survey, although some analytical work on potentially economically significant units was provided by several mineral exploration companies.

Any compilation of data from multiple sources requires compromises in the handling of differing interpretations and mapping detail in adjacently mapped areas. Also, all areas could not be mapped to the degree that would provide a complete and solid data base for interpretation. This report contains examples of all of these compromises and constraints. In particular, all areas within the study area were not mapped to the same degree of detail (see Appendix D) and, therefore, some compromises regarding lithostratigraphic contacts were necessary. In addition, controversial areas for which more than one interpretation of the geology existed required a judgement as to which interpretation was to be used on the compilation. Justification for the interpretations used are included within the text of this report.

Belt Terminology

Any author of a regional report on the geology of crystalline rocks in the southeast almost immediately encounters the problems related to the "belt" terminology which is commonly used to define the major rock groupings as long, linear belts. Although there is almost universal dislike for the "belt" terminology, terms such as Blue Ridge, Inner Piedmont, Talladega, etc., have become entrenched in the literature and in the minds of Appalachian geologists. The use of these terms has almost become an obligatory part of any manuscript written on the southern Appalachian orogen. Faced with these entrenched terms, authors of reports on crystalline rocks in the southeast must select one of four alternatives when preparing a manuscript: 1) using the belt classification of either Crickmay (1952) or King (1955); 2) using a previously

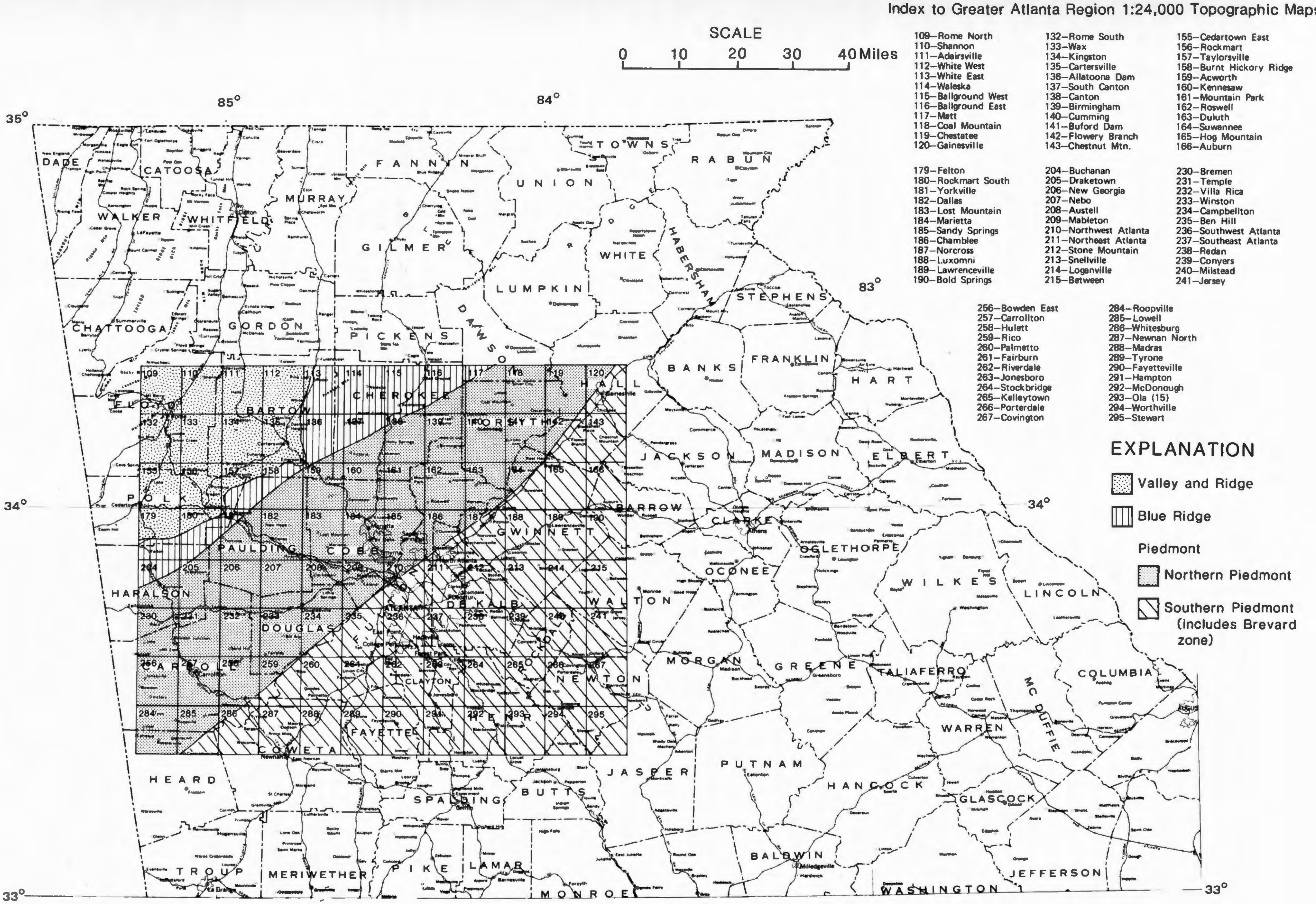

Figure 1. Greater Atlanta Regional Map area with geologic provinces and index to 1:24,000 U.S. Geological Survey topographic quadrangles.

defined modification of these classifications (e.g., Hatcher, 1978a); 3) proposing a new modification of these classifications based upon local considerations; or 4) proposing an entirely new classification. All of the four alternatives listed above have drawbacks, and selection of any one alternative will not meet with universal acceptance. In the report on the Greater Atlanta Region, we have chosen to follow the third alternative and propose a modification of King's (1955) original classification. This modification of King's classification of geologic belts and the reasoning behind it are presented below.

In choosing the third alternative, we have eliminated the other three based on the following considerations. In the 30 years since Crickmay (1952) and King (1955) originally proposed their belt terminology, knowledge of the geology of the crystalline rocks in the southern Appalachians has increased substantially. Detailed mapping has shown that the belts as originally defined are too general, have little relation to physiographic provinces, and have poorly defined boundaries. Because of this, geologists in various parts of the orogen have modified the belt terminology to fit their own particular observations. Thus, Hatcher (1978a) modified King's Blue Ridge by separating it into three subdivisions: an eastern, a central and a western Blue Ridge belt, while Neathery and others (1974, 1975) termed part of what King called Blue Ridge as northern Piedmont. Belt modifications of neither Hatcher nor Neathery are appropriate when applied to major lithologic units of the Greater Atlanta Region. Lithologic units of the study area contain characteristics that lend support to both Hatcher and Neathery's belt modifications, but also do not completely fit either author's modification of King's belts. For the above reason we feel that alternatives 1 and 2 as presented above have more liabilities than good characteristics and therefore have not been used in this report.

The fourth alternative is to propose an entirely new classification based on local considerations. The problem with this alternative is that the terms Piedmont and Blue Ridge have become so entrenched in the literature that it is doubtful that any locally defined terminology proposed would ever reach any significant level of usage or recognition outside of the State of Georgia. An example of this is Crickmay's (1952) terminology which has been largely ignored outside of the state. We, therefore, conclude that the third alternative of proposing a new modification of preexisting terms based on local considerations is the most appropriate.

Rocks of the Atlanta Region in this report are divided into three major geologic provinces (Valley and Ridge, Blue Ridge, and Piedmont) as modified after King (1955). Physiographic terms used for the belt terminology are retained because they are so entrenched in the literature, but it must be emphasized that they have little or no relevance to the physiographic provinces.

In this report the Valley and Ridge geologic province is similar to the Valley and Ridge belt of King (1955). It is composed of the unmetamorphosed to weakly metamorphosed rocks of the foreland fold and thrust belt, but also includes the basal lower Cambrian clastic rocks of the Chilhowee Group (Unaka belt of King, 1955). The southern and eastern boundary of the Valley and Ridge geologic province is the Cartersville fault that separates the relatively unmetamorphosed lower Cambrian lithologies from late Precambrian Ocoee Supergroup lithologies.

The Blue Ridge geologic province as defined in this report bears little resemblance to the Blue Ridge belt as defined by King (1955). King (1955) recognized that the Blue Ridge belt included portions of the Blue Ridge and Piedmont physiographic provinces and generally defined it as comprising the area between the Unaka Mountains on the northwest and the Brevard fault zone to the southeast. King also recognized several less extensive belts in the Blue Ridge, namely the Dahlonega and Murphy belts. Other geologists have been troubled by the broadly defined Blue Ridge belt and have modified it into either several smaller belts (i.e., eastern, central, and western Blue Ridge belts of Hatcher, 1978a) or termed part of King's Blue Ridge belt, northern Piedmont (Neathery and others, 1974, 1975). Hatcher's eastern Blue Ridge belt roughly corresponds with the northern Piedmont as defined in Alabama, with one notable exception: the inclusion of the Talladega belt in the northern Piedmont of Alabama.

In this report on the Greater Atlanta Region we define the Blue Ridge geologic province as covering the area between the Cartersville and Allatoona faults, including rocks of the Talladega and Murphy belts. The Blue Ridge geologic province therefore coincides generally with the rifted continental margin where debris from the continent was deposited (miogeoclinal portion of the orogen).

Rocks lying between the Allatoona fault and Fall Line (Coastal Plain unconformity) are interpreted to lie in the Piedmont geologic province. Since the Brevard represents a prominent feature in this area and separates similar lithologies and stratigraphic sequences, the area north and west of the Brevard fault zone is termed northern Piedmont and that south and east of the Brevard is termed southern Piedmont. The northern Piedmont as defined in this report differs from the northern Piedmont as defined in Alabama in that the former does not include rocks of the Talladega belt. The boundary between Blue Ridge and Piedmont geologic provinces roughly corresponds to the transition from miogeoclinal to eugeoclinal deposition in the Appalachian orogen.

The southern Piedmont as defined in this report would cover the area between the Brevard fault zone and the Coastal Plain overlap. Rocks of the Charlotte and Carolina slate belts are interpreted as subdivisions of the southern Piedmont much as the Talladega and Murphy belts represent subdivisions of the Blue Ridge geologic province.

Previous Works

VALLEY AND RIDGE

As with most of northwest Georgia, earliest reports on the geology of that part of the Greater Atlanta Regional Map area underlain by Valley and Ridge rocks were done by C.W. Hayes (1891, 1901, 1902). In these early reports, Hayes outlined the stratigraphy and structure of a major portion of the Valley and Ridge in Georgia, named and defined the Coosa, Rome, and Cartersville faults in this same area (1891, 1902), and set the stage for numerous subsequent arguments over the position of the Cartersville fault by moving the trace eastward from his original interpretation (Hayes, 1901). Although much of Hayes' work was modified later, the primary contributions of this exceptional pioneer in Georgia geology still remain intact. At about the same time as Hayes was publishing his reports on the Valley and Ridge, Spencer (1893, p. 3) published a compendium on the "scientific, economic, and agricultural standpoints" of the Paleozoic Group in northwest Georgia. More specifically, Spencer (1893) described the geology and mineral resources of Polk, Floyd, Bartow, Gordon, Murray, Whitfield, Catoosa, Chattooga, Walker and Dade Counties.

For a short period of time following Hayes' and Spencer's work, advances in the knowledge of the geology of the Valley and Ridge followed the lines of individual economic mineral studies in a series of bulletins published by members of the Geological Survey of Georgia. Most of these reports covered the occurrence of economic minerals throughout the State with only a portion of the report covering northwest Georgia. Topics covered in these reports include: iron ores in Polk, Bartow, and Floyd Counties (McCallie, 1900); bauxite (Watson, 1904); ocher (Watson, 1906); fossil iron ore deposits (McCallie, 1908); limestones and cement materials (Maynard, 1912); slate (Shearer, 1918); and barite (Hull, 1920). In addition, two reports on manganese deposits of Georgia were produced (Watson, 1908; Hull and others, 1919) as well as a second report on iron ore deposits (Haseltine, 1924). Somewhat later, Smith (1931) published on shales and brick clays of Georgia and Furcron (1942) reported on dolomites and magnesium limestones.

In 1948, a revision of Valley and Ridge stratigraphy was published by Butts and Gildersleeve (1948). Much of these data were incorporated previously into the State Geologic Map of 1939 (Cooke and others, 1939). Butts and Gildersleeve (1948) provided some revisions to the 1939 map and included a section on the mineral resources of northwest Georgia. Kesler (1950) subsequently published his detailed report on the geology and mineral resources of the Cartersville area. In this report, Kesler disputed the existence of the Cartersville fault of Hayes (1901) and revised the Paleozoic stratigraphy in the Cartersville area. An important aspect of Kesler's stratigraphic revision is that he limited the Shady Dolomite to the stratigraphic zone containing interbedded hematite and dolomite. This aspect of Paleozoic stratigraphy will be discussed further in following paragraphs.

Croft (1963) produced the first of two reports on the hydrology of Bartow County in which he indicated that much of the Lower Cambrian sequence was overturned. Shortly after the publication of Croft's report, the Geological Society of Georgia made the Cartersville fault problem and associated Paleozoic stratigraphy the subject of a field trip. In the report published for the field trip, Bentley and others (1966) suggested that the Cartersville fault did not exist south of Bolivar and that quartzites unconformably overlying the Corbin gneiss are Weisner Formation (Chilhowee Group).

Cressler (1970) published a report on the hydrology of Floyd and Polk Counties and McLemore and Hurst (1970) reported on the carbonate rocks of the Coosa Valley area. Cressler and others (1979) published the second report on the geohydrology of Bartow County that also included the geohydrology of Cherokee and Forysth Counties, which lie east of the Cartersville fault. Cressler and others (1979) provided mapping in the Cartersville area and, like Butts and Gildersleeve (1948) and Croft (1963), expanded the limits of the Shady Dolomite to include dolomitic limestones that Kesler (1950) had placed in the Rome Formation. Included in the report by Cressler and others (1979) were the results of mapping in southern Bartow County by Crawford (1977a, 1977b). This mapping outlined the trace of the Cartersville fault through southern Bartow County. Much of the information derived by Cressler and Crawford was presented on the Georgia Geological Society field trip in 1977 (Chowns, 1977).

The first detailed study of the stratigraphy and depositional environments of the lowermost Cambrian rocks in northwestern Georgia was carried out by Mack (1980). Mack's work established the internal stratigraphy for the Chilhowee Group just west of the Cartersville fault and related these findings to the better known Chilhowee Group in Tennessee.

Reade and others (1980) published the results of their investigation in the Emerson-Cartersville area. Most mapping done in that investigation took place in the barite pits of the Thompson-Weinman Corporation. In that report, usage of the term "Shady Formation" is restricted to a black dolostone directly above the ledge-forming quartzites of the Weisner Formation, whereas dolostones above this black carbonate are placed in the Rome Formation. Reade and others' (1980) definition of the Lower Cambrian stratigraphy, which is similar to that of Kesler's (1950) stratigraphy, is an indication of the problems involved with stratigraphic and structural interpretation in the Cartersville area.

BLUE RIDGE

In this report, the term Blue Ridge is limited to those rocks present between the Allatoona fault (McConnell and Costello, 1980b) and the Cartersville fault. As with the Valley and Ridge, the earliest work in the Blue Ridge was done by C.W. Hayes. In 1891, Hayes first reported on faulting in the Cartersville area and introduced the term "Cartersville fault." Hayes (1891) mapped the trace of the Cartersville fault directly through the city of Cartersville possibly coincident with what is now referred to as the White fault. In a subsequent publication Hayes (1901) relocated the fault a few miles to the east. Much of Hayes' work in the Blue Ridge remains unpublished. In his unpublished Cartersville folio, Hayes (1895) outlined the stratigraphy and structure of the Blue Ridge just east of the Cartersville fault and pointed out the nonconformity between the Corbin Gneiss and its cover sequence. In addition, Hayes' map implied equivalence between those rocks overlying the Corbin Gneiss Complex and rocks that were later to be termed Talladega belt rocks (Crickmay, 1952). Hayes' early work and relocation of the trace of the Cartersville fault set the stage for an 80-year controversy over the existence of the fault and the stratigraphy of the sedimentary and crystalline rocks in the Cartersville area. This controversy persists today.

Shortly after Hayes' work, the series of publications by the Geological Survey of Georgia regarding various mineral commodities began. These publications specifically related to Blue Ridge geology include McCallie's (1907) report on the marbles of Georgia, Hull's (1920) report on barite, Prindle's (1935) report on kyanite and vermiculite, and Furcron and Teague's (1945) report on sillimanite and kyanite deposits. During this same period, Bayley (1928) published the geology of the Tate quadrangle and described in detail the various types of Georgia marble. Also, Crickmay (1936) reported on the Talladega Series in the southern Appalachians including that portion of the Blue Ridge in the Greater Atlanta Regional

Map. Crickmay (1936) indicated that the Talladega Series, originally defined in Alabama, extends across western Georgia to near Cartersville and then turns northward toward North Carolina and Tennessee. In that interpretation rocks of the Murphy belt group and parts of the Ocoee Supergroup were considered part of the Talladega series. With the publication of Crickmay's report, the controversy over the Cartersville fault problem began in earnest. In 1950, Kesler indicated that the Cartersville fault did not exist east of Cartersville and that the Corbin Gneiss was a "static emplacement." Rocks overlying the Corbin were included in the Lower Cambrian Valley and Ridge sequence and amphibolites south of the Allatoona fault were considered to be para-amphibolites (i.e., metamorphosed Rome shale) Kesler (1950).

In 1964, Sever published a report on the geology and ground water in Dawson County in the extreme northeastern part of the study area, and Fairley (1965) revised the work of Bayley (1928) in the Tate Quadrangle. Smith and others (1969) published a listing of previous and new isotopic age dates and an isograd map of Georgia which included the Blue Ridge. Shortly before Smith and others' (1969) report, the Cartersville fault problem was addressed at the annual meeting of the Georgia Geological Society (Bentley and others, 1966). Bentley and others (1966) extended the Cartersville fault southward to near Bolivar, but questioned its existence east of Cartersville. They reassigned rocks defined by Hayes as Ocoee to the Weisner Formation of the Chilhowee Group (Bentley and others, 1966).

In 1970, Crawford and Medlin suggested that graphitic phyllites of the Talladega belt were equivalent to those in the Sandy Springs Group and Cressler (1970) described parts of the Talladega belt in his study of the geology and hydrology of Polk County. Hurst (1970, 1973) published regional reports that included what is here termed "Blue Ridge." Hurst (1970) outlined metamorphic isograds and indicated that the Cartersville fault was present east of Cartersville. Hurst (1973) interpreted the Cartersville fault to be absent east of Cartersville and equated rocks overlying the Corbin Gneiss with the Weisner Formation and Shady Dolomite. Crawford and Medlin (1973) suggested that Talladega belt rocks are equivalent to rocks exposed in the Austell-Frolona antiform to the southeast; Fairley (1973) equated members of the Murphy belt group with rocks south of the Allatoona fault (i.e., New Georgia Group of this report); and Power and Forrest (1973, p. 698) described the stratigraphy and paleogeography of the Murphy belt group suggesting it represented an "ancient transgressive linear shoreline."

During 1973, information regarding relative ages of rocks in the Blue Ridge also was published. McLaughlin and Hathaway (1973) described the occurrence of fossils in the Murphy Marble that suggested an early Paleozoic age for the marble, but Chapman and Klatt (1983) cast doubt on this interpretation by showing that fossils associated with the Murphy marble are within Quaternary sinkhole deposits. Odom and others (1973) reported a Pb-Pb age of 1000 m.y. from zircons extracted from the Corbin Gneiss. Dallmeyer (1975) confirmed a Grenville or Proterozoic Y age for the Corbin Gneiss using $^{40}Ar/^{39}Ar$ techniques.

Since 1973, published work on Blue Ridge geology was related primarily to problems of the Cartersville fault east of Cartersville and the stratigraphy and structure of the rocks southeast of Emerson (Plate I). Crawford (1976, 1977a, 1977b), in several open-file maps, outlined the lithologic characteristics of the northeastern portion of the Talladega belt. Crawford's interpretation of the western portion of the Cartersville fault was reported in the Georgia Geological Society guidebook prepared by Chowns (1977). Crickmay (1933) and Costello (1978) reported on ductile shear zones in the Corbin Gneiss; O'Connor and others (1978) reported on the stratigraphy and structure of the Salem Church anticlinorium; and McConnell and Costello (1979) indicated that large-scale crustal shortening had occurred in the southwestern Blue Ridge. Cressler and others (1979) and Crawford and Cressler (1981, 1982) suggested that the Talladega "Group" and associated lithologies overthrust the Great Smoky fault (an extension of the Cartersville fault in this report) and the southwestern terminus of the Salem Church anticlinorium along a low-angle fault termed the "Emerson (Cartersville) fault." McConnell and Costello (1980b, 1982a) disputed this interpretation and suggested that rock units of the Talladega belt bend around the Emerson reentrant in the Cartersville-Great Smoky fault (Cartersville fault in this report) and merge with rocks of the Ocoee Supergroup. McConnell and Costello (1980b) and Costello and McConnell (1980) outlined the basic stratigraphy of rocks nonconformably overlying the Corbin Gneiss equating them to the Ocoee Supergroup. Some of these units were later formalized (McConnell and Costello, 1984).

Other recent publications on the geology of the Blue Ridge include "Economic geology of the Georgia Marble District" (Power, 1978), a report on uranium in graphitic phyllites in this area (McConnell and Costello, 1980a), and an abstract on recumbent folding in rocks nonconformably overlying the Corbin Gneiss (Costello and McConnell, 1981). In 1982, a preliminary compilation of the geology in the Greater Atlanta Regional Map area was published (McConnell and Abrams, 1982a).

NORTHERN PIEDMONT

The term northern Piedmont as used in this report includes those rocks northwest of the Brevard fault zone and southeast of the Allatoona fault. Although the problem of regional "belt" terminology was discussed in a previous section, it can be said here that rocks and stratigraphic successions of the northern Piedmont strongly resemble those south of the Brevard fault zone and differ from Ocoee Supergroup, Murphy belt group and Talladega "Group" rocks north of the Allatoona fault. These relationships as well as the fact that the area between the Brevard and Allatoona faults is physiographically Piedmont are the factors related to terming this area northern Piedmont.

Previous works on the geology of the northern Piedmont are bimodally split with regard to time. During the late 1800's and early 1900's, bulletins published by the Geological Survey of Georgia dealt with many economic minerals known to occur in the northern Piedmont. Early publications relating to economic mineral and rock occurrences present in the northern Piedmont include reports on corundum deposits (King, 1894), gold deposits (Yeates and others, 1896; Jones, 1909), granites and gneisses (Watson, 1902), manganese (Watson, 1908), asbestos, talc and soapstone (Hopkins, 1914), pyrite deposits (Shearer and Hull, 1918), manganese (Hull and others, 1919) iron ore deposits (Haseltine, 1924), and aluminosilicate deposits (Prindle, 1935; Furcron and Teague, 1945).

In the years between 1945 and 1966, only two reports on the northern Piedmont were published: Crickmay's (1952) *Geology of the crystalline rocks of Georgia* and Hurst's (1955) geologic map of the Kennesaw Mountain-Sweat Mountain area. In his report, Crickmay coined the belt terminology for Georgia and included what in this report is termed northern Piedmont in his Wedowee-Ashland and Tallulah belts.

Publications relating to the geology of the northern Piedmont picked up again in the late 1960's with Higgins' (1966) report and map (Higgins, 1968) on the Brevard zone. In these publications, Higgins outlined the general stratigraphy north of the Brevard fault zone near Atlanta and introduced the term Sandy Springs Sequence, which was subsequently revised to the Sandy Springs Group by Higgins and McConnell (1978a, 1978b). In the early 1970's Hurst published two regional studies (1970, 1973) on crystalline rocks in Georgia. In the latter of these, Hurst (1973) used the term "Blue Ridge" for what in this report is referred to as northern Piedmont. In addition, Hurst (1973), using terms originally introduced in Alabama by Adams (1926), defined the Ashland Group and Wedowee Formation in Georgia. These terms, derived from rock units described in Alabama, were used to define rocks in the southwestern part of the northern Piedmont. The use of these terms and their applicability are discussed in detail in a later section.

Hurst and Crawford (1970) published a report on the sulfide deposits of the Coosa Valley area which included geochemical maps as well as reconnaissance mapping in Paulding and Haralson Counties and descriptions of cores from various sources. Similar compilations were published by Long (1971) and Hurst and Long (1971) for the Chattahoochee-Flint area. Crawford and Medlin (1970, 1971, 1973, 1974) and Medlin and Crawford (1973) described the stratigraphy and structure of the northern Piedmont in west-central Georgia. These reports presented interpretations regarding the stratigraphy and structure of the area between the Cartersville and Brevard fault zones. Additional publications from the mid-to-early 1970's are: the petrology and geochemistry of some of the felsic gneisses in west Georgia (Coleman and others, 1973; Bearden, 1976; Sanders, 1977); origin and strontium isotope composition of amphibolites in the Cartersville to Villa Rica area (Hurst and Jones, 1973; Jones and others, 1973); a geologic map of Forsyth and parts of Fulton Counties (Murray, 1973); open-file maps of an area along the northwestern border of the northern Piedmont (Crawford, 1976, 1977a, 1977b); and K-Ar dates of rocks on either side of the Brevard zone (Stonebraker, 1973).

In the late 1970's there was a revival of interest in publications regarding economic minerals and their occurrences. Cook (1978b, 1978c) reported on soil geochemistry in the area of the Franklin-Creighton gold mine and on several other massive sulfide deposits in western Georgia. Somewhat later Abrams and others (1981), Abrams and McConnell (1981a, 1982a, 1982b, 1982c) and McConnell and Abrams (1982b, 1983) interpreted the massive sulfide and gold deposits in west Georgia to be volcanogenic in origin and showed the genetic and geographic relationship between banded iron formation and most of the major massive sulfide and gold deposits in west Georgia.

During the late 1970's and early 1980's the results of studies on stratigraphic and structural problems in the northern Piedmont on both local and regional scales were published. Higgins and McConnell (1978a; 1978b) revised and formalized the terminology of the Sandy Springs Group; Kline (1980, 1981) indicated that rocks of the Sandy Springs Group are present south of the Brevard fault zone; McConnell (1980a) described a metabasaltic unit with back-arc basin affinities (i.e., Pumpkinvine Creek Formation) on the northwestern border of the northern Piedmont; and Abrams and McConnell (1981a, 1981b) and McConnell and Abrams (1978) revised the stratigraphy and structural interpretations in the Austell-Villa Rica area emphasizing the influence of multiple deformation in this area. Two regional studies were completed in this period. McConnell and Costello (1980b) led a field trip across the northern Piedmont and southwestern Blue Ridge and defined the major rock units and structural features in those two areas, and McConnell and Abrams (1982a) compiled the available data for the northern Piedmont onto one map.

SOUTHERN PIEDMONT AND BREVARD FAULT ZONE

The term southern Piedmont, as used in this report, consists of rocks southeast of the Brevard fault zone. This usage would include parts of King's (1955) Inner Piedmont belt and Crickmay's (1952) Dadeville belt.

As with all of the aforementioned geographic areas, some of the earliest work performed in the southern Piedmont was published in the form of bulletins describing economic mineral occurrences. Economic minerals and rocks that were discussed in this area include corundum (King, 1894); gold (Yeates and others, 1896; Jones, 1909); asbestos, soapstone and talc deposits (Hopkins, 1914); granites and gneisses (Watson, 1902); kyanite and vermiculite (Prindle, 1935); sillimanite and kyanite (Furcron and Teague, 1945); and pyrite deposits (Shearer and Hull, 1918).

The first significant study of the geology of the southern Piedmont outside of economic reports was that done by Crickmay (1952) in his study of the crystalline rocks in Georgia. Crickmay (1952) termed rocks of the Brevard fault zone the Brevard belt and rocks southeast of the Brevard the Dadeville belt. Two observations in Crickmay's report are interesting in light of the current ideas regarding the nature of the Brevard fault zone. Crickmay commented on the "button" schist, suggesting that it resulted from the formation of a second cleavage, and also noted that rocks of the Dadeville belt were "essentially a repetition of the rocks of the Tallulah belt . . ." (i.e., northern Piedmont) (Crickmay, 1952, p. 6).

Following the work of Crickmay, interest turned to the major post-metamorphic granite intrusives which are so prominent in the Piedmont southeast of the Brevard zone. Herrmann (1954) provided the first detailed mapping in the southern Piedmont in the Stone Mountain-Lithonia district. Herrmann (1954) described in detail the structure and petrography in this area as well as the aggregate industry that had developed. Beginning in 1957, a series of abstracts and articles was published regarding the age of some of the aforementioned granite intrusives. Pinson and others (1957) reported ages of approximately 280 m.y. for the Stone Mountain Granite, 290 m.y. for the Lithonia Gneiss, and 340 m.y. for the Ben Hill Granite. Subsequent publications by Pinson and others (1957a, 1958) and Grunenfelder and Silver

(1958) redefined the ages for the previously mentioned rock units and gave an age of approximately 295 m.y. for the Panola Granite. Interest in the age of these post-metamorphic intrusive rocks continued into the 1960's, 1970's and 1980's as the methodology of isotopic dating improved and the precision of the age determinations was refined. Although the exact ages for these intrusive bodies varied, the succeeding reports (i.e., Long and others, 1959; Whitney and others, 1976; Dallmeyer, 1978; Atkins and Higgins, 1980; Higgins and Atkins, 1981) essentially confirmed late Paleozoic ages for the post-metamorphic intrusive rocks. The results of investigations into the timing of metamorphism were being reported at the same time as ages for post-metamorphic intrusives. Initial K-Ar work on schists and gneisses in the southern Piedmont by Pinson and others (1957), Kulp and Eckelmann (1961) and Long and others (1959) indicated ages from approximately 350 m.y. to 250 m.y. with a distinct "younging" trend to the southeast from Atlanta. Kulp and Eckelmann (1961) suggested that these ages indicated two periods of regional metamorphism; one at approximately 350 m.y. and the second near 250 m.y. ago. Using the above ages, Hurst (1970) coined the term "hot belt" for the area containing the younger ages. Stonebraker (1973) provided additional K-Ar analyses on samples from traverses across the Brevard zone near Atlanta. Finally, Dallmeyer (1975) indicated that $^{40}Ar/^{39}Ar$ ages suggested that the younger age-dates obtained by K-Ar methods are the result of differences in cooling and uplift rates. He suggested an age of 365 m.y. for peak metamorphism of the region described here as southern Piedmont (Dallmeyer, 1975).

Outside of isotopic dating efforts, geologic interest in the southern Piedmont during the late 1950's and 1960's was concentrated around the Stone Mountain Granite. Reports regarding mineralogical variation (Wright, 1966), weathering (Grant, 1963), and intrusion mechanics (Grant, 1969) of the Stone Mountain Granite were published during this time period. Grant (1962) also led a field trip into the Stone Mountain-Lithonia district. The 1970's and early 1980's saw a continuation of geologic interest in the Stone Mountain Granite. Reports on the origin (Whitney and others, 1976) and geochemistry (Atkins and others, 1980b) of the Stone Mountain Granite as well as another field trip guidebook for the area (Grant and others, 1980) were published.

After a gap of over a decade, publication on the stratigraphy and structure of the southern Piedmont resumed in the mid-1960's with the publications on the Brevard zone by Higgins (1966, 1968). In the recent past, reports regarding the various aspects of stratigraphy and structure were published (i.e., Atkins and Higgins, 1978, 1980; Atkins and others, 1980a; Higgins and others, 1980a, 1980b; Higgins and Atkins, 1981; Kline, 1980, 1981).

Much of the preceding geologic information from all of the aforementioned geographic areas was included in the compilation of the 1976 State Geologic Map of Georgia. This map also included unpublished reconnaissance mapping by various geologists (Georgia Geologic Survey, 1976).

STRATIGRAPHY

Introduction

Detailed and reconnaissance geologic mapping has formed the basis on which stratigraphic successions for the Blue Ridge, northern Piedmont and southern Piedmont were developed. Much of this mapping expanded upon earlier reconnaissance mapping by many authors.

In the Blue Ridge, the proposed stratigraphic terminology and correlations are, to some degree, a return to those of C.W. Hayes (1895) in his unpublished report on the Cartersville 30-minute sheet. Although written nearly 100 years ago, Hayes' report on the Cartersville area, particularly the stratigraphic correlations and his interpretation of the relationship between the Corbin Gneiss Complex and its cover rocks, is consistent with our interpretations.

South of the Allatoona fault and north of the Brevard zone, imprecise and over-extended terms such as Ashland and Wedowee are abandoned in favor of two major groups (i.e., New Georgia and Sandy Springs Groups) that are distinguished on the basis of lithology, protolith, and depositional environment. Resolution of a recognizable stratigraphy in the northern Piedmont also has led to the recognition of stratigraphic indicators for massive sulfide and gold deposits (Abrams and McConnell, 1982a).

Southeast of the Brevard fault zone, Higgins and Atkins (1981) defined the Atlanta Group. In this report, we use units defined by Higgins and Atkins, but reinterpret the structural setting, redefining the major structural feature, the Newnan-Tucker synform, as a synformal anticline rather than a synformal syncline as originally proposed (Higgins and Atkins, 1981). The stratigraphic succession used in the Valley and Ridge is after Cressler (1970) and Cressler and others (1979), which were modified from Hayes (1902) and Butts and Gildersleeve (1948).

The following discussion describes in detail only those rock units that are in areas which have undergone substantial revision during this investigation. In this report capitalization of previously defined stratigraphic units follows the original author's usage unless otherwise defined in this text. For a description of all stratigraphic units within the Greater Atlanta Regional area see Appendix A of this report.

Stratigraphy of the Valley and Ridge

Rocks ranging in age from Lower Cambrian(?) to Pennsylvanian are present in the Valley and Ridge portion of the Greater Atlanta Regional Map. Our work in the Valley and Ridge portion of the Greater Atlanta Region was directed at an area in the immediate vicinity of Cartersville (Fig. 2). For this reason we have limited our discussion of Valley and Ridge stratigraphy to rocks in that area. This means that only Lower Cambrian rocks (Chilhowee through Rome Formations) are discussed. The reader is referred to Appendix A for detailed descriptions of the Middle Cambrian through Pennsylvanian section in this area.

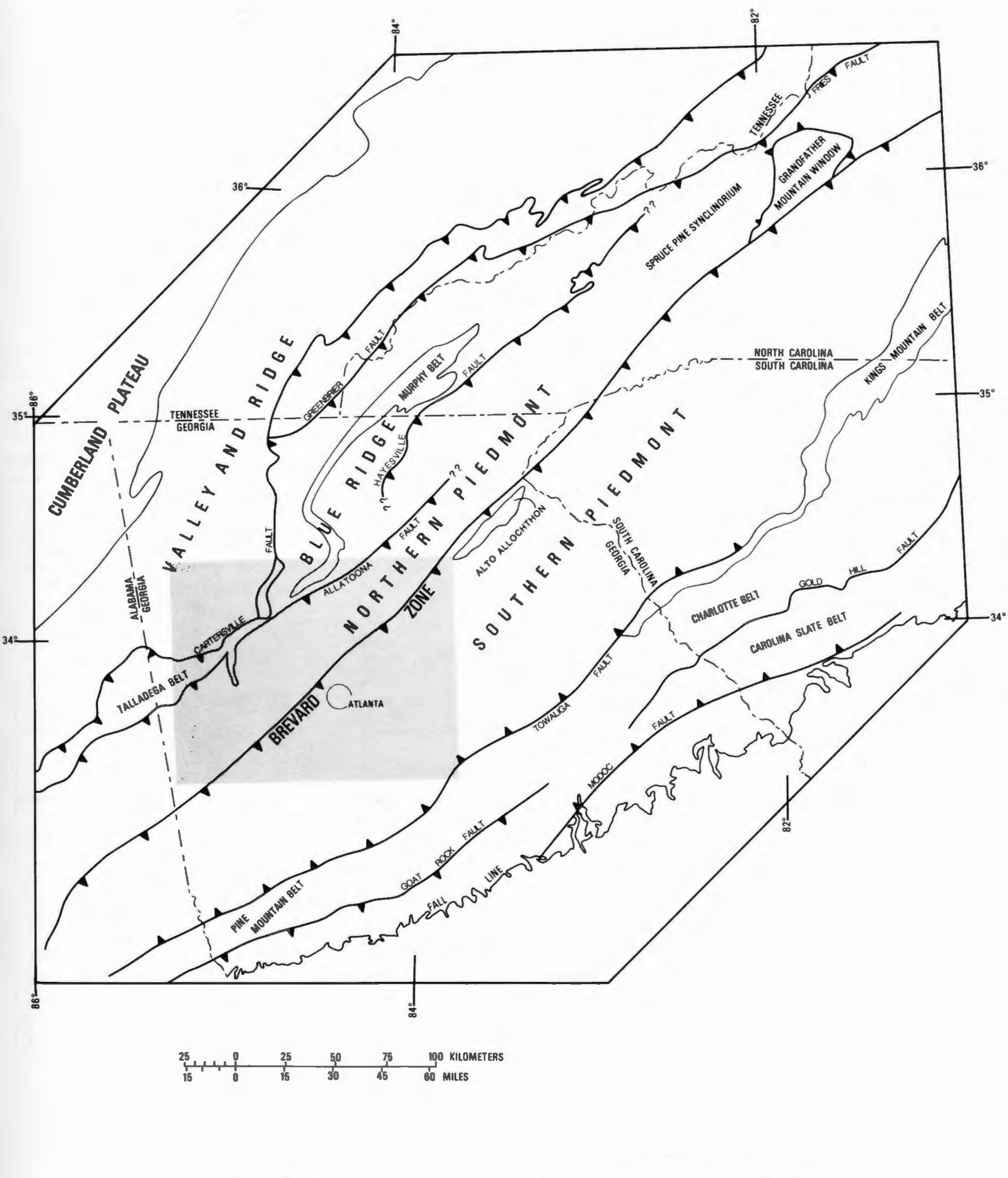

Figure 2. **Regional location map showing boundaries of the Greater Atlanta Regional Map and regional setting of map area (modified after McConnell and Costello, 1982).**

Chilhowee Group rocks are the oldest rocks present in the Valley and Ridge. The base of the Chilhowee is not exposed in this area because the Chilhowee occurs as the oldest unit in a series of imbricate thrust sheets along the trace of the Cartersville fault. Mack (1980) divided the Chilhowee Group in Georgia and Alabama into four formations, i.e., Cochran, Nichols, Wilson Ridge and Weisner Formations (Table 1). Of these, only the two uppermost units (i.e., Wilson Ridge and Weisner) are known to be present in the Greater Atlanta Region. Mack (1980) formalized the Wilson Ridge Formation and described it as fine- to coarse-grained, moderately well-sorted orthoquartzite. Overlying the Wilson Ridge Formation is the Weisner Formation (Mack, 1980). The Weisner is composed of very fine- to fine-grained orthoquartzite, varying to cross-bedded fine- to coarse-grained orthoquartzite, conglomerate, and greenish-gray mudstone (Mack, 1980). In light of the controversy over the existence of the Cartersville fault in the vicinity of Cartersville and the equivalence of the Pinelog Formation and Chilhowee Group, it is interesting to note the lithologic differences between the two units. Mack (1980) suggested that the Wilson Ridge Formation was deposited in a nearshore, high-energy environment and the Weisner Formation was deposited in a beach or barrier-island environment. This differs sharply from the characteristics of the Pinelog Formation east of the Cartersville fault where the Pinelog consists of locally, poorly sorted, graded conglomerates, diamictites, and black shales (graphitic phyllites) interlayered with fine- to medium-grained quartzites. These lithologies and textures in the Pinelog Formation are indicative, at least in part, of a high-energy deep-water environment in a rapidly subsiding basin. Previous attempts to equate the Pinelog with the Chilhowee and to deny the existence of the Cartersville fault are discussed in the Blue Ridge section.

Table 1. Stratigraphic successions in the Valley and Ridge. Capitalization of units follows original author's usage.

Hayes, 1902	Butts and Gildersleeve, 1948	Kesler, 1950	Cressler, 1970; and Cressler and others, 1979	Mack, 1980	This Report (after Cressler, 1970; and Cressler and others, 1979)	
Lookout sandstone	Pottsville formation	NOT DEFINED	Pennsylvanian (undivided)	NOT DEFINED	Pennsylvanian (undivided)	Pennsylvanian
Bangor limestone	"Bangor" limestone		Bangor Limestone		Bangor Limestone	
Oxmoor sandstone	Floyd shale Rockmart slate		Hartselle Sandstone Member		Hartselle Sandstone Member	Mississippian
Floyd shale			Floyd Shale		Floyd Shale	
Fort Payne chert	Fort Payne chert		Fort Payne Chert Lavender Shale Member | Fort Payne Chert Lavender Shale Member		Fort Payne Chert (Includes Lavender Shale Member)	
Chattanooga shale	Chattanooga shale		Armuchee Chert		Armuchee Chert	Devonian
Frog Mountain sandstone | Armuchee chert	Armuchee chert					
Rockwood formation	Red Mountain formation Sequatchie formation		Red Mountain Formation		Red Mountain Formation	Silurian
Rockmart slate	Maysville limestone Trenton limestone Lowville limestone Ottosee shale Tellico formation Athens shale Holston marble		Upper and Middle Ordovician (undivided) | Rockmart Slate		Upper and Middle Ordovician (undivided)	Ordovician
Chickamauga limestone	Lebanon limestone Lenoir limestone Mosheim limestone Murfreesboro limestone Newala limestone		Lenoir Limestone Newala Limestone		Rockmart Slate Newala Limestone	
Knox dolomite	Knox dolomite		Knox Group		Knox Group	Cambrian
Conasauga formation	Conasauga shale	Conasauga formation	Conasauga Formation		Conasauga Group	
Rome formation	Rome formation	Rome formation	Rome Formation		Rome Formation	
Beaver limestone	Shady dolomite	Shady dolomite	Shady Dolomite		Shady Dolomite	
Weisner quartzite	Weisner quartzite	Weisner formation	Chilhowee Group	Weisner Formation Wilson Ridge Formation Nichols Formation Cochran Formation	Chilhowee Group	

Overlying the Chilhowee Group is the Shady Dolomite. The boundaries of the Shady Dolomite in the Cartersville area are subject to some disagreement (Table 1). Kesler (1950) and Reade and others (1980) believe that the Shady Dolomite should be restricted to a basal, thin, black or dark-gray, fine-grained dolostone having paper-thin shale lamellae. In their interpretation, Reade and others (1980) place the overlying gray dolostone and interlayered dolostone and shale in the Rome Formation. In contrast, Cressler and others (1979) place all of the dolostones above the Chilhowee and below the Rome shales in the Shady Dolomite. Archaeocyathids were found in both the lower dark-gray unit and upper light-gray unit (Stan Bearden, personal commun., October, 1982). Costello and others (1982) note that the light-gray dolostones interfinger with shales that generally are assigned to the Rome Formation and indicate that they are time equivalents of the Rome Formation. This report follows the definition of the Shady Dolomite as reported by Cressler and others (1979) (Table 1).

The Rome Formation is composed of fine-grained, slightly calcareous, green to red sandstone (Butts and Gildersleeve, 1948). Sandstone is interlayered with greenish shale that weathers to a gray, pinkish or yellowish shale. Thin layers of limestone also are present.

Stratigraphy of the Blue Ridge

The Blue Ridge portion of the Greater Atlanta Regional Map is dominated by two major structural features which lie adjacent to each other (Fig. 3), the Salem Church anticlinorium and Murphy synclinorium. The determination of a stratigraphic succession in these two structures is complicated by 1) lack of continuous exposures, 2) multiple fold events, 3) both brittle and ductile faulting, 4) sedimentary facies changes, and 5) internal unconformities. The combination of the five above-mentioned factors has resulted in numerous, often conflicting, interpretations regarding the stratigraphic sequence. Generally, interpretations of the stratigraphic sequence in this area were dependent on whether or not the Corbin Gneiss Complex was considered as intrusive into the Blue Ridge sequence and if the Cartersville fault was interpreted to be present east of Cartersville. A brief summary of the various interpretations was presented in the Previous Works section of this report and will not be repeated here, but investigations related to this report (McConnell and Costello, 1980b, 1982a) have shown that Hayes' original work in the area, with minor modifications, is correct. Hayes' observations regarding the presence of a nonconformity between the

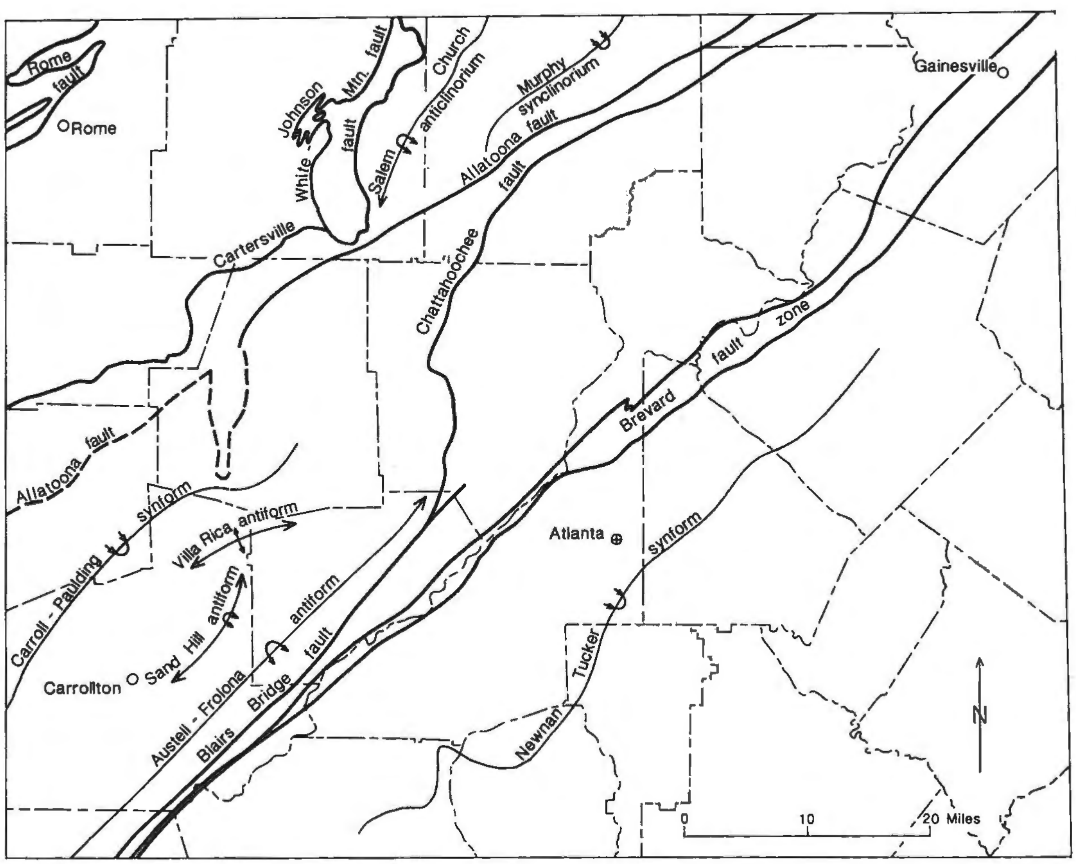

Figure 3. Major structural features of the Greater Atlanta Regional Map.

Corbin Gneiss and its cover sequence were confirmed in an investigation by Costello (1978). While the presence or absence of the Cartersville fault may never be proven to everyone's satisfaction, evidence seems to support its existence as Hayes (1901) proposed.

In the Blue Ridge portion of the Greater Atlanta Regional Map, the Corbin Gneiss Complex represents the southwesternmost exposures of Grenville (Proterozoic Y) basement in the Blue Ridge portion of the Appalachian orogen. The Corbin Gneiss is nonconformably overlain by a thick succession of predominantly clastic rocks interpreted to be lithostratigraphic equivalents of the Ocoee Supergroup as defined in Great Smoky Mountains National Park by King and others (1958). The Ocoee, in turn, is overlain conformably by rocks of the Murphy belt group.

CORBIN GNEISS COMPLEX

Rocks of the Corbin Gneiss Complex occur in the core of the Salem Church anticlinorium (Fig. 4). The term Corbin Gneiss Complex was informally introduced by McConnell and Costello (1980b) to describe rocks previously defined as Corbin granite (Hayes, 1901) and Salem Church granite (Bayley, 1928). This term was subsequently formalized in a paper by McConnell and Costello (1984). Although areally separated within the Salem Church anticlinorium, the Corbin and Salem Church lithofacies of the Corbin Gneiss Complex are believed to be exposed parts of a single basement complex (McConnell and Costello, 1982b, 1984). This conclusion is based not only on apparent similarities in mineralogy and texture, but also on similarities of stratigraphic sequence overlying both gneisses. One lithofacies of the Corbin Gneiss Complex was dated isotopically by Odom and others (1973) yielding an age in excess of one billion years on the basis of a lead-lead zircon age. Later work by Dallmeyer (1975) using $^{40}Ar/^{39}Ar$ techniques reaffirmed a Grenville age for the Corbin.

Rocks comprising the Corbin Gneiss Complex represent an intricate association of ortho- and paragneisses with the dominant lithofacies being a coarse-grained quartz-monzonitic orthogneiss with megacrysts of microcline. Samples from this lithofacies were used in isotopic age determinations of Odom and others (1973). However, this rock crosscuts small bodies of paragneiss composed of graphite-bearing meta-arkose (Costello, 1978) (Fig. 5). The age of these paragneisses is unknown, but they may represent remnants of an earlier orogenic belt largely remobilized during the Grenville event. All of these lithofacies underwent granulite facies metamorphism during the Grenville. Compositions within the metaigneous lithofacies of the Corbin vary from granite to granodiorite (Table 2; Fig. 6). Variation diagrams of weight percent silica versus weight percent of other oxides (Harker

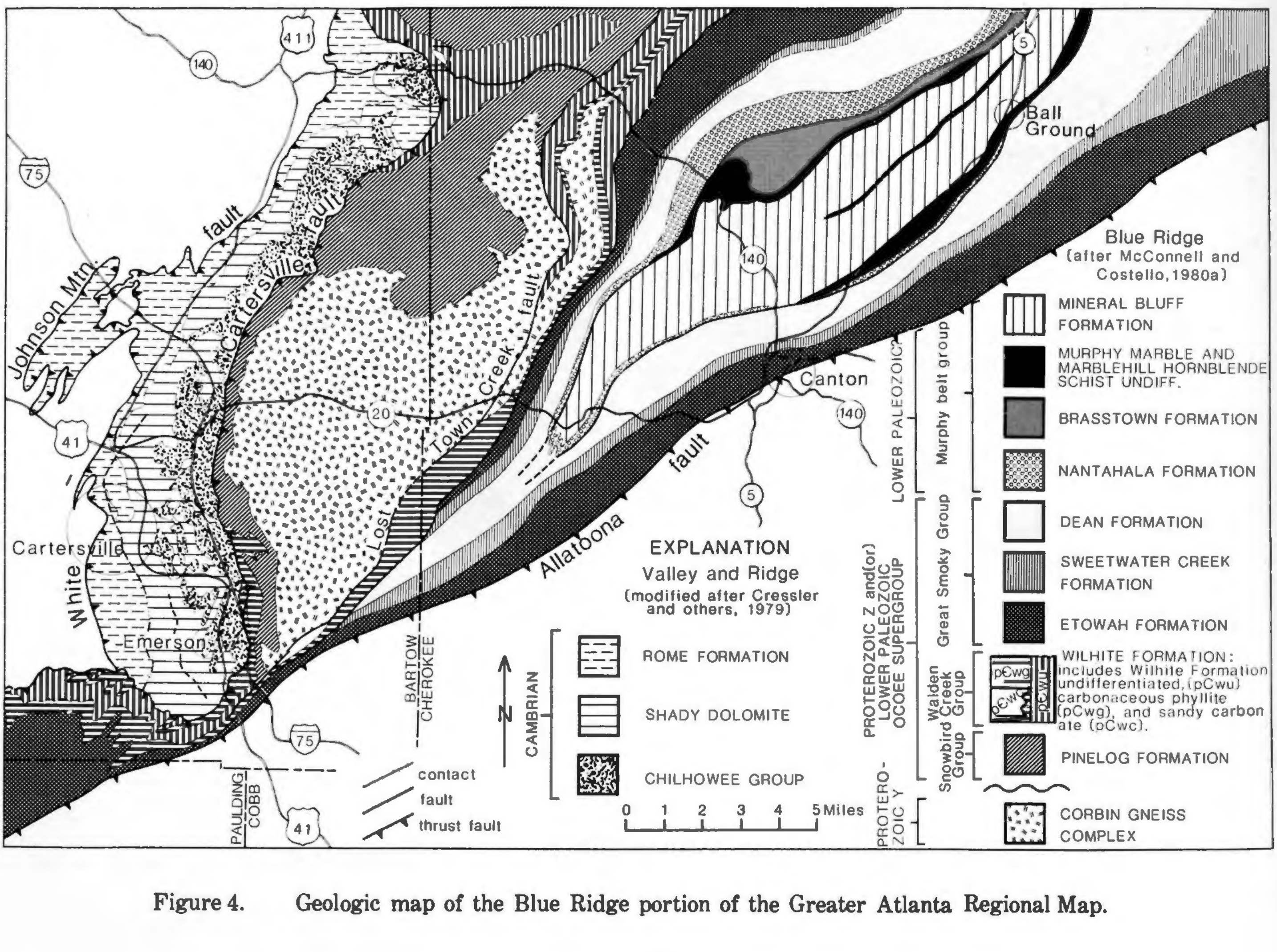

Figure 4. Geologic map of the Blue Ridge portion of the Greater Atlanta Regional Map.

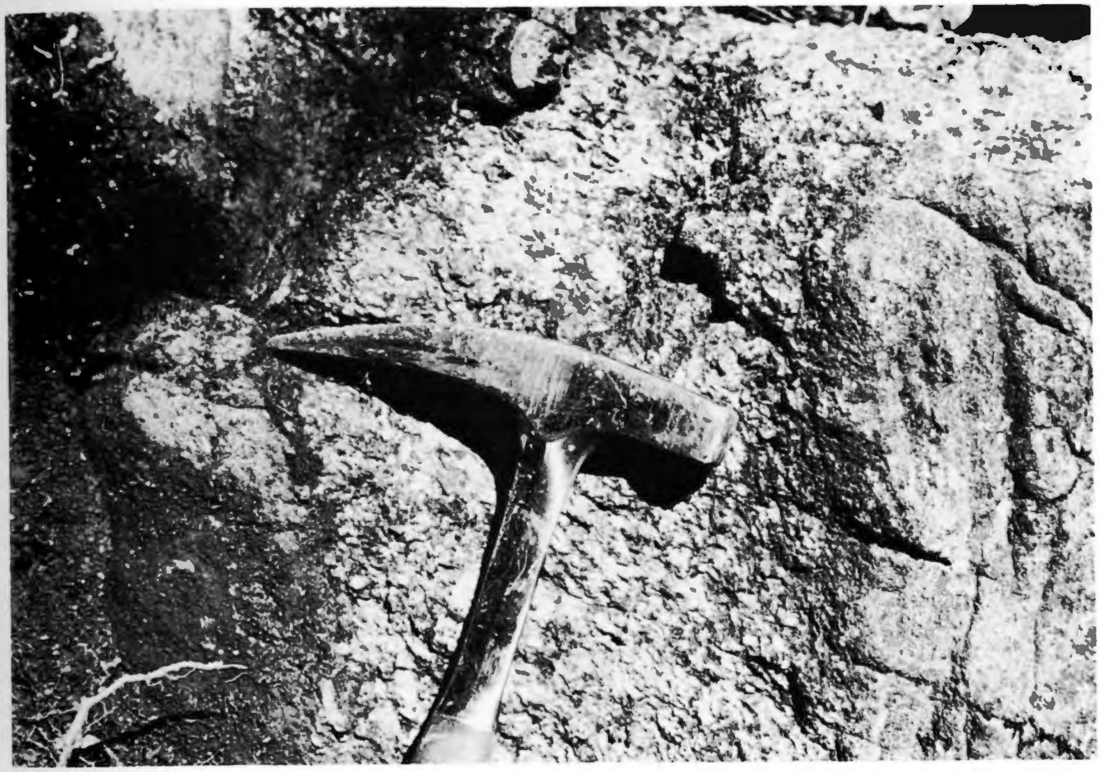

Figure 5. Photograph of paragneiss crosscut by igneous phase of the Corbin Gneiss Complex.

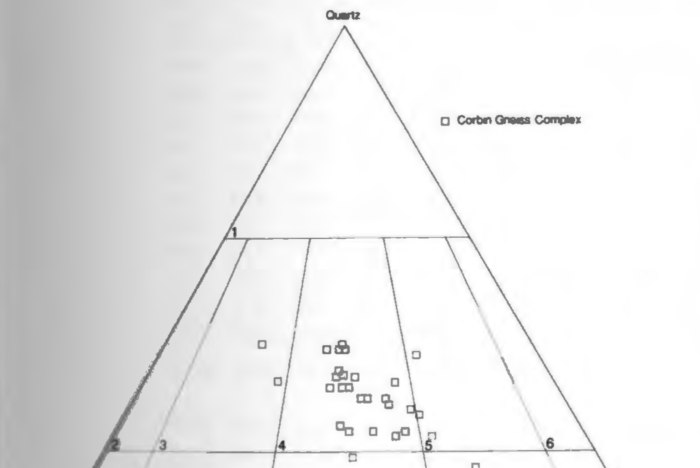

Figure 6. Plots of normative analyses of the Corbin Gneiss Complex, classification modified after Streckeisen (1976) modal diagram with quartz monzonite field added. 1=Quartz-rich granitoids, 2=Alkali-feldspar granite, 3=Two feldspar granite, 4=Quartz monzonite, 5=Granodiorite, 6=Quartz diorite, 7=Alkali-feldspar-quartz syenite, 8=Quartz syenite, 9=Quartz-rich monzonite, 10=Quartz monzodiorite, 11= Tonalite, 12=Alkali-feldspar syenite, 13=Syenite, 14=Monzonite, 15=Monzodiorite, 16=Diorite.

diagrams) are given for analyses presented in this report (Fig. 7). They show well-defined relationships with silica for TiO_2 and FeO, while the relationships between silica and other oxides are more diffuse. However, Martin (1974) reports a differentiation trend is apparent for all oxides except Ca0 and Al_2O_3 when analyses are plotted on Larson-type variation diagrams.

Parts of the Corbin Gneiss Complex contain a significant amount of pyroxene. This lithofacies was described originally as an augite granite by Hayes (unpublished data, 1895) and as an andesine-augite gneiss by Kesler (1950). Most recently this same facies was mapped as a metagabbro by Crawford (*in* Cressler and others, 1979). In this report this rock is referred to as a granulite facies gneiss. The granulite gneiss lithofacies is composed of graphite, ilmenite, microcline, blue quartz, biotite, pyroxene, and andesine. Microprobe analyses of pyroxenes indicate that ferrohypersthene dominates over augite (K. Gillon, written commun., 1980).

An additional lithofacies of the Corbin Gneiss Complex consists of a white to light-gray, medium- to coarse-grained rock that Kesler (1950) originally described as an oligoclase-mica gneiss. Kesler (1950) estimated the composition of this facies to be almost wholly plagioclase (An $_{10}$to An $_{15}$) and blue quartz with minor amounts of orthoclase, muscovite and biotite. This rock is compositionally similar to the Salem Church gneiss lithofacies and field relationships suggest that it is the same lithologic unit as the Salem Church (McConnell and Costello, 1984).

Table 2. Whole-rock chemistry and normative analyses for thirty samples from the Corbin Gneiss Complex.

SAMPLE NO.	19	25	28	30	34	40	49	51	53	58	628	64A	67	68	76
SiO_2	69.12	68.90	67.80	70.14	73.60	70.60	63.46	68.60	69.00	71.60	66.20	62.24	71.80	57.84	68.00
Al_2O_3	15.00	15.80	15.00	15.30	13.00	14.30	14.50	14.80	13.80	12.50	14.80	15.50	13.80	17.40	14.80
Fe_2O_3	1.13	1.46	1.88	0.89	1.09	1.38	1.15	0.47	1.76	0.99	1.18	1.65	0.79	1.58	1.26
FeO	2.04	2.11	2.99	2.26	1.09	1.82	5.98	2.55	2.92	2.62	4.88	6.70	2.62	7.58	2.92
MgO	0.40	0.77	0.83	0.68	0.24	0.20	0.60	0.25	0.35	0.40	0.75	1.00	0.30	1.45	1.00
CaO	1.72	1.00	1.16	1.62	2.04	1.84	4.06	2.80	2.60	3.04	2.60	3.10	2.10	4.50	0.76
Na_2O	2.56	2.70	2.00	3.37	2.63	2.70	3.64	2.96	2.63	2.70	2.70	2.70	2.00	3.10	2.70
K_2O	6.00	5.06	4.82	4.10	5.42	5.30	3.00	6.00	5.06	4.02	4.22	3.97	4.82	2.77	5.42
H_2O	0.88	1.10	2.07	0.56	0.40	0.83	0.13	0.45	0.58	0.28	0.43	0.25	0.85	0.34	1.30
TiO_2	0.70	0.78	1.10	0.80	0.30	0.78	1.75	0.80	1.00	0.80	1.60	2.00	0.60	2.50	1.50
MnO	0.04	0.04	0.04	0.02	0.01	0.02	0.05	0.02	0.04	0.02	0.05	0.08	0.02	0.09	0.04
TOTAL	99.59	99.72	99.69	99.74	99.73	99.77	98.32	99.70	99.74	98.97	99.41	99.19	99.70	99.15	99.70
Q	26.20	29.88	33.00	29.39	33.08	29.94	19.17	21.65	27.61	30.69	25.18	19.66	35.31	13.46	27.56
CO	1.17	4.06	4.38	2.37	0.00	0.78	0.00	0.00	0.00	0.00	1.06	1.13	1.47	1.12	3.11
Z															
OR	35.46	29.90	28.48	24.23	32.03	31.32	17.73	35.46	29.90	28.48	24.92	23.46	28.48	16.37	32.03
AB	21.66	22.85	16.92	28.52	22.25	22.85	30.80	25.05	22.25	22.85	22.85	22.85	16.92	20.56	22.85
AN	8.53	4.96	5.75	8.04	7.66	9.13	14.37	9.38	10.91	7.75	12.90	15.38	10.42	22.32	3.77
DI					2.04		5.01	3.92	1.70	6.26					
NE															
EN	1.00	1.92	2.07	1.69	0.10	0.50	1.05	0.27	0.63	0.13	1.87	2.49	0.75	3.61	2.49
FS	1.73	1.45	2.20	2.13	0.11	0.95	5.08	1.33	1.70	0.37	5.44	7.79	3.20	8.65	1.92
MT	1.64	2.12	2.73	1.29	1.58	2.00	1.67	0.68	2.55	1.44	1.71	2.39	1.15	2.29	1.83
IL	1.33	1.48	2.09	1.52	0.57	1.48	3.32	1.52	1.90	1.52	3.04	3.80	1.14	4.75	2.85

SAMPLE NO.	78	79	81	82	88	92	94	95	97	99	104	108	110	112	113
SiO_2	68.40	68.36	65.20	69.60	67.80	67.20	63.20	67.20	66.40	63.54	70.80	68.64	68.02	66.16	73.26
Al_2O_3	15.30	16.00	14.30	14.20	12.80	14.80	14.20	13.50	15.00	16.70	14.70	15.00	15.80	16.00	13.50
Fe_2O_3	1.67	1.09	2.73	1.16	0.85	0.78	1.00	1.35	1.10	1.98	0.92	2.01	0.97	0.80	0.68
FeO	2.55	1.90	5.10	2.92	4.37	3.35	7.29	4.00	4.23	4.52	1.60	1.97	2.55	3.06	1.82
MgO	0.58	0.87	1.95	0.72	0.98	1.45	0.98	1.52	1.16	0.54	0.94	1.30	0.72	0.80	0.33
CaO	1.76	0.50	2.66	1.86	3.36	2.56	3.44	2.96	4.66	3.88	0.10	1.60	1.74	2.44	2.08
Na_2O	2.43	2.00	2.43	2.17	2.70	2.96	2.70	2.70	2.83	2.43	1.62	2.00	2.83	2.96	2.00
K_2O	5.30	6.62	2.65	5.30	4.58	5.06	4.34	4.22	3.61	3.73	6.50	4.58	5.90	6.26	5.06
H_2O	0.90	1.54	0.62	0.48	0.45	0.44	0.29	0.75	0.43	0.64	1.80	1.59	0.24	0.30	0.22
TiO_2	0.80	0.80	1.75	1.32	1.50	1.00	1.66	1.32	1.00	1.50	0.80	1.09	0.90	0.78	0.80
MnO	0.02	0.02	0.08	0.02	0.04	0.02	0.09	0.04	0.04	0.09	0.00	0.02	0.02	0.02	0.03
TOTAL	99.71	99.70	99.47	99.75	99.43	99.62	99.19	99.56	99.56	99.55	99.78	99.80	99.69	99.58	99.78
Q	28.43	28.43	30.33	30.55	25.26	21.32	18.21	25.38	23.20	24.03	34.50	34.02	23.07	16.92	36.63
CO	2.37	4.64	2.60	1.51	0.00	0.00	0.00	0.00	0.00	1.61	4.82	3.84	1.59	0.00	0.95
Z															
OR	31.32	39.12	15.66	31.32	27.06	29.90	25.65	24.94	21.33	22.04	38.41	27.06	34.86	36.99	29.90
AB	20.56	16.92	20.56	18.36	22.85	25.05	22.85	22.85	23.95	20.56	13.71	16.92	23.95	25.05	16.92
AN	8.73	2.48	13.20	9.23	9.28	12.15	13.81	12.25	17.56	19.25	0.50	7.94	8.63	11.88	10.32
DI					6.26	0.45	2.81	2.02	4.69					0.19	
NE															
EN	1.44	2.17	4.86	1.79	1.39	3.50	2.16	3.31	2.05	1.34	2.34	3.24	1.79	1.96	0.82
FS	2.02	1.30	4.37	2.39	2.80	3.78	8.82	3.60	3.75	4.35	0.86	0.19	2.43	3.65	1.50
MT	2.42	1.58	3.96	1.45	1.23	1.13	1.45	1.96	1.59	2.87	1.33	2.91	1.41	1.16	0.99
IL	1.52	1.52	3.32	2.51	2.85	1.90	3.15	2.51	1.90	2.85	1.52	2.07	1.71	1.48	1.52

Data modified after Martin (1974). Analyses by J.R. Landrum in the laboratories of the Georgia Geologic Survey. Silica, calcium, and magnesium by wet chemical methods; water determined by loss on ignition; titanium oxide and iron oxide determined calorimetrically; other elements AA and flame photometry.

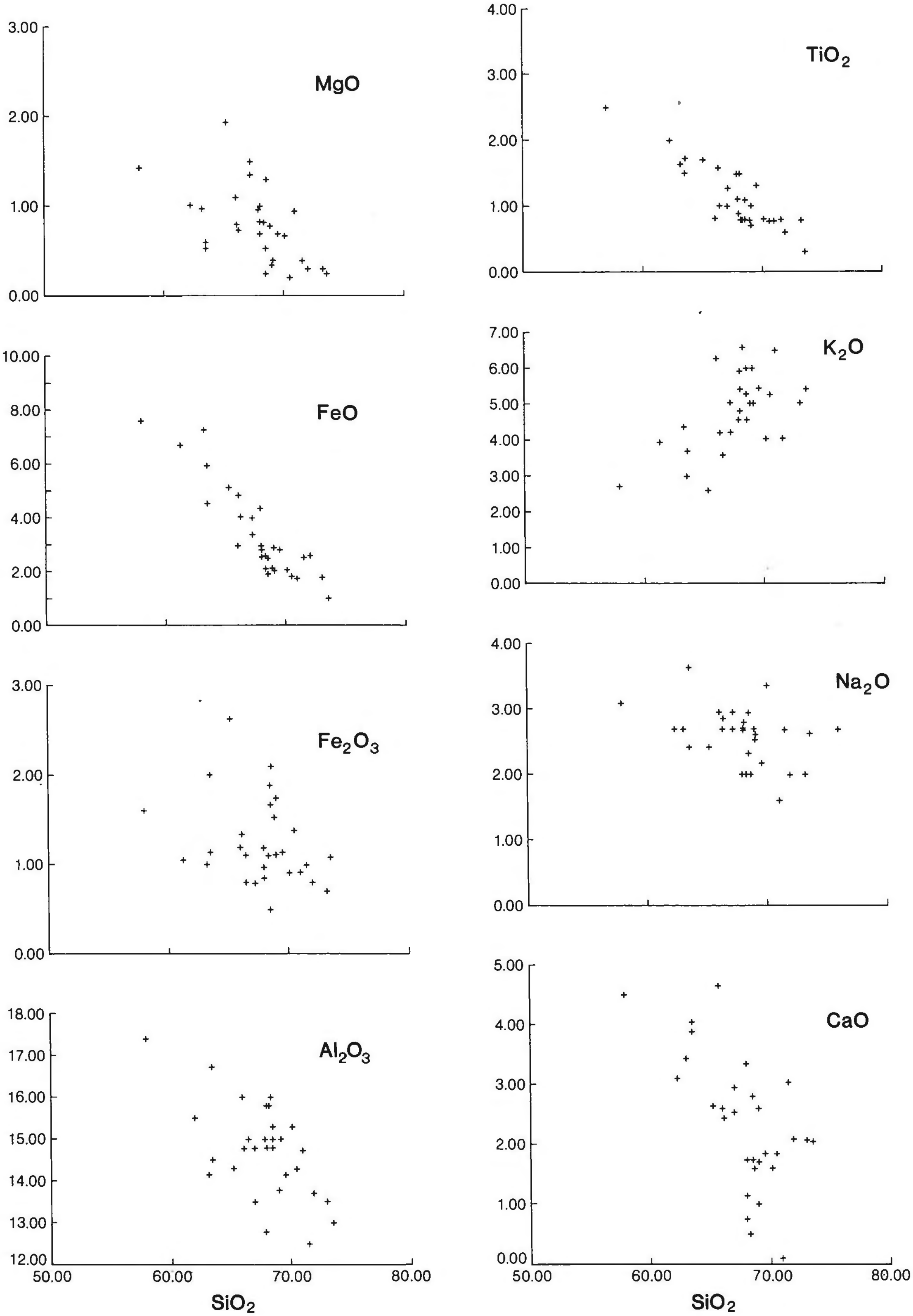

Figure 7. Variation diagrams showing the relationship of SiO_2 to other oxides, Corbin Gneiss Complex (after McConnell and Costello, 1984).

OCOEE SUPERGROUP

Hayes (1895) included rocks above the Corbin Gneiss Complex in the Ocoee series and termed them the Pinelog conglomerate and Wilhite slate. Hayes described the Pinelog conglomerate as consisting of a basal arkosic layer which so closely resembled the underlying granite and augen gneiss that "it is difficult to determine the exact limits of the igneous and sedimentary rocks" (Hayes, unpublished manuscript, 1895, p. 28). This unit is overlain by beds of quartzite, conglomerate and black slate. Hayes believed the Pinelog was a basal conglomerate overlying his Corbin granite.

With minor modifications, McConnell and Costello (1980b) redefined Hayes' Pinelog conglomerate and Wilhite slate as Pinelog Formation and Wilhite Formation. In a subsequent report, McConnell and Costello (1984) formalized these terms for this area. The Pinelog Formation is composed of an interlayered sequence of metaconglomerate, metasandstone, and locally carbonaceous metasiltstone and metashale. Basal units that lie nonconformably on the Corbin Gneiss Complex consist of poorly sorted quartz-pebble metaconglomerates, metasandstone, and graphitic phyllite. These, in turn, are overlain by thickly bedded and graded metaconglomerates, cross-bedded metasandstone, graphitic phyllites and relatively thin lenses of immature, poorly sorted lithic metaconglomerates (diamictite). The lithic metaconglomerate is a distinctive lithofacies within the Pinelog Formation and is observed in a similar stratigraphic position north of the boundaries of the Greater Atlanta Regional Map (McConnell and Costello, 1984). Metasandstones of the Pinelog Formation are composed of quartz and muscovite with traces of epidote, hornblende, biotite, zircon, and various opaques. Locally, the Pinelog contains flaggy quartzites and structures described as worm burrows (O'Connor and others, 1978).

The greatest portion of the Pinelog Formation probably was derived directly from the Corbin. This was noted by Hayes who stated: "This area of Corbin granite at one time probably formed an island, since it is surrounded, in part at least, by rocks derived from its waste" (Hayes, 1901, p. 406). Exposures documenting the relationships between the Corbin Gneiss Complex and its cover rocks are present along the western limb of the Salem Church anticlinorium. Although stratigraphic relationships along this limb were overturned by later folding, an erosional unconformity is observable along Lake Arrowhead in western Cherokee County and along the shores of Lake Allatoona north of Bethany Bridge Road, southeastern Bartow County (Costello, 1978; McConnell and Costello, 1980b, 1982a).

Above the Pinelog Formation is a relatively thin sequence of metasandstone, sandy marble and carbonaceous and non-carbonaceous, locally calcareous metasiltstone termed the Wilhite Formation. The lithologic character of this unit led Hayes (1895) to equate it with the Wilhite slate that he mapped in the Cleveland, Tennessee, area (Hayes, 1901). According to Hayes (1895), of the units mapped in the Cleveland area, only the Wilhite retains its lithologic characteristics toward the south. In later reports on the geology of the Great Smoky Mountains, King and others (1958), Hamilton (1961), Hadley and Goldsmith (1963), King (1964), and Newman and Nelson (1965) redefined stratigraphic relationships of the Ocoee Supergroup and included the Wilhite Formation in their Walden Creek Group. In order to conform to King and others' (1958) stratigraphy, McConnell and Costello (1980b) modified Hayes' Wilhite slate in the Salem Church anticlinorium and renamed it the Wilhite Formation. Wilhite Formation in the study area, like Wilhite defined in the Great Smoky Mountains, contains most of the carbonate rocks in the Ocoee Supergroup.

On the southeastern limb of the Salem Church anticlinorium, the Pinelog and a large part of the Wilhite Formation are truncated by a series of en-echelon faults grouped together into the Lost Town Creek fault zone (McConnell and Costello, 1982b, 1984). In this area, rocks of the Wilhite Formation lie in fault contact with Corbin Gneiss Complex and structually are overlain by rocks of the Great Smoky Group. The Great Smoky Group is the uppermost subdivision of the Ocoee Supergroup as defined by King and others (1958). On the northwestern limb of the Salem Church anticlinorium, rocks of the Wilhite Formation are overlain in apparent stratigraphic conformity by rocks of the Great Smoky Group.

Lithostratigraphic equivalents of the Great Smoky Group were mapped in Fannin, Union and Towns Counties, Georgia, by Hurst (1955) and Dallmeyer and others (1978). In the Greater Atlanta Region, McConnell and Costello (1980b; 1984) subdivided rocks that were previously interpreted to be Great Smoky equivalents (Hadley, 1970; Dallmeyer, 1975; Power and Forrest, 1973) into three formations: Etowah Formation, Sweetwater Creek Formation, and Illinois Creek Formation (Dean Formation in this report). These formations, in a general sense, can be correlated with formations of the Great Smoky Group defined to the northeast (Table 3), although part of the section apparently is missing.

The Etowah Formation is the oldest unit of the Great Smoky Group in the study area and is named for exposures in the confluence of the Etowah and Little Rivers in southwestern Cherokee County (Fig. 8). In the Greater Atlanta Region the Etowah Formation is the basal unit exposed in the Murphy synclinorium. It lies in apparent conformity above the Wilhite Formation northwest of the axial trace of the Salem Church anticlinorium (Fig. 4), but is overthrust by rocks of the northern Piedmont on the southeastern limb of the Murphy synclinorium. The Etowah is composed of a monotonous sequence of interlayered metasandstones and meta-argillite (sericite phyllite) with small lenses of calc-silicate granofels locally present. The lack of carbonate and graphite in the bedded units of the Etowah Formation separates this unit from the underlying Wilhite Formation. The Etowah grades upward into the Sweetwater Creek Formation.

The Sweetwater Creek Formation is named for exposures along Sweetwater Creek on Lake Allatoona in western Cherokee County (Fig. 9). Dominance of coarse metaclastic rocks and presence of graphitic phyllite in the Sweetwater Creek Formation distinguishes it from the underlying Etowah Formation. The boundary between the two units is difficult to define, but generally is placed at a point where coarse clastic material constitutes more than 50 percent of the unit. The Sweetwater Creek Formation is characterized by poorly sorted, blue quartz-bearing conglomeratic metasandstone. Monomineralic pebble-sized clasts within the conglomerate are dominantly quartz and feldspar. Lithic clasts, i.e., slate chips, also are common. Slate chips ranging from 1 to 12 in. in length, are similar to dark phyllites in other parts of the formation suggesting that the conglomerate is intraformational. Interlayered with the conglomeratic sandstone are thick layers of graphitic and sericite phyllite.

Table 3. Regional correlation chart for rocks in the Blue Ridge.

LAFORGE AND PHALEN (1913) Ellijay Quadrangle	BAYLEY (1928) Tate Quadrangle	HURST (1955) Mineral Bluff Quadrangle	MOHR (1973)	DALLMEYER AND OTHERS (1978)	THIS PAPER (Modified after McConnell and Costello, 1980b)
		Murphy Belt	*Murphy Belt Group*	*Murphy Group*	*Murphy Belt Group*
		Mineral Bluff Fm.	unexposed	Mineral Bluff Fm.	Mineral Bluff Fm.
Nottely Quartzite	Nottely Quartzite	Nottely Quartzite		Nottely Quartzite	Not Present
Andrews Schist	Not Present	Andrews Fm.		Andrews Fm.	Marble Hill HbS.
Murphy Marble	Murphy Marble	Murphy Marble		Murphy Marble	Murphy Marble
Valleytown Formation	Valleytown Formation	Brasstown Formation	Brasstown Formation	Brasstown Formation	Brasstown Formation
Brasstown Schist	Not Present				
Tusquitee Quartzite		Tusquitee Quartzite	Tusquitee Member	Tusquitee Quartzite	Not Present
Nantahala Slate	Nantahala Schist	Nantahala Slate	Nantahala Fm.	Nantahala Fm.	Nantahala Fm.
		Great Smoky Group	*Ocoee Supergroup; Great Smoky Group*	*Ocoee Supergroup; Great Smoky Group*	*Ocoee Supergroup; Great Smoky Group*
Great Smoky Formation	Great Smoky Formation	Dean Formation	Dean Fm. / Horse Br. Member	Dean Formation	Dean Formation
		Hothouse Formation	Ammons Formation	Hothouse Formation	Not Present
		Hughes Gap Formation	Grassy Branch Formation	Hughes Gap Formation	Sweetwater Creek Formation
		Transition Zone	Anakeesta Formation	Wehutty Formation	
		Copperhill Fm.	Thunderhead Formation	Copperhill Formation	Etowah Formation
			FAULT		Wilhite Fm.
	Hiwassee schist	Not Exposed	Grenville Age Basement	Not Exposed	Pinelog Formation
Gneisses and Granite	Snowbird Fm. ?				
	Carolina Gneiss				Corbin Gneiss Complex

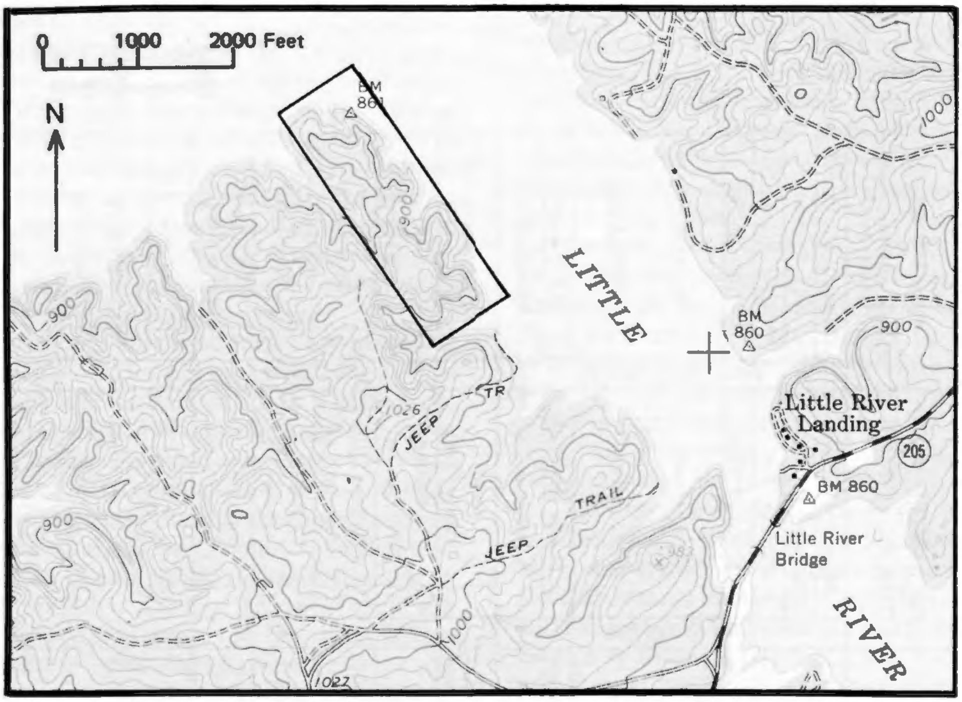

Figure 8. Type locality of the Etowah Formation of the Great Smoky Group (U.S. Geological Survey, South Canton, Georgia, 1:24,000 topographic quadrangle).

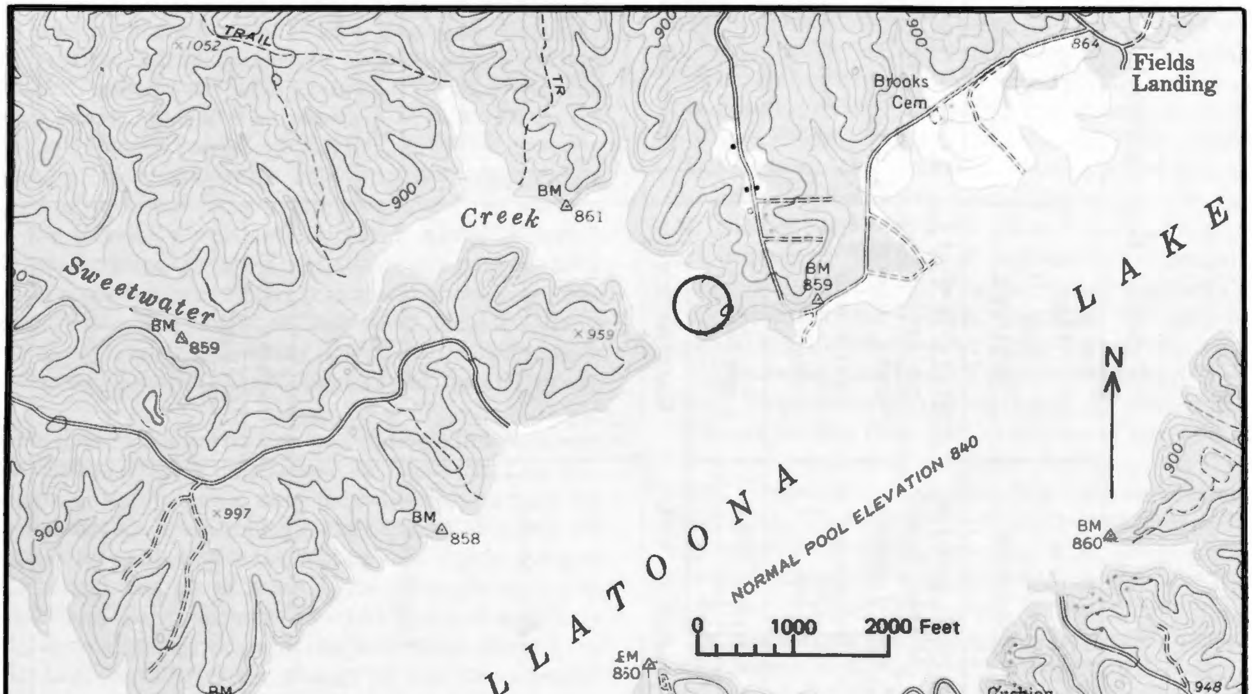

Figure 9. Type locality of the Sweetwater Creek Formation of the Great Smoky Group (U.S. Geological Survey, South Canton, Georgia, 1:24,000 topographic quadrangle).

The uppermost unit of the Great Smoky Group in the study area is the Dean Formation (Table 3). The Dean Formation was formally designated by Hurst (1955) for exposures along the west side of Dean Ridge, Fannin County. The Dean lies gradationally above the Sweetwater Creek Formation and is best exposed along Illinois Creek at Lake Allatoona in western Cherokee County and eastern Bartow County (Fig. 10). The Dean Formation in this area is characterized by quartz-pebble metaconglomerate which differs from that in the Sweetwater Creek Formation in that conglomerate of the Dean contains lesser amounts of dark minerals and is somewhat better sorted. Conglomerate in the Dean Formation also contains detrital plagioclase, perthitic microcline and tourmaline. Associated with the conglomerate are thick beds of metasandstone and sericite phyllite. Staurolite, garnet and chloritoid are common metamorphic accessory minerals in the phyllites. The Dean Formation conformably underlies the Nantahala Formation of the Murphy belt group. McConnell and Costello (1980b) informally designated this unit as the Illinois Creek Formation and noted its similarity to the Dean Formation.

MURPHY BELT GROUP

The Dean Formation of the Great Smoky Group is conformably overlain by metasedimentary rocks of the Murphy belt group. Murphy belt group rocks are exposed in the axial portion of the Murphy synclinorium which terminates in the study area (Figs. 3 and 4). Keith (1904) first described Murphy group rocks, including seven units: Nantahala slate, Tusquitee quartzite, Brasstown schist, Valleytown formation, Murphy marble, Andrews schist, and Nottely quartzite. Later work by LaForge and Phalen (1913) and Bayley (1928) extended Keith's original stratigraphy into Georgia. Hurst (1955), Fairley (1965, 1973), and Power and Forrest (1973) subsequently refined Murphy belt group stratigraphy.

The basal unit of the Murphy belt group is Nantahala Formation (Fairley, 1965). It lies conformably on the Dean Formation in the study area and is perhaps the most continuous unit in the Murphy belt group. Extending southward from the Georgia-North Carolina line, Nantahala Formation defines the western limb of the Murphy synclinorium through Georgia; however, continuity of this unit on the eastern limb of the synclinorium is disrupted by faulting (Bayley, 1928). The Nantahala Formation characteristically is a carbonaceous phyllite to laminated, dark argillite and fine- to medium-grained metasandstone. While Hurst (1955, p. 57) interpreted Nantahala to represent a deep-water, euxinic environment, Power and Forrest (1973, p. 706) interpreted it to represent a tidal-flat or lagoonal environment.

The Brasstown Formation overlies the Nantahala Formation. The Tusquitee Quartzite, which occurs between the Brasstown and Nantahala Formations to the north, is not present in the southwestern Blue Ridge, presumably because of nondeposition (LaForge and Phalen, 1913). Recent mapping by R.D. Hatcher, Mark Ausburn, and students of Hatcher has shown that the Tusquitee is not a separable unit and should be mapped as part of the Nantahala (Robert D. Hatcher, written commun., 1983). Recent workers were unable to separate Keith's (1907) Valleytown formation from the Brasstown and the two units were subsequently combined into the Brasstown Formation (Hurst, 1955; Fairley, 1965; Power and Forrest, 1973). The Brasstown Formation is a sequence of interlayered gray schists and micaceous quartzites that weather to buff to orange saprolite. To the north near Jasper, Georgia, the Brasstown is well exposed and, owing to its slabby character, is quarried locally for flagstone. West of Canton (Plate I), the Brasstown is only exposed in small fault slices along the southeast limb of the Murphy synclinorium. Power and Forrest (1973) noted the presence of local beds and lenses of calc-silicate granofels as a characteristic of the Brasstown.

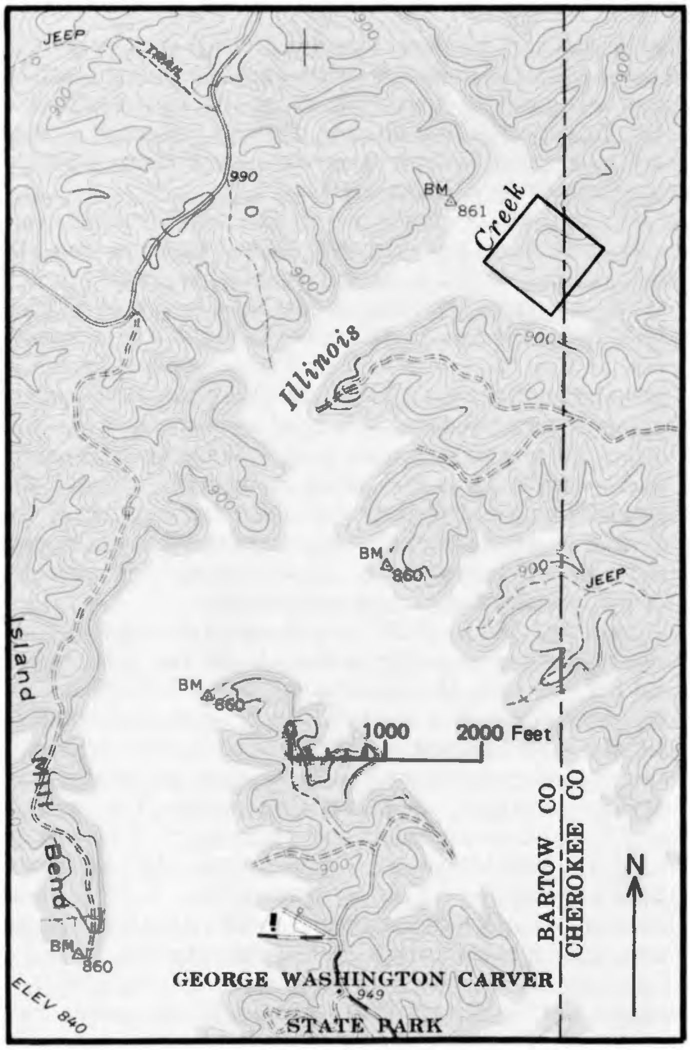

Figure 10. Location of exposures of Dean Formation of the Great Smoky Group in the Greater Atlanta Regional Map area (U.S. Geological Survey, Allatoona Dam, Georgia, 1:24,000 topographic quadrangle).

Overlying the Brasstown Formation is the well-known Murphy marble, a fine- to medium-grained calcite and dolomite marble. Bayley (1928), Fairley (1965) and Power and Forrest (1973) noted that the outcrop belt of the Murphy Marble is discontinuous with the latter suggesting that this argued for a reef or carbonate bank origin (Power and Forrest, 1973, p. 707). Murphy Marble is easily the most economically significant commodity in the Murphy belt group and is quarried for dimension and crushed stone as well as fillers and extenders in both Georgia and North Carolina. The marble is quarried extensively at Tate, Whitestone, Marble Hill, Jasper, and Ball Ground, Georgia, where it is best exposed. Smaller, discontinuous outcrops occur from Waleska, Georgia, to Wesser, North Carolina.

Keith (1907) originally described a thin calc-schist overlying the Murphy Marble that he termed Andrews schist. In the Tate-Marble Hill area, Murphy Marble grades upward into a calcareous, hornblende-bearing schist that Fairley (1965) termed Marble Hill Hornblende Schist. The transition zone between these units is approximately 50 ft. thick in the Tate-Marble Hill area (Power, 1978). Fairley (1965) interpreted the hornblende schist to be of sedimentary origin and assigned it to a stratigraphic position between the Murphy Marble and Andrews Formation. Power and Forrest (1973) disagreed with Fairley's stratigraphic interpretation of the hornblende schist and concluded that, in keeping with Keith's (1907) original interpretation, the Marble Hill and Andrews Formations are stratigraphic equivalents.

Although Bayley (1928) showed a small outcrop of Nottely Quartzite on his map, other workers in the Tate area (Power and Forrest, 1973; McConnell and Costello, 1980b) have not observed the Nottely in this area. Occurring above the Marble Hill Hornblende Schist is a thick sequence of pelitic rocks, which includes garnet-quartz-sericite schist and, locally, pure sericite schist that is mined as a talc substitute. These schists are believed to be equivalent to the Mineral Bluff Formation (Fairley, 1965; Power and Forrest, 1973; McConnell and Costello, 1980b) as defined by Hurst (1955) in the Mineral Bluff quadrangle. Fairley (1965) pointed out the fact that the Mineral Bluff has numerous intercalations of calc-schist in the Tate area, a factor used by Power and Forrest (1973) to suggest that the Mineral Bluff represented open-marine shelf conditions during deposition.

REGIONAL CORRELATIONS

As stated previously, the lack of fossiliferous horizons and favorable units for isotopic dating (excluding the Corbin Gneiss Complex), and the questions regarding the nature of the Cartersville fault have led to many different interpretations of the age and correlation of major lithologic units in the Blue Ridge portion of the study area. In light of several recent reports on the subject (McConnell and Costello, 1980b, 1982a, 1984; Cressler and others, 1979; Sears and others, 1981; Sears and Cook, 1982; Costello and others, 1982), a discussion of the correlations is warranted.

In general, interpretations regarding the age and correlative rock units for rocks which lie unconformably on the Corbin Gneiss Complex (i.e., Pinelog and Wilhite Formations) may be split into two broad categories. Hayes (1901) concluded that the Cartersville fault exists east of Cartersville and that it separates lower Paleozoic sediments in the Valley and Ridge from metamorphosed, Precambrian sediments unconformably overlying or intruded by the Corbin Gneiss. With minor modifications, this general interpretation was subscribed to by many subsequent workers (Crickmay, 1936; Cressler and others, 1979; Hadley, 1970; McConnell and Costello, 1980b; this report). The second interpretation began with LaForge (*in* Hull and others, 1919) and was later emphasized in Kesler's report on the Cartersville district in which he suggested that the Cartersville fault does not exist east of Cartersville and that rocks overlying the Corbin Gneiss are equivalent to lower Paleozoic Weisner and Shady Formations (Kesler, 1950). Workers wholly or in part subscribing to this interpretation include Bentley and others (1966), Fairley (1973), Hurst (1973) and Sears and others (1981). With the above-outlined interpretations in mind, an examination of the lithology and depositional environment of the various sequences is necessary.

We suggest that the controversy over the stratigraphic position of rocks nonconformably overlying the Corbin Gneiss Complex results, at least in part, from an oversimplification of lithology and structure. We believe this is the case where rocks nonconformably overlying the Corbin were interpreted to be Weisner Formation (Kesler, 1950; Hurst, 1973; Sears and others, 1981). While lithologic differences between rocks of the Chilhowee Group and Pinelog and Wilhite Formations can be attributed to facies changes within a single unit, the Chilhowee Group represents an easily recognizable, regionally continuous rock sequence in the southern Appalachians. King and others (1958) and King (1964) noted these characteristics of the Chilhowee Group in discounting correlations between Chilhowee Group and Great Smoky Group rocks. Significant lithologic differences do exist between the Chilhowee Group near the Cartersville fault (i.e., Weisner Formation after Mack, 1980) and Pinelog and Wilhite Formations. As defined, the Weisner Formation consists predominantly of vitreous quartzite with lesser amounts of conglomerate, sandstone and sandy shale (Hayes, 1902). The Weisner Formation generally is believed to be equivalent to the Hesse Sandstone of the Chilhowee Mountain belt of east Tennessee (Whisonant, 1974; Mack, 1980). Whisonant (1974) interpreted the Hesse-Weisner units to represent a thin sheet of "clean, well-sorted orthoquartzite" (Whisonant, 1974, p. 238) that was deposited during a period of relative tectonic stability. In contrast to the well-sorted and relatively mature character of the Weisner Formation, rock units lying nonconformably on the Corbin Gneiss Complex (i.e., Pinelog and Wilhite Formations) locally are poorly sorted and immature. The Pinelog and Wilhite Formations form a heterogeneous assemblage of polymictic metaconglomerates, sandstones, and carbonaceous and non-carbonaceous siltstones. Interlayered with the above rocks are thin lenses of siliceous marble and diamictite. In general, individual units within the Pinelog or Wilhite do not show extensive lateral continuity. The immaturity of sediments in the Pinelog and Wilhite as well as their poorly sorted character suggest that they were deposited, at least partially, in an environment where rapid subsidence and rapid deposition were common. While not conclusive, these lithologic differences should not be overlooked, particularly when the Weisner Formation is such a distinctive unit.

Additional doubts are raised about correlating Chilhowee Group rocks with those rocks nonconformably overlying the Corbin Gneiss Complex, when relationships between the Chilhowee Group and Ocoee Supergroup in the Great Smoky Mountains National Park are studied. In the foothills area of the Great Smoky Mountains, King and others (1958) and King (1964) have reported that rocks of the Chilhowee Group unconformably overlie Walden Creek Group rocks. Walden

Creek Group rocks are interpreted to rest conformably (King, 1964) on Snowbird Group which, in turn, overlies Grenville basement. East of the Greenbrier fault, the stratigraphic sequence is basement-Snowbird Group-Great Smoky Group (King and others, 1958). Thus, in areas where the Ocoee Supergroup is present, it has been shown to lie between rocks of the Chilhowee Group and Grenville basement. In eastern Tennessee the Ocoee Supergroup is approximately 50,000 ft. thick (King, 1964), whereas it is considerably thinner in the Greater Atlanta Region (16,000 ft. thick, McConnell and Costello, 1984). The correlation of rocks nonconformably overlying Corbin Gneiss Complex with the Chilhowee Group in an area where Ocoee Supergroup rocks are known to be present would seem to require a very large erosional unconformity in a very limited area. We believe that the simpler and more geologically feasible interpretation that does not require an erosional unconformity and takes into account the lithological differences is to equate rocks of the Pinelog-Wilhite sequence to the Ocoee Supergroup.

The most compelling evidence for a fault separating the Ocoee Supergroup rocks and Chilhowee Group rocks in the Cartersville area is the difference in deformation observed on opposite sides of the trace of the fault. While at least three major fold events are recognized in rocks east of the fault (McConnell and Costello, 1982a; Costello and others, 1982), only the last two of these fold events are observed in rocks to the west of the fault (Reade and others, 1980).

A second problem regarding correlation of units in the Blue Ridge as defined in this report is the relationship between rocks of the Ocoee Supergroup and Talladega belt rocks. This problem is due, in part, to a lack of quadrangle mapping in the Talladega belt in Georgia. Interpretations as to the age of rocks in the Talladega range from middle to upper Paleozoic, based on reported fossils in the Jemison Chert and Erin Shale (Smith, 1903; Shaw, 1970, 1973; Gilbert, 1973; Gastaldo and Cook, 1981), to at least partially Precambrian, based on lithologic similarities and areal continuity with Ocoee Supergroup rocks exposed along strike with the Talladega in north-central Georgia (Hayes, 1901; Prouty, 1923; Stose and Stose, 1944; McConnell and Costello, 1980b; Crawford and Cressler, 1981, 1982). The Talladega "problem" in Georgia has involved two questions: whether or not the Cartersville fault exists southwest of Cartersville and, assuming it does, what part of the Ocoee Supergroup makes up the Talladega in Georgia. With regard to the first question, Hurst (1973) questioned the need for the Cartersville fault southwest of Cartersville suggesting that the Talladega in Georgia was lying unconformably on lower Paleozoic sedimentary rocks. Hurst (1973) indicated that the age of the Talladega in Georgia was post-Early Ordovician. This interpretation, which depends upon an unconformable contact at this boundary, is questionable in light of a recently published report by Crawford (1977c), who reported that, west of Emerson (Fig. 4), the Cartersville fault thrust Talladega rocks over Cambrian to Mississippian-age Valley and Ridge rocks. With the evidence that the Cartersville fault is present southwest of Cartersville, the question then arises as to which units in the Ocoee Supergroup trend into the Talladega at Emerson. Cressler and others (1979), Cressler and Crawford (1976) and Crawford and Cressler (1981, 1982) suggested that the Talladega "Group"[1] and associated lithologies overthrust the Great Smoky fault and the southwestern terminus of the Salem Church anticlinorium along a low-angle fault termed the "Emerson (Cartersville) fault." In their interpretation, Crawford and Cressler (1981, 1982) limit rocks comprising the Talladega at Emerson to the Great Smoky Group. McConnell and Costello (1980b; 1982a) disagreed with Crawford and Cressler (1981, 1982) and suggested that rocks nonconformably overlying the Corbin (Pinelog and Wilhite Formations) as well as Great Smoky Group rocks trend into the Talladega belt. This bulletin follows the interpretation of McConnell and Costello (1980b; 1982a).

Confusion regarding the geology of the Talladega at Emerson results from a complex interplay of faulting, folding and depositional environments. The importance of the Emerson (Cartersville) fault (Cressler and Crawford, 1976; Crawford and Cressler, 1981, 1982) and the fault's impact on the stratigraphic relationships are here considered minimal. In order to understand the relationships that exist at Emerson, it is necessary to establish a reference point from which to correlate Ocoee lithologies across the area east of Emerson into what has been defined as Talladega belt. Such a reference point exists in the stratigraphic sequence present on the western limb of the Salem Church anticlinorium east of Cartersville. The transition from basement gneiss upward into a high-energy clastic sequence (Pinelog Formation) and then into a sequence that represents a lower energy, more restricted depositional environment (Wilhite Formation) is of paramount importance in efforts to decipher relations east of Emerson. This same lithologic succession can be traced from the northeastern terminus of the Salem Church anticlinorium approximately 15 mi. to the northeast of Emerson, southward to Interstate 75 just east of Emerson. At the southwestern terminus of the Salem Church anticlinorium, the Corbin Gneiss Complex and Pinelog Formation plunge beneath the surface, but the overlying Wilhite Formation continues to the southwest uninterrupted and therefore forms part of the Talladega belt in this area. In conjunction with the plunging out of competent lithologies like the Corbin Gneiss and quartzites of the Pinelog Formation, faulting associated with transposition during F_2 folding becomes less apparent. Rocks of the Great Smoky Group, in fault contact with graphitic phyllites of the Wilhite Formation to the northeast near Waleska, are believed to conformably overlie the Wilhite to the southwest of Emerson and, therefore, also compose part of the Talladega in this area (Fig. 2). All of this, with the exception of some revision of stratigraphic nomenclature, is similar to what Hayes proposed nearly 90 years ago. His Wilhite slate, Pinelog conglomerate, and Gilmer formation are stratigraphic equivalents with the Wilhite Formation, Pinelog Formation and Great Smoky Group of this report (Table 3).

[1] Smith (1888) originally defined the Talladega Group for exposures along Talladega Creek in Alabama. Tull (1982) interprets these rocks at the type locality as lying above the pre-Lay Dam Formation unconformity and of middle Paleozoic age. Present usage in Alabama follows Smith's original definition, but other rocks in the Talladega belt stratigraphically below those exposed along Talladega Creek do not belong to the Talladega "Group" as defined by Smith (Tull, 1982).

Stratigraphy of the Piedmont

NORTHERN PIEDMONT

Rocks lying between the Allatoona fault and the Brevard fault zone (Fig. 2) are defined in this report to be in the northern Piedmont. This usage diverges from common terminology used in Alabama, South Carolina and Georgia (i.e., Tull, 1978; Hurst, 1973; Hatcher, 1978a). In several recent reports (McConnell and Costello, 1980b; Abrams and McConnell, 1981a; McConnell and Abrams, 1982a, 1982b) the regional stratigraphy and structure in the northern Piedmont has been revised. These reports resulted from detailed and reconnaissance mapping carried out as part of the Greater Atlanta Regional Map project. A conclusion reached as a result of this mapping effort was that some names previously used to describe major rock units are no longer suitable. Prior to the studies mentioned above, major rock units in western Georgia were either assigned a numerical classification (Crawford and Medlin, 1973) or correlated with the Ashland and Wedowee units in Alabama (Hurst, 1973). The numerical classification used by Crawford and Medlin (1973) is inappropriate due to its dependence on a single major fold event as its basis. Multiple deformation and its influence on the local stratigraphy in the northern Piedmont is documented in many recent reports (Hatcher, 1977, 1978a; McConnell and Costello, 1980b; Abrams and McConnell, 1981a). The numerical designation therefore is abandoned in this report. Relating rocks of the northern Piedmont with the terms Ashland and Wedowee also is not appropriate. Ashland Mica Schist and Wedowee Formation are somewhat ambiguous field terms used by Prouty (1923) and Adams (1926) to describe major rock units in Alabama. Since its introduction, the name Ashland has held several different stratigraphic ranks including group status (Hurst, 1973) and supergroup status (Tull, 1978). Neathery and Reynolds (1973) suggested that the term "Ashland Mica Schist" be abandoned because they believe that units of the Wedowee Formation are traceable across metamorphic boundaries into rocks that were previously assigned to the Ashland Mica Schist. Also, the Wedowee Formation as defined by Bentley and Neathery (1970) contains units defined as part of the Ashland Supergroup by Tull (1978). To add to the confusion, rocks of the Ashland Supergroup as defined by Tull (1978) are present only in the Coosa block and rocks of the Wedowee are present only in the Tallapoosa block. Thomas and others (1979) indicate that only Tallapoosa block rocks (i.e., Wedowee Group and Emuckfaw-Heard sequence) are present in west Georgia north of the Brevard fault zone. However, Hurst (1973) has defined rocks of both Wedowee Formation and Ashland Group in the northern Piedmont of Georgia.

Due to their ambiguous original definition, their subsequent accumulation of several different stratigraphic ranks, and confusion over their boundaries, McConnell and Costello (1980b) suggested that both Ashland and Wedowee be dropped as stratigraphic names in Georgia. To replace Ashland and Wedowee in Georgia, McConnell and Costello (1980b) informally introduced the names Dallas group and Roosterville group. These two groups together with the Sandy Springs Group (Higgins and McConnell, 1978a, 1978b) encompassed all major rock units in the northern Piedmont of Georgia. In a subsequent report, Abrams and McConnell (1981a) revised the boundary between the Dallas and Roosterville groups and changed the name of the Dallas group to New Georgia Group (Fig. 11). As a result of the boundary change, sequences of rocks of dominantly volcanic origin comprise the New Georgia Group.

Although areal separation and apparent lithologic differences prohibit any direct correlation with rocks in Georgia, we speculate that rocks of the New Georgia Group are, at least in part, equivalent to rocks of the Ashland Supergroup (Table 4). This is based primarily on the fact that both the New Georgia Group and Ashland Supergroup contain a large proportion of metavolcanic rocks and similar types of ore deposits. In addition, we also suggest that rocks defined as Wedowee Formation in Alabama (Tull, 1978) are equivalent to rocks of the Sandy Springs Group, particularly rocks of the Sandy Springs Group western belt. This correlation is based on lithologic similarities and the association of both Sandy Springs Group and Wedowee Formation with major volcanic-bearing rock groups (i.e., New Georgia Group and Ashland Supergroup, respectively).

In their preliminary report, McConnell and Costello (1980b) indicated that the Sandy Springs Group was the oldest rock sequence in the northern Piedmont. This interpretation was based on lithologic similarities between the Sandy Springs Group and Tallulah Falls Formation (Hatcher, 1974), the latter of which lies, at least in part, nonconformably on Grenville basement in northeast Georgia (Hatcher, 1977, 1978a). Hatcher (1978a) also speculated, however, that a large part of the Tallulah Falls Formation was deposited on oceanic crust. Recent mapping in western Georgia supports the oceanic crust hypothesis. Rocks of the New Georgia Group are interpreted to represent back-arc basin volcanics that formed on attenuated (rifted) continential crust. This interpretation is based on chemistry of the volcanic rocks in the New Georgia Group which is bimodal and suggests back-arc basin or ocean ridge tholeiite affinity (McConnell, 1980a; McConnell and Abrams, 1982b). The presence of attenuated and, possibly, largely engulfed continental crust is postulated to provide a source for the large volume of felsic volcanic rocks in the New Georgia Group and to provide a mechanism for the presence of Grenville basement unconformably beneath the Tallulah Falls Formation. We further speculate that as volcanic activity decreased in the basin, it was infilled by flysch facies greywackes, argillites and subordinate volcanic rocks of the Sandy Springs Group.

Another result of the detailed mapping in western Georgia is the confirmation of lithostratigraphic equivalence between rocks of the Roosterville group and Sandy Springs Group. McConnell and Costello (1980b) suggested the possible equivalence of the two units in their report. In this bulletin, we propose that the term "Roosterville group" be dropped and rocks previously within the Roosterville be considered to be the western belt of the Sandy Springs Group (Fig. 11). This proposal is based on lithologic similarities between units of the Sandy Springs Group and Roosterville group as well as on the presence of similar stratigraphic sequences in both groups.

In the following discussion an interpretation of the stratigraphic sequence in the northern Piedmont is presented. Due to a lack of definitive isotopic ages, regionally significant

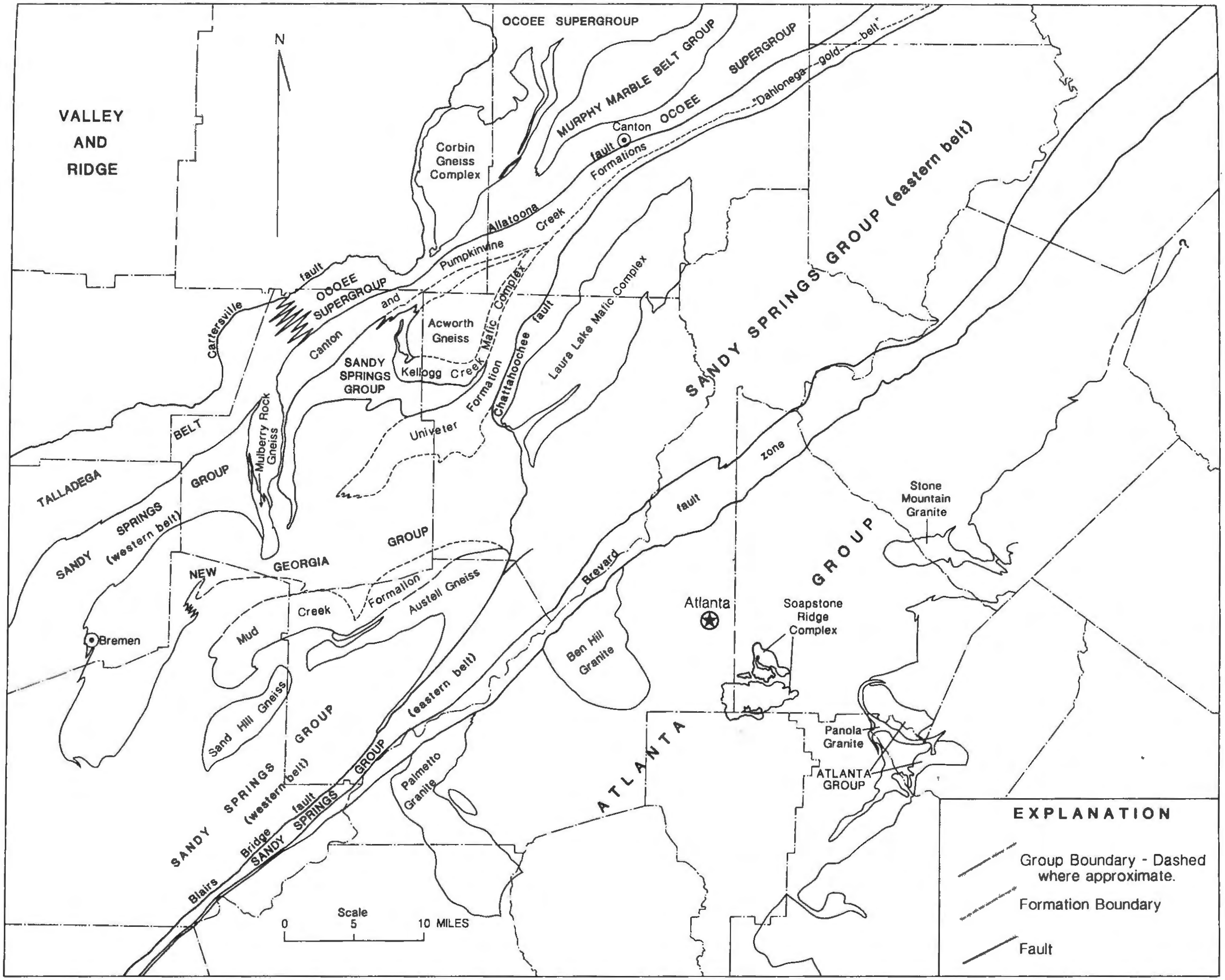

Figure 11. Group and formation boundaries of the crystalline rocks of the Greater Atlanta Regional Map.

Table 4. **Proposed correlation chart of lithologic units in the Alabama, Georgia and South Carolina Piedmont.**

Alabama Modified after Tull (1978)		Georgia (this report) west		east	Northeast Georgia and South Carolina Hatcher (1974)		Georgia Modified after Hurst* (1973)
	Emuckfaw Formation	Sandy Springs Group	Bill Arp Formation	Factory Shoals Formation	Tallulah Falls Formation	Greywacke, schist Quartzite, schist	Wedowee Formation
	Wedowee Group		Andy Mountain Formation			Aluminous schist	
				Chattahoochee Palisades Quartzite		not present	
Ashland Supergroup	Mad Indian and Hatchet Creek Groups		Dog River Formation	Powers Ferry Formation		Greywacke, schist, amphibolite	
	Higgins Ferry and Poe Bridge Mountain Formations	New Georgia Group			Hornblende gneiss, amphibolite		Ashland Group
	— Fault — Hillabee Chlorite Schist				Basement		

*Hurst (1973) interpreted the Wedowee to be older than Ashland.

facing criteria, and (or) fossils, this interpretation relies in part on the lithologic similarities between rocks of the Sandy Springs Group and Tallulah Falls Formation defined in northeastern Georgia by Hatcher (1971a). The similarities between these two sequences have been noted by many geologists (Hatcher, 1974, 1975; Higgins and McConnell, 1978a; Gillon, 1982). The stratigraphic interpretation presented herein is also in part dependent on Hatcher's (1971a, 1974) interpretation of an unconformable contact between Grenville basement and the Tallulah Falls Formation.

New Georgia Group

Rocks of the New Georgia Group (Abrams and McConnell, 1981a) form an irregular belt that extends from the Bremen area on the west northeastward to Canton where the belt narrows considerably and continues northeastward to at least the Dahlonega area, forming the "Dahlonega gold belt" (Fig. 11). The outcrop belt of the New Georgia Group, which is at least 130 mi. long and, at its widest, is 17 mi. wide, contains most of the base and precious metal deposits in the Greater Atlanta Regional Map area. New Georgia Group rocks are exposed in the core of a large-scale second-generation synform that plunges to the northeast. The base of the New Georgia Group is not exposed and its exact thickness is unknown. Sandy Springs Group (eastern belt) rocks are in fault contact with the New Georgia Group along the Chattahoochee and Blairs Bridge faults in the eastern and northern part of the belt (Plate I and Fig. 11). The contact between the Sandy Springs Group (western belt) and New Georgia Group near Villa Rica is gradational and this gradation is expressed by the apparent waning of volcanic activity as time progressed. The New Georgia Group is characterized by the dominance of metavolcanic rocks over metasedimentary rocks. On the other hand, the Sandy Springs Group is dominantly metasedimentary and contains a steadily decreasing volcanic component upward.

That part of the New Georgia Group that is exposed in the study area is composed of an intermingled sequence of metamorphosed felsic and mafic volcanic and subvolcanic rocks, plutonic rocks and a proportionally smaller amount of sedimentary rocks. At least two cycles of volcanism are recognizable in the New Georgia Group, but the scarcity of distinct volcanic textures due to metamorphic overprinting and deformation limits the accuracy of estimates regarding the exact proportions of felsic to mafic volcanic material in these cycles. The obliteration of original sedimentary or volcanic textures during metamorphism and intense deformation and complexities within the original volcanic pile combine to make definition of internal stratigraphy in the New Georgia Group very difficult. However, portions of the New Georgia Group are relatively well known and provide some understanding of the stratigraphy of the group. Two areas studied in detail occur on the borders of the New Georgia Group outcrop belt. Lithologic units in these areas are the Mud Creek Formation in the Villa Rica area to the southwest and the Pumpkinvine Creek Formation to the northeast. A third formation in which some idea of internal stratigraphy of the New Georgia Group can be ascertained is in the Univeter Formation located near the center of the outcrop belt of the New Georgia Group (Fig. 11).

In the vicinity of Villa Rica, Abrams and McConnell (1981a) were able to define the Mud Creek Formation of the

New Georgia Group (Fig. 11). The Mud Creek Formation is composed predominantly of locally garnetiferous, equigranular hornblende-plagioclase amphibolite and hornblende gneiss interlayered with garnet-biotite schist and gneiss, banded iron formation (magnetite quartzite), and metadacite (low potassium orthogneiss). Banded iron formation forms an excellent stratigraphic marker unit as well as being an important horizon in regard to base and precious metal deposits (Abrams and others, 1981; Abrams and McConnell, 1981a, 1982a). For that reason, banded iron formation in the Villa Rica area was designated a member of the Mud Creek Formation and termed the Cedar Lake Quartzite (Abrams and McConnell, 1981a). The dominant facies of the Cedar Lake Quartzite is composed of layers and disseminated grains of magnetite and specular hematite in a coarse to micro-crystalline quartzite (Fig. 12). Manganese (weathered spessartine quartzite), sulfide and aluminous facies iron formation also are common in the Villa Rica area.

A distinctive structural feature of the Villa Rica area is the Villa Rica antiform (Fig. 13). This antiform is a parasitic

Figure 12. Photograph of Cedar Lake Quartzite (banded iron formation) from the type locality.

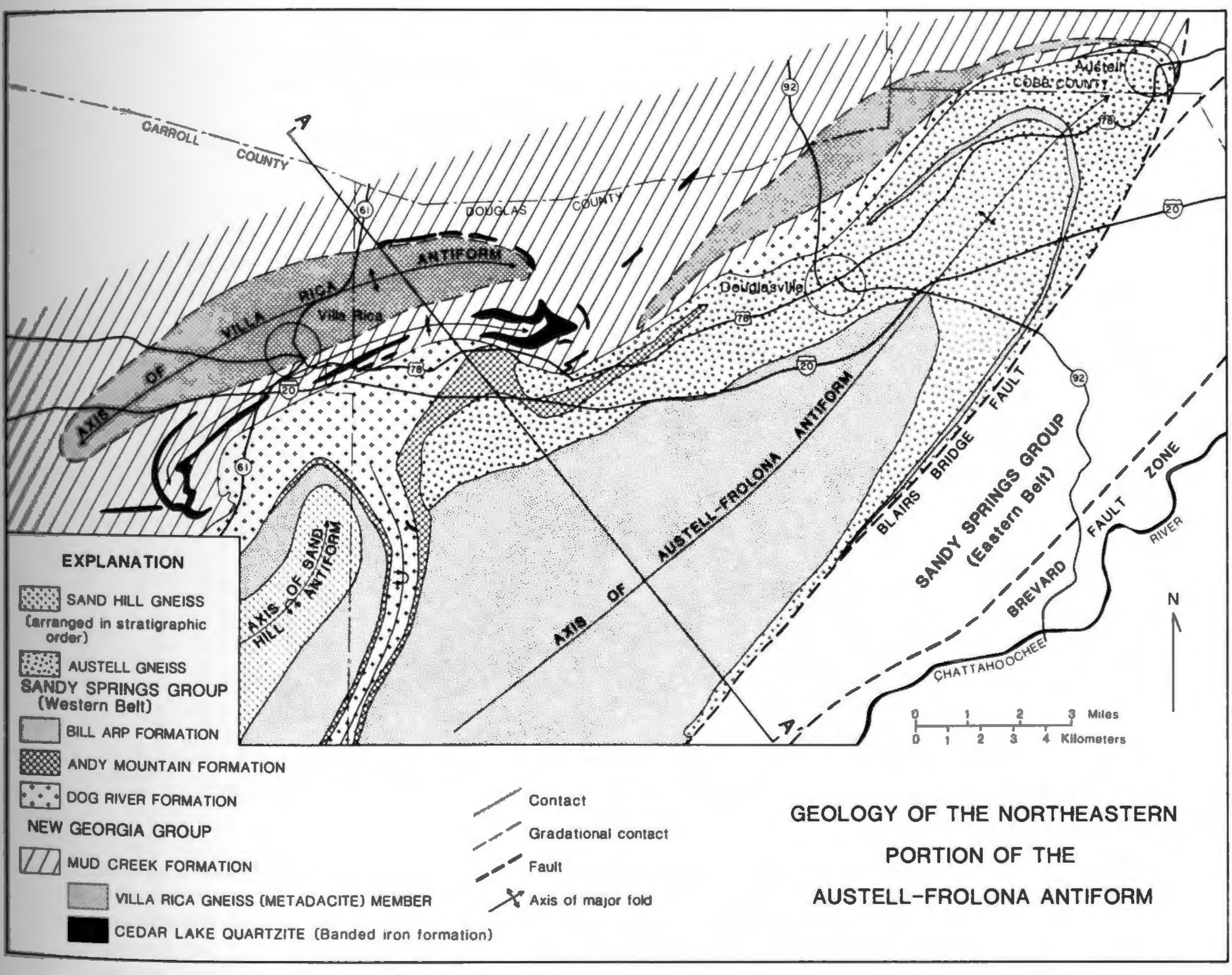

Figure 13. Geologic map of the northeastern portion of the Austell-Frolona antiform (modified after Abrams and McConnell, 1981a). Cross section A - A' is shown in Figure 26.

upwarp on the southern limb of the large synform cored by the New Georgia Group. Exposed in the crest of the Villa Rica antiform is an equigranular biotite-quartz-oligoclase (An_{26} to An_{30}) gneiss that is characterized by low concentrations of K_20 (Sanders, 1977). Although originally termed a granite (McCallie, *in* Yeates and others, 1896), it is now believed to be dacitic to rhyodacitic in composition (Fig. 14) (Abrams and McConnell, 1981a). Abrams and McConnell (1981a) formally termed this unit the Villa Rica Gneiss for exposures in and around the city of Villa Rica. The Villa Rica antiform plunges beneath the surface just east of Villa Rica (Fig. 13). East-northeast of where the Villa Rica antiform plunges out, another gneiss very similar to the Villa Rica Gneiss is exposed in the crest of another elongate antiform. Sanders (personal commun., 1981) found that this gneiss is chemically dissimilar to the Villa Rica Gneiss and contains slightly higher concentrations of K_20, MgO, total Fe, and CaO and slightly lower values for SiO_2 and Na_20. Abrams and McConnell (1981a) and Abrams (1983) suggested that the two gneisses were equivalent based on their similar structural and stratigraphic position. In this report, we consider the chemical variations to be minor facies variations within a single lithostratigraphic unit and interpret this body to be equivalent to the Villa Rica Gneiss. Interference as a result of second-generation folding (F_{2a}) is responsible for the separation of the gneiss in map view. Contact relationships between these two felsic bodies and the surrounding rocks, and examination of core from several mines and prospects in the Villa Rica area suggest that the Villa Rica Gneiss is interlayered with mafic metavolcanic and metasedimentary rocks. These factors are interpreted to indicate that the Villa Rica Gneiss, at least in part, is a metamorphosed dactic subvolcanic intrusive.

On the northwestern border of the New Georgia Group, a sequence remarkably similar to the Mud Creek Formation was recognized by McConnell (1980a). This sequence includes the Canton Formation and the Pumpkinvine Creek Formation, of which the Galts Ferry Gneiss is a member. These units are exposed in the limbs and crest of an antiform much like the Mud Creek Formation (Fig. 15). The Galts Ferry Gneiss, like the Villa Rica Gneiss, is exposed in the crest of the fold and is

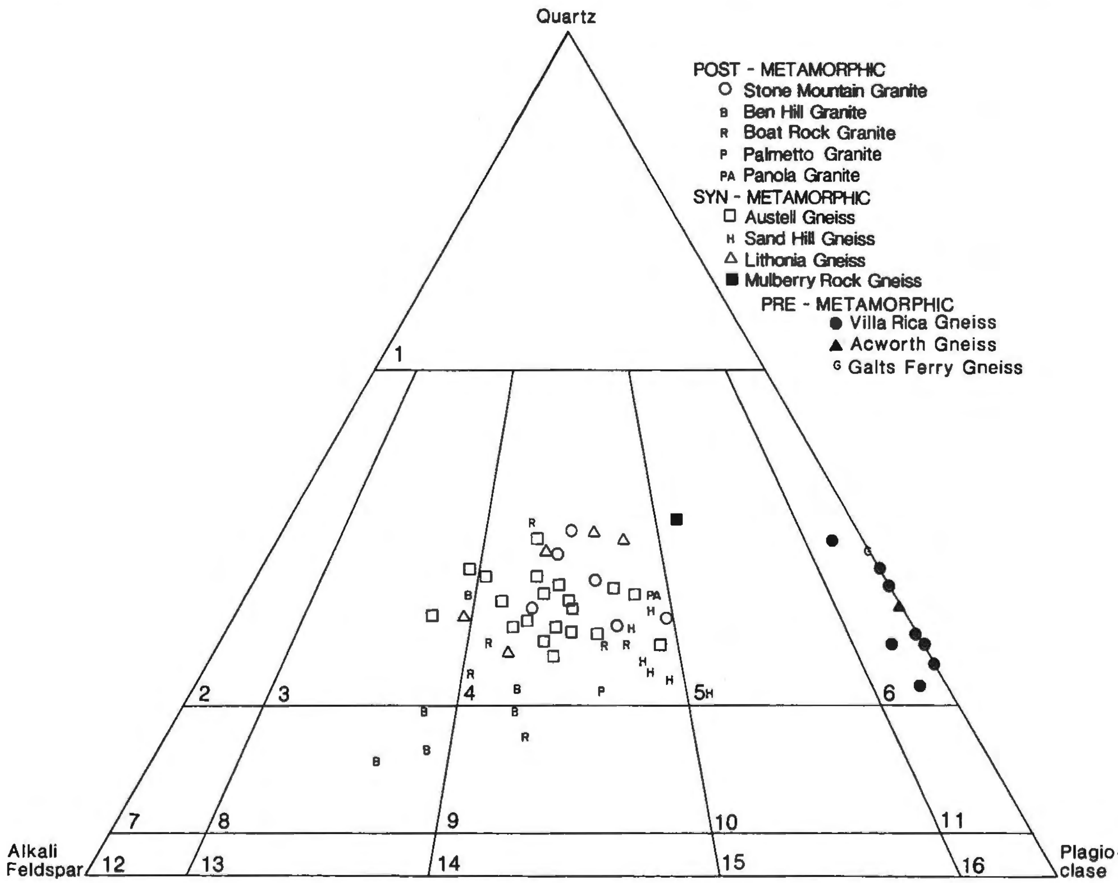

Figure 14. Plots of modal analyses of felsic igneous rocks in the Greater Atlanta Regional Map area, classification modified after Streckeisen (1976) modal diagram with quartz monzonite field added. Analyses after Grant and others (1980), Cofer (1958), Abrams (1983), Abrams and McConnell (1981a), Dooley (*in* Atkins and others, 1980a), Herrmann (1954), Sanders (unpublished data), and this report. 1=Quartz-rich granitoids, 2=Alkali-feldspar granite, 3=Two-feldspar granite, 4=Quartz monzonite, 5=Granodiorite, 6=Quartz diorite, 7=Alkali-feldspar-quartz syenite, 8=Quartz syenite, 9=Quartz-rich monzonite, 10=Quartz monzodiorite, 11=Tonalite, 12=Alkali-feldspar syenite, 13=Syenite, 14=Monzonite, 16=Diorite.

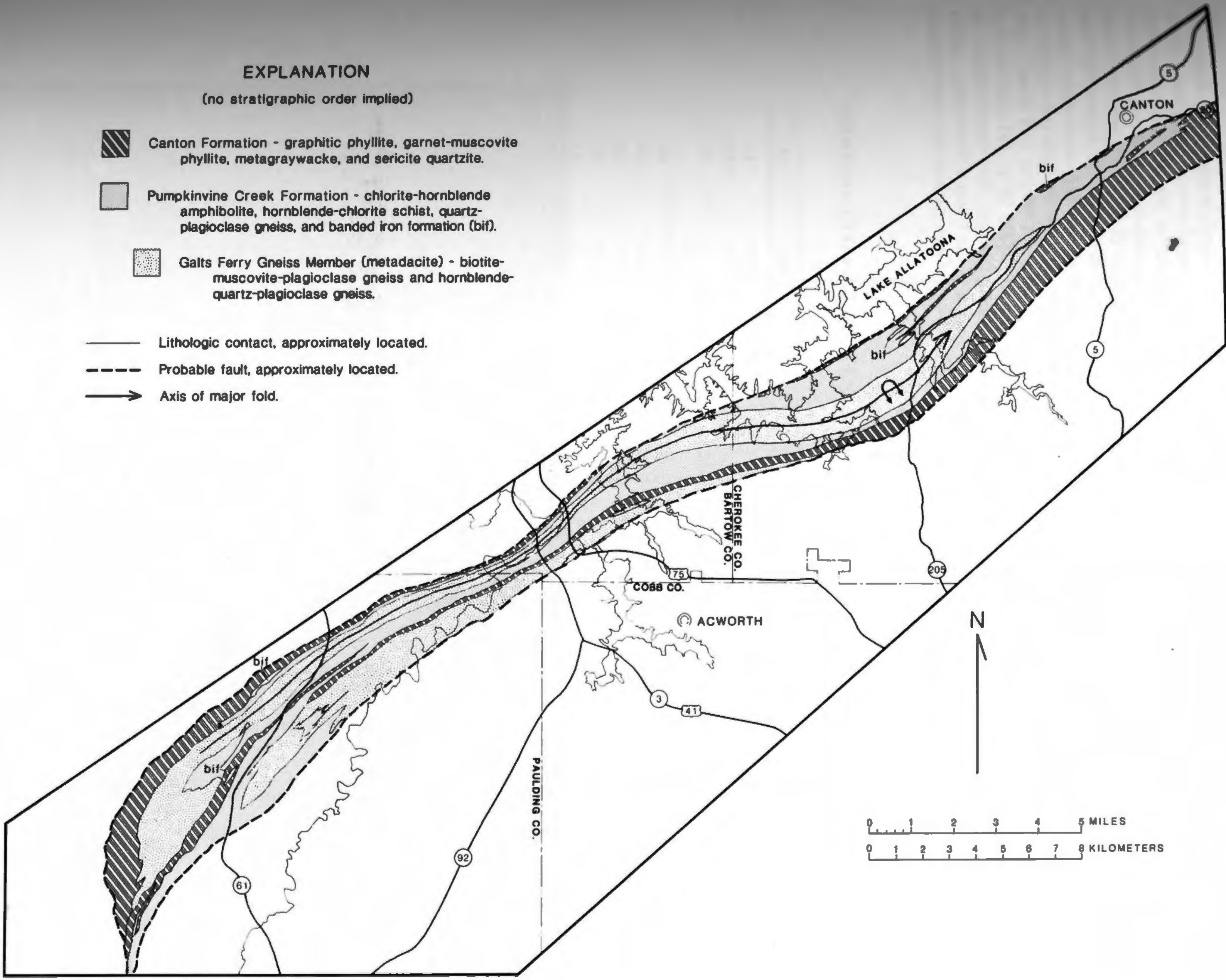

Figure 15. Geologic map of the Pumpkinvine Creek and Canton Formations.

characterized by low concentrations of K_2O (Table 5). Although McConnell (1980a) recognized and mapped the Galts Ferry, it was not formally designated. This report serves to formally name the Galts Ferry Gneiss Member of the Pumpkinvine Creek Formation for exposures near Galts Ferry Landing on Lake Allatoona (Fig. 16). The Galts Ferry Gneiss is a hornblende-quartz-plagioclase gneiss that shows distinct mesoscopic banding due to variation in hornblende content (Fig. 17). Hornblende gneiss is interlayered with a biotite-muscovite-plagioclase gneiss with 12 to 18 in. layers of hornblende gneiss and actinolite-chlorite schist (Crawford, 1976). Locally, the Galts Ferry Gneiss contains ellipsoidal quartz phenocrysts and subhedral feldspar grains in a fine-grained matrix. Gradationally above the Galts Ferry Gneiss in the Pumpkinvine Creek Formation is fine- to medium-grained amphibolite with interlayered garnet-quartz-albite gneiss, sericite phyllite and mylonite gneiss (McConnell, 1980a). Since McConnell's initial study, a discontinuous, but regionally mappable, banded iron formation was recognized to be interlayered with amphibolite of the Pumpkinvine Creek Formation. Whole-rock, trace element, and rare-earth element analyses from amphibolites of the Pumpkinvine Creek Formation (Tables 6, 7 and 8, Fig. 18a-e) suggest that they were derived from tholeiitic, possibly ocean-ridge basalts (McConnell, 1980a). Relict volcanic textures within the Pumpkinvine Creek Formation (Hurst and Jones, 1973; McConnell and Abrams, 1982b) (Fig. 19) confirm that amphibolites are of volcanic origin. Structurally above the Pumpkinvine Formation is the Canton Formation. Bayley (1928) originally defined the Canton schist as being composed

Table 5. Chemical and normative analyses of the Galts Ferry (GF), Villa Rica (VR), and Dallas (DA) Gneisses. (Oxides in weight percent)

SAMPLE NO.	GF-1*	GF-2*	GF-3*	GF-4*	GF-5*	VR	DA
SiO_2	60.0	70.1	74.7	76.9	72.6	68.8	71.1
Al_2O_3	16.3	13.5	13.3	14.3	13.2	17.1	14.9
Fe_2O_3	3.1	3.0	1.0	0.3	3.2	.7	2.0
FeO	4.2	1.9	1.5	0.7	1.8	1.3	
MgO	3.5	1.4	0.8	0.3	0.7	.9	0.6
CaO	6.5	4.5	3.2	2.1	2.5	4.1	2.8
Na_2O	4.2	4.3	4.5	4.5	4.3	5.7	5.8
K_2O	0.3	0.1	0.0	0.0	0.6	1.0	0.7
TiO_2	0.9	0.5	0.3	0.1	0.2	.4	0.3
MnO	0.1	0.1	0.0	0.0	0.1	0.0	0.0
TOTAL	99.1	99.4	99.3	99.7	99.2	100.0	98.2
				CIPW NORMS			
qz	15.14	33.91	39.82	45.57	38.66	20.99	28.17
co			.08	3.08	.93		
or	1.77	.59				5.91	4.14
ab	35.54	36.39	38.08	38.08	36.39	48.23	49.08
an	24.74	17.24	15.88	10.42	12.40	18.12	12.55
ne							
wo	3.14	2.12				1.07	.17
en	2.03	1.70				.66	.15
fs	.90	.18				.35	
en	6.69	1.99	1.99	.75	1.74	1.65	1.22
fs	2.96	.19	1.43	.46	.52	.87	
fo							
fa							
mt	4.49	4.35	1.45	1.16	4.64	1.04	
il	1.71	.95	.57	.19	.38	.72	.04
hm							1.99
pf							.61
ru							
ap							.02
cc							
TOTAL	99.11	99.40	99.30	99.71	99.21	99.61	98.14

*Analysis performed in the laboratory of the Georgia Geologic Survey; Roger Landrum, Analyst.

of carbonaceous or graphitic, garnetiferous mica schist. Mapping related to the Greater Atlanta Regional Map project revealed that these garnetiferous, graphitic schists occur only locally and that they interfinger with quartzite and metagreywacke. These interlayered units and the local occurrence of graphite schist suggest that the term Canton "schist" as defined by Bayley (1928) is too restrictive and should be revised. In this report, we propose to redefine the Canton as the Canton Formation including within the Formation other rock types and lithofacies equivalents. The Canton Formation is named for exposures near Canton in southeastern Cherokee County (Fig. 20). The Canton Formation crops out continuously on the southeastern limb of the major fold containing the Pumpkinvine Creek Formation and Galts Ferry Gneiss (Fig. 15), but occurs only in fault slices along the northwestern limb, which is marked by the trace of the Allatoona fault.

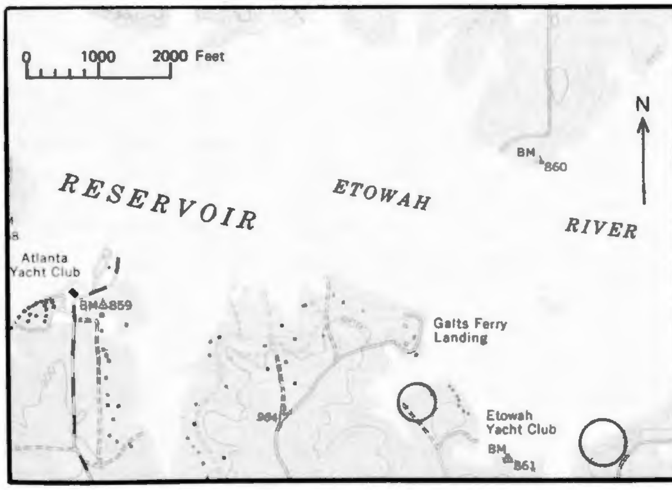

Figure 16. Type locality of the Galts Ferry Gneiss Member of the Pumpkinvine Creek Formation (U.S. Geological Survey, Allatoona Dam, Georgia, 1:24,000 topographic quadrangle).

Figure 17. Photograph of the Galts Ferry Gneiss from the type locality.

Table 6. Chemical and normative analyses of amphibolites from the Pumpkinvine Creek Formation (after McConnell, 1980a). (Oxides in weight percent)

SAMPLE NO.	AC-10B	AC-10	104-1	CHE-240	CA-1	CA-4	CA-6	CA-10	CA-12	CA-14
SiO_2	46.46	49.86	48.64	47.50	50.80	46.60	49.00	48.60	46.50	46.90
Al_2O_3	14.50	14.50	15.50	17.50	14.30	12.30	15.10	15.20	13.00	15.30
Fe_2O_3	4.83	5.14	4.00	5.11	2.90	2.30	2.30	3.10	3.50	1.80
FeO	7.85	8.70	8.05	7.59	8.50	8.20	8.90	7.50	8.40	8.40
MgO	7.50	7.20	7.80	7.20	6.90	7.50	9.00	8.60	5.50	8.40
CaO	11.30	6.90	8.62	7.06	9.50	13.40	9.30	11.10	15.00	10.10
Na_2O	2.35	3.80	3.28	3.28	3.70	2.80	3.10	2.60	1.70	3.30
K_2O	0.22	0.12	0.25	0.25	0.16	0.08	0.11	0.10	0.12	0.15
H_2O	1.34	1.68	1.36	1.92	0.90	1.50	1.80	1.40	1.20	2.20
TiO_2	1.25	1.30	2.00	1.60	1.40	1.00	1.10	0.96	1.40	0.87
P_2O_5	0.10	0.30	0.01	0.10	0.17	0.12	0.11	0.10	0.16	0.10
MnO	0.19	0.22	0.22	0.24	0.21	0.23	0.20	0.19	0.27	0.21
CeO_2	—	—	—	—	0.36	4.00	—	—	3.20	2.20
TOTAL	99.89	99.72	99.73	99.35	99.80	100.03	100.02	99.45	99.95	99.93

CIPW NORMS

	AC-10B	AC-10	104-1	CHE-240	CA-1	CA-4	CA-6	CA-10	CA-12	CA-14
qz	0.710	0.262				0.184			5.661	
co										
or	1.301	0.711	1.481	0.778	0.947	0.473	0.650	0.594	0.709	0.887
ab	19.907	32.245	27.830	29.131	31.371	23.686	26.226	22.122	14.392	27.943
an	28.397	22.215	26.904	26.153	21.982	20.751	26.956	29.672	27.500	26.510
ne										
wo	11.303	4.237	6.643	8.008	9.123	8.202	7.705	10.457	10.717	3.783
en	18.699	17.982	14.596	12.534	15.107	18.673	12.166	15.598	13.705	10.329
fs	8.723	10.020	6.450	5.646	9.927	11.930	7.055	7.268	10.729	6.365
en										
fs										
fo			3.422	4.117	1.480		7.178	4.161		7.432
fa			1.666	2.044	1.071		4.588	2.137		5.047
mt	7.011	7.473	5.815	6.313	4.213	3.334	3.334	4.520	5.077	2.612
il	2.377	2.476	3.809	3.269	2.664	1.899	2.089	1.833	2.660	1.653
hm										
pf										
ru										
ap	0.237	0.713	0.024	0.456	0.403	0.284	0.260	0.238	0.379	0.237
cc	—	—	—	0.046	0.820	9.094	—	—	7.281	5.007
TOTAL	98.666	98.334	98.640	98.494	99.110	98.510	98.209	98.600	98.811	97.806

Table 7. Partial trace element analyses of amphibolite of the Pumpkinvine Creek Formation (in ppm).

SAMPLE NO.	AC-10B	AC-10	104-1	CHE-240	CA-1	CA-4	CA-6	CA-10	CA-12	CA-14
Cr	580	340	680	440	200	230	420	450	110	450
Ni	130	91	170	150	68	68	120	110	56	120

Analyses performed in the laboratories of the U.S. Geological Survey.

Table 8. Rare-earth element concentrations from amphibolites of the Pumpkinvine Creek Formation (after McConnell, 1980a).

SAMPLE NO.	AC-10B	AC-10	104-1	CHE-240	CA-1	CA-4	CA-6	CA-10	CA-12	CA-14
La	13.42	15.90	25.46	26.86		9.27	9.27	8.97		8.42
Ce	11.03	18.90	12.76	21.16	12.61	9.28	9.12	8.30	11.48	8.11
Nd	19.79	19.25	29.01	27.58	13.67		15.67	10.50	16.67	10.50
Sm	16.77	21.39	26.19	25.76	16.85	11.71	12.15	10.33	16.19	10.33
Eu	13.94	17.31	19.76	19.68	16.52	10.88	11.65	11.35	16.23	11.01
Gd					10.72	8.84	7.63	7.23	8.47	10.44
Tb	15.50	19.67	25.66	20.21	12.98	16.28	12.13	12.77	18.11	10.85
Ho	8.18	10.78	12.44	10.84	6.53	5.66	3.14	5.46	6.63	5.57
Tm	17.59	26.56	21.43	22.51	11.63	7.23	7.77	6.43	10.40	6.00
Yb	14.17	18.67	13.74	14.64		12.50	11.55	11.20		10.95

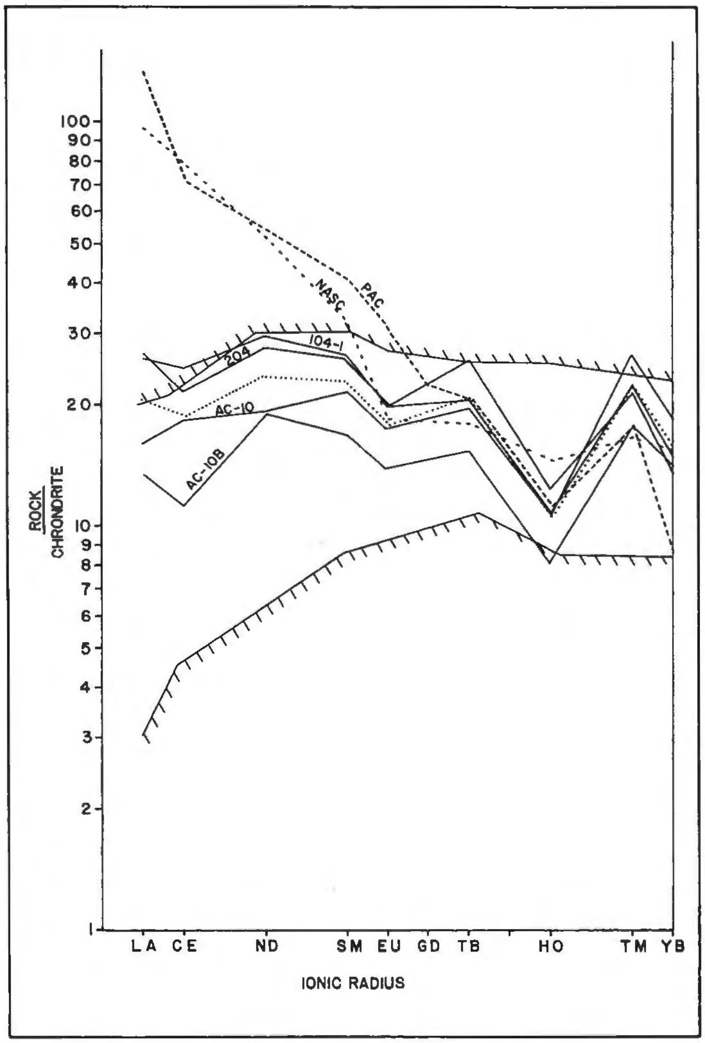

Figure 18a. Rare-earth element data for the Pumpkinvine Creek Formation plotted against chondrites (after McConnell, 1980a). NASC= composite of North America shales (Haskin and others, 1968); PAC= para-amphibolite composite; and AVG=average of four samples of the Pumpkinvine Creek Formation. Region between hatchured lines is the field for modern oceanic tholeiites (Bryan and others, 1976).

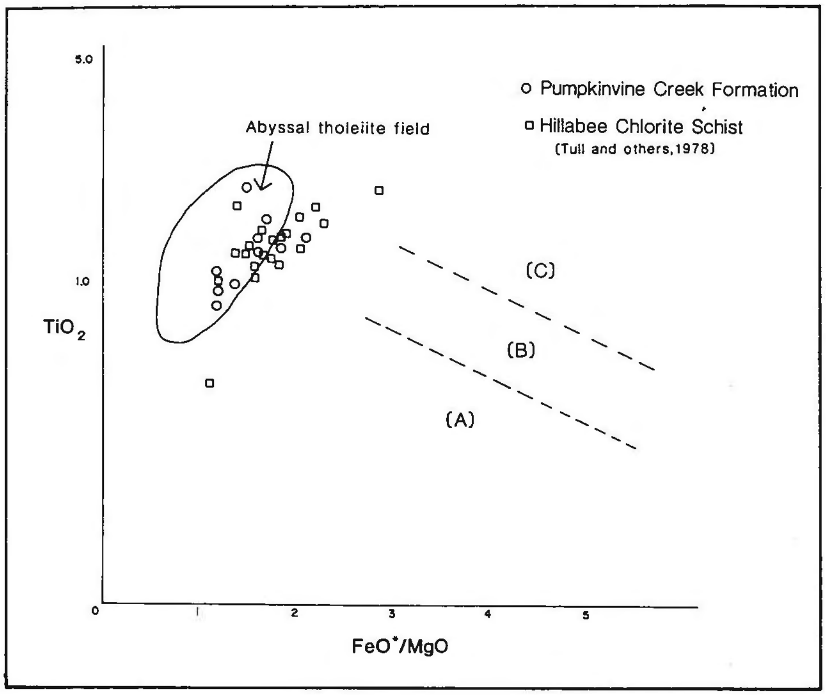

Figure 18b. Discrimination of volcanic rock types based on TiO_2 vs. FeO*/MgO (after Miyashiro, 1975). A = Calc-alkalic series; B = Calc-alkalic and tholeiitic series; and C = Tholeiitic series (after McConnell, 1980a).

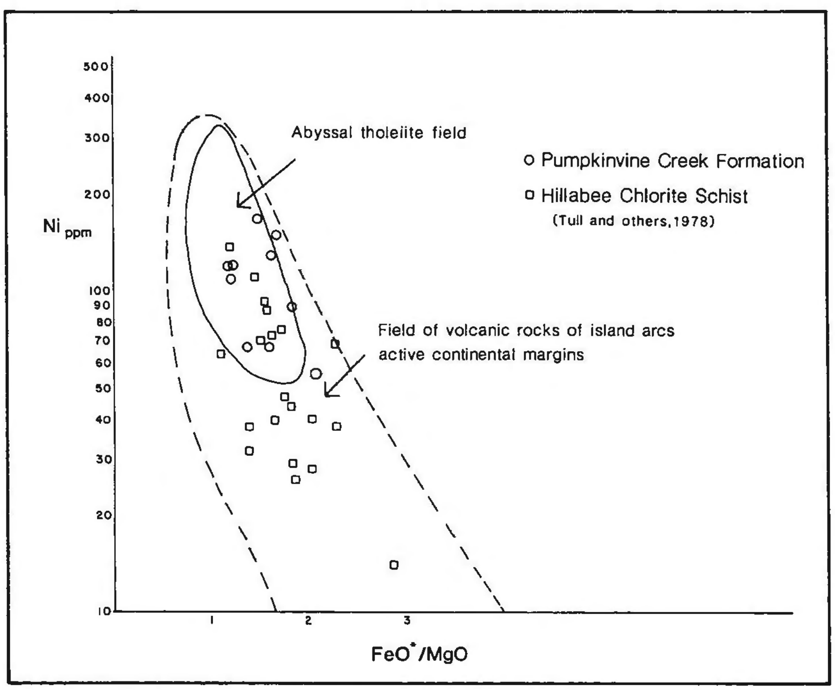

Figure 18c. Discrimination of volcanic rock series based on the Ni vs. FeO*/Mg) relationship (after Miyashiro and Shido, 1975; McConnell, 1980a).

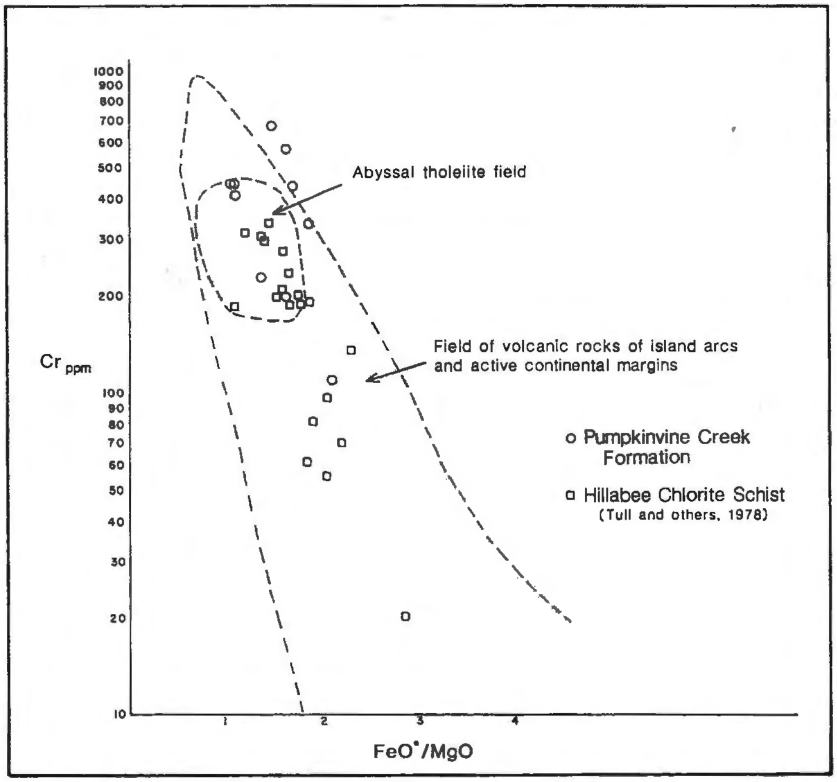

Figure 18d. Discrimination of volcanic rock series based on the Cr vs. FeO*/MgO relationship (after Miyashiro and Shido, 1975; McConnell, 1980a).

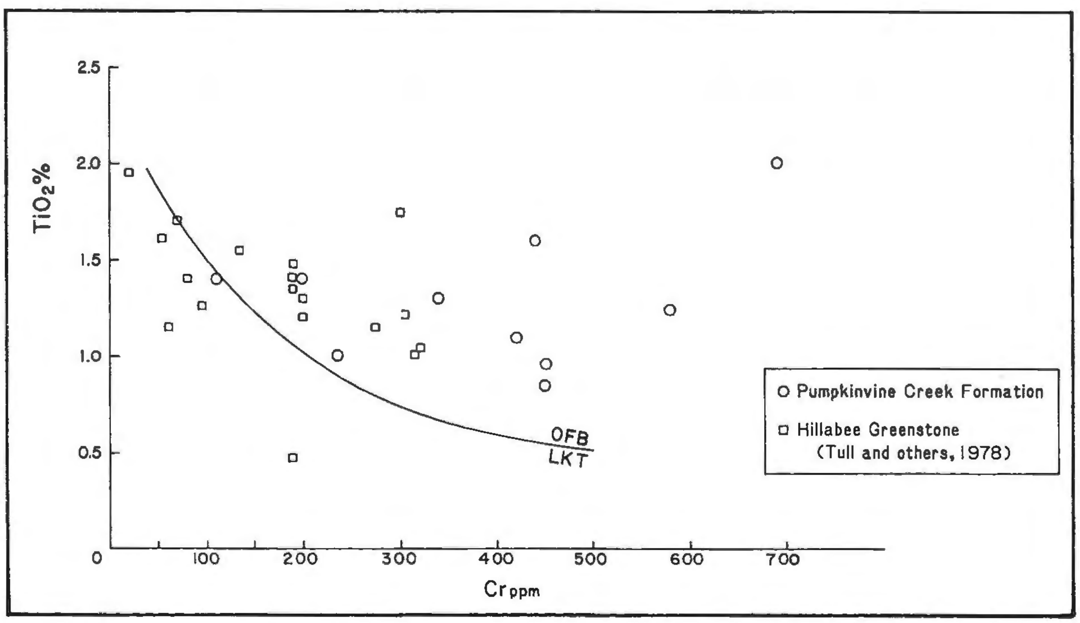

Figure 18e. Discrimination of ocean floor basalts (OFB) vs. low potassium tholeiites (LKT) on the basis of Cr vs. TiO_2 (after Pearce, 1975; McConnell, 1980a).

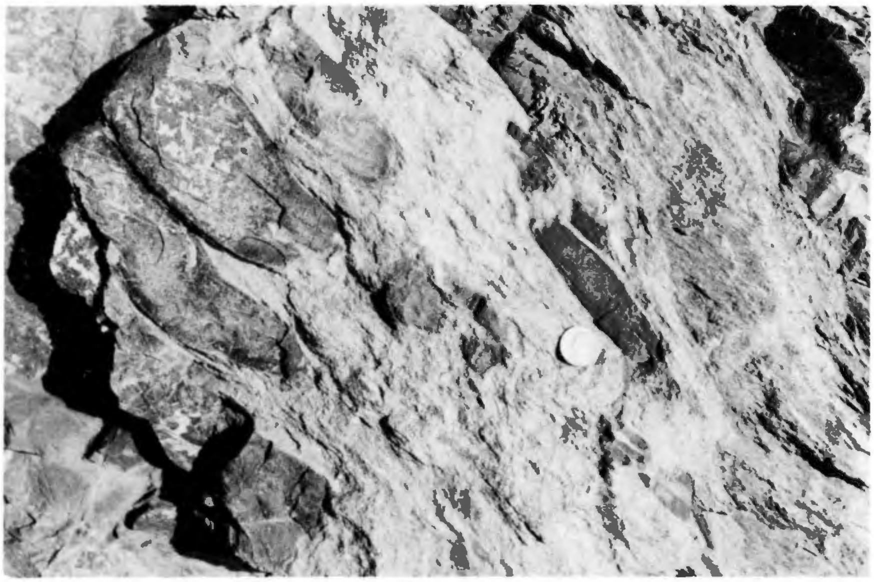

Figure 19. Photograph of relict pillows in the Pumpkinvine Creek Formation at the type locality.

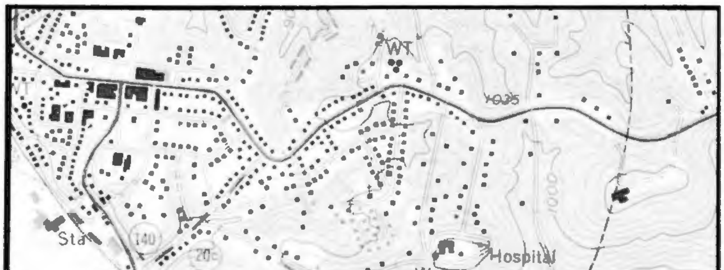

Figure 20. Type locality of the Canton Formation (U.S. Geological Survey, Canton, Georgia, 1:24,000 topographic quadrangle).

Centrally located in the New Georgia Group outcrop area is a sequence of amphibolite, hornblende gneiss, garnet-biotite-muscovite schist, banded iron formation, and garnet-chlorite schist termed the Univeter Formation (this report). The Univeter Formation was informally termed the Interstate formation by McConnell and Abrams (1982a, 1982b). This report serves to formally define the Univeter Formation for exposures at Univeter, southern Cherokee County (Fig. 21). The Univeter Formation is traceable from Dallas on the southwest, through the Dahlonega area, to at least as far northeast as Nacoochee in White County (Ken Gillon, 1982). The Univeter Formation is composed of hornblende-andesine gneiss (amphibolite/hornblende gneiss) with an intervening thin, garnet-biotite-muscovite schist ± amphibole. Also present locally is a thin (less than 5 ft.) banded iron formation and coarsely garnetiferous chlorite schist (Fig. 22). The association of banded iron formation and chlorite schist with base and precious metal deposits in the Univeter Formation will be described in detail in a subsequent section. The hornblende-andesine gneiss in the Univeter Formation is interpreted to form two limbs of a fold. This unit is here termed the Lost Mountain Amphibolite Member of the Univeter Formation for exposures on Lost Mountain in western Cobb County (Fig. 23). The intervening schist member is termed the Rose Creek Schist Member for exposures near Rose Creek Church in southwestern Cherokee County (Fig. 24). A typical characteristic of this member is the presence of biotite grains crossing the regional foliation in the rock (i.e., cross-biotite schist).

Although locally cut out by faulting, the Lost Mountain Amphibolite-Rose Creek Schist sequence is traceable for a distance of over 80 miles. This sequence also lies along a major tectonic boundary for most of its length. Northeast of Kennesaw (Plate I) the Univeter Formation is in contact with a high-grade migmatitic terrain to the southeast (i.e., Sandy Springs

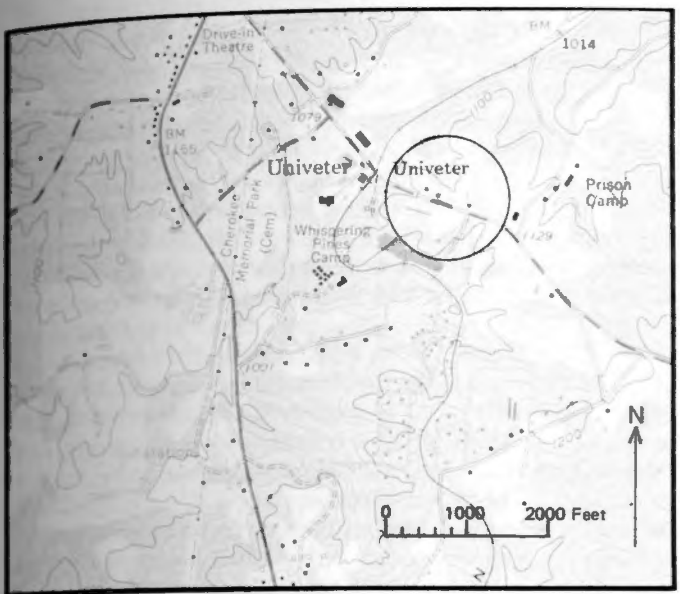

Figure 21. Type locality of the Univeter Formation (U.S. Geological Survey, Canton and South Canton, Georgia, 1:24,000 topographic quadrangles).

Figure 22. Photograph of the garnet-chlorite schist (alteration zone) south of the Little Bob mine.

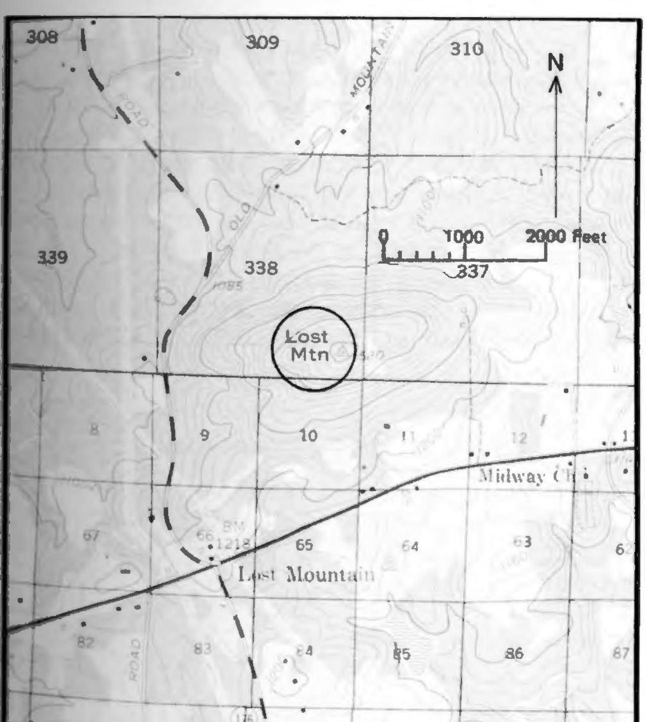

Figure 23. Type locality of the Lost Mountain Amphibolite Member of the Univeter Formation (U.S. Geological Survey, Lost Mountain, Georgia, 1:24,000 topographic quadrangle).

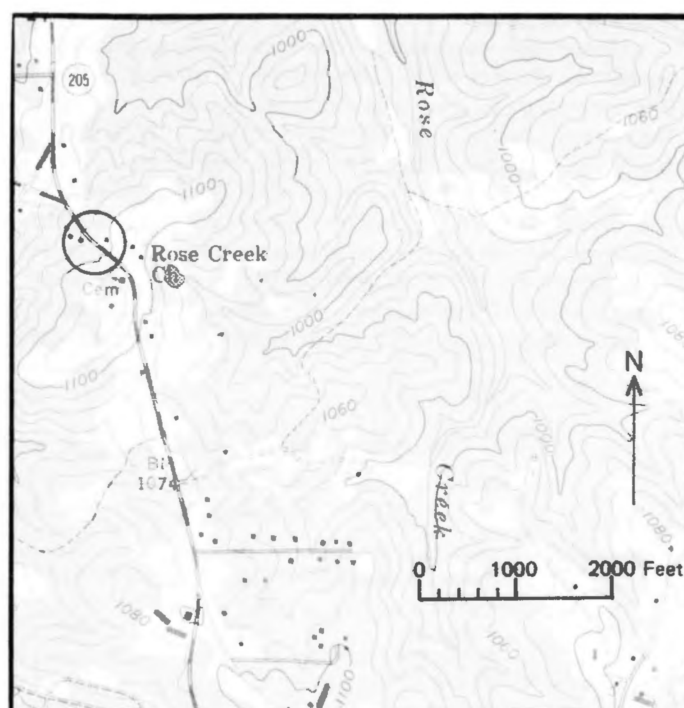

Figure 24. Type locality of the Rose Creek Schist Member of the Univeter Formation (U.S. Geological Survey, Kennesaw, Georgia, 1:24,000 topographic quadrangle).

Group), while in the Univeter Formation and rocks northwest of it no migmatization is apparent. The southeastern boundary of the Univeter marks a migmatic front and is interpreted as a fault. McConnell and Abrams (1982a) interpreted this fault as an extension of the Chattahoochee fault as modified from Hurst (1973) (Fig. 11).

The largest part of the New Georgia Group is made up of an intermixed sequence of amphibolite, hornblende gneiss and felsic gneiss (Plate I). Within this intermixed sequence, several rock units are important with regard to both the igneous and economic history of this area. In regard to the intrusive/extrusive units, four are definable: Acworth Gneiss, Villa Rica Gneiss, Dallas gneiss, and Galts Ferry Gneiss. All of these gneisses show the effects of metamorphism and deformation. The Acworth Gneiss occurs in eastern Paulding and western Cobb Counties (Plate I). The Acworth Gneiss is a medium-grained, biotite-quartz-plagioclase (An_{31}) gneiss with accessory muscovite and epidote. No potassium feldspar is apparent (Table 9). Mafic xenoliths are found in the Acworth Gneiss which crops out in a complex faulted fold that now has the appearance of a teardrop (Plate I).

The Villa Rica, Galts Ferry and Acworth Gneisses represent a large portion of the felsic rock in the New Georgia Group. All are dacitic in composition and have interfingering relationships with the country rock. We interpret these gneisses to represent a period of dacitic volcanism in the New Georgia Group. In this interpretation, felsic rocks in and around Dallas (Dallas gneiss, Table 9) also are believed to be shallow intrusive rocks with apophyses into the country rocks rather than the result of partial melting of the country rock (i.e., migmatites).

One of the most distinctive and stratigraphically important lithologies within the northern Piedmont is banded iron formation. Banded iron formation is present throughout the outcrop belt of the New Georgia Group (Abrams and McConnell, 1982a, 1982b; McConnell and Abrams, 1982b), and was described in detail in the Villa Rica area (Abrams and McConnell, 1981a). Banded iron formation forms a distinct stratigraphic marker horizon in an area where there are few, and, therefore, is a valuable aid in deciphering the deformational history of the northern Piedmont. In addition, it is apparent that iron formation has a distinct genetic relationship to massive sulfide and gold deposits in this area (Abrams and McConnell, 1982b, 1982c; McConnell and Abrams, 1982b). Banded iron formation in the New Georgia Group occurs as relatively thin layers (1 to 6 ft.) of thinly banded magnetite quartzite intercalated with amphibolite. Banded iron formation also is present in both belts of the Sandy Springs Group where it occurs as thin layers (1 to 6 in.) in amphibolite of the basal units (Powers Ferry Formation and Dog River Formation) and as an approximately 6 ft. thick section (possibly repeated by folding) in carbonaceous schists interpreted to be Andy Mountain Formation. Estimating the exact number of different layers and individual thicknesses of units is made difficult by isoclinal folding and thickening of iron formation in hinges and thinning on the limbs of folds. Magnetite and/or specular hematite occur as distinct layers and disseminated grains in a matrix of quartz with accessory garnet and epidote. Individual layers of concentrated iron oxide vary in thickness from .1 to 3 in. The dominant facies of banded iron formation in western Georgia is an oxide facies composed of hematite, magnetite, various unidentified manganese oxides and quartz. Gradational with the oxide facies are aluminous and sulfide facies. An associated facies of iron formation is composed predominantly of epidote, garnet, and quartz with minor magnetite and biotite. Abrams and others (1981) reported that garnet makes up as much as 25 percent of the rock in this facies of iron formation. Sulfide facies iron formation is composed dominantly of pyrite and pyrrhotite interlayered with quartz.

Sandy Springs Group

The Sandy Springs Group originally was termed the Sandy Springs Sequence by Higgins (1966, 1968) and was redefined as the Sandy Springs Group by Higgins and McConnell (1978a, 1978b). In their reports, Higgins and McConnell indicated that rocks termed Andy Mountain Formation (Abrams and McConnell, 1981a) adjacent to the Austell Gneiss northwest of the Austell-Frolona antiform were equivalent, in part, to the Sandy Springs Group. This correlation was based primarily on lithologic similarity and preliminary mapping in the area by McConnell. In subsequent reports, McConnell and Costello (1980b) and Abrams and

Table 9. Modal analyses of felsic igneous rocks northwest of the Brevard fault zone.

	Mulberry Rock Gneiss	Villa Rica Gneiss	Acworth Gneiss	Galts Ferry Gneiss	Dallas Gneiss
Points Counted	(1020)	(Visual Estimate)	(1031)	(972)	(1311)
Quartz	36%	24%	25%	32%	23%
Plagioclase	38%	60%	50%	51.5%	63%
Microcline	16%	3%	—	—	1%
Biotite	—	4%	19%	—	7%
Muscovite	9%	3%	2%	—	2%
Epidote	1%	5%	4%	2%	3%
Chlorite	—	—	—	4%	tr
Garnet	tr	—	—	2%	—
Amphibole	—	1%	—	7.5%	2%
Opaque	tr	—	—	1%	—
TOTAL	100.00%	100.00%	100.00%	100.00%	100.00%

McConnell (1981a) also considered these rocks as well as most rocks in the Austell-Frolona antiform to be equivalent to the Sandy Springs Group, but tempered this interpretation due to the still preliminary mapping in the area. The term Roosterville group was informally introduced to define these rocks present in the Austell-Frolona antiform (McConnell and Costello, 1980b). In this report, we consider rocks present in the Austell-Frolona antiform and conformably above the New Georgia Group as equivalent to the Sandy Springs Group and have abandoned the term Roosterville group. These rocks are now interpreted as a western belt of the Sandy Springs Group due to lithologic and stratigraphic similarities. The eastern belt of the Sandy Springs Group is that defined by Higgins and McConnell (1978a, 1978b). These units are separated by the Chattahoochee-Blairs Bridge fault system.

The Chattahoochee fault was originally defined by Hurst (1973) as marking the western contact of the Sandy Springs Group. In subsequent reports, McConnell and Abrams (1978, 1982a) redefined the trace of the Chattahoochee fault, but still recognized it as representing the western and northern boundary of the Sandy Springs Group (eastern belt) for most of its length (Plate I). From a point just north of Austell, northward and then northeastward through the northeastern part of Greater Atlanta Region (Plate I), rocks of the Sandy Springs Group are thrust over New Georgia Group rocks along the Chattahoochee fault (McConnell and Abrams, 1982a). The outcrop pattern at Austell was interpreted to indicate that the Chattahoochee thrust plate was overridden by rocks on the Blairs Bridge thrust plate (McConnell and Abrams, 1978).

Sandy Springs Group (eastern belt). The Sandy Springs Group is the most areally extensive rock group in the northern Piedmont. In his report, Higgins (1966) indicated that the Sandy Springs sequence terminated at the Brevard fault zone. However, in recent years it has become apparent that Sandy Springs Group rocks occur on either side of the Brevard zone (Kline, 1980, 1981; McConnell, 1980b; McConnell and Abrams, 1982a). This interpretation is consistent with the observations of Crawford and Medlin (1974) to the southwest and Hatcher (1972, 1978b) to the northeast.

As defined by Higgins and McConnell (1978a), the Sandy Springs Group consists of four formations (Table 10): Powers Ferry Formation, Chattahoochee Palisades Quartzite, Factory Shoals Formation, and Rottenwood Creek Quartzite. Subsequent work in the type area of the Sandy Springs Group indicates that the Chattahoochee Palisades Quartzite and Rottenwood Creek Quartzite are exposed parts of a single unit that is repeated by folding. Minor lithologic variations between the two units are attributable to facies changes within the unit. Therefore, the upper quartzite unit (Rottenwood Creek Quartzite) of the Sandy Springs Group is abandoned in this report and those rocks previously defined as Rottenwood Creek are correlated with the Chattahoochee Palisades Quartzite.

Table 10. Correlation chart of the Sandy Springs Group, eastern and western belts.

<table>
<tr><th>Rocks in the Austell-Frolona Antiform
Hurst (1973)</th><th>Rocks in the Austell-Frolona antiform
Crawford and Medlin (1974)</th><th>Sandy Springs Group (western belt)
this paper</th><th>Sandy Springs Group (eastern belt)
this paper</th><th>Sandy Springs Group
Higgins and McConnell (1978)</th><th>Tallulah Falls Formation
Hatcher (1974)</th><th>"Sandy Springs sequence"
Crawford and Medlin (1974)</th></tr>
<tr><td rowspan="6">Wedowee Formation</td><td rowspan="3">Bill Arp Formation</td><td rowspan="3">Bill Arp Formation</td><td>Not defined</td><td>Not defined</td><td>Not defined</td><td>Mt. Olive Church (schist)</td></tr>
<tr><td rowspan="4">Factory Shoals Formation</td><td>Rottenwood Creek Quartzite</td><td>Quartzite-schist member and greywacke-schist member (?)</td><td>Adamson quartzite</td></tr>
<tr><td rowspan="3">Factory Shoals Formation</td><td rowspan="3">Garnet-aluminous-schist member</td><td>Backbone schist</td></tr>
<tr><td rowspan="3">Frolona formation</td><td rowspan="3">Andy Mountain Formation</td><td>Anneewakee graphitic schist-quartzite</td></tr>
<tr><td>Sparks Reservoir (schist and gneiss)</td></tr>
<tr><td>Chattahoochee Palisades Quartzite</td><td>Chattahoochee Palisades Quartzite</td><td>Not defined</td><td>Dry Creek Quartzite</td></tr>
<tr><td rowspan="3"></td><td rowspan="3"></td><td rowspan="3">Dog River Formation</td><td rowspan="3">Powers Ferry Formation</td><td rowspan="3">Powers Ferry Formation</td><td rowspan="3">Greywacke-schist-amphibolite member</td><td>Chapel Hill Church (gneiss and schist)</td></tr>
<tr><td>Mt. Vernon Church graphitic schist-quartzite</td></tr>
<tr><td>Mt. Vernon Church schist</td></tr>
</table>

The Powers Ferry Formation is the oldest unit in the Sandy Springs Group. The base of the Powers Ferry is not present in the eastern belt of the Sandy Springs Group, but the base of an equivalent unit (i.e., Dog River Formation?) in the western belt is exposed to the northwest where it is gradational with rocks of the New Georgia Group. In general, the Powers Ferry Formation is composed of intercalated gneiss, schist, and amphibolite. Biotite-quartz-plagioclase gneiss ("metagreywacke") occurs locally within the formation. Within the lower part of the Powers Ferry Formation, layered amphibolite is mappable for short distances. One such amphibolite layer was termed the Mableton Amphibolite Member by Higgins and McConnell (1978a).

Overlying the Powers Ferry Formation is the Chattahoochee Palisades Quartzite. This quartzite was originally interpreted to unconformably overlie the Powers Ferry Formation (Higgins, 1966), but is now interpreted in this report to be gradational with the more siliceous members of the Powers Ferry (i.e., metagreywacke). The Chattahoochee Palisades Quartzite, although locally absent due to nondeposition or tectonic thinning, is commonly exposed as a massive, white, yellowish, or bluish, sugary to vitreous quartzite containing accessory mica and elongate garnets. Locally, graded bedding is present; but transposition of original layering has limited the usefulness of this feature as a stratigraphic indicator. Interlayered with the above are feldspathic quartzite and muscovite schist.

Gradationally above the Chattahoochee Palisades Quartzite is the Factory Shoals Formation (Higgins and McConnell, 1978a). The Factory Shoals Formation is composed predominantly of a light-gray, lustrous, garnet-biotite-oligoclase or muscovite-biotite-plagioclase metagraywacke that varies to a kyanite-quartz schist or staurolite-muscovite-quartz schist. This schist unit grades laterally into a graphite-muscovite schist. An important characteristic of the Factory Shoals Formation is the almost complete lack of amphibolite.

Sandy Springs Group (western belt). Just to the northwest of the Chattahoochee fault is a major northeast-trending antiform termed the Austell-Frolona antiform. As originally defined by Medlin and Crawford (1973) and Crawford and Medlin (1974), the Austell-Frolona antiform is traceable from near Roanoke, Alabama, to Austell, Georgia. Rocks in the Austell-Frolona antiform (Fig. 13) were previously correlated with the Wedowee Formation (Hurst, 1973) or termed Unit II (Crawford and Medlin, 1973). All of the above authors based their stratigraphic interpretations on the assumption of the occurrence of only one major folding event in the northern Piedmont. Wrapping of the regional foliation around the noses of large second-generation folds (i.e., Austell-Frolona antiform; Abrams and McConnell, 1981a) and the effect of multiple deformation on the stratigraphic sequence in this area were not recognized.

McConnell and Abrams (1982a) revised the stratigraphy of the northeastern part of the Austell-Frolona antiform. In general, rocks of the Austell-Frolona were divided into four formations: an unnamed lower unit (i.e., Dog River Formation of this report), Andy Mountain Formation, Bill Arp Formation and Austell Gneiss (Abrams and McConnell, 1981a). In their report, Abrams and McConnell (1981a) interpreted the Austell-Frolona to represent an antiformal syncline. This interpretation was based on similarities between the Sandy Springs Group and the rock sequence observed in the Austell-Frolona antiform. The Sandy Springs Group, as already outlined, is composed of a basal gneiss-schist-amphibolite unit with significant amounts of amphibolite and banded iron formation in the lower part of the unit. This is overlain by a quartzite that, in turn, is overlain by a metagraywacke with little to no amphibolite but substantial amounts of graphitic phyllite. This sequence is very similar to the Dog River-Andy Mountain-Bill Arp sequence in the Austell-Frolona antiform.

Rocks lying gradationally above the Mud Creek Formation on the northwestern limb of the Austell-Frolona antiform herein are termed the Dog River Formation for exposures near and along Dog River in northeastern Douglas County (Fig. 25). The Dog River Formation is composed of an intercalated sequence of muscovite-biotite-quartz-feldspar gneiss (metagraywacke), garnet-muscovite schist, amphibolite and thin (1 to 3 in.) layers of banded iron formation. The presence of this banded iron formation and the lithologic similarity of this unit to upper parts of the underlying New Georgia Group suggest that the contact with the New Georgia Group is gradational and represents a gradual waning of volcanism in this area.

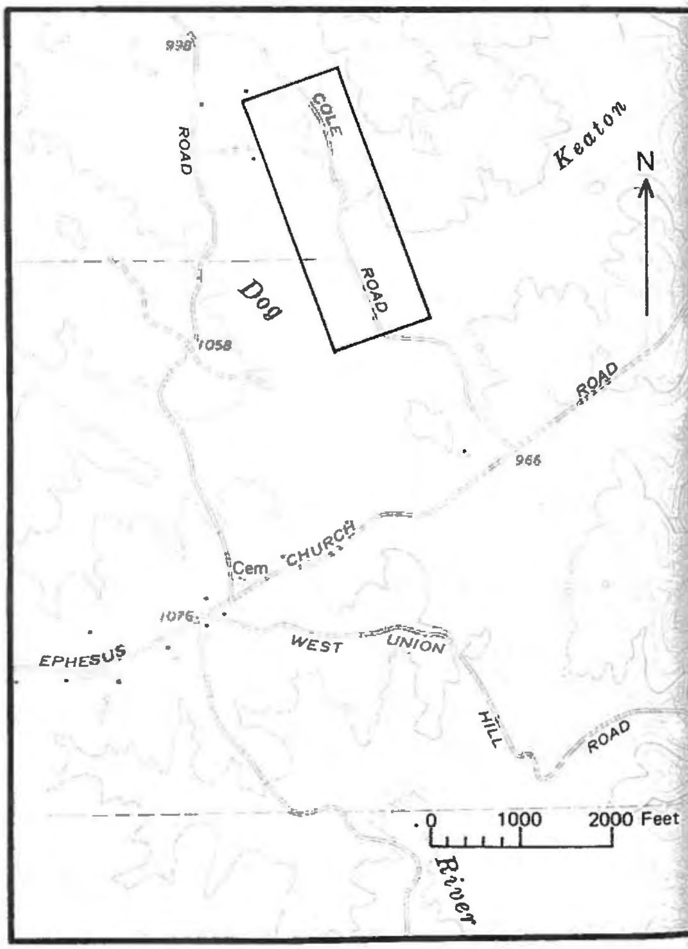

Figure 25. Type locality of the Dog River Formation of the Sandy Springs Group, western belt (US. Geological Survey, Villa Rica, Georgia, 1:24,000 topographic quadrangle).

Conformably above the Dog River Formation is the Andy Mountain Formation (Abrams and McConnell, 1981a). Based on the stratigraphic succession observed in the Sandy Springs Group, eastern belt, rocks of the Andy Mountain Formation are interpreted to stratigraphically underlie rocks of the Bill Arp Formation, but, due to refolding, now structurally overlie them (Fig. 26). In the crestal portion of the Austell-Frolona antiform is a unit termed the Frolona formation by Crawford and Medlin (1974). They defined the Frolona formation as containing layered graphitic staurolite-kyanite-garnet-feldspar-quartz-mica schist, non-graphitic mica schist, feldspathic micaceous quartzite, clean quartzite and quartz-pebble conglomerate. The Andy Mountain Formation is composed of garnet-muscovite-quartz-schist ± staurolite, graphitic garnet-muscovite-quartz schist and clean, sugary quartzite. Abrams and McConnell (1981a) interpreted the Frolona and Andy Mountain Formations to be lithostratigraphic equivalents of each other and dropped the term Frolona formation. Rocks of the Andy Mountain Formation occur both in the crest of the Austell-Frolona antiform (Plate I) and as a tectonically thinned unit on its northwestern limb (Plate I, Fig. 13). These two occurrences define the limbs of the antiformal syncline that is the Austell-Frolona fold (Fig. 26). Crawford and Medlin (1970) traced graphite-bearing rocks northwest of the Austell-Frolona antiform (Plate I). These rocks are the continuation of the Andy Mountain Formation which occurs on the northwestern limb of the antiform. The outcrop pattern of the Andy Mountain Formation defines the limbs of a regional second-generation synform conjugate to the Austell-Frolona. Mapping related to the Greater Atlanta Regional Map project has shown that rocks of the Dog River Formation trend around this fold and the stratigraphic sequence in this area is complete with respect to the sequence of units defined in the Sandy Springs Group, eastern belt. These units, with the New Georgia Group forming the core of this second-generation fold, define a major first-order nappe structure that was subsequently refolded by later deformational events (Fig. 27).

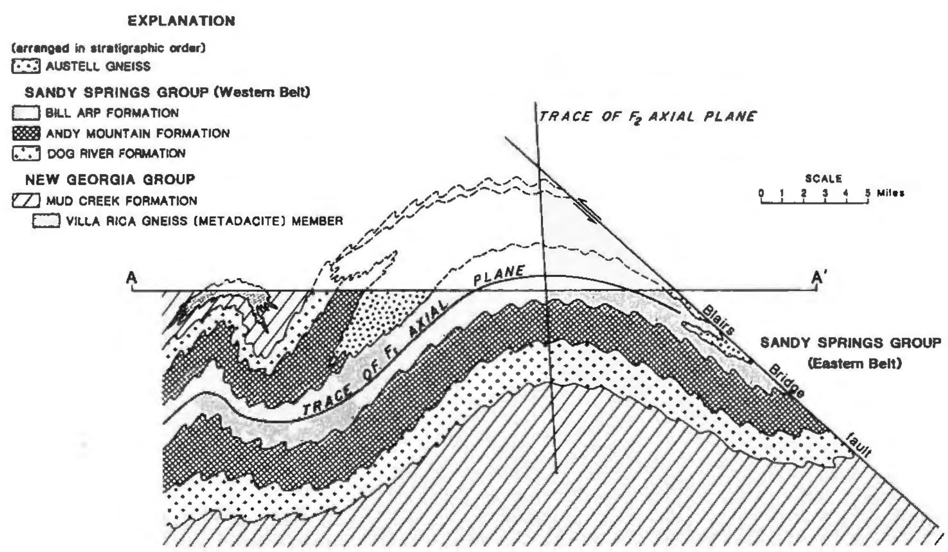

Figure 26. Cross section through the Austell-Frolona antiform (modified from Abrams and McConnell, 1981a). See Figure 13 for trace of cross section.

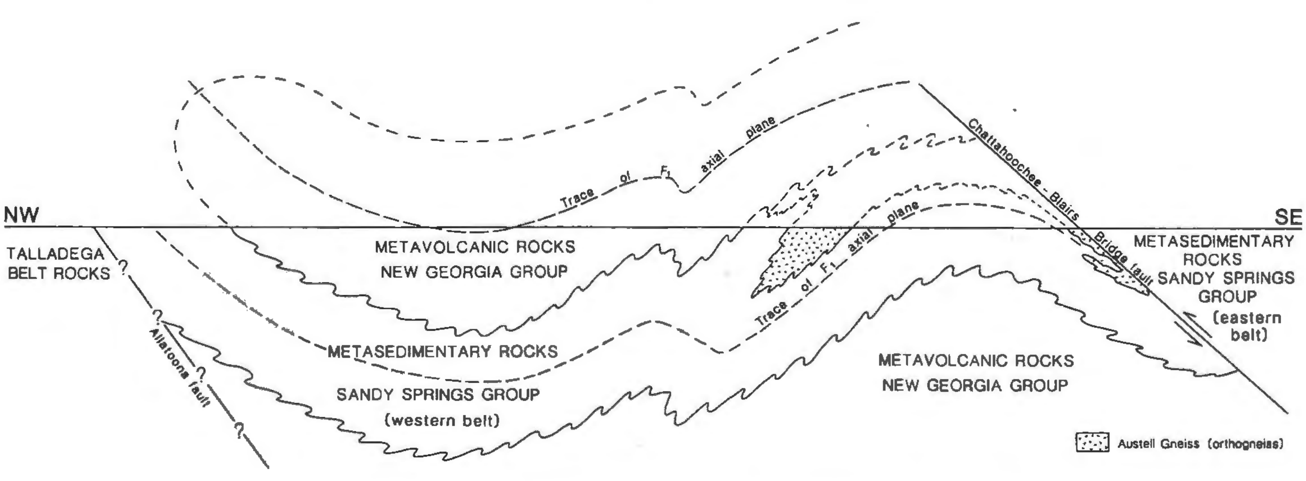

Figure 27. Diagrammatic cross section through the northern Piedmont.

Stratigraphically overlying the Andy Mountain Formation are rocks of the Bill Arp Formation. The Bill Arp Formation was introduced informally by Crawford and Medlin (1974) to refer to rocks that structurally underlie the Austell Gneiss and structurally overlie their Frolona formation. Abrams and McConnell (1981a) formalized the Bill Arp Formation in their revision of the stratigraphy in this area. Abrams and McConnell (1981a) indicated that rocks of Crawford and Medlin's (1974) Union Grove Church schist were petrographically indistinct from the Bill Arp Formation and, thus, included them within the Bill Arp. This portion of the Bill Arp Formation was interpreted as either a roof pendant of Bill Arp Formation within the metaigneous Austell Gneiss or the result of interference between F_1 and F_2 folds. The Bill Arp Formation consists dominantly of interlayered mica schists and metagraywacke. Rock types include garnet-biotite-muscovite-plagioclase-quartz schist, muscovite schist, quartz-muscovite-biotite schist, muscovite-biotite-quartz-plagioclase schist and "metagraywacke" (Abrams and McConnell, 1981a). Metamorphosed calcareous lenses, possible original limy lenses, locally occur as elongate structures parallel to the plane of foliation in the metagraywacke. These lenses have a concentrically zoned mineralogy with calcite and quartz as the dominant minerals (Sanders and others, 1979). The calc-silicate lenses are best observed in exposures on Interstate 20 just east of the intersection with Georgia Highway 5. The Bill Arp Formation was intruded semi-concordantly by the Austell Gneiss. Xenoliths of the Bill Arp Formation within the Austell Gneiss are common, but are best exposed in a road cut on the eastbound lane of Interstate 20, 1.25 mi. west of its junction with Highway 5 (Fig. 28). Many of the xenoliths are characterized by a hornfels texture that is not obscured by the regional metamorphic fabric (Fig. 29).

Unclassified stratigraphic units. The Long Island Creek Gneiss (Higgins and McConnell, 1978a, 1978b) is separated from the Sandy Springs Group to the northwest and Brevard fault zone rocks to the southeast by faults (Higgins, 1966, 1968). The gneiss is composed of epidote, biotite, quartz, and plagioclase with accessory sphene, hornblende and garnet (Higgins and McConnell, 1978a, 1978b) and is typically coarse grained with a mylonitic overprint present adjacent to the faults (Higgins, 1966, 1968). The stratigraphic position of the gneiss is unknown due to its fault relationship with surrounding lithologies. For this reason Higgins and McConnell (1978a, 1978b) excluded the Long Island Creek Gneiss from the actual Brevard fault zone, but in earlier work by Higgins (1966, 1968) the unit was included in the Brevard zone.

The Yellow Dirt Gneiss is also associated with the Brevard fault zone. The Yellow Dirt Gneiss was originally named by Crawford and Medlin (1974) for exposures of the unit that they were able to map from Randolph County, Alabama, to Douglas County, Georgia. Higgins and McConnell (1978a, 1978b) later formalized the name proposed by Crawford and Medlin (1974). The Yellow Dirt Gneiss is a "fine-to medium-grained, biotite-epidote-muscovite-quartz-plagioclase-microcline rock that has strong cataclastic mylonitic textures" (Higgins and McConnell, 1978a, p. 54). Crawford and Medlin (1974) found the effects of shearing to be variable along the strike of the unit with deformation more severe in Carroll County, Georgia. A similar textural variability was noted by Abrams (1983) in Douglas County where the Yellow Dirt Gneiss varies from a blastoporphyritic gneiss with rotated microcline grains to a silicified and strongly sheared mylonite. Higgins (1966, 1968) included portions of the Yellow Dirt Gneiss in his Brevard zone mylonite gneiss unit, but Crawford and Medlin (1974) suggested that the gneiss was part of the Sandy Springs Group. Higgins (1968) placed a fault on the southeast side of his mylonite gneiss unit while Crawford and Medlin (1974) extended the Long Island fault of Higgins (1968) to form the northwest boundary of the Yellow Dirt Gneiss. The fault-bounded nature of the Yellow Dirt Gneiss makes the stratigraphic position of this unit, like that of the Long Island Gneiss, uncertain.

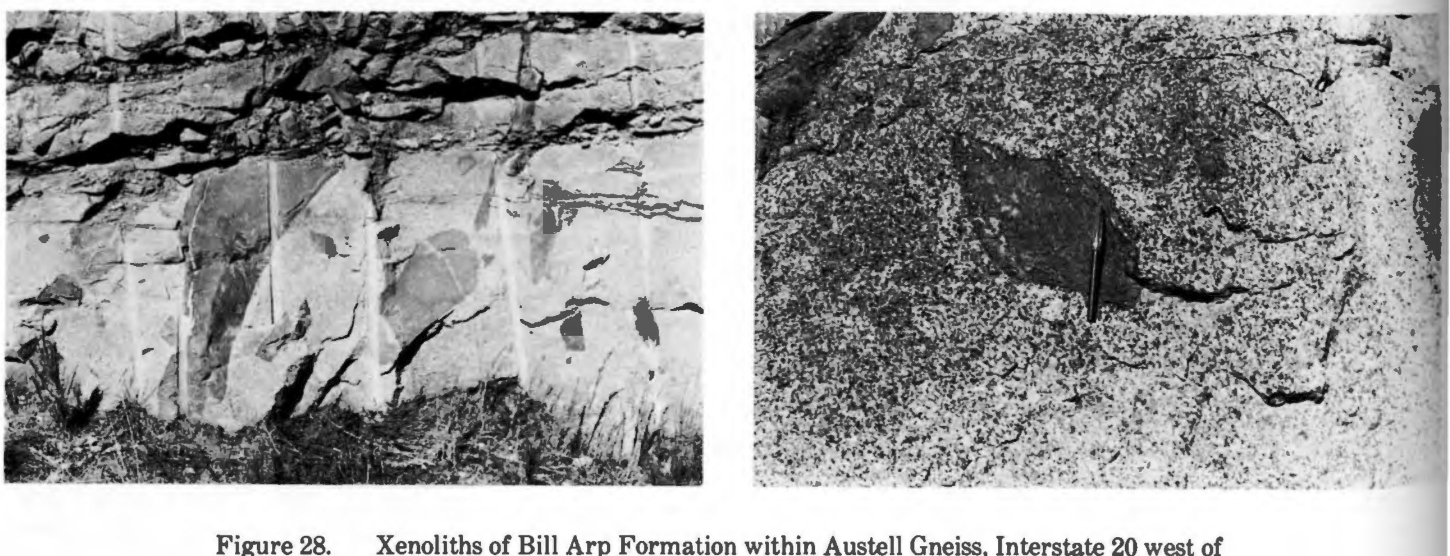

Figure 28. Xenoliths of Bill Arp Formation within Austell Gneiss, Interstate 20 west of Douglasville, Georgia. Photograph B is detail from center of photograph A.

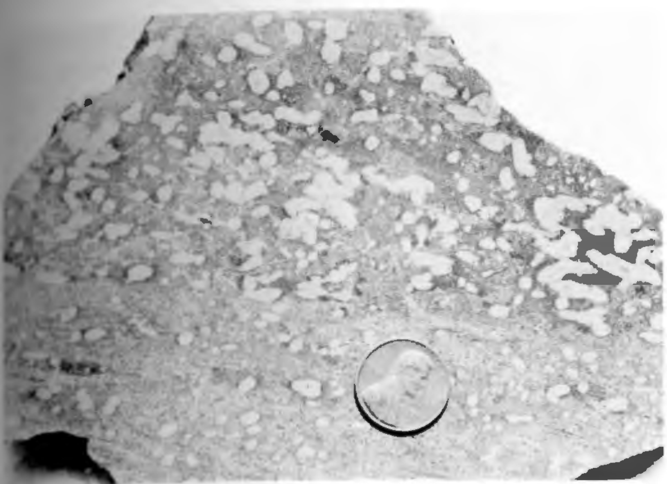

Figure 29. Xenolith of Bill Arp Formation displaying hornfels texture.

Regional Correlations

Prior to revisions of stratigraphy of the northern Piedmont presented in this report, rocks of the New Georgia Group were termed upper Ashland Group (Hurst, 1973) and the western belt of Sandy Springs Group rocks was considered to be a combination of the Wedowee Formation and lower part of the Ashland Group (Hurst, 1973). Reasons for abandoning the terms Ashland and Wedowee have been previously presented, but it is useful to review these terms because of the regional correlations that were previously suggested. Hurst (1973) proposed that rocks of the Ashland Group were equivalent to rocks of the Ashe Formation in North Carolina as defined by Rankin and others (1973). Wedowee Formation rocks, believed by Hurst (1973) to underlie the Ashland Group, had no apparent equivalent to the northeast. However, Hatcher and Butler (1979) have indicated that rocks of the Sandy Springs Group and its probable northeastern Georgia equivalent, Tallulah Falls Formation, are equivalent to Ashe Formation. Although Hurst (1973) suggested that part of what is now called Sandy Springs Group could be equivalent to part of the Ashland Group, he questioned the equivalence of the Sandy Springs and Tallulah Falls Formation. In this report, we agree with the interpretation expressed in Hatcher (1975) and Hatcher and Butler (1979) that the Sandy Springs Group, Tallulah Falls Formation and portions of the Ashe Formation are equivalent. New Georgia Group rocks are interpreted to lie conformably beneath rocks of the Sandy Springs Group in the Greater Atlanta Region. We speculate that they may represent lithostratigraphic equivalents to the amphibolite-dominated portion of the Ashe near Jefferson, North Carolina (Rankin and others, 1973). While the apparent lack of felsic to intermediate volcanics in the Ashe Formation (Rankin and others, 1973) casts doubt on such a correlation, metamorphosed felsic volcanic rocks are more easily erroneously classed as having sedimentary protoliths than are metamorphosed mafic volcanics. An alternative interpretation of the New Georgia Group equates it with the Mt. Rogers volcanics as described by Rankin and others (1973). Volcanic rocks of the Mt. Rogers Formation are chemically bimodal like those present in the New Georgia Group, but Mt. Rogers lithologies are exposed only on the northwestern limb of the Blue Ridge anticlinorium (Rankin and others, 1973). New Georgia Group rocks do not occur along trend with Mt. Rogers Group rocks and, therefore, direct correlation between the two groups is not possible.

BREVARD FAULT ZONE

The Brevard fault zone is a distinct linear zone of ductile shearing that is traceable from the Coastal Plain onlap in Alabama, northeastward through Georgia, South Carolina and most of North Carolina (Hatcher, 1971b, 1978a; Hurst, 1973). Interpretations regarding the nature of movement and the extent of displacement along the Brevard fault zone are varied. Some workers have suggested that the Brevard zone represents a left-lateral strike-slip fault with a thrust component (Reed and others, 1970), while others have interpreted the Brevard to be a right-lateral strike-slip fault (Reed and Bryant, 1964) with a thrust component (Higgins, 1966). Hatcher (1971a, 1978a) interpreted the Brevard zone to be a reactivated backlimb thrust on the Blue Ridge thrust sheet and Burchfiel and Livingston (1967) have suggested that the Brevard is a linear root zone similar to alpine-type root zones. Many other interpretations have been proposed for the Brevard zone, but they are too numerous to list in this report. The reader is referred to several summary articles (Roper and Justus, 1973; Hatcher, 1978a) for a more complete listing of the various interpretations.

In the Greater Atlanta Region the Brevard fault zone separates the northern Piedmont from the southern Piedmont. The Brevard fault zone is bounded on the southeast by rocks of the Atlanta Group (Higgins and Atkins, 1981) and on the northwest by rocks of the Sandy Springs Group (Higgins and McConnell, 1978a, 1978b). Crawford and Medlin (1973) denoted the boundaries of the Brevard fault zone by the presence of a well-developed secondary foliation that they termed a "cataclastic foliation." This secondary foliation (S_2) is axial-planar to second-generation folds (F_2) and is present in the areas outside of the Brevard fault zone; therefore, the presence of a second foliation is not a criterion for inclusion in the Brevard zone in this report. Only those rocks that have undergone intense ductile shearing are included in the Brevard zone. Rocks present in the Brevard zone include protomylonite, mylonite, blastomylonite, button schist, and phyllonite. Occurring in association with the phyllonites are muscovite aggregates (Higgins, 1966) and zones of flattened and poikiloblastic garnets (Abrams, 1983). Textures indicative of late, local normal faulting are also recognized along the trace of the Brevard zone in this area.

The interpretation used in this report for at least the postmetamorphic history of the Brevard fault zone involves little vertical displacement along the Brevard in the Atlanta area. The lack of major vertical displacement is supported by the fact that equivalent lithologies and stratigraphic successions are observed to be present on opposite sides of the Brevard fault zone (Hatcher, 1971b, 1972, 1978b; Kline, 1980, 1981; this report). Also, if significant post-metamorphic vertical displacement had occurred along the Brevard fault zone, metamorphic grade on opposite sides of the Brevard zone should be substantially different. This is not the case in the Greater Atlanta Region.

Stratigraphic control is another aspect to the Brevard fault zone. Hatcher (1975, 1978a) indicated that the Brevard fault zone was stratigraphically controlled for at least part of its length and is bordered by several equivalent rock units (i.e., Heard group, Sandy Springs Group, Tallulah Falls Formation, Ashe Formation) for most of its length. In the Greater Atlanta Regional Map area, the stratigraphic distinction is not as clear as it is to the northeast. Although the Sandy Springs Group is present along the northwestern boundary of the Brevard zone in the Greater Atlanta Region, the absence of units defined as Chauga River Formation (Hatcher, 1969) south of Flowery Branch complicates the issue of stratigraphic control of the Brevard zone. In this area, rocks of the Sandy Springs Group occur on both sides of the Brevard fault zone (Kline, 1980, 1981). However, the Wolf Creek Formation (Higgins and Atkins, 1981), a unit composed of thinly laminated amphibolite interlayered with "button" schist, is lithologically and texturally similar to and in the same relative tectonic position as the Poor Mountain Formation in northeastern Georgia where the Poor Mountain Formation borders on the Alto Allochthon (Hatcher, 1978b). The Wolf Creek Formation may represent the lithostratigraphic equivalent of a portion of the Poor Mountain Formation and the stratigraphic association of the Brevard fault zone readily apparent to the northeast would be present at least as far southwest as Atlanta. A speculative extension of this correlation would be that the rocks exposed in the Newnan-Tucker synform may represent another allochthon resting on Poor Mountain Formation equivalents.

SOUTHERN PIEDMONT

In the recent past, the so-called "belt" terminology or geographic separation of rocks (i.e., northern and southern) was criticized for its ambiguity and in some cases its inapplicability (Crawford and Medlin, 1970; Medlin and Crawford, 1973; McConnell, 1980b). However, no suitable replacement was proposed to enable geographic placement of various rock sequences within the regional geologic framework. In the Atlanta area, rock sequences north of the Brevard fault zone were redefined by one set of workers (McConnell and Costello, 1980b; Abrams and McConnell, 1981a; McConnell and Abrams, 1982a, 1982b; this report), while south of the Brevard, another set of workers has redefined stratigraphic relationships (Atkins and Higgins, 1980; Higgins and Atkins, 1981). Although similar rocks and stratigraphic sequences exist on both sides of the Brevard zone, little effort has gone into relating the two areas. Thus, the geologic distinction between rocks on either side of the Brevard zone is more apparent than real.

Atlanta Group

Studies of stratigraphic relationships within that portion of the Greater Atlanta Regional Map southeast of the Brevard zone generally are limited to two reports (Atkins and Higgins, 1980; Higgins and Atkins, 1981). These reports define a stratigraphic succession of rocks (Atlanta Group, Fig. 11) that occurs in either a synformal anticline or a synformal syncline (Higgins and Atkins, 1981). Higgins and Atkins (1981) interpret this structure as a syncline, but indicate that the stratigraphic sequence they propose is inverted if the alternative hypothesis is correct. Many rock units defined by Higgins and Atkins (1981) are lithologically similar to units defined northwest of the Brevard fault zone (Appendix A gives a brief description of all rock units in the Greater Atlanta Regional Map south of the Brevard fault zone). In the Atlanta area, Kline (1980, 1981) and McConnell (1980b) indicated that rocks of the Sandy Springs Group are present on both sides of the Brevard fault zone. This is consistent with observations farther northeast (Hatcher, 1978b), as well as those related to this report (Plate Ia). The recognition that similar rock sequences exist on both sides of the Brevard zone opens the way for a reinterpretation of stratigraphic relationships within Higgins and Atkins' (1981) Atlanta Group using age and structural relationships established north of the Brevard zone. Rocks northwest of the Brevard zone can serve as a guide for stratigraphic interpretation because of the nonconformable relationship between Grenville basement and Sandy Springs Group equivalent Tallulah Falls Formation in northeastern Georgia (Hatcher, 1974, 1977). Therefore, some indication of stratigraphic "up" is available northwest of the Brevard zone. Comparing mineralogical characteristics of some units in the Atlanta Group with those defined in the northern Piedmont also allows for the reinterpretation of the origin of several rock units defined by Higgins and Atkins (1981), in particular, the Intrenchment Creek Quartzite. The Intrenchment Creek Quartzite is defined as a spessartine-bearing quartzite (coticule rock) and mica schist unit that is composed locally of 15 to 30 percent spessartine garnet and 70 to 85 percent quartz (Higgins and Atkins, 1981). The chemical composition of this rock is attributed to be the result of "halmyrolytic alteration" of oceanic sediments associated with mafic volcanic rocks by Higgins and Atkins (1981, pg. 20). However, spessartine-bearing quartzites are common in the predominantly volcanogenic New Georgia Group northwest of the Brevard zone and in volcanogenic sequences elsewhere (John Slack, personal commun., 1982). In the New Georgia Group spessartine quartzites are associated with banded iron formation. In addition, manganiferous quartzites are a facies of banded iron formation in the Draketown area and contain up to 53 percent manganese (Abrams and McConnell, unpublished data). We suggest that a more likely origin for the Intrenchment Creek Quartzite is derivation from exhalative processes and deposition as a siliceous chemical sediment within a volcanic terrain. The aluminous nature of the quartzite may suggest inclusion of a clay fraction (Abrams and McConnell, 1982b). The presence of garnet facies iron formation in association with mafic and felsic volcanics (i.e., Camp Creek and Big Cotton Indian Creek Formations; Higgins and Atkins, 1981) southeast of the Brevard fault zone is similar to relationships observed in the New Georgia Group northwest of the Brevard zone. The fact that similar stratigraphic sequences are present on both sides of the Brevard zone (Hatcher, 1972, 1978b; Crawford and Medlin, 1973; Kline, 1980, 1981; McConnell, 1980b) and that lithologic similarities exist between the New Georgia Group and the Intrenchment Creek Quartzite, Camp Creek Formation, Big Cotton Indian Creek sequence suggest that they formed in similar environments, possibly contemporaneously. If the above-mentioned stratigraphic sequences are coeval, a basis for reinterpreting the character of the Newnan-Tucker synform (Higgins and Atkins, 1981) exists. In this report, the Camp Creek Formation, Big Cotton Indian Creek Formation and Intrenchment Creek Quartzite are interpreted as the oldest units in the Atlanta Group (analogous to the New Georgia Group northwest of the Brevard fault zone) and the Newnan-Tucker synform, therefore, is a synformal anticline with stratigraphically younger units occurring on limbs of the structure (Plate I). Sandy Springs Group rocks and their probable equivalents[1] in the Atlanta Group (Table 11, Plate Ib) are present on the limbs of the synform and stratigraphically overlie New Georgia Group equivalents (Plate I).

We also suggest that the relationship of Snellville Formation rocks to the Lithonia Gneiss is more likely a fault than an unconformity as previously suggested by Atkins and Higgins (1980). Atkins and Higgins (1980) interpreted this contact as an unconformity, but also gave evidence for characterizing this contact as a fault. This bulletin favors the latter interpretation of this contact primarily because of evidence cited by Atkins and Higgins (1980). Also, the "unconformity" interpretation requires a second Paleozoic metamorphic event for which, in the Greater Atlanta Region, there is a lack of strong evidence. However, due to a lack of detailed mapping in the area by the authors of this bulletin, the contact is expressed as a stratigraphic contact on Plate I.

Outside of the area mapped by Higgins and Atkins (1981) little to no data are available for compilation. Information that does exist is in the form of open-file maps. Other areas (i.e., the easternmost part of the Greater Atlanta Regional Map) where no detailed data are available for compilation are left blank (Plate I). Open-file mapping of Crawford and Medlin (Georgia Geologic Survey, 1976) was used in the southwesternmost portion of the Greater Atlanta Regional Map.

[1] Lithologic descriptions of rocks in the Wolf Creek Formation, Norcross Gneiss and, in part, the Promised Land Formation (Atkins and Higgins, 1980) resemble lithologies in the New Georgia Group and may represent New Georgia equivalents. This correlation would require that other members of the Atlanta Group be part of an allochthonous sheet resting on the Wolf Creek Formation, etc. as was previously proposed in the Brevard Fault Zone section.

Regional Correlations

The similarity between rock units and stratigraphic sequences across the Brevard fault zone was previously discussed in this and previous reports (Crawford and Medlin, 1973; Hatcher, 1972, 1978b). In general, correlatives of the Sandy Springs and New Georgia Groups are believed to occur southeast of the Brevard fault zone in rocks defined as Atlanta Group. We speculate that, although complicated by intrusion of late Paleozoic plutons and the presence of large migmatitic terranes such as the Lithonia Gneiss, rocks defined as Atlanta Group by Higgins and Atkins (1981) probably were deposited in similar environments and had similar provenance to the New Georgia and Sandy Springs Group rocks. Therefore, correlations made in a previous section for rocks of the New Georgia and Sandy Springs Groups (i.e., equivalent to Ashe Formation) may be applicable for rocks of the Atlanta Group.

PLUTONIC ROCKS

Post Grenville-age intrusive rocks generally are limited to the Piedmont portion of the Greater Atlanta Region, although numerous pegmatites occur in the Blue Ridge (Galpin, 1915). In the Greater Atlanta Regional Map area, plutons of known Grenville and possibly older age are restricted to the Corbin Gneiss Complex east of a Cartersville in the Blue Ridge province (Fig. 4) where a 1,000-m.y.-old, coarse, megacrystic facies crosscuts a metasedimentary precursor (Costello, 1978; McConnell and Costello, 1984).

Table 11. Proposed correlation chart of northern and southern Piedmont lithologic units.

<table>
<tr><th colspan="2">Atlanta Group
modified after Higgins and Atkins, 1981</th><th>Sandy Springs and New Georgia Groups
this paper</th></tr>
<tr><td rowspan="2">Snellville Formation</td><td>Norris Lake Schist</td><td>Factory Shoals Formation</td></tr>
<tr><td>Lanier Mountain Quartzite Member</td><td>Chattahoochee Palisades Quartzite</td></tr>
<tr><td>Inman Yard Formation</td><td>Promised Land Formation</td><td rowspan="7">Powers Ferry Formation Undifferentiated</td></tr>
<tr><td>Norcross Gneiss</td><td>Wolf Creek Formation</td></tr>
<tr><td>Clairmont Formation</td><td>Senoia Formation</td></tr>
<tr><td colspan="2">Wahoo Creek Formation</td></tr>
<tr><td colspan="2">Stonewall Formation</td></tr>
<tr><td rowspan="2">Clarkston Formation</td><td>Fairburn Member</td></tr>
<tr><td>Tar Creek Member</td></tr>
<tr><td>Big Cotton Indian Formation</td><td>Intrenchment Creek Quartzite</td><td rowspan="2">New Georgia Group</td></tr>
<tr><td colspan="2">Camp Creek Formation</td></tr>
</table>

Paleozoic intrusive rocks in the Piedmont may be divided into three main categories. These general categories include plutons interpreted as 1) premetamorphic, 2) pre- to synmetamorphic, and 3) postmetamorphic. Timing of the Paleozoic metamorphic event in the Piedmont is not exactly defined, but was interpreted to have occurred in the Piedmont southeast of the Brevard fault zone 365 m.y. ago by Dallmeyer (1975). Abrams and McConnell (1981b) suggested that the age of peak metamorphism in the northern Piedmont also is approximately 365 m.y. ago. An upper limit on the timing of metamorphism in Georgia may be assumed to be 350 m.y. based on the age of Elberton Granite (Whitney and Wenner, 1980). The three main categories of plutons have distinct chemical signatures. These signatures characterize the evolutionary changes which this portion of the Appalachian orogen has undergone.

Premetamorphic Intrusives (Category 1)

Intrusive rocks in the Piedmont portion of the Greater Atlanta Regional Map that were emplaced prior to major metamorphic and deformational events often have their original character masked by these subsequent events. In particular, it is difficult to distinguish between a fine-grained metaplutonic rock and a metavolcanic rock due to obliteration of most igneous textures by subsequent recrystallization. However, several premetamorphic plutons are recognizable in this area. Most of the plutons of this category are in close proximity to extrusive rocks of similar composition. Because of this association we have termed these intrusive and extrusive rocks, intrusive-extrusive complexes. Other characteristics of plutons in this category are general concordance with regional trends, low potassium concentrations in felsic units and moderately high TiO_2 concentrations in mafic units.

In the northern Piedmont, intrusive-extrusive complexes are recognized only in the New Georgia Group where they are associated with numerous volcanogenic massive sulfide and gold deposits (Abrams and others, 1981; McConnell and Abrams, 1982b). Intrusions of this category also have been affected by all major episodes of penetrative deformation to have affected the Piedmont. The Villa Rica Gneiss, Laura Lake Mafic Complex, Acworth Gneiss, Kellogg Creek Mafic Complex and Galts Ferry Gneiss are members of the premetamorphic category north of the Brevard fault zone, while biotite-plagioclase gneisses in the Big Cotton Indian, Camp Creek, and possibly Promised Land Formations as well as the Norcross Gneiss may represent premetamorphic intrusive-extrusive complexes south of the Brevard zone.

One of the characteristics of premetamorphic felsic to intermediate intrusive rocks in the New Georgia Group is the low concentration of potassium in these rocks. This characteristic is documented by major element analyses of the Galts Ferry Gneiss, Villa Rica Gneiss and Dallas gneiss (Table 5; Fig. 30) and modal analyses of the Villa Rica, Dallas, Galts Ferry and Acworth Gneisses (Table 9; Fig. 14). At this stage, some consideration must be given to the fact that potassium, due to its high mobility during metamorphism, may have migrated out of the felsic gneisses of this category (James Tull, personal commun., 1983). However, we find no evidence for this migration and feel that it would be fortuitous for potassium migration to occur preferentially in one rock unit in the northern Piedmont (New Georgia Group) with respect to another (Austell Gneiss). While we believe that potassium, sodium, aluminum, and magnesium alteration has affected many of the rocks in the New Georgia Group as seen in the coarse garnet-chlorite schists and coarse kyanite-quartz granofels, we interpret these as primary features formed largely by the hydrothermal plumbing system present when volcanic rocks of the New Georgia Group were being deposited.

Mafic intrusive complexes of category 1 in the northern Piedmont are the Laura Lake and Kellogg Creek Mafic Complexes. The Laura Lake and Kellogg Creek Complexes are apparently associated with mafic extrusives and with rocks of dacitic composition (i.e., Acworth Gneiss in association with the Kellogg Creek, see Plate I; and felsic components in the Laura Lake Complex).

The Laura Lake Mafic Complex is the largest intrusive-extrusive complex (approximately 80 sq. mi.) in the Piedmont portion of the Greater Atlanta Regional Map (Plate I). The term Laura Lake Mafic Complex was introduced informally by McConnell and Costello (1980b) to describe a large body of amphibolite, metagabbro and meta-ultramafic rocks in eastern Cobb and southern Cherokee Counties (Plate I). We propose to elevate the term to formal status. The Laura Lake Mafic Complex is named for exposures near Laura Lake in eastern Cobb County (Fig. 31).

The areal extent and mafic character of the Laura Lake Mafic Complex should result in a significant aeromagnetic signature; however, aeromagnetic maps currently available characterize the Laura Lake Complex as a series of elongate highs and lows (Higgins and Zietz, 1975). The composite mass of Laura Lake Complex is not distinguishable on aeromagnetic maps. This contrasts with iron formations associated with the Pumpkinvine Creek and Lost Mountain Formations (Higgins and Zietz, 1975) that form linear aeromagnetic highs in western Cobb County. Very high magnetic anomalies noted as Kennesaw Mountain by Higgins and Zietz (1975) probably are either an expression of iron formation known to be near this area or magnetite porphyroblasts present in the amphibolite and leucocratic gneiss (Fig. 32). Although Higgins and Zietz (1975) suggested that the gneiss at Kennesaw Mountain was allochthonous, lack of a significant aeromagnetic signature for the entire Laura Lake suggests that the complex is thin and probably rootless.

Chemically, the Laura Lake Complex bears some similarity to amphibolites in the New Georgia Group. The Laura Lake is separated from the outcrop belt of the New Georgia Group by a thin strip of Sandy Springs Group rocks. The outcrop pattern of the Laura Lake Complex suggests that it crosscuts stratigraphy in the Sandy Springs Group, particularly in central Cobb County where the Laura Lake Complex lies structurally beneath the Chattahoochee Palisades Quartzite at Sweat and Blackjack Mountains (Plate I). The aforementioned relationships suggest that the Laura Lake may have intruded rocks of the Sandy Springs Group. Due to lithologic similarities between the New Georgia Group and Laura Lake Complex, an alternative interpretation, which is favored by this report, is that the Laura Lake represents a slice of the New Georgia Group that, along with the Sandy Springs Group, was thrust over units of the New Georgia Group along the Chattahoochee fault (Plate I). Local faulting along the eastern margin of the Laura Lake Complex cuts out portions of the Sandy Springs Group. Rock exposures and (or) mapping are not extensive enough to conclusively prove one interpretation over another.

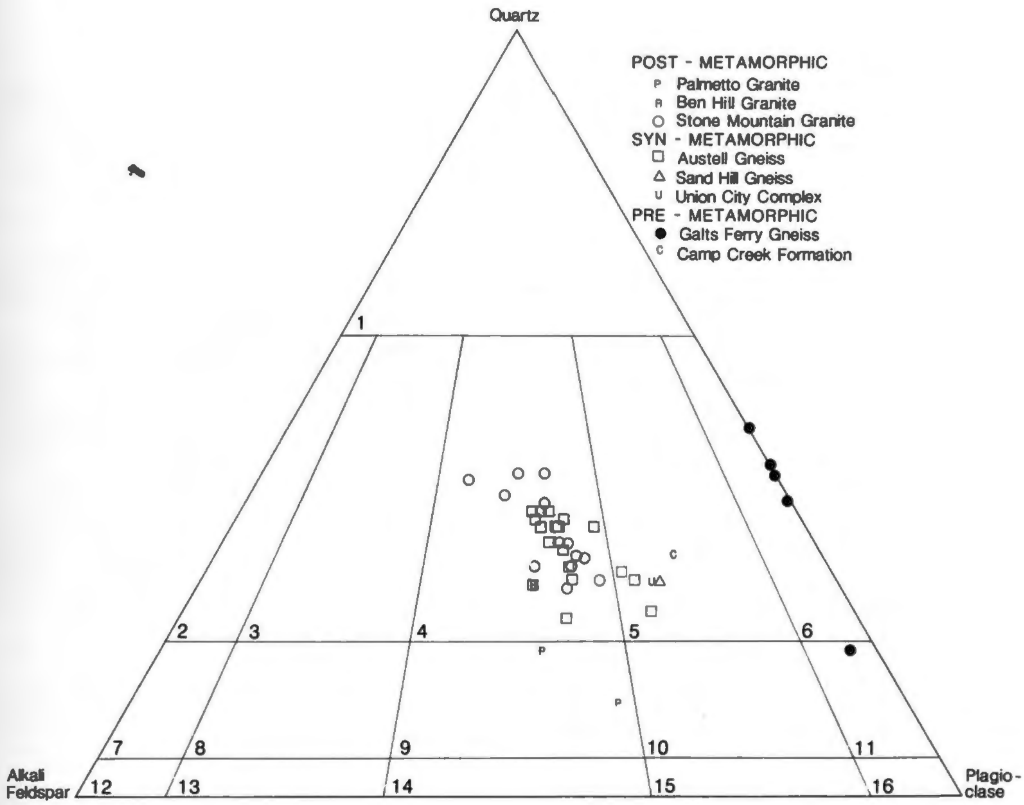

Figure 30. Plot of normative analyses of felsic igneous rocks in the Greater Atlanta Regional Map area, classification modified after Streckeisen (1976) modal diagram with quartz monzonite field added. Analyses after Grant and others (1980); Abrams (1983); this report. 1=Quartz-rich granitoids, 2=Alkali-feldspar granite, 3=Two-feldspar granite, 4=Quartz monzonite, 5=Granodiorite, 6=Quartz diorite, 7=Alkali-feldspar-quartz syenite, 8=Quartz syenite, 9=Quartz-rich monzonite, 10=Quartz monzodiorite, 11=Tonalite, 12=Alkali-feldspar syenite, 13=Syenite, 14=Monzonite, 15=Monzodiorite, 16=Diorite.

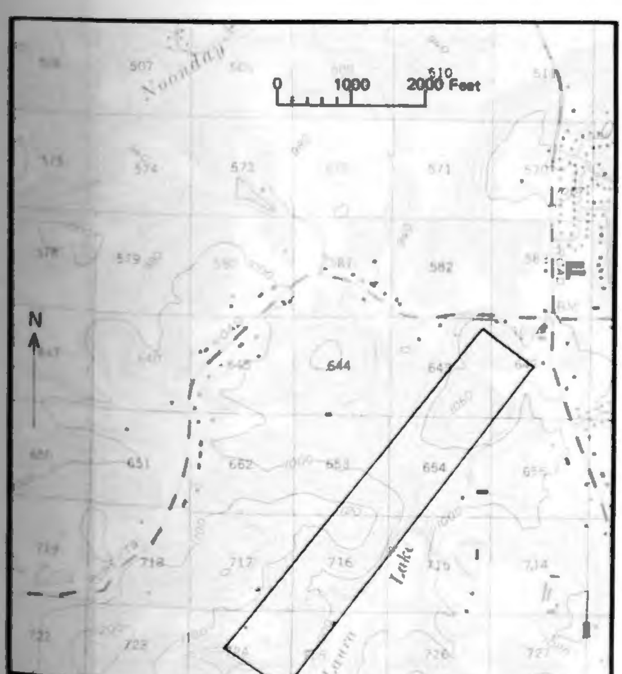

Figure 31. Type locality of the Laura Lake Mafic Complex (U.S. Geological Survey, Kennesaw, Georgia, 1:24,000 topographic quadrangle).

Figure 32. Photograph of magnetite porphyroblasts in exposure of the Laura Lake Mafic Complex, Interstate 575 at Bells Ferry Road exit.

The Laura Lake Mafic Complex is composed predominantly of migmatitic garnet amphibolite with smaller amounts of clinopyroxene (relict, altering to amphibole)-bearing metagabbro, felsic gneiss, meta-ultramafic lithologies and banded iron formation. Magnetite occurs as medium to coarse grains in felsic members and in grains as large as ¼ in. across as common porphyroblasts in amphibolite. Leucocratic neosome in the Laura Lake is composed of very coarse-grained amphibole-quartz-plagioclase (An_{32}) rock. Amphiboles in the neosome were observed to reach 1½ in. across (Fig. 33). A distinct and mappable unit of intermediate gneiss is present along the western margin of the Laura Lake Mafic Complex (Plate I). This gneiss is locally quarried for aggregate near Kennesaw and has a quartz diorite composition (Sample 6, Table 12). Hurst (1952) informally termed this rock Kennesaw gneiss. This report proposes to formally designate the Kennesaw Gneiss Member of the Laura Lake Mafic Complex for exposures east of the town of Kennesaw (Fig. 34).

Another premetamorphic mafic complex is present west of the outcrop area of the Laura Lake Complex, in the New Georgia Group in southern Bartow, northeastern Paulding and northwestern Cobb Counties (Plate I). McConnell and Costello (1980b) informally termed this unit the Kellogg Creek metagabbro. Crawford and Medlin (1970) described this rock as being sheared and concordant with the regional trend. Like the Laura Lake Complex, the Kellogg Creek is composed of garnet amphibolite, metagabbro and lesser amounts of meta-ultramafic rocks. Although no direct evidence for an extrusive facies were observed, amphibolites associated with the metagabbro may possibly represent an extrusive component. The variety of rock types associated with the Kellogg Creek suggests that "gabbro" is not an appropriate term to describe this unit. In this report, therefore, the Kellogg Creek metagabbro is formally designated the Kellogg Creek Mafic Complex for exposures along Kellogg Creek in southern Cherokee County (Fig. 35). Chemically, rocks of the Kellogg Creek Complex are distinct from either the Laura Lake Mafic Complex or other amphibolites in the New Georgia Group (Table 12, samples labeled KC; Fig. 36). The gabbroic facies of the Kellogg Creek generally is higher in aluminum and lower in TiO_2 than other mafic rocks in this area (Fig. 36). While it may have an associated extrusive facies, the Kellogg Creek Complex may not be related to documented mafic volcanic rocks in the New Georgia Group.

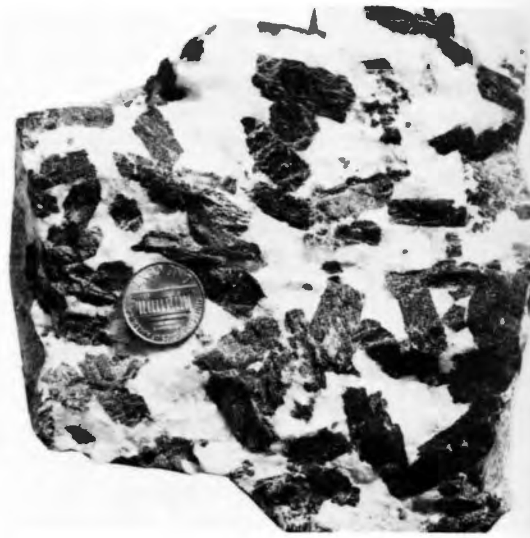

Figure 33. Photograph of coarse amphiboles in the Laura Lake Mafic Complex, Interstate 575 just east of Interstate 75.

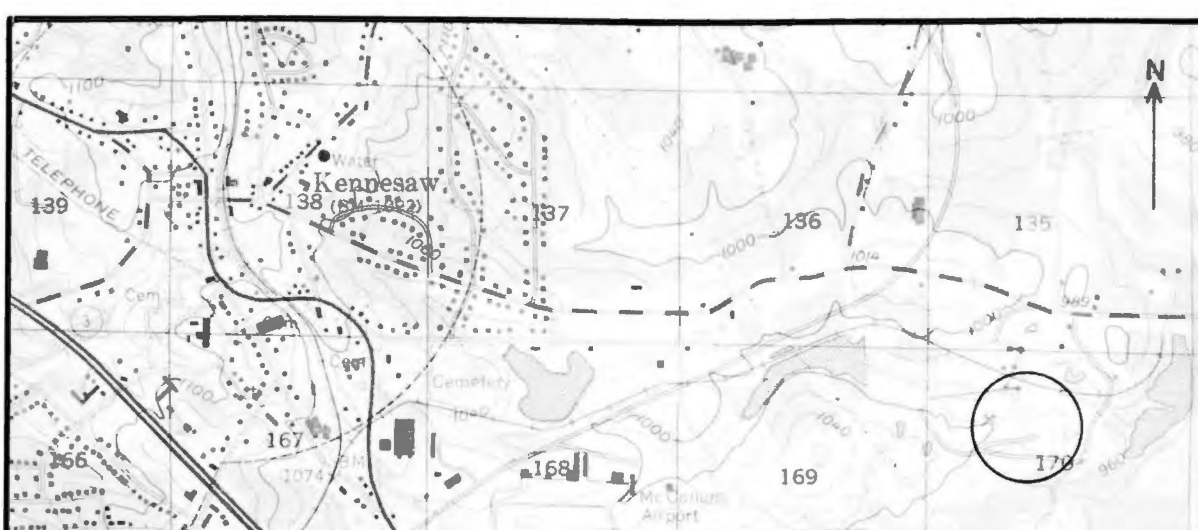

Figure 34. Type locality of the Kennesaw Gneiss Member of the Laura Lake Mafic Complex (U.S. Geological Survey, Kennesaw, Georgia, 1:24,000 topographic quadrangle).

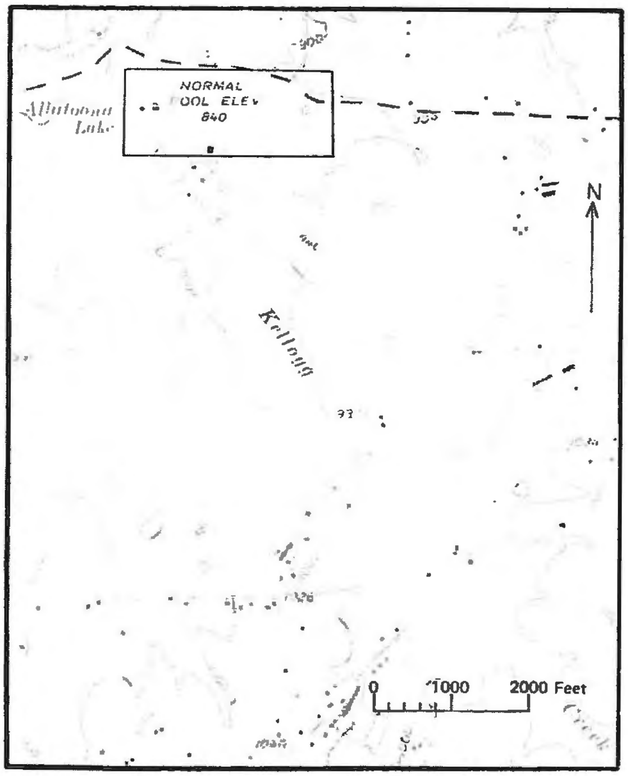

Figure 35. Type locality of the Kellogg Creek Mafic Complex (U.S. Geological Survey, Kennesaw, Georgia, 1:24,000 topographic quadrangle).

Figure 37 shows the compositional variation of the magmatic liquid in igneous rocks of the New Georgia Group. The trend given by advancing crystallization suggests that the intrusives of Category 1 in the New Georgia Group most likely formed from a tholeiitic magma.

Pre- to Synmetamorphic Intrusives (Category 2)

Pre- to synmetamorphic intrusive rocks of the Piedmont, like those intrusives in the premetamorphic category, retain penetrative deformation fabrics associated with Paleozoic metamorphism. However, unlike those intrusives in category 1, pre- to synmetamorphic intrusives show no direct relationship to any extrusive rocks. While premetamorphic intrusive-extrusive complexes (category 1) show some characteristics common to Buddington's (1959) epizone, pre- to synmetamorphic intrusives show more characteristics of the mesozone (Buddington, 1959). Intrusives of category 2 are distinctly more potassic than category 1 intrusives and generally are peraluminous to meta-aluminous. The Austell, Sand Hill, and Mulberry Rock Gneisses are examples of pre- to synmetamorphic intrusives northwest of the Brevard fault zone while only the Union City Complex and possibly the Lithonia Gneiss fit category 2 characteristics southeast of the Brevard. Other examples both northwest and southeast of the Brevard zone no doubt exist, but, at this time are not defined. The Lithonia Gneiss is not considered further in this report because of its complex migmatitic character and the fact that it is believed, at least in part, to have originated by incipient melting of country rock (Grant and others, 1980).

Table 12. Chemical analyses of mafic to intermediate rocks of the northern Piedmont.

SAMPLE NO.	LL1*	LL2*	LL3*	LL4*	LL5*	LL6*	LL7*	LL8*	LL9*	LL10*	LL11*
SiO_2	53.6	51.5	48.0	49.4	48.8	61.2	48.4	51.6	52.3	53.0	53.4
Al_2O_3	15.0	17.3	21.7	9.7	18.4	17.7	13.4	17.0	16.5	15.4	14.8
Fe_2O_3	3.2	3.6	4.8	3.2	3.1	3.5	8.7	7.4	5.0	4.7	6.4
FeO	9.2	9.4	7.1	6.8	7.3	2.2	4.9	5.8	7.4	8.6	6.7
MgO	7.7	5.9	4.5	18.0	8.4	2.7	6.1	4.6	4.2	4.9	4.5
CaO	6.3	6.9	9.1	10.4	10.2	5.9	11.4	6.9	8.1	7.5	6.6
Na_2O	1.4	3.5	2.2	0.8	1.6	3.5	3.2	4.6	3.4	2.8	4.5
K_2O	1.4	0.3	0.4	0.4	0.4	1.4	0.2	0.2	0.2	0.1	0.1
TiO_2	0.9	0.4	1.1	0.2	0.5	0.5	1.4	1.2	1.1	0.9	1.1
MnO	0.3	0.3	0.2	0.2	0.2	0.1	0.1	0.0	0.2	0.2	0.1
TOTAL	99.0	99.1	99.1	99.1	98.9	98.7	97.8	99.3	98.4	98.1	98.2

SAMPLE NO.	KC1**	KC2**	KC38**	KC4**	KC6**	KC7**	KC8**	KC12**	KC12*	KC13*	KC14*	KC15*	KC16*	KC17*
SiO_2	46.00	46.00	47.00	46.00	50.50	47.00	46.00	50.00	45.8	41.8	56.1	49.5	51.2	51.9
Al_2O_3	26.20	22.50	19.90	19.90	17.50	22.50	22.50	16.30	17.4	16.7	11.6	11.0	11.5	18.2
Fe_2O_3	2.95	3.40	4.10	4.10	7.40	4.20	3.75	9.60	4.1	5.7	2.8	2.3	2.4	3.1
FeO	—	—	—	—	—	—	—	—	7.6	12.7	5.8	7.4	7.6	7.2
MgO	4.60	5.62	7.10	7.60	7.40	5.90	6.00	4.40	7.9	8.7	10.8	14.2	14.6	6.4
CaO	14.00	14.00	15.00	15.00	11.00	15.50	16.20	11.00	14.1	9.6	10.7	11.5	10.5	9.1
Na_2O	1.65	1.65	1.48	1.45	2.80	1.05	1.35	3.00	1.2	1.6	0.8	0.8	0.2	1.4
K_2O	0.19	0.11	0.13	0.13	0.40	0.13	0.11	0.23	0.3	0.3	0.2	0.2	0.5	0.9
TiO_2	0.13	0.18	0.24	0.20	0.28	0.20	0.15	0.73	0.3	1.9	0.2	0.6	0.2	0.6
MnO	0.07	0.08	0.07	0.08	0.12	0.10	0.08	0.12	0.2	0.2	0.2	0.2	0.2	0.2
TOTAL	95.79	93.54	95.02	94.46	97.40	96.58	96.14	95.38	98.9	99.2	99.2	97.7	98.9	99.0

*Analyses performed in the laboratory of the Georgia Geologic Survey; Roger Landrum, Analyst.
**After Wallace (1978) unpublished senior thesis.

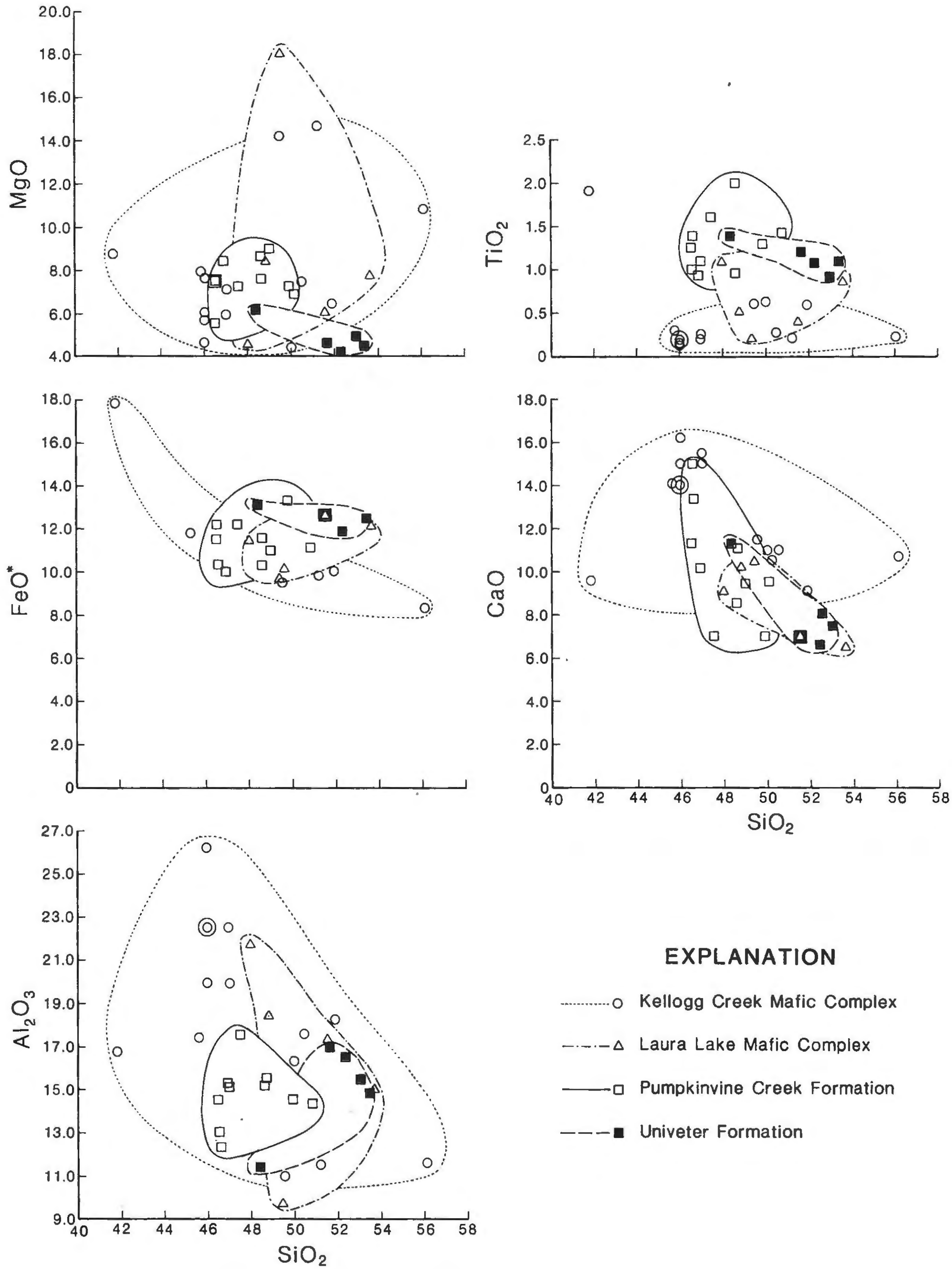

Figure 36. Variation diagrams of mafic rocks of the New Georgia Group. Superimposed symbols (e.g.,◎) refer to superimposed points. $FeO^* = FeO + .9Fe_2O_3$.

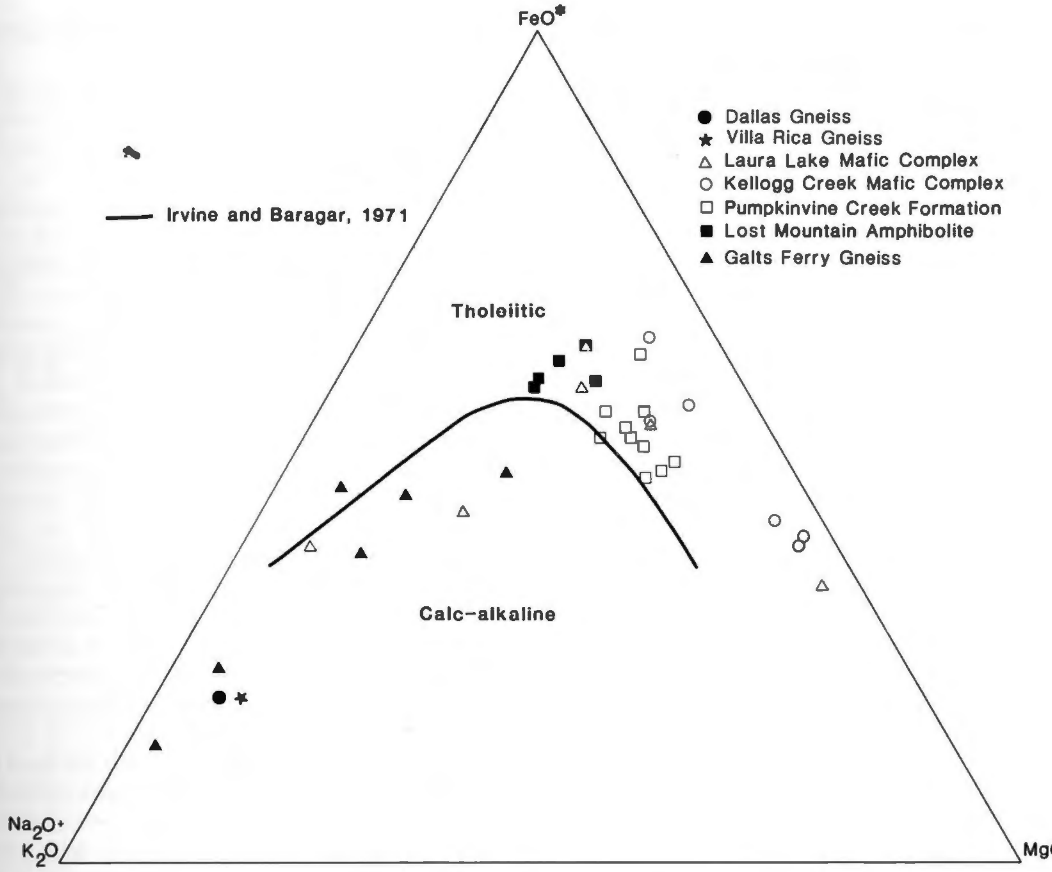

Figure 37. $(Na_2 + K_2O)$, $(FeO + .9Fe_2O_3)$, (MgO) plot showing the iron enrichment trend of metaigneous rocks of the New Georgia Group.

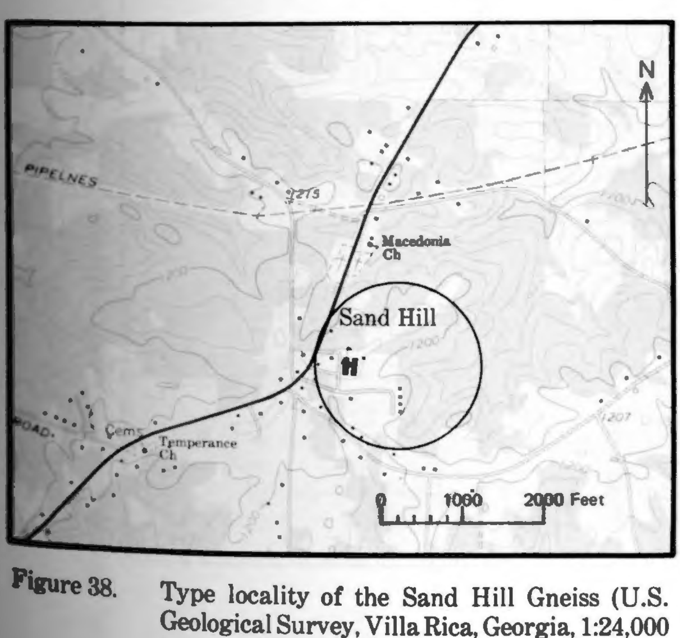

Figure 38. Type locality of the Sand Hill Gneiss (U.S. Geological Survey, Villa Rica, Georgia, 1:24,000 topographic quadrangle).

The best-defined member of pre- to synmetamorphic intrusive rocks is the Austell Gneiss in Douglas and southwestern Cobb Counties (Plate I). Abrams (1983) described the Austell Gneiss as a fine- to coarse-grained blastoporphyritic to nonporphyritic gneiss composed of muscovite, biotite, oligoclase, quartz and microcline. The intrusive character of the Austell is well documented by exposures of xenoliths and hornfels textures along Interstate 20 west of Atlanta (Figs. 28 and 29). The Sand Hill Gneiss is compositionally similar to and is located just to the southwest of the outcrop area of the Austell Gneiss in eastern Carroll County (Fig. 11). This gneiss is herein formally termed the Sand Hill Gneiss for exposures near Sand Hill, eastern Carroll County (Fig. 38). Although the Sand Hill is texturally similar to the Austell, it contains greater amounts of muscovite, quartz and plagioclase and lesser amounts of microcline than the Austell. A third felsic gneiss defined in the northern Piedmont that fits the characteristics of the pre- to synmetamorphic category is the Mulberry Rock Gneiss. The Mulberry Rock Gneiss occurs in western Paulding County, at the Allatoona fault, the boundary between the Blue Ridge and northern Piedmont. The Mulberry Rock Gneiss is named here for exposures at Mulberry Rock, a prominent exposure of the Gneiss in western Paulding County

(Fig. 39). As the trace of the Allatoona fault is somewhat uncertain in this area, the Mulberry Rock Gneiss could lie in either Blue Ridge or Piedmont. If the former is correct, then the possibility exists that the Mulberry Rock could represent basement in this area. Data are limited on the Mulberry Rock Gneiss, but a single modal analysis shows the gneiss to be composed predominantly of muscovite, microcline, quartz, and plagioclase. Modal biotite is notably absent (Table 9). The gneiss is present in the core of a large fold that bends the regional northeast-southwest foliation to a north-south trend (Plate I).

Common to all three intrusives (i.e., the Austell, Sand Hill and Mulberry Rock Gneisses) is that they are compositionally granite to quartz monzonites, lie in the crestal areas of regional folds (see next section), retain the regional foliation, and show distinctly elevated potassium concentrations relative to pre-metamorphic intrusives. Whole-rock chemical analyses of the Austell and Sand Hill Gneisses are presented in Tables 13 and 14. Plotted in relation to silica, other oxide concentrations show a distinct differentiation trend, notably for FeO*, MgO, CaO, and TiO_2 (Fig. 40). Total alkalies remain relatively constant with respect to increasing silica content. The differentiation trend shown in Figure 40 is derived primarily from data on the Austell Gneiss. The fact that samples of the Sand Hill Gneiss plot along the same trend suggests that the Austell and Sand Hill might have a common parent. Also plotted on Figure 40 is a single whole-rock analysis from the Union City Complex (UC2, Table 15). This sample of the Union City Complex plots on or near the Austell-Sand Hill trend. While not conclusive, this suggests that the Union City Complex, at least partially, may have a common parent with the Austell and Sand Hill.

Postmetamorphic Intrusives (Category 3)

Postmetamorphic intrusive rocks in the Greater Atlanta Region can be divided into two subdivisions: those emplaced approximately 300 to 325 m.y. ago, and those emplaced approximately 180 to 230 m.y. ago. The older of the two subdivisions of Category 3 is represented by large felsic plutons such as the Stone Mountain and Palmetto Granites. Intrusives of this older subdivision generally are limited to the area southeast of the Brevard fault zone. The younger of the two subdivisions of Category 3 is represented by Jurassic-Triassic diabase dikes. In the Greater Atlanta Region, diabase dikes occur predominately in the southern Piedmont, but at least one small diabase dike is reported from eastern Cherokee County (Lester and Allen, 1950). All intrusives in Category 3 lack evidence of penetrative deformation associated with Paleozoic metamorphism, although, following peak metamorphism, ductile shearing along the Brevard zone has affected two intrusives in this category (i.e., Palmetto and Ben Hill Granites). Other than geologic mapping, little work was done on intrusives of this category during this investigation. However, published data as well as a small number of new whole-rock analyses provide an opportunity to compare and contrast rocks of the postmetamorphic category with the two categories previously described.

The Stone Mountain Granite is the most comprehensively studied rock unit in the Piedmont portion of the Greater Atlanta Regional Map. Many investigations over the past thirty years (Herrmann, 1954; Wright, 1966; Whitney and others, 1976; Dallmeyer, 1978; Grant and others, 1980; and Whitney and Wenner, 1980) have studied chemical, textural and mineralogical aspects of the Stone Mountain Granite

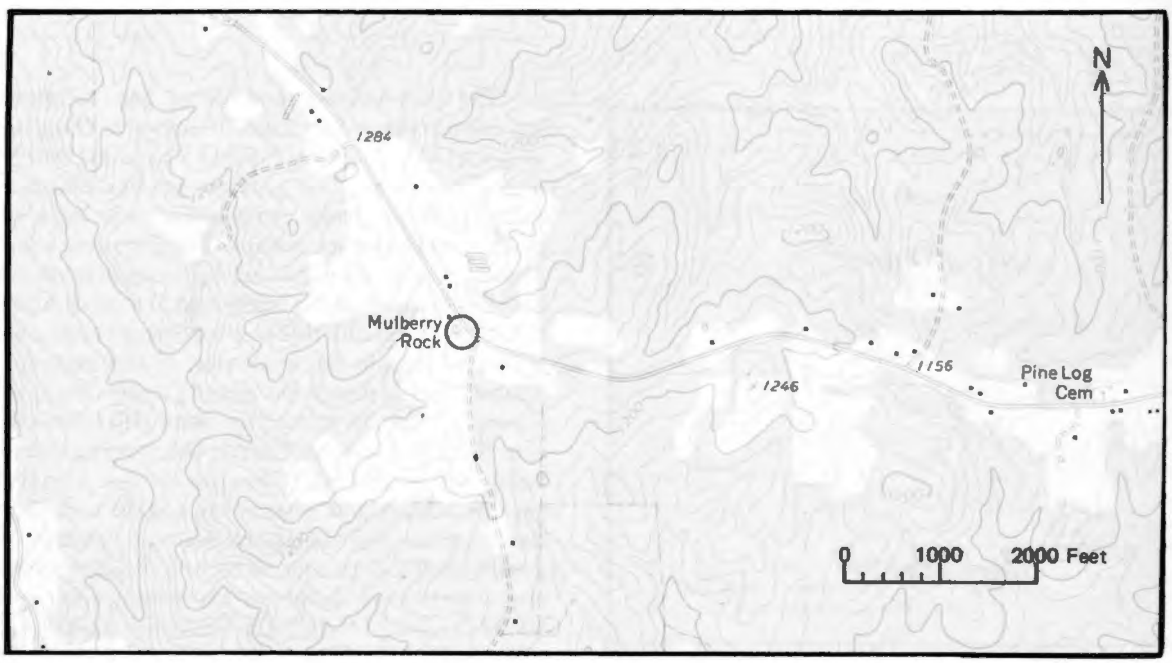

Figure 39. Type locality of the Mulberry Rock Gneiss (U.S. Geological Survey, New Georgia, Georgia, 1:24,000 topographic quadrangle).

Table 13. Chemical and normative analyses of the Austell Gneiss. (Oxides in weight percent.)

SAMPLE NO.	18**	19**	20**	21**	22*	23*	24*	25*	26*	27*	28*	29*	30**	31**	32**
SiO_2	77.1	76.8	77.6	73.0	73.2	71.4	71.0	68.6	76.2	68.7	74.8	77.1	69.8	76.1	72.2
Al_2O_3	12.1	12.1	12.7	15.9	14.2	13.7	13.2	14.2	12.3	14.7	12.8	12.2	14.5	12.7	13.6
Fe_2O_3	0.2	0.4	0.8	0.5	1.1	1.1	1.0	1.2	0.7	1.3	1.1	0.2	1.4	0.4	0.5
FeO	0.8	0.4	0.6	1.0	0.4	1.0	1.4	2.0	0.8	2.0	0.7	0.6	1.7	0.8	2.0
MgO	0.3	0.1	0.2	0.4	0.3	0.8	0.8	1.1	0.6	1.3	0.5	0.4	0.9	0.2	0.9
CaO	1.2	1.0	0.6	1.0	1.3	2.1	1.9	2.9	1.1	3.0	1.6	0.9	3.0	1.4	2.4
Na_2O	3.4	3.5	3.7	3.9	3.5	3.3	3.8	3.8	3.4	4.5	3.5	3.5	3.7	3.6	3.5
K_2O	4.8	4.9	3.8	3.7	4.8	4.4	5.0	3.5	4.9	3.5	4.4	4.6	3.8	4.4	3.6
TiO_2	0.2	0.1	0.2	0.3	0.2	0.4	0.4	0.5	0.2	0.6	0.3	0.1	0.6	0.2	0.4
MnO	0.1	0.1	0.0	0.1	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.0	0.1	0.1	0.1
TOTAL	100.2	99.4	100.2	99.8	99.0	98.3	98.6	97.9	100.30	99.7	99.8	99.6	99.5	99.9	99.3
CIPW NORMS															
qz	35.92	35.66	39.90	32.91	31.54	30.27	25.58	25.34	34.57	21.39	33.98	36.27	26.12	34.88	30.66
co			1.41	3.66	1.12	.28									
or	28.36	28.96	22.46	21.86	28.36	26.00	29.55	20.68	28.96	20.68	26.00	27.18	22.46	26.00	21.27
ab	28.77	29.62	31.31	33.00	29.62	27.92	32.15	32.15	28.77	38.08	29.62	29.62	31.31	30.46	29.62
an	3.58	2.83	2.98	4.96	5.80	8.81	4.19	11.35	3.83	9.57	6.22	3.99	11.73	5.50	10.77
ne															
wo	.99	.66					1.07	.67	.46	1.75	.42	.07	1.32	.60	.48
en	.39	.25					.61	.38	.34	1.08	.36	.04	.82	.21	.21
fs	.61	.42					.41	.26	.08	.56		.03	.42	.41	.26
en	.35		.50	1.00	.72	1.89	1.41	2.36	1.38	2.16	.83	1.16	1.43	.29	2.03
fs	.55		.11	1.11		.36	.94	1.66	.32	1.12		.82	.74	.58	2.52
fo															
fa															
mt	.29	.58	1.16	.72	.91	1.59	1.39	1.74	1.13	1.88	1.43	.29	2.03	.58	.72
il	.38	.19	.38	.57	.40	.72	.68	1.03	.46	1.18	.63	.27	1.14	.38	.76
hm															
pf															
ru															
ap					.24	.36	.21	.45	.17	.50	.19	.09			
cc						.23	.75	.07	.02	.09	.07	.07			
TOTAL	100.19	99.17	100.21	99.79	99.71	97.93	98.94	98.14	100.49	100.04	99.75	99.90	99.52	99.89	99.30

*After Abrams, 1983

**Analyses done by H. Smith and J. Reid, in the laboratories of the U.S. Geological Survey, Reston, Virginia.

Table 14. Chemical and normative analyses of the Sand Hill Gneiss. (Oxides in weight percent.)

SAMPLE NO.	33**	34**	35**	36**
SiO_2	69.9	73.1	72.6	68.8
Al_2O_3	16.3	13.7	13.4	14.1
Fe_2O_3	1.1	0.4	0.4	1.0
FeO	1.4	1.4	1.6	2.1
MgO	0.6	0.6	0.7	1.0
CaO	2.2	1.2	1.5	2.2
Na_2O	4.4	3.2	3.2	3.3
K_2O	3.1	4.7	4.4	4.6
TiO_2	.05	0.3	0.4	0.6
MnO	.00	0.1	0.1	0.1
TOTAL	99.5	98.7	98.3	97.8
CIPW NORMS				
qz	26.45	32.16	31.92	24.96
co	1.71	1.17	.65	
or	18.32	27.77	26.00	27.18
ab	37.23	27.08	27.08	27.92
an	10.91	5.95	7.44	10.07
ne				
wo				.35
en				.18
fs				.16
en	1.49	1.49	1.74	2.31
fs	.84	1.93	2.13	2.06
fo				
fa				
mt	1.59	.58	.58	1.45
il	.95	.57	.76	1.14
hm				
pf				
ru				
ap				
cc				
TOTAL	99.49	98.70	98.30	97.78

**Analyses done by H. Smith and J. Reid, in the laboratories of the U.S. Geological Survey, Reston, Virginia.

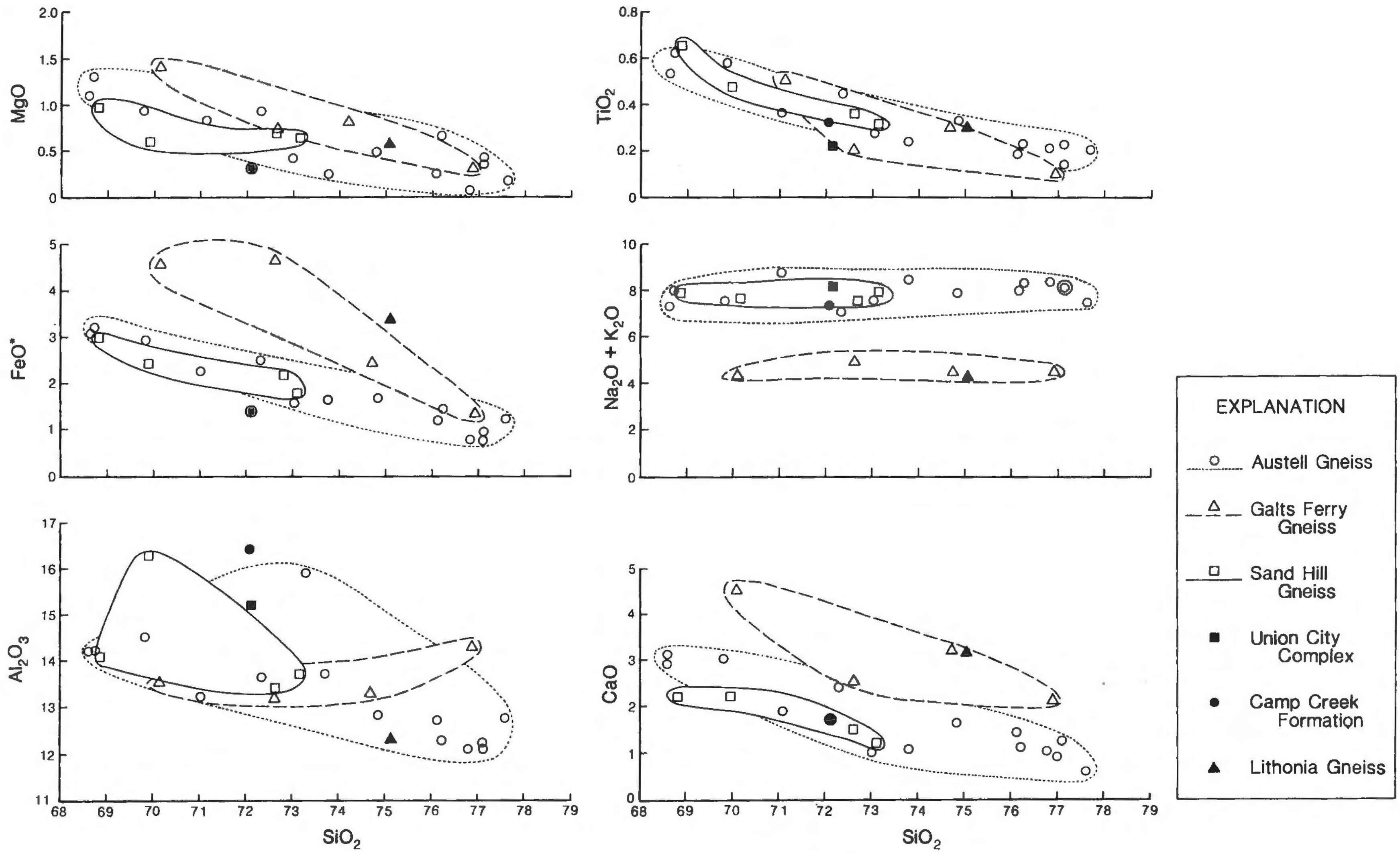

Figure 40. Variation diagrams of premetamorphic and synmetamorphic rocks of the Greater Atlanta Region.

Table 15. **Chemical and normative analyses of intrusive rocks of the southern Piedmont. (Oxides in weight percent)**

SAMPLE NO.	P1*	P2*	BH1*	UC2*	CC1*
SiO_2	68.1	65.3	68.9	72.1	72.1
Al_2O_3	16.5	17.5	17.0	15.2	16.4
Fe_2O_3	1.0	1.1	0.6	0.3	0.2
FeO	1.0	2.0	1.7	1.2	1.1
MgO	0.5	0.9	0.7	0.3	0.3
CaO	1.3	2.6	1.7	1.7	1.7
Na_2O	4.0	4.6	3.3	4.7	4.6
K_2O	6.1	5.2	5.0	3.4	2.9
TiO_2	0.5	0.3	0.5	0.2	0.3
MnO	0.1	0.1	0.0	0.0	0.1
TOTAL	99.1	99.6	99.4	99.1	99.7
			CIPW NORMS		
qz	17.79	10.86	25.06	26.92	29.45
co	.95		3.07	.70	2.60
or	36.05	30.73	29.55	20.09	17.14
ab	33.85	38.92	27.92	39.77	38.92
an	6.45	11.74	8.43	8.43	8.43
ne					
wo		.48			
en		.23			
fs		.23			
en	1.25	2.01	1.74	.75	.75
fs	.37	2.21	1.80	1.63	1.55
fo					
fa					
mt	1.45	1.59	.87	.43	.29
il	.95	.57	.95	.38	.57
hm					
pf					
ru					
ap					
cc					
TOTAL	99.11	99.57	99.39	99.10	99.70

*Analyses performed in the laboratory of the Georgia Geologic Survey; Roger Landrum, analyst.

Because of this interest in the Stone Mountain Granite, whole-rock and trace element chemical data are abundant. Figure 41 shows plots of major oxides from analyses by Whitney and others (1976) and Grant and others (1980). Plots of silica versus other oxides show that the Stone Mountain Granite has a very restricted silica range in comparison to the Austell Gneiss and plots distinctly below the Austell trend for TiO_2, CaO, MgO, and FeO*. Several analyses from other postmetamorphic plutons (Table 15) also are plotted in Figure 41, but the data are too sparse to draw any conclusions regarding their relation to the Stone Mountain Granite or other categories of intrusives.

The occurrence of diabase dikes in Georgia was first described in detail by Lester and Allen (1950). In their report, Lester and Allen (1950) indicate that diabase dikes strike predominantly northwest-southeast and dip approximately 75 to 90 degrees to the east. Weigand and Ragland (1970) studied the chemical character of diabase dikes of the eastern U.S. and concluded that those dike's occurring in Georgia and Alabama (including those in the Greater Atlanta Region) are olivine tholeiites and low TiO_2 quartz normative tholeiites. Somewhat later, Dooley (1977) isotopically dated several diabase dikes in Georgia using K-Ar methods. Dooley's work showed that many diabase dikes contain environmental excess ^{40}Ar that was incorporated into the dikes during crystallization (Dooley, 1977). Diabase dikes are believed to have intruded rocks of the Georgia Piedmont in three distinct pulses (Dooley, 1977): the first approximately 228 m.y. ago, the second approximately 200 m.y. ago and the third approximately 180 m.y. ago.

Summary

Intrusive rocks in the Piedmont portion of the Greater Atlanta Regional Map outline an evolving orogen. Premetamorphic felsic and mafic extrusive-intrusive complexes of category 1 define a period of igneous activity during which syngenetic massive sulfide and gold deposits in the Dahlonega gold belt were formed. McConnell and Abrams (1982b) proposed that rocks of category 1 in the New Georgia Group represented a younger analog of "greenstone belts" characteristic of Archean terranes. Similarities between the New Georgia Group and the Abitibi greenstone belt of Canada were used as a basis for this correlation. These similarities include predominance of mafic over felsic volcanics; dacitic composition of felsic volcanics; chemical sediments (banded iron formation) located near the top of sequences that are possibly at the end of a volcanic cycle; bimodal volcanic chemistry; Cu-Zn dominated base-metal deposits; and the presence of subvolcanic plutons within the volcanic pile. Sangster (1980) has suggested that greenstone belts formed in areas of crustal tension. A similar tectonic setting for the New Georgia Group is supported by trace and rare-earth element analyses from mafic volcanic rocks in the New Georgia Group (Fig. 18a-e). New Georgia Group rocks, therefore, may have formed in either a back-arc or marginal basin tectonic setting (McConnell, 1980a; McConnell and Abrams, 1982b). A similar tectonic setting also may be appropriate for rocks of the Big Cotton Indian, Camp Creek and Promised Land Formations and the Intrenchment Creek Quartzite (Atlanta Group) southeast of the Brevard fault zone.

As volcanism waned, the basin, floored by intrusive-extrusive complexes and subordinate sediments, was infilled by flysch facies greywackes, argillites and subordinate volcanic rocks of the Sandy Springs Group and its equivalents southeast of the Brevard zone (Plate I). During the mid- to late Paleozoic (approximately 365 m.y. ago), all rocks of the aforementioned succession underwent high-grade metamorphism. Just prior to or during the late Paleozoic metamorphic event, a second major intrusive event occurred. This episode of plutonism is most notably documented by the syntectonic Austell Gneiss (Abrams and McConnell, 1981b). Higher alkali contents than the premetamorphic plutons, deeper level of emplacement, and their intrusion in the crestal areas of folds (F_1) suggest that they were intruded into a thickened, tectonically active crust.

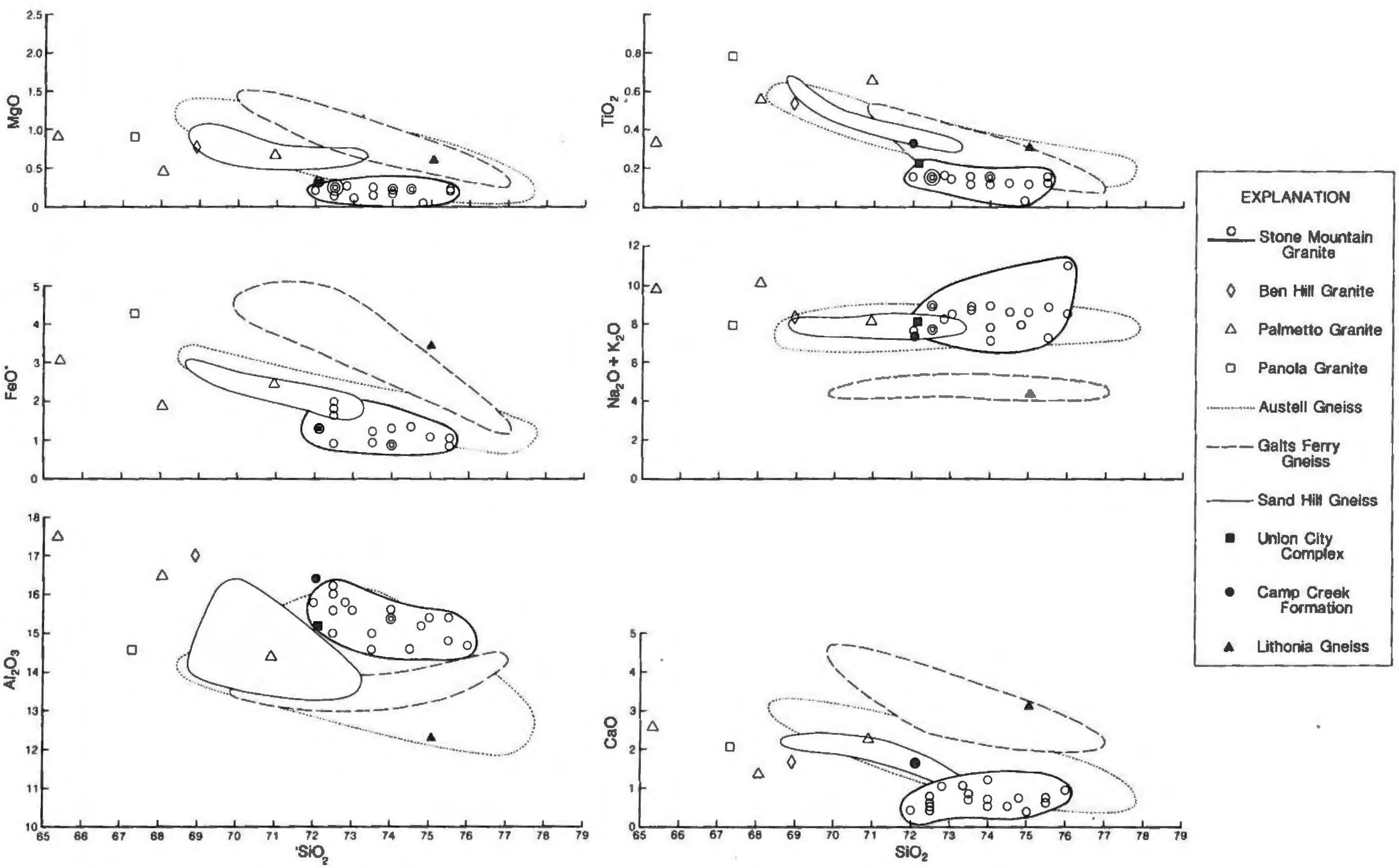

Figure 41. Variation diagrams of felsic igneous rocks in the Greater Atlanta Region.

Following the peak of the metamorphism and deformation in the Piedmont, a third group of plutons was emplaced. Most of these plutons are approximately 300 m.y. old (Whitney and Wenner, 1980; Higgins and Atkins, 1981) and lack the penetrative fabric associated with regional metamorphism. Sinha and Zietz (1982) have proposed that intrusives in the postmetamorphic category used in this report are part of a Hercynian magmatic arc along the eastern margin of the Appalachian orogen. This magmatic arc formed over a western-dipping subduction zone.

Diabase dikes were intruded along tensional fractures during the initial stages of rifting along the continental margin of eastern North America (Weigand and Ragland, 1970). This stage of rifting began approximately 280 m.y. ago (Weigand and Ragland, 1970).

METAMORPHISM AND DEFORMATION

As with most other aspects of geology in the Greater Atlanta Region, previous workers limited their interpretations and discussions of deformation to a particular belt, e.g., northern Piedmont or southern Piedmont, but regional relations generally were not addressed. This report serves to combine data and interpretations from various geographic subdivisions in the Greater Atlanta Regional Map into a comprehensive interpretation of metamorphism and deformation. The only two prior attempts to describe metamorphism on a regional scale were by Smith and others (1969) and Hurst (1970); however, little detailed mapping was available at that time.

Metamorphism

At least two episodes of progressive regional metamorphism and one episode of localized retrogressive metamorphism are apparent in rocks of the Greater Atlanta Region. A late, localized zeolitic facies event also is recognized across most of the Piedmont (R.D. Hatcher, personal commun., 1983). Progressive regional metamorphic events occurred in Grenville and mid-Paleozoic time, and localized retrogressive metamorphism occurred along major fault zones in the mid- to late Paleozoic. Butler (1972) suggested that two major episodes of regional metamorphism occurred in the Paleozoic (i.e., Taconic and Acadian in age). Direct evidence for two major progressive metamorphic events is lacking in rocks of both the Greater Atlanta Region and Tallulah Falls Dome (Hatcher, 1974). Although Atkins and Higgins (1980) have proposed that two major metamorphic events affected rocks southeast of the Brevard fault zone in the Paleozoic, this interpretation was based largely on the interpretation of a major unconformity between the Lithonia Gneiss and Snellville Formation (Atkins and Higgins, 1980). However, O'Connor and others (1974) and Atkins and Higgins (1980) also present evidence that supports a fault solution for this contact. If the correct interpretation of this contact is that it is a fault, then evidence supporting a second progressive metamorphic event in the Paleozoic is significantly reduced. Until direct evidence for a second progressive metamorphic event in the Paleozoic is found in the Greater Atlanta Region, it is assumed that only a single event occurred.

Basement gneisses exposed in the Salem Church anticlinorium (i.e., Corbin Gneiss Complex) contain evidence of Grenville-age granulite facies metamorphism. Ferro-hypersthene and Mg-rich garnet-bearing facies of the Corbin Gneiss Complex (Martin, 1974; K. Gillon, written commun., 1980) are indicative of this granulite facies event. Precambrian rocks stratigraphically overlying the Corbin show no evidence of this event. Textures related to this metamorphism, for the most part, have a retrogressive metamorphic overprint produced by the Paleozoic metamorphic event, although some rocks do retain a marked discordance between the planar fabric present in the Corbin and the more dominant planar fabric in the cover rocks. Dallmeyer (1975) presented isotopic evidence supporting a Grenville age for the pre-Paleozoic metamorphic event. $^{40}Ar/^{39}Ar$ ages of 702 and 735 m.y. from biotite concentrates of the coarse-grained phase of the Corbin were interpreted to represent cooling ages following Grenville metamorphism (Dallmeyer, 1975).

Paleozoic metamorphism affected rocks of the Corbin Gneiss Complex as well as most other rocks in the Greater Atlanta Region. Exact timing of this event is uncertain, but Dallmeyer (1978) concluded that peak metamorphism in the southern Piedmont southeast of the Brevard fault zone occurred approximately 365 m.y. ago. Abrams and McConnell (1981b) extrapolated Dallmeyer's (1978) data northwest of the Brevard zone and concluded that regional metamorphism in the northern Piedmont of Georgia occurred approximately 365 m.y. ago. Tull (1978) also recognized only one major Paleozoic event in the northern Piedmont of Alabama and inferred that peak metamorphism occurred there approximately 348 m.y. ago based on evidence derived by Wampler, Neathery and Bentley (1970). Based on Rb-Sr whole-rock ages from the northern Alabama Piedmont, Russell (1978) placed the peak of metamorphism at 360 to 380 m.y. ago. Thomas and others (1979) suggested that the major dynamothermal phase to affect the northern Piedmont of Alabama occurred during the Devonian.

Metamorphic isograds formed during Paleozoic metamorphism probably defined a Barrovian series increasing from the northwest to southeast prior to subsequent deformation. Late folding and faulting have deformed isograds and locally retrograded mineral assemblages. Figure 42 is a representation of isograds drawn on the first appearance of metamorphic index minerals in the Greater Atlanta Regional Map. This diagram must be taken in the context that it is highly interpretive and that all rocks in the Greater Atlanta Region do not have the necessary bulk compositions to accurately reflect metamorphic grade. Smith (*in* Bentley and others, 1966) and Hurst (1970) reported that rocks of the lower Cambrian sequence just west and north of the Cartersville fault have undergone low-grade metamorphism and that there is a metamorphic break across the fault. Just east of the Cartersville fault, rocks of the Pinelog and Wilhite Formations are metamorphosed to chlorite grade. Although data are sparse, the pattern of isograds suggests that they were folded by the formation of the Salem Church anticlinorium (F_2) (McConnell and Costello, 1984).

From the Cartersville fault metamorphic grade increases up to kyanite grade toward the axis of the Murphy synclinorium, but the core of the Murphy synclinorium contains lower grade rocks than the surrounding area. This relationship is similar to that observed in northern Georgia (Dallmeyer and

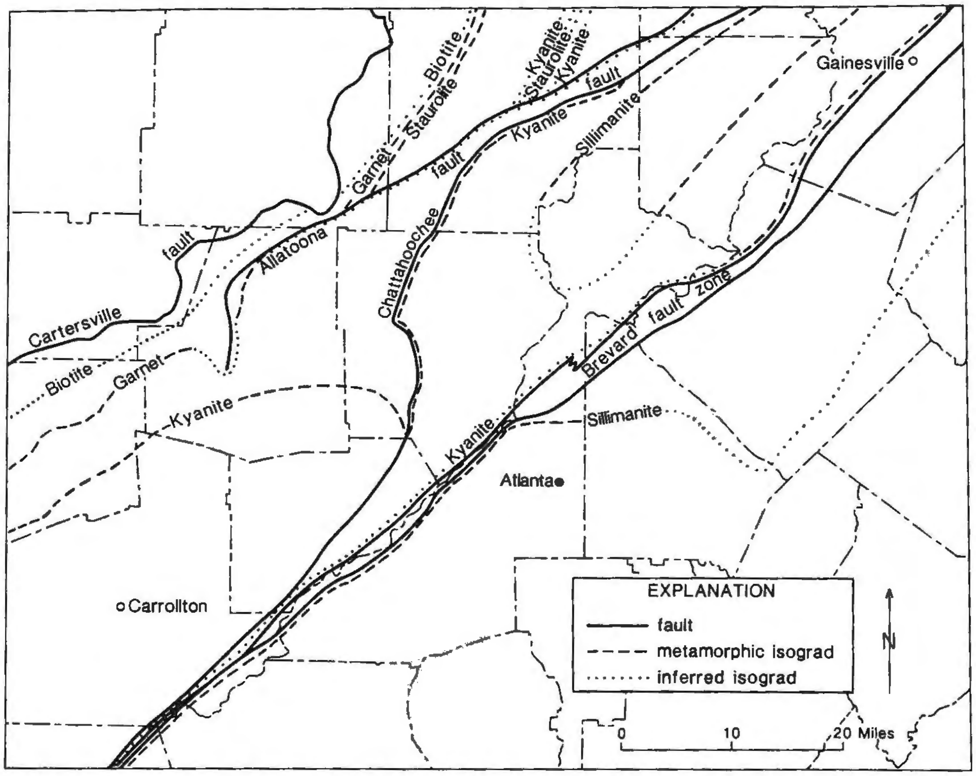

Figure 42. Generalized plot of post Grenville metamorphic isograds in the Greater Atlanta Regional Map area.

others, 1978). The trace of the Allatoona fault and rocks of the New Georgia Group that lie just southeast of the fault in the Dahlonega trend form a distinct metamorphic "low" (Fig. 42) that is traceable northeastward along trend into the area of Helen, Georgia (K. Gillon, 1982). Rocks of the New Georgia Group in the Dahlonega trend in the Greater Atlanta Region are characterized by garnet-grade metamorphism, while rocks on either side of the Dahlonega trend (Fig. 11) are of kyanite or higher grade (Fig. 42). Kyanite does occur locally in the Canton Formation southeast of the Allatoona fault. McConnell (1980a) reported that biotite was altered to chlorite in some of the rocks in the Pumpkinvine Creek Formation just south of the Allatoona fault near Emerson. This suggests that the metamorphic low associated with the Allatoona fault may be, at least partially, caused by retrogression. The trace of the Chattahoochee fault (modified after Hurst, 1973) is present just southeast of the Dahlonega trend in the northeastern part of the Greater Atlanta Regional Map (Fig. 11). The Chattahoochee fault forms the boundary between rocks of the Sandy Springs Group to the southeast and New Georgia Group to the northwest and is a distinctly traceable tectonic boundary across the northern Piedmont of Georgia. The Chattahoochee fault is a migmatitic front with little to no anatectic melting apparent north of the fault and abundant pegmatites and aplites south of the fault. Metamorphic grade also increases across the Chattahoochee fault trace (Fig. 42), from garnet on the northwest to kyanite to the southeast. Unrecrystallized mylonite locally occurs along the trace of the Chattahoochee fault and is interpreted to suggest that the Chattahoochee fault is a syn- to post-metamorphic (post-peak metamorphism) fault that displaces units of the Sandy Springs Group over the New Georgia Group.

Southeast of the Chattahoochee fault, metamorphic grade remains at kyanite with a few reported sillimanite occurrences except for localities where metamorphic mineral assemblages are retrogressed by late movements along the Brevard fault zone. Although the significance of the Brevard zone is debated by many authors, the fact that it is a zone of retrogressive metamorphism is widely accepted (Higgins, 1966; Hurst, 1970; Hatcher, 1975). In the Atlanta area Higgins (1966) reported that metamorphism of the Brevard zone is characterized by the presence of muscovite, quartz, biotite, epidote, chlorite and garnet. Hurst (1973), Crawford and Medlin (1973), and Kline (1981) report kyanite and staurolite occurrences in rocks of the Brevard zone.

Southeast of the Brevard fault zone metamorphic grade increases to sillimanite (Higgins, 1966). Sillimanite grade dominates throughout the southern Piedmont to the southeastern margin of the Greater Atlanta Regional Map.

Deformation

The style, intensity, and number of deformational events vary significantly across the area of the Greater Atlanta Regional Map. While tracing individual fold events across major tectonic boundaries is possible, some fold events, particularly late events, are not present in all areas. In this report, major deformational and folding events are listed and described numerically in sequence of their occurrence. This numbering system, like stratigraphic names, can only be used with certainty in the area of its definition; the relationship with deformational events recognized in other areas must be displayed by use of a correlation chart for tectonic events

(Table 16). Geographic names used to describe fold generations south of the Brevard zone (Atkins and Higgins, 1980) are not employed in this bulletin.

The first deformational event (Table 17) recognized in the Greater Atlanta Region is premetamorphic faulting along the Allatoona fault zone. (Hatcher, 1978a; McConnell and Costello, 1980b; McConnell, 1980a). The Allatoona fault as used in this bulletin is a redefinition of the Allatoona fault as described by Hurst (1973). Hurst (1973) defined the Allatoona fault as separating Talladega belt rocks from "Ashland Group" rocks in Paulding County and Lower Cambrian sediments from "Ashland Group" rocks in Bartow County. McConnell and Costello (1980b) redefined the Allatoona fault as thrusting northern Piedmont rocks (Sandy Springs and New Georgia Groups in this report) over Blue Ridge rocks (Talladega belt-Ocoee Supergroup rocks). In this bulletin, the usage of the Allatoona fault follows that of McConnell and Costello (1980b). In the northeastern part of the Greater Atlanta Regional Map, the Allatoona fault separates two distinct terranes. On the northwest are rocks of the Corbin Gneiss Complex, Ocoee Supergroup and Murphy belt group which lack: a significant volcanic component; any large post-Grenville age plutons; and significantly large mafic and ultramafic bodies. To the southeast of the Allatoona fault in this area, are rocks of the New Georgia and Sandy Springs Groups that are characterized by the presence of large amounts of metavolcanic rocks, Paleozoic plutons, and mafic and ultramafic rocks. The contact between these two rock sequences is sharp and is locally denoted by the absence of units and evidence of retrogressive metamorphic effects. In the western part of the Greater Atlanta Regional Map, along the trend of the Allatoona fault, phyllites and metasandstones of the Talladega belt are in contact with units interpreted to be the upper portion of the Sandy Springs Group, western belt. The distinction between rocks of the Talladega belt and Sandy Springs Group in this area is not clear owing to the absence of large amounts of mafic metavolcanics in the upper portion of the Sandy Springs Group. Also, there is no apparent retrogressive metamorphism associated with the contact. Therefore, the transition from Sandy Springs Group to Talladega belt rocks is not as abrupt as the transition from New Georgia Group to Ocoee Supergroup rocks observed to the northeast. In this regard, we have indicated on Figure 11 that the trace of the Allatoona fault through this area would most likely be along the Sandy Springs-Talladega belt boundary. However, an alternative interpretation would be that the Allatoona fault is not present in this area and rocks of the Talladega belt represent stratigraphic equivalents to rocks of the Sandy Springs Group.

As stated above, the Allatoona fault, at least in the northeastern part of the Greater Atlanta Regional Map, separates two distinct geologic terranes. A similar relationship is observed in northeastern Georgia where the Hayesville fault (Hatcher and others, 1979; Hatcher and Odom, 1980) separates a dominantly volcanic, ultramafic, granite-bearing terrane on the southeast from a nonvolcanic, abundant basement-bearing terrane on the northwest. The Allatoona fault probably represents the southwestern extension of the Hayesville fault.

The most intense deformational event recognized in the Greater Atlanta Region is the second (D_2, Table 17). Rocks of

Table 16. Correlation chart of fold events in the Piedmont and Blue Ridge.

Northeast Georgia (after Hatcher and Butler, 1979)	ARM area (this report, includes Blue Ridge and northern and southern Piedmont)	Southern Piedmont (after Atkins and Higgins, 1980)
F_1 isoclinal recumbent EW-NE trend (S_1 rarely observed)	not recognized	not recognized
F_2 isoclinal recumbent EW-NE trend, dominant S-surface	F_1 isoclinal recumbent ENE trend, dominant S-surface.	Buck Branch generation
F_3 upright isoclinal to open, NE trend	F_2 upright isoclinal to open, NE trend	
		Klondike generation
F_4 crenulation cleavage, NE trend	F_{2a} upright, open, NE trend	
not recognized	F_3 open to isoclinal, SW vergent, SE trend	Elijah Mountain generation
F_5 upright, open NE trend	not recognized	not recognized
		Scott Creek generation
F_6 upright, open, NW trend	F_4 upright, open NW trend	
		Tara generation

Table 17. Post-Grenville tectonic elements of the Greater Atlanta Region.

Generation	Fold Style	Lineations Generation	Lineations Type	Timing	Event
D_1	not observed	—	—	Pre-metamorphic	Hayesville & Greenbrier faults.
D_2 (F_1)	Isoclinal recumbent; NE trending, NW vergence	L_{1a}	Elongation	Late Paleozoic (350-480 m.y.)	Regional metamorphism. Intrusion of Austell and Sand Hill Gneisses.
		L_{1b}	Intersection	Late Paleozoic (370 m.y.)	Ductile shearing in basement gneisses and along Allatoona, Cartersville and Brevard faults. Retrograde metamorphism.
(F_2)	Tight, upright to overturned; NE trending, NW vergence	L_2	Intersection	Late Paleozoic (post-metamorphic)	Salem Church anticlinorium, Austell-Frolona antiform, Newnan-Tucker synform.
(F_{2a})	Tight, upright to overturned; NNE trending, NW vergence	L_{2a}	Intersection	Late Paleozoic (post-metamorphic)	Sand Hill antiform.
D_4	not observed	—	—	Late Carboniferous	Brittle faulting; emplacement of Blue Ridge thrust sheet.
D_5 (F_3)	Open, Upright to overturned; SE trending, SW vergence	L_3	Intersection	Hercynian (?)	Folds plane of Great Smoky fault.
D_6 (F_4)	Open, upright; NW trending			(?)	

the Blue Ridge and Piedmont portions of the Greater Atlanta Regional Map are affected by D_2 which is characterized by isoclinal, recumbent, northeast-trending and northwest-vergent folds (F_1). Regional progressive metamorphism was coeval with F_1 and is indicated by development of an axial-planar foliation (S_1). Axial-planar foliation formed during D_2 is the predominant S-surface present in the Blue Ridge and Piedmont portion of the Greater Atlanta Regional Map and completely transposes earlier surfaces. Ductile shear zones in the Fort Mountain Gneiss, Corbin Gneiss Complex, and those associated with the Brevard fault zone are believed to have developed during this event, but after the peak of metamorphism as indicated by retrograde mineral assemblages. Russell (1976) indicates a 368 m.y. Rb-Sr whole-rock age for mylonites in the Grenville-aged Fort Mountain Gneiss which lies to the north of the Corbin Gneiss outside the boundaries of the Greater Atlanta Regional Map. Major ductile shearing along the Brevard zone was dated as last occurring approximately 356 m.y. ago by Odom and Fullagar (1973) and 387 m.y. ago by Bond and Fullagar (1974). From zircons analyzed from the Henderson Gneiss in North Carolina, Sinha and Glover (1978) derived ages of 440 m.y. and 360-390 m.y. for mylonitization and reactivation of the Brevard zone. As described in a previous section, the peak of metamorphism in the Piedmont near Atlanta is believed to have occurred approximately 365 m.y. ago (Dallmeyer, 1978). The near coincidence of the timing of ductile shearing and peak metamorphism in this area and structural evidence given below suggest that the Brevard zone in the Atlanta area and shear zones in the Fort Mountain Gneiss and Corbin Gneiss Complex developed, at least in part, simultaneously with and possibly as a result of intense shearing and transposition along the axial zone of F_1 isoclines. Intrafolial folds in the Brevard zone have axes parallel to F_1 fold trends and F_1 axial-planes are aligned parallel to the mylonitic foliation. The above evidence supports a genetic relationship between the ductile shearing in the Brevard zone and the F_1 fold event. Roper and Dunn (1973) previously proposed a similar, albeit more complex, mechanism for the formation of mylonites in the Brevard zone in South Carolina.

A later, perhaps local episode of ductile shearing along the Brevard fault zone is suggested by textures present in the Palmetto and Ben Hill Granites. Both plutons are approximately 325 m.y. old (Higgins and Atkins, 1981) and contain a mylonitic fabric near the Brevard zone. This suggests that at least two stages of ductile shearing occurred after the peak of metamorphism (356 m.y. and 325 m.y.). Hatcher and Butler (1979) previously referred to this history of multiple movements along the Brevard zone to the northeast in North and South Carolina.

In the Piedmont and Blue Ridge, F_1 folds are large-scale recumbent isoclines. In the Blue Ridge, the axial zone of one recumbent anticline is occupied by the Corbin Gneiss Complex, while in the northern Piedmont the axial zone of another recumbent anticline is occupied by rocks of the New Georgia Group. The lower limb of the northern Piedmont recumbent anticline is interpreted to be exposed along the north side of the Austell-Frolona antiform (F_2) (Figs. 26 and 27). The same limb is interpreted in this report to be exposed along the northwestern limb of the Carroll-Paulding synform (Fig. 3; modified after Crawford and Medlin, 1973) where rocks of the Sandy Springs Group are again exposed. Sandy Springs Group rocks east of the Chattahoochee fault are highly migmatized, while rocks of the Sandy Springs Group west of the Chattahoochee fault lack evidence of anatectic melting. In addition, in the southwestern part of the Sandy Springs outcrop area on the southeastern limb of the Austell-Frolona antiform (Plate I), Sandy Springs Group rocks (western belt) are in contact with Sandy Springs Group rocks (eastern belt) along the Blairs Bridge fault. The two relationships mentioned above are interpreted in this report to suggest that the eastern belt of Sandy Springs Group rocks represents the limb of a tectonically lower nappe that was thrust over rocks of the New Georgia Group along the Chattahoochee fault. Southeast of the Brevard fault zone, rocks of the Atlanta Group are interpreted to be exposed in the core of another recumbent anticline (F_1). The Brevard zone, present between two recumbent anticlines, may represent a tightly compressed and sheared syncline (i.e., tectonic slide).

An important aspect of D_2 deformation is its apparent absence in rocks of the Valley and Ridge west of the Cartersville fault. Isoclinal recumbent folds are present in rocks of the Blue Ridge just east of the Cartersville fault (Costello and McConnell, 1981), but nowhere are described in rocks of the Valley and Ridge; therefore, rocks west of the Cartersville fault seem to lack the pervasive deformation characteristic of rocks in the Blue Ridge. Deformation in Lower Cambrian rocks of the Chilhowee Group, Shady Dolomite, and Rome Formation is characterized by dominance of thrust faults over folds (Hull, 1920) and lack of pervasive deformation that is characteristic of rocks east of the Cartersville fault. Folds recognized in the Valley and Ridge closely resemble in style and orientation F_2 folds that are present in the Blue Ridge. Differences noted in the number of fold events on either side of the Cartersville fault are interpreted to suggest that the early F_1 fold event is not present in the Valley and Ridge and therefore, the presence of the Cartersville fault, in part, is justified by the absence of F_1 in the Valley and Ridge.

Deformation related to D_3 is characterized by large, open to isoclinal, upright to overturned, northeast-trending folds (F_2). Outcrop patterns in all geographic subdivisions of the Greater Atlanta Regional Map are controlled by folds of this generation. Northeast-trending folds in the Valley and Ridge as well as the Salem Church anticlinorium in the Blue Ridge, and the Austell-Frolona antiform, Carroll-Paulding synform (modified after Crawford and Medlin, 1973), Villa Rica antiform, and Newnan-Tucker synform (Fig. 3) in the Piedmont were formed during this event. Generally, folds of this generation (F_2) are tight to isoclinal near the Brevard fault zone but open away from the Brevard. Axial-planar foliation is well developed only in the hinges of F_2 folds, and transposition of the S_1 surface is locally apparent. The Austell-Frolona antiform is the best known structure related to F_2 folding. Based on stratigraphic relationships, the Austell-Frolona antiform was interpreted to represent an antiformal syncline (Fig. 26) by Abrams and McConnell (1981a). Older rocks of the New Georgia Group now structurally overlie younger rocks of the Sandy Springs Group along the northwestern limb of the Austell-Frolona antiform (Fig. 27).

Subsequent to the formation of the Austell-Frolona antiform, a series of open to tight, upright to overturned to the northwest, northeast-trending folds was generated (e.g., Sand Hill antiform, Fig. 3). Crawford and Medlin (1973) interpreted these folds to be digitations of the same generation of folds that formed the Austell-Frolona antiform and indicated that they are cylindrical. The Austell-Frolona antiform also is cylindrical (Abrams and McConnell, 1981a) and is oriented east-northeast in contrast to the north-northeast trend of the later folds. Because both fold generations are cylindrical and have differing trends, they can not be of the same generation. We interpret those folds that lie along the northwestern limb of the Austell-Frolona to be representative of changes in the stress field during the latter stage of D_3 deformation.

D_4 deformation is characterized by brittle faulting present most notably along the Cartersville and Blue Ridge thrusts as well as the Brevard fault zone. Late movements along these fault zones, characterized by brittle deformation and a correspondingly shallow overburden, probably represent the last stages of northwest directed stress. Crawford (1977c) indicated that rocks as young as Mississippian in age were overthrust by rocks in the Cartersville thrust sheet. Timing of this stage of deformation must, therefore, be post-Early Mississippian.

Costello and others (1982) and Costello and McConnell (1983) suggested that the fault that separates late Precambrian Ocoee Supergroup rocks on the east from the Lower Cambrian sequence on the west may not represent the Great Smoky fault as it is defined in Tennessee (Neuman and Nelson, 1965). Numerous authors (Georgia Geologic Survey, 1976; Cressler and others, 1979; McConnell and Costello, 1980b; Reade and others, 1980) following the lead of Stose and Stose (1944) have extended the Great Smoky fault southward and connected it with the Cartersville fault in Georgia. In the Greater Atlanta Regional Map area, the Cartersville fault thrusts late Precambrian Ocoee Supergroup rocks over Lower Cambrian rocks. In Tennessee, the Miller Cove-Sylco Creek faults form a thrust relationship similar to the Cartersville fault (i.e., thrusting late Precambrian Ocoee Supergroup rocks over the Lower Cambrian and late Precambrian sequence); therefore, Costello and McConnell (1983) have proposed that the Cartersville fault is an extension of the Miller Cove-Sylco Creek faults and that the Great Smoky thrust sheet must lie farther to the west.

At least two other major faults formed during D_4 traverse the area underlain by rocks of the Valley and Ridge in the Greater Atlanta Region. These are the Rome and Coosa faults. Hayes (1902) defined both the Rome and Coosa faults in his Rome folio. The Rome fault is the westernmost fault in the Greater Atlanta Regional Map and thrusts Conasauga Group over Mississippian Floyd Shale. Hayes (1902) noted that the Rome fault was folded during deformation subsequent to the emplacement of the thrust sheet. In the hanging wall of the Rome fault, rocks of the Conasauga Group are overthrust by rocks of the Coosa thrust sheet (Hayes, 1902). Hayes (1902) indicated that the Coosa thrust sheet was emplaced later than the Rome thrust sheet.

Subsequent to the emplacement of the Blue Ridge and Cartersville thrust sheets, southeast-trending, moderately tight, upright to overturned folds formed. These folds are recognized only in the northern part of the northern Piedmont, Blue Ridge and Valley and Ridge. Fairley (1965) recognized these folds in the Tate quadrangle while McConnell and Costello (1982a) described these folds and their effect on the trend of units in the Blue Ridge south and east of Emerson as well as their deformation of the plane of the Cartersville fault in that area. Folds of this generation may also be present southeast of the Brevard fault zone where O'Connor (1977) and Atkins and Higgins (1980) show southeast-trending folds that Atkins and Higgins (1980) termed Elijah Mountain folds (Table 16).

The last major compressive tectonic event recorded in rocks of the Greater Atlanta Region is characterized by gentle open warps that in the northern Piedmont have a northwest trend. Atkins and Higgins (1980) indicated that two late-stage warping events occurred in the southern Piedmont. In this report, these two late warp fold generations are grouped together into the F_4 fold generations (Table 16).

ECONOMIC RESOURCES

Introduction

Many parts of the Greater Atlanta Region have been prospected and mined extensively in the past for commodities ranging from gold to sand. As the Greater Atlanta Regional Map encompasses portions of three major geologic provinces (i.e., Valley and Ridge, Blue Ridge, and Piedmont, Fig. 1), there is a wide variety of both commodities and host rocks within its boundaries. Host rocks range from the limestones and shales of the Valley and Ridge to granites and granite gneisses of the Piedmont.

Twenty-eight commodities were mined or prospected in the Greater Atlanta Region. Of these, only barite, ocher, sand, granite and granite gneisses (dimension stone and crushed), limestone, structural clays, and marble are still actively mined (Martin and Stafford, 1972; Kline and O'Connor, 1981). Appendix B presents a comprehensive list of mines and prospects (active and inactive, by commodity) within the Greater Atlanta Regional Map. This list was compiled from various sources listed at the end of Appendix B. A map delineating approximate locations for these mines and prospects also accompanies this report (Plate II).

Because host rocks vary from geologic province to province, commodities of each province are discussed separately. The Piedmont province is divided into two sections, northern and southern, at the Brevard fault zone. As the authors of this report mapped predominantly in the northern Piedmont, base metal and gold deposits of that area are discussed in greater detail than those in other areas of the Greater Atlanta Regional Map.

Valley and Ridge

The most extensively mined and prospected area within the Greater Atlanta Region is the Valley and Ridge Province, with most of the activity centered on the Cartersville district. In the past, bauxite, barite, limonite, manganese, tripoli, ocher and umber, limestone, shale and clay, slate, and sand and gravel were mined or quarried for commercial use. Some of these commodities had limited workings; others were worked extensively for limited periods, while commodities such as barite, ocher, limestone, shale, clay, and sand and gravel are still worked today (Kline and O'Connor, 1981).

Limonite, ocher and umber, manganese, bauxite, and barite are, for the most part, secondary deposits (O'Neil and Wyndham, 1954). Mining of these deposits has been mostly by open-pit method. Secondary deposits of limonite, ocher, manganese, and barite occur in association with each other, commonly in the same cut (Hull and others, 1919). This type of deposit is largely confined to the Cartersville mining district and is associated with the Shady Dolomite, Knox Group, Rome Formation, Conasauga Formation, and Chilhowee Group (McCallie, 1900; Watson, 1906; Hull and others, 1919; Butts and Gildersleeve, 1948).

BARITE

Barite deposits are largely confined to the Cartersville mining district (Plate IIa), although some occurrences are reported from western Bartow, eastern Floyd, and western Cherokee Counties. Barite has been mined in the Cartersville district since 1887 (Kesler, 1950). Primary barite occurs in veins within the Rome Formation and in veins and as fossil replacements in Shady Dolomite (Kesler, 1950). Barite is mined for use as a medium in drilling muds, in the production of barium chemicals and glass, or as a filler, pigment, or extender (Brobst, 1973). Ore varies from crystalline to granular barite (Hull, 1920) and is accompanied by or encloses sulfides (generally pyrite) (Kesler, 1950).

Barite deposits occur as several types: vein, replacement, breccia, residual, colluvial and alluvial. Of these, the residual, colluvial and alluvial deposits are the largest and best commercial deposits (Hull, 1920). Barite is found associated with the Rome Formation, Conasauga shale and limestone, Knox Group, Weisner Formation (Chilhowee Group), Shady Dolomite and at the Shady-Weisner contact (Hull, 1920; Butts and Gildersleeve, 1948; Kesler, 1950). Hull (1920), Butts and Gildersleeve (1948) and Chowns (1977) viewed the Shady Dolomite as the host for most of the important barite occurrences, whereas Kesler (1950) indicates that the main deposits of barite are found associated with the calcareous metashale of the Rome Formation. Reade and others (1980) indicate that dolostones of the Rome Formation are the main source of the barite. Stan Bearden (written commun., 1982) indicates that the host rock for barite is a light-grey dolostone which overlies ocherous clays. The reader is referred to the Valley and Ridge stratigraphy section of this report for a discussion of the Rome-Shady stratigraphic problem.

OCHER AND UMBER

Ocher and umber deposits are confined to a narrow, north-south trending belt adjacent to the west side of the Cartersville fault in Bartow County (Butts and Gildersleeve, 1948). The ochers of this area were used predominantly in the manufacture of linoleum and oil cloth, in addition to some use as a coloring agent (Butts and Gildersleeve, 1948). Currently, the deposits are mined for use as a pigment in paint, in concrete capping and in chemicals (Martin and Stafford, 1972). Mining of the ore began in 1877 (Butts and Gildersleeve, 1948) and has continued on a small scale to the present. The ore consists of very fine-grained limonite and clay with some hematite (Butts and Gildersleeve, 1948; Kesler, 1950). The ocher varies in color depending on amounts of intermixed clays, hematite, and limonite (Watson, 1906). The presence of as much as 5 percent disseminated manganese in some deposits also affects color and classifies the ore as umber, rather than ocher (Kesler, 1950).

Watson (1906) stated that the ocher was limited to the Weisner Formation (Chilhowee Group) where ocher occupies fracture zones and is associated with clays derived from the weathered Weisner. Hull (1920) stated that the commercial ocher deposits belong to the clays of the Shady Dolomite and Weisner Formation. In a conclusion similar to that of Hull (1920), Kesler (1950) stated that ocher deposits occur in weathered Shady Dolomite, conformable to the underlying Weisner. O'Neil and Wyndham (1954) suggested that the deposits were formed by hydration of hematite in the Shady. Bearden (1981) suggested that the ocher occurs as a primary stratiform deposit overlying the Chilhowee Group.

MANGANESE

The largest and most commercially important manganese deposits in Georgia are located within the Cartersville mining district in Bartow County. Other less productive manganese mining districts of Georgia lie outside the boundaries of the Greater Atlanta Regional Map in Whitfield, Catoosa, northwest Polk and southwest Floyd Counties (Butts and Gildersleeve, 1948). Manganese was first mined in Georgia in 1866 (Butts and Gildersleeve, 1948). The ore's most important use is as an alloy in the manufacture of steel (Butts and Gildersleeve, 1948).

Manganese deposits in the Valley and Ridge portion of the Greater Atlanta Regional Map are secondary in origin (Hull and others, 1919; Kesler, 1950) and occur as residual, replacement, vein or detrital deposits (Hull and others, 1919). Kesler (1950) and O'Neill and Wyndham (1954) reported that no primary source for the manganese could be found. Manganese deposits take the form of nodules, pellets, powder, breccia, irregular masses or crystals (Hull and others, 1919). Kesler (1950) reported pyrolusite to be the dominant mineral with associated psilomelane and cryptomelane. Hull (1920) also reported the presence of manganite, whereas Butts and Gildersleeve (1948) report both manganite and braunite. Manganese is associated with limonite, ocher, and barite (Hull and others, 1919; Hull, 1920; Butts and Gildersleeve, 1948; Kesler, 1950). The closest association is with the brown iron ore, limonite, where contacts between manganese ores and limonite ores are gradational (Hull and others, 1919; Butts and Gildersleeve, 1948; Kesler, 1950). Pierce (1944) recognized the presence of cobalt associated with manganese deposits near Cartersville and Cedartown and, in his descriptions of the Gemes and Ward Mines, Pierce reported .5 to 1.3 percent cobalt from manganese ore.

Hull and others (1919) and Butts and Gildersleeve (1948) stated that ores of manganese were formed from residual clays derived from the decayed Shady Dolomite and Weisner Formation. O'Neil and Wyndham (1954) inferred a similar origin and found the ore to be located in residual clays overlying the Weisner. Kesler (1950) placed the manganese ore zone in the residuum of the calcareous component of the Rome Formation, whereas Hull and others (1919) stated that the economic occurrences of manganese are only minor in the Rome Formation and Conasauga Group.

IRON ORE

Iron ores of the Valley and Ridge consist of two types, brown iron ores (limonite and goethite) and red iron ores (hematite) (Butts and Gildersleeve, 1948). Hayes (1901) stated that brown iron ores were the most important of the two types of deposits. Deposits of brown iron ore were first mined prior to the Civil War, but production declined in the late 1800's. Mining operations increased during World War II (Butts and Gildersleeve, 1948); however, there is no commercial production at the present.

The principal brown iron ore localities are within Bartow, Polk, and Floyd Counties, with the best commercial deposits in the Cartersville district in eastern Bartow County (McCallie, 1900; Lewiecki, 1949). Other less important iron ore areas are the Iron Hill and Linwood districts, also in Bartow County; the Fish Creek (Grady) and Aragon districts of Polk County; and the Silver Creek district (near Reesburg) of Floyd County (Butts and Gildersleeve, 1948).

Both red and brown iron ores are secondary and occur as nodules, pebbles, "pots" (hollow concretions), boulders, or large (sometimes connected) masses in residual clays (McCallie, 1900; Butts and Gildersleeve, 1948; Kesler, 1950). Ore generally occurs in association with manganese (McCallie, 1900; Hull, 1920). In deposits of Floyd County, McCallie (1900) also observed an association between iron ores and bauxite. Hayes and Eckel (1902), Kesler (1950), and O'Neil and Wyndham (1954) considered the source of the iron ores to be the weathering or oxidation of pyrite and iron carbonate (siderite); however, McCallie (1900) interpreted the origin of the brown iron ore to be due only to the oxidation of iron carbonate. Ores are commonly referred to as limonite, but Cook (1978a) considers goethite to be the main mineral constituent of the ore.

McCallie (1900) concluded that iron ores of the Greater Atlanta Region are associated with the Weisner Formation in Bartow County and that ore consisted chiefly of limonite, hematite, and siderite. Knox Group rocks were considered by McCallie (1900) to be the host for these ores in Polk and Floyd Counties. Kesler (1950) stated that the best commercial deposits of iron ore in the Cartersville district occurred in residuum of calcareous rocks of the Rome and Weisner Formations with smaller occurrences in the Shady Dolomite (associated with ocher and umber) and in fractured or brecciated Weisner. O'Neil and Wyndham (1954) saw a relationship similar to that of Kesler and suggested that iron ore formed from the weathering of pyrite and possibly siderite in the Weisner, Rome, and Shady. Butts and Gildersleeve (1948) stated that the iron ores are associated with residual clays of the Shady Dolomite, Newala Limestone, Weisner Formation, and Knox Dolomite. Hurst and Crawford (1970) noted the apparent coincidence of old iron-ore mines in the Shady, Knox, and Newala with geochemical anomalies for copper and zinc. They, like O'Neil and Wyndham (1954), indicated that the iron ore may represent a deeply weathered gossan, perhaps overlying a metalliferous sulfide deposit.

TRIPOLI

Tripoli was mined to a limited extent in Georgia until approximately 1936 by both open-cut and underground methods (Butts and Gildersleeve, 1948). Its main use was as an abrasive, but tripoli was also used as a filler for paint, cement and rubber (Crickmay, 1937; Butts and Gildersleeve, 1948). Within the area of the Greater Atlanta Regional Map, tripoli deposits are located in Bartow, Floyd, and Polk Counties. The best occurrences are near Silver Creek in Floyd County (Crickmay, 1937; Butts and Gildersleeve, 1948). Tripoli of Georgia is composed of fine-grained, nearly pure, chalcedonic quartz (Crickmay, 1937; Butts and Gildersleeve, 1948). Butts and Gildersleeve (1948) suggested that Georgia tripoli is a residual deposit that results from weathering of siliceous limestone. Most deposits are associated with the Knox Dolomite, but smaller deposits are also associated with the Shady Dolomite in the Greater Atlanta Region and with the Bangor Limestone and Murphy Marble outside the boundaries of the Greater Atlanta Regional Map (Crickmay, 1937; Butts and Gildersleeve, 1948).

BAUXITE

Georgia bauxite is composed of hydrated alumina, principally as gibbsite (Cook, 1978a). Deposits are secondary and form in place by the weathering of aluminous minerals (Butts and Gildersleeve, 1948). Associated with gibbsite are halloysite and kaolinite with minor amounts of iron and manganese (Watson, 1904; Butts and Gildersleeve, 1948). The ore occurs as pebble ore, pisolitic ore (spherical concretions), oolitic ore, vesicular ore, or amorphous ore within clay (Watson, 1904; Butts and Gildersleeve, 1948). Color varies from white to red, depending on the amount of iron present (Watson, 1904; Butts and Gildersleeve, 1948).

The largest deposits of bauxite occur in Bartow and Floyd Counties, with minor occurrences in Polk, Walker, Chattooga, and Gordon Counties (Watson, 1904; Butts and Gildersleeve, 1948). Two of the three principal bauxite districts lie within the boundaries of the Greater Atlanta Regional Map. These are the Hermitage district in Floyd and Bartow Counties and Bobo district in Floyd and Polk Counties (Watson, 1904; Butts and Gildersleeve, 1948).

Watson (1904), Lewiecki (1949), Butts and Gildersleeve (1948) and White and others (1966) agree that the ore is predominantly associated with the residual clays of the Knox Group. The deposits are not limited to a specific horizon, but occur throughout the Knox as "well-defined pockets" (Butts and Gildersleeve, 1948). Deposits of bauxite in the Bobo district follow the trend of north-south faults between the Conasauga Group and Knox Group (Watson, 1904; Butts and Gildersleeve, 1948). White and others (1966) found a similar relationship between bauxite deposits and faults of the Hermitage district.

SHALE AND CLAY

Commercial clays in the area of the Valley and Ridge include those in shales in addition to those in residual, colluvial and alluvial clay deposits (Smith, 1931; Butts and Gildersleeve, 1948). Deposits of clay are presently mined in several areas of the Valley and Ridge, including portions of Bartow, Floyd, and Polk Counties (Martin and Stafford, 1972; Kline and O'Connor, 1981; O'Connor, in preparation). These deposits produce structural clays for the manufacture of sewer pipe, building and fire brick, decorative and roofing tile and earthenware (Smith, 1931; Butts and Gildersleeve, 1948; O'Connor, in preparation).

Veatch (1909) considered clays from the Floyd Shale, Rockmart Slate and Conasauga Group to be good for clay products. He also considered the clays of the Fort Payne Chert and Knox Group to be of sufficient quality for use as fire clays, but thought clays of the Rome Formation to be "stoney" and of no commercial value. At the time of Veatch's publication the area around Rome held the most actively mined deposits. Many other areas, including those in the Floyd Shale and Rome Formation, remained undeveloped. Veatch (1909) also reported production of brick at Cartersville, at Adairsville in the Conasauga Group, and at Rockmart where both portland cement and brick were manufactured from the Rockmart Slate. Butts and Gildersleeve (1948) stated that the most suitable shales for structural clay products are within the Rome Formation, Conasauga Group, Floyd Shale, Rockmart Slate and Red Mountain Formation. At present, clay production is from the Conasauga Group, at Adairsville (Bartow County) and south of Rome (Floyd County); and the Floyd Shale, west of Rome (Floyd County) (Martin and Stafford, 1972; Kline and O'Connor, 1981; O'Connor, in preparation).

Shales and clays of the Conasauga Group and Floyd Shale show considerable economic potential for brick and tile manufacture. These clays are characterized by an illitic clay mineralogy and show a good range of firing temperatures and colors (O'Connor, in preparation). Both the Conasauga and Floyd shales and clays occur extensively over large areas of northwest Georgia and are easily mined by conventional surface mining methods. The Floyd Shale is particularly desirable because it tends to have sufficient plasticity for easy molding of a variety of differently shaped ceramic bodies (O'Connor, in preparation). Further information on the ceramic firing characteristics of these and other clay and shale units in the Valley and Ridge is available in O'Connor (1983, in preparation).

SLATE

Slate is used as dimension stone, as roofing slate or granules, and as expanded lightweight aggregate. Deposits in the Greater Atlanta Region occur in Polk and Bartow Counties in the Rockmart and Fairmont belts of Butts and Gildersleeve (1948).

The Rockmart belt, underlain by the Rockmart Slate, lies parallel to the Cartersville fault and includes parts of Bartow and Polk Counties (Shearer, 1918; Butts and Gildersleeve 1948). Slates of this area are fine grained and dark colored (Butts and Gildersleeve, 1948). Quarrying of the Rockmart Slate began in approximately 1850 (Butts and Gildersleeve 1948) and continues to the present. Most production today is for use as lightweight aggregate (Martin and Stafford, 1972)

The Fairmont belt extends northward from White in Bartow County to Murray County outside the northern boundary of the Greater Atlanta Regional Map (Butts and Gildersleeve, 1948). Commercial slates of this belt occur in the Conasauga Formation (Butts and Gildersleeve, 1948). Slate of the Conasauga are green due to an abundance of chlorit

(Shearer, 1918; Butts and Gildersleeve, 1948). These slates were mined for roofing aggregate and tile (Martin and Stafford, 1972), but there is no production at present.

Shearer (1918) also recognized areas of the Rome Formation as a possible commercial roofing material. Slate in these areas is light in color, but beds are thin (Shearer, 1918).

LIMESTONE

Limestone of northwest Georgia, including dolomite, is used as aggregate for roads, in concrete, and for agricultural purposes. In the past, limestone was also used for dimension stone, for paving and in other construction (Maynard, 1910; Butts and Gildersleeve, 1948; Martin and Stafford, 1972).

Limestone-bearing formations of the Greater Atlanta Region include the Shady Dolomite, Conasauga Group, Knox Group, Newala Limestone, Murfreesboro Limestone, Moccasin Limestone and Bangor Limestone (Butts and Gildersleeve, 1948). McLemore and Hurst (1970) noted the potential resources of limestones in the Knox Group, Conasauga Group, Newala Limestone and Shady Dolomite. Color, thickness of beds, and texture vary among the different formations. Maynard (1912) stated that the Knox Dolomite was suitable for road materials, concrete, and as a flux. He also stated that limestone of the Conasauga Formation was suitable as a flux and for lime.

Current production of limestone in the Greater Atlanta Region occurs in Bartow and Floyd Counties. In Bartow County, northwest and west of Cartersville, limestone from the Conasauga Formation until recently was used in the manufacture of cement (Bruce O'Connor, written commun., 1983). At the Rome quarry (Floyd County), limestone from the Floyd Shale is used as aggregate for construction purposes (Martin and Stafford, 1972; Kline and O'Connor, 1981).

MOLYBDENUM

Although the Shiloh Church molybdenum deposit is located immediately outside the boundaries of the Greater Atlanta Regional Map, the deposit occurs in lithologic units that extend into the Greater Atlanta Regional Map. For this reason molybdenum is included in the list of economic resources of the Greater Atlanta Regional Map.

Molybdenum ore occurs in the Newala limestone and Knox Group (Foss and others, 1983) near Cedartown. Host rock is a pyritic breccia which also contains anomalous amounts of Zn, Pb, As, and Ni (Foss and others, 1983). Foss and others (1983) interpret the deposit as Mississippi Valley type and suggest that the potential for other deposits in the Newala/Knox may be good.

SAND AND GRAVEL

Uses of sand and gravel are numerous. They include uses in concrete, as road gravel, as an abrasive, in glass manufacture, and as roofing or paving materials (Teas, 1921; Yeend, 1973).

In the Greater Atlanta Region most commercial sand and gravel deposits are found along streams (Teas, 1921; Butts and Gildersleeve, 1948). These deposits were worked in the past by excavation of flood plains and by dredging and pumping of stream beds (Butts and Gildersleeve, 1948). Deposits were once worked in Bartow and Floyd Counties along the Etowah and Oostanaula Rivers (Teas, 1921; Butts and Gildersleeve, 1948).

Blue Ridge

Mined or prospected commodities of the Blue Ridge geologic province include feldspar, mica, talc, gold, barite, limonite, marble, kyanite, staurolite and sand. Of these, only sand (Kline and O'Connor, 1981) and marble (Robert Power, personal commun., 1982) are actively mined or quarried within the boundaries of the Greater Atlanta Regional Map.

BARITE

Barite deposits of the Blue Ridge occur in the Corbin Gneiss Complex, Pinelog Formation, and Wilhite Formation (Hull, 1920). Hull (1920) suggested that the Corbin Gneiss was the source for the barite deposits of the Valley and Ridge because the body contains anomalous amounts of barium oxide. Barite occurs as a replacement of calcareous material in rocks overlying the Corbin (Pinelog and Wilhite Formations) (Hull, 1920) and was mined from the Corbin Gneiss at or near the Corbin/Wilhite contact. Barite ore also is associated with brown iron ores as in the Valley and Ridge (Hull, 1920).

PEGMATITES

Pegmatites are composed of interlocking grains of quartz, potassium feldspar and plagioclase with accessory mica (predominantly muscovite). Associated minerals are tourmaline, garnet, apatite and beryl (Furcron and Teague, 1943). Minerals of economic importance found in pegmatites are feldspar, for use in enamels, glazes and china; muscovite; and beryl. Of these, only muscovite and beryl were mined within the Greater Atlanta Regional Map. Mining was by open-cut method (Galpin, 1915). No active mining of pegmatites is being conducted in the Blue Ridge area of the Greater Atlanta Regional Map at present.

Muscovite makes up as much as 30 percent of the pegmatite in some instances (Galpin, 1915). Both sheet and ground mica are economically important: sheet mica is used as an insulating, dielectric or glazing material; ground mica is used in paints, wallpaper, rubber goods, drilling mud, and in roofing materials (Lesure, 1973). Sheet mica was mined from several localities within the Blue Ridge (Plate II; Galpin, 1915; Furcron and Teague, 1943). The best known of these localities is probably the Amphlett Mine in Cherokee County where muscovite sheets were reported to exceed 10 in. (Cook, 1978a).

Beryl is also reported from the Amphlett mine (Cook, 1978a) and several other localities within the Blue Ridge (Furcron, 1959). The mineral is a useful source of beryllium which is used in alloys, specifically, beryllium-copper alloys (Furcron, 1959). Production has ceased at present, but during and immediately after World War II beryl was mined extensively (Furcron, 1959; Cook, 1978a).

GRAPHITE

Graphite of the Wilhite Formation was mined and prospected in the Blue Ridge portion of the Greater Atlanta Regional Map. The graphite is amorphous in form and is associated with pyrite in a "copper stained" rock that also contains trace amounts of gold (Hayes and Phalen, 1907, p. 464). Mining of graphite by open-pit methods occurred at two locations south of Emerson (Hayes and Phalen, 1907; Cook, 1978a). Samples of ore containing as much as 12 to 15 percent graphite were produced (Hayes and Phalen, 1907). Some uses of graphite are as a polish or lubricant and as a source of carbon in steelmaking (Weis, 1973).

LIMONITE

Limonite of the Blue Ridge occurs as massive vesicular ore or as concretionary nodules. Most ores are associated with the Murphy Marble and the Mineral Bluff, Brasstown, and Nantahala Formations with larger ore bodies located at the contacts between schists and less permeable rocks (Haseltine, 1924). Most occurrences are within a belt known as the Chattahoochee Iron Lead (Haseltine, 1924) which begins north of the Etowah River near Canton, Georgia, and extends westward. Deposits were prospected mainly for local use (Haseltine, 1924). Limonite of the area probably results from weathering of pyrite or associated magnetite within the host rock (Haseltine, 1924).

MANGANESE

Manganese within the Blue Ridge occurs in sporadic deposits adjacent to the Cartersville fault. These deposits are no longer actively mined or prospected. See Valley and Ridge section for a discussion of other manganese deposits of the Greater Atlanta Region.

MARBLE

Actively quarried marble deposits of Georgia lie predominantly north of the Greater Atlanta Regional Map in the Murphy belt in Pickens County, Georgia. There the rock is quarried for both dimension stone and crushed marble as well as fillers and extenders.

Georgia marble of the Murphy Marble belt is well known as an excellent building, interior and monument stone. A variety of colors of marble exists due to the presence of minor accessory minerals (McCallie, 1907). Bayley (1928), in a report on the Tate Quadrangle, discussed the various commercial varieties of dimension stone marble in Georgia.

Crushed marble is used as a filler, roofing aggregate, in paper coating, and in the manufacture of agricultural lime (McCallie, 1907; Martin and Stafford, 1972). In the Greater Atlanta Region, marble was formerly quarried from the County Line Quarry near the Bartow-Cherokee County line and, currently, crushed marble is produced from a new quarry located near Ball Ground in Cherokee County (W.R. Power, personal commun., 1982).

SAND AND GRAVEL

Sand is presently dredged from streams within southeastern Bartow County and north of Canton in Cherokee County. Actively worked deposits are located on Pumpkinvine Creek and the Etowah River (Kline and O'Connor, 1981). Deposits are used primarily as construction material (Martin and Stafford, 1972).

TALC AND CHLORITE

Talc and chlorite were prospected and mined at several locations within the Blue Ridge portion of the Greater Atlanta Regional Map, but no substantial commercial deposits were found (Hopkins, 1914). Chlorite schist interlayered with sericite schist was mined as a talc substitute in southern Cherokee County and talc is reported west of Ball Ground (Hopkins, 1914). These minerals are used as fillers and lubricants (Martin and Stafford, 1972).

GOLD

Gold associated with quartz and pyrite has been mined and prospected in the Blue Ridge in Cherokee and Bartow Counties. The gold occurs in what was described as "narrow bands of siliceous material" (Jones, 1909, page 151). Mining was by both open-cut and underground methods (Yeates and others, 1896; Jones, 1909). A more detailed discussion of gold is presented in the northern Piedmont minerals section.

ALUMINOSILICATES

Kyanite and staurolite are reported to occur locally in the area around Ball Ground (Furcron and Teague, 1945; Furcron, 1960a). No aluminosilicate deposits of commercial value are known in the Blue Ridge portion of the Greater Atlanta Region.

Piedmont

NORTHERN PIEDMONT

Mineral deposits of the northern Piedmont were mined and prospected extensively, with most activity taking place from the late 1800's to approximately 1920. Abandoned gold and sulfide mines and prospects dot the area underlain by rocks of the New Georgia Group (Fig. 11, Plates II and III). Deposits of gold, sulfides, magnetite and manganese were formed contemporaneously within volcanogenic rocks of this sequence and are related both genetically and spatially. For this reason, deposits of gold, sulfides, magnetite (associated with banded iron formation) and manganese are discussed together rather than as separate and distinct commodities. Gold, sulfides and related commodities also are discussed in greater detail than other commodities in the northern Piedmont due to recent detailed work by the authors. Other commodities previously mined or prospected in the northern Piedmont include mica-bearing pegmatites, titaniferous magnetite, corundum, asbestos, soapstone, talc, graphite, clay, sand and gravel, and aggregate. Presently, active workings include only sand and gravel, clay, and crushed stone.

Gold, Sulfides, Magnetite, and Manganese

The northern Piedmont contains numerous gold and sulfide deposits. Mining and prospecting began prior to the Civil War and continued to approximately 1920 (Table 18). Deposits of gold and disseminated and massive sulfides in this area previously were interpreted to have formed by hydrothermal or magmatic replacement (Jones, 1909; Shearer and Hull, 1918; Hurst and Crawford, 1970), but are now recognized to be syngenetic (Abrams and others, 1981; Abrams and McConnell, 1982a, 1982b; McConnell and Abrams, 1982b). Ores present in the New Georgia Group are stratabound and lie predominantly within a sequence of metamorphosed mafic to felsic volcanic rocks interlayered with subordinate metasediments (Fig. 43). Volcanic cycles within the terrain are culminated by Algoma-type banded iron formation (BIF), now represented by its metamorphic equivalent, magnetite quartzite (Abrams and McConnell, 1982a, 1982b, 1982c; McConnell and Abrams, 1982b). Iron formation was mined or prospected locally for iron and associated manganese in the early 1900's (Hull and others, 1919; Haseltine, 1924).

Table 18. Selected mines and prospects of western Georgia.

Mine or Prospect	Lithologies Present	Group or Formation	Ore Type or Grade (if available)	Production (if available)
1. Franklin-Creighton (Standard Pyrites)	amphibolite, mica shist, chlorite schist and banded iron formation	Univeter Formation	pyrite and gold; Au 6.5 oz./ton (1)*	622,000 to 933,000 grams Au (2) 22,000 tons pyrite concentrates (4)
2. Cherokee	amphibolite, mica, schist, and auriferous quartz "vein" (1)	Pumpkinvine Creek Formation	pyrite, pyrrhotite, gold and silver; Au 7.35 oz./ton; Ag .73 oz./ton (3)	
3. Sixes	amphibolite, hornblende gneiss, mica schist, auriferous quartz "vein" (1)	Pumpkinvine Creek and Canton Formations	Chalcopyrite, pyrite, gold; Cu 1.05%; Au .07 oz./ton (3)	
4. Georgianna	amphibolite, mica schist (1)	Pumpkinvine Creek Formation	gold .25 oz./ton (1)	
5. Bell-Star	hornblende gneiss, sericite and chlorite schists and banded iron formation	Univeter Formation	gold, pyrite, chalcopyrite, sphalerite, and magnetite (4) Au 4.95 oz./ton (3)	
6. 301	mica schist (3)	Univeter Formation	gold 2.9 oz./ton (3)	
7. LaBelle	mica schist (1)	Canton Formation	gold .122 oz./ton (1)	
8. Rich (Canton)	hornblende schist, graphitic mica schist, chlorite schist (4)	Pumpkinvine Creek and Canton Formations	pyrite, chalcopyrite, sphalerite, galena, gahnite; Zn 2.12%; Pb. .15% (4)	
9. Villa Rica	chlorite schist, hornblende gneiss, leucocratic gneiss, garnet biotite gneiss	Mud Creek Formation	Chalcopyrite, sphalerite, pyrite and pyrrhotite	400,000 tons pyrite ore (6)
10. Pine Mountain (Stockmar)	muscovite-paragonite quartzite ± pyrite and kyanite	Mud Creek Formation	gold	
11. Little Bob	chlorite schist ± garnet, sericite quartzite and schist, garnet hornblende schist and gneiss	Univeter Formation	chalcopyrite, sphalerite; pyrite, pyrrhotite and gahnite; Cu 6.48%; Zn 3.43% (4)	14,516 long tons for sulfuric acid from 1918 to 1919 (5)
12. Smith-McCandless	muscovite schist and chlorite schist ± garnet	New Georgia Group	chalcopyrite, sphalerite pyrite and pyrrhotite; Cu .3-3.6%; Zn .6-4.09% Ag. .25-1.0 oz./ton; Au .04 oz./ton (4)	
13. Tallapoosa	chlorite schist, garnet muscovite schist ± graphite, and dolomite	Dog River Formation	chalcopyrite, pyrite, gold, sphalerite; Cu .1-4.75%; Zn .5-5.1%; Au .45 oz./ton; Ag 1.4 oz./ton (4)	7,450 tons at av. 3.5% Cu; 50,000 lbs. secondary ore (chalcocite) (4)
14. Swift (McClarity)	chlorite-amphibole schist and felsic gneiss	New Georgia Group	pyrite, chalcopyrite, pyrrhotite and magnetite (4)	
15. Yorkville	mica schist, amphibolite, and banded iron formation	Dog River Formation	gold	
16. Rush-Banks	chlorite-hornblende schist and sericite schist (4)	Dog River Formation	pyrite, pyrrhotite and chalcopyrite; Cu 3.85% (4)	3 car loads shipped (4)
17. Reeds Mountain	sericite quartzite, kyanite quartz sericite schist, chlorite schist, hornblende and biotite gneisses	New Georgia Group	pyrite	4,000 tons pyrite concentrate (4)
18. Royal	chlorite-amphibole schist, mica schist and banded iron formation	Dog River Formation	gold .32 oz./ton (3)	
19. Bonner	mica schist and felsic gneiss	Dog River Formation	gold .25 oz./ton	

(1) Yeates and others, 1896
(2) Pardee and Park, 1948
(3) Georgia Geologic Survey mineral files, unpublished
(4) Shearer and Hull, 1918
(5) Hurst and Crawford, 1970
(6) Cook, 1970

*Numbers in parentheses refer to references listed above.

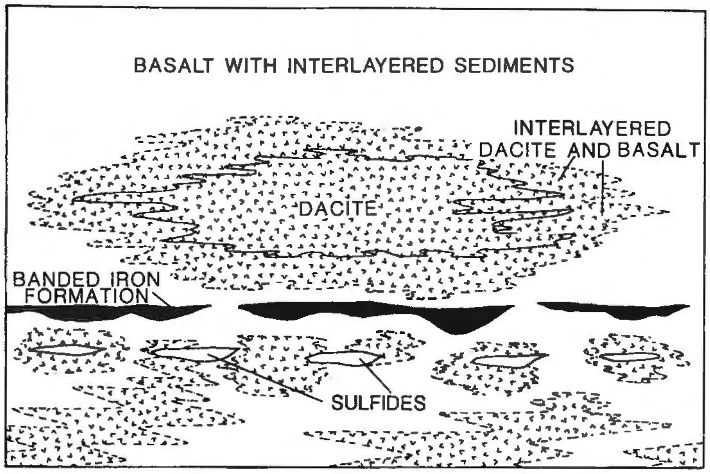

Figure 43. Generalized model of the sequence of events in the Mud Creek and Pumpkinvine Creek Formations.

Rocks of the New Georgia Group form a volcanogenic sequence that extends from near Bremen on the west, northeastward through Canton where the outcrop belt narrows and continues northeastward outside the area of the Greater Atlanta Regional Map to form what is termed the "Dahlonega gold belt" (Fig. 11). New Georgia Group rocks are dominantly metavolcanic and metaplutonic rocks with interlayered metamorphosed volcaniclastics and sediments. These rocks grade stratigraphically upward, through decreasing abundance of metavolcanics, into the predominantly metasedimentary Sandy Springs Group (McConnell and Abrams, 1982a). This gradational zone marks the southeastern boundary of the New Georgia Group. Due to multiple folding, rocks of the New Georgia Group lie within a major structure which is interpreted as an overturned or refolded syncline in which rocks of the older New Georgia Group were overturned to lie in a position structurally above younger rocks (Fig. 27).

Rocks of the northern Piedmont were subjected to at least one episode of regional metamorphism and at least four (McConnell and Costello, 1980b; Abrams and McConnell, 1981a), and in some places six or more (Hatcher, 1977), fold events. Metamorphism, as high as upper amphibolite facies, has recrystallized the entire sequence and rocks now consist predominantly of metamorphosed felsic (leucocratic biotite gneiss, quartz sericite schist) and mafic (amphibolite, hornblende gneiss) volcanic rocks. Second-generation folds dominate outcrop patterns (McConnell and Abrams, 1978; R.D. Hatcher, written commun., 1978; Abrams and McConnell, 1981a), and ores of sulfides and gold that were deformed and remobilized by metamorphism now lie predominantly within the crests and hinges of these second-generation folds. For this reason early mining efforts in rocks of the New Georgia Group followed the axial traces of these folds. Later fold events lacked the intensity to remobilize ore, but interference between these folds and earlier fold events complicates outcrop patterns and definition of ore horizons (Abrams and others, 1981; Abrams and McConnell, 1982a, 1982b; McConnell and Abrams, 1982b).

Banded iron formation (BIF) forms a distinct, easily traceable unit that provides an excellent stratigraphic marker in this multiply deformed terrain. The iron formation is associated genetically with ores of the area and overlies sulfide ore horizons (Abrams and others, 1981; Abrams and McConnell, 1982a, 1982b, 1982c; McConnell and Abrams, 1982b). A spatial relationship also exists between the banded iron formation and mines and prospects of western Georgia (Plate III). This close relationship between the iron formation and ores makes the BIF a valuable tool for exploration and interpretation of premetamorphic relationships and structures in a highly deformed terrain. The iron formation is discontinuous, probably due to nondeposition or attenuation during folding. Banded iron formation is composed predominantly of fine to coarse, disseminated magnetite and layers of magnetite in a coarse to microcrystalline quartzite (oxide facies) (Fig. 12). This facies of iron formation also contains specular hematite, varying amounts of garnet and minor biotite. In addition to oxide facies, a sulfide and an aluminous facies were recognized. The sulfide facies is characterized by pyrite and pyrrhotite; the aluminous facies, by abundant sand-size garnets that locally constitute up to 25 percent of the rock. The aluminous zones possibly represent areas of clay sedimentation or hydrothermally altered tuffaceous material within the volcano-sedimentary environment (G.O. Allard, personal commun., 1981; Abrams, 1983). The iron formation also locally contains graphite and in some zones is rich in manganese (Tables 19 and 20). Manganese-rich zones were prospected in the Draketown area of the northern Piedmont in the early 1900's (Watson, 1908; Hull and others, 1919). Manganese ores also represent volcanogenic deposits like those manganese deposits commonly found in volcanic sequences associated with basic to acidic volcanics and iron deposits (Roy, 1976).

Table 19. Partial whole-rock analyses of banded iron formation from previous works. (Oxides in weight percent.)

Sample Number	$Si0_2$	Fe	MnF_1
1**	28.30	15.80	15.23
2**	5.84	16.47	53.17
3**	15.29	3.35	41.02
4**	5.36	1.62	51.37
5**	13.96	3.89	44.00
Hu 128*	44.00	3.13	24.85
Hu 129*	44.10	29.12	5.55
Hu 126A*	5.54	1.60	49.74
Hu 129A*	9.96	16.68	15.83
Crane 24*	23.76	2.80	32.08
6**	19.74	5.26	33.57
Hu 122*	5.30	1.23	53.70
Crane 25*	22.34	6.27	32.58
S-364***	25.73	3.55	28.35
7***	39.76	36.94	0.15
8***	—	48.59	4.52
9***	32.05	3.08	24.25
10***	15.11	—	46.03
Crane 41***	30.47	13.77	14.72
Crane 37*	19.74	5.26	33.57

*Hull and others, 1919
**Georgia Geologic Survey mineral files (unpublished)
***Shearer and Hull, 1918.

Table 20. Partial whole-rock analyses of banded iron formation (this report). (Oxides in weight percent)

SAMPLE NO.	SiO_2	Fe	Al_2O_3	Mn	TiO_2	P_2O_3	MgO	CaO	V(ppm)
VR-4*	27.00	50.65	0.80	2.00	0.05				
VR-14*	72.00	18.10	1.60	0.80	0.10	0.30			
VR-15*	90.40	5.06	0.50	0.90	0.05	0.30			
VR-20*	67.40	21.70	2.40	0.05	0.00	0.10			
VR-22A*	83.00	10.85	1.60	0.00	0.00	0.10			
VR-22*	67.50	21.70	1.80	0.30	0.00	0.10			
VR-27*	67.00	5.79	19.00	0.20	0.10	0.20			
N-190*	42.00	36.80	1.50	6.00	0.00	0.10			
N-191*	90.50	0.10	2.20	0.10	0.20	0.20			
W-52*	73.80	18.10	1.80	0.10	0.00	0.01			
W-133*	57.00	28.94	1.20	1.50	0.00	0.20			
BHR-3	71.20	11.27	3.20	0.01	0.17	0.06	0.17	0.98	20
L. BOB-M	63.60	23.35	0.61	0.00	0.03	0.05	0.03	0.00	70
DR-9	80.80	10.63	0.32	0.00	0.00	0.02	0.03	0.00	10
NG-8-8-0	83.50	9.66	0.82	0.00	0.00	0.05	0.05	0.30	20
BU-11-22-1	89.40	6.07	0.25	0.00	0.00	0.01	0.05	0.00	100
N-190	85.60	7.04	0.83	0.00	0.08	0.02	0.17	0.19	20
N-195	76.70	12.33	0.81	0.00	0.03	0.02	0.08	0.00	20
TE-129	84.40	7.99	0.84	0.00	0.02	0.01	0.05	0.00	50
VR-8	77.90	4.68	6.30	0.00	0.05	0.06	1.70	7.00	150
VR-9	86.40010	7.07	0.42	0.00	0.00	0.00	0.00	0.00	10
VR-20	81.70	10.55	0.43	0.00	0.01	0.00	0.00	0.00	30

*Analyses done in the laboratory of the Georgia Geologic Survey; Roger Landrum, analyst. Iron and manganese calculated as elemental Fe and Mn.

These manganese-enriched zones have been metamorphosed to form manganese oxides (pyrolusite, psilomelane) (Watson, 1908, p. 189; Hull and others, 1919, p. 178 and 181) and spessartite.

Gold analyses of 55 banded iron formation samples yielded trace to .41 ppm gold (Table 21). Samples from near Burnt Hickory Ridge contain above average gold values, and McConnell and Abrams (1983) suggested that iron formation was a source for gold mined from several placer deposits of that area.

Early reports on gold deposits (Yeates and others, 1896; Jones, 1909) refer to the occurrence of two types of deposits in the northern Piedmont. These are placer and "vein" -type deposits. Jones (1909, p. 43) attributed the origin of gold deposits of the area to "deposition of the ores from heated waters coming from great depths." On the basis of stratigraphic relationships and the association of gold and sulfide deposits with banded iron formation and other rocks of volcanic affinity, both gold and sulfide deposits of the northern Piedmont are interpreted to be syngenetic and subsequently remobilized by metamorphism (Abrams and others, 1981; Abrams and McConnell, 1982a, 1982c; McConnell and Abrams, 1982b). Volcanogenic gold deposits occur within felsic volcanic rocks and interlayered volcanic/sedimentary rocks and as placer type deposits (Abrams and McConnell, 1982c). They occur predominantly in association with sulfide deposits within specific rock units in the New Georgia Group. These units are: the Pumpkinvine Creek and Canton Formations on the northeastern border of the New Georgia Group, the Univeter Formation in the center of the group, and the Mud

Table 21. Gold assays of banded iron formation.

SAMPLE NO.	AU (PPM)	SAMPLE NO.	AU (PPM)
BHR2	.24	NG2	.02
DR5	.07	NG5	.22
DR7	.07	NG6	.04
DR11	.10	BHR1	.10
NG7	.03	DR1	.08
NG14	.03	DR2	.06
TE8	.03	DR3	—
W1	.03	DR4	.02
W2	.03	DR6	.05
DR8	.07	DR10	.04
DR9	.10	N3	—
NG1	—	N12	.02
NG8	.03	N15	.03
NG9	—	VR5	—
TE11	—	VR7	.02
VR6	—	VR16	.02
BRE1	.07	TE12	.02
VR9	.03	RM	—
CA1	.07	BHR3	—
N	.07	BUC11	—
TE129	.20	N190	—
NG4	.07	N195	—
LB5	.41	Y5	.01
WC2	.02	VR8	—
BUC2	.03	VR5	.02
BS1	.26	VR20	—
CT6	.01	KM4	.01
		LR3	.01

Creek Formation near the southern boundary of the New Georgia Group (Fig. 11). Rocks of the Pumpkinvine, Canton and Univeter Formations extend northeastward outside the boundaries of the Greater Atlanta Regional Map to form the "Dahlonega Gold Belt." In addition, some gold and base metal deposits are found on the northeastern border of the New Georgia Group in rocks interpreted to be lower Sandy Springs Group (western belt) (McConnell and Abrams, 1982b). Examples of these are the Tallapoosa sulfide mine and the Royal gold mine (Plate III, Table 18).

The Stockmar or Pine Mountain gold mine near Villa Rica is one of the best known gold mines of the area. At that location, gold was mined along the axes of second-generation folds from a pyritic paragonite muscovite quartzite ± kyanite. The quartzite lies within the boundaries of the Villa Rica Gneiss (metadacite) (Abrams and McConnell, 1981a). Saprolite residuum developed on other siliceous zones within the metadacite also were mined for gold by hydraulic means.

Sulfides occur as stratabound deposits within the same distinct stratigraphic and lithologic units as gold. As previously stated, these ores were remobilized to thicken in the hinges and attenuate along the limbs of second-generation folds. Ores are massive to disseminated and contain variable amounts of pyrite, chalcopyrite, and sphalerite. Pyrrhotite is also present, but is due, in part, to metamorphism of pyrite. Galena is present, but in minor amounts (Cook, 1970). Host rocks consist of mafic or interlayered felsic and mafic metavolcanic rocks. Sulfide deposits in the western Georgia Piedmont were mined primarily for the production of sulfuric acid (Shearer and Hull, 1918). In the 1880's the Tallapoosa and Little Bob mines were opened to mine sulfides for manufacture of sulfuric acid (Shearer and Hull, 1918), but at the Tallapoosa mine copper ore was also recovered (Hurst and Crawford, 1970). Later, around 1899, the Villa Rica mine opened and was shortly followed by the opening of others such as the Bell Star, Reeds Mountain and Swift mines (Shearer and Hull, 1918). The area of the western Georgia Piedmont was drilled extensively in the 1950's and 60's, specifically at the location of abandoned mines and prospects. Analyses of cores from several locations indicate zones reasonably high in copper and zinc (Hurst and Crawford, 1970).

In recent mapping of the Greater Atlanta Region, several stratigraphic and lithologic indicators to ore zones were recognized (Plate III). The importance of banded iron formation as an exploration tool in the northern Piedmont of Georgia was first noted by Abrams and others in 1981. Other lithologic and stratigraphic indicators known to be associated with volcanogenic ores of the northern Piedmont are aluminosilicate assemblages, magnesium-aluminum assemblages, and tourmalinite (Abrams and McConnell, 1982c and Plate III). Aluminosilicate assemblages are represented by distinct zones of coarse kyanite-quartz granofels (Fig. 44). These zones also contain pyrite, muscovite, and paragonite with minor amounts of garnet and staurolite. Magnesium-aluminum assemblages are characterized by chlorite and (or) anthophyllite. Allard and Carpenter (1981) have pointed out that these aluminosilicate and magnesium-aluminum assemblages commonly result from alteration around geothermal fields associated with base and precious metals. Rock present at the Stockmar (Pine Mountain) mine is an example of one these alteration zones. Tourmalinite consists of massive

Figure 44. Photograph of kyanite-quartz granofels from 3.5 miles southwest of New Georgia.

or poorly foliated tourmaline-quartz rock. Slack (1982) has noted the significance of these lithologic indicators to ore bodies. In the area of the Greater Atlanta Regional Map, these units do not form extensive zones within the New Georgia Group, but do appear to be related to ore zones (Plate III). More detailed mapping of the New Georgia Group may show tourmalinite to be more abundant than presently recognized.

Soapstone, Talc, and Asbestos

In general, soapstone, talc, and asbestos deposits occur in anthophylite-chlorite schists, altered ultramafic rocks or altered siliceous dolomites. None of the above commodites are presently mined within the Greater Atlanta Region. The only substantial mining effort for talc within the confines of the Greater Atlanta Regional Map was at the Verde Antique Quarry in southern Cherokee County in 1890 (McCallie, 1907). The quarry there was first worked for talc, but serpentine, soapstone, and marble are reported at the site and marble and soapstone were later worked (McCallie, 1907; Hopkins, 1914). Prospecting for talc and asbestos was done primarily in rocks of the New Georgia Group in Hall, Cherokee, Cobb, Paulding, Carroll, and Douglas Counties, but no other deposits of commercial value were found.

The dominant asbestiform mineral in asbestos deposits in Georgia is anthophyllite (Teague, 1956). Anthophyllite is found predominantly within anthophyllite-chlorite schists which are also host rocks for corundum in the area of the New Georgia Group. Associated minerals include minor olivine, actinolite, talc, and epidote. These magnesium-aluminum rich rocks are interpreted as alteration zones or pipes within the volcanic sequence (Abrams and McConnell, 1982c). Carpenter (1982) discussed the significance of these Al-Mg assemblages and noted that they are found beneath volcanogenic massive sulfide deposits like the Mattagami and Noranda deposits in Quebec. Plate III shows the location of these bodies and their relationship to gold and base metal mines and prospects of northwestern Georgia Piedmont.

Talc occurs in foliated sheets and massive, compact bodies (Hopkins, 1914). The best known use of the mineral is in toiletries such as talcum powder, but talc is also used in paints, rubber roofing products, insecticides, asphalt, lubricants, ceramics and in the production of talc crayons (Hopkins, 1914; Martin and Stafford, 1972). Soapstone associated with talc deposits is used for interior, building and monument stone (Hopkins, 1914). Asbestos was used in chemical filters, as a filler in rubber, as an insulating material and in construction materials (Hopkins, 1914; Teague, 1956).

Corundum

Corundum was prospected and mined prior to the turn of the century in the Blue Ridge and northern Piedmont of Georgia. During the late 1800's Georgia was the largest U.S. producer of abrasive corundum (Cook, 1978a). No producing deposits occur within the boundaries of the Greater Atlanta Regional Map, although portions of the northern Piedmont contain corundum and were prospected extensively (King, 1894; Furcron, 1960b). Occurrences of corundum are typically associated with magnesium-rich rocks including altered peridotites, pyroxenites, and anthophyllite-chlorite schists (King, 1894; Furcron, 1960b). Corundum occurs in these rocks in chlorite-walled "veins or pockets" associated with plagioclase, phlogopite, quartz, actinolite, hornblende, margarite, and vermiculite (King, 1894; Furcron, 1960b). Several varieties of corundum are common to the northern Piedmont and include gem-quality corundum, known as sapphire, and dull, opaque corundum (King, 1894). Corundum is found in sand-sized grains, massive blocks, and small to large crystals (King, 1894). King (1894) reported blocks weighing more than 500 lbs. from areas outside the Greater Atlanta Regional Map in the Blue Ridge and blocks of 50 to 100 lbs. from Heard County immediately south of the Greater Atlanta Regional Map boundaries.

Corundum localities are reported from the Greater Atlanta Region in Carroll, Douglas, Paulding, Cobb, and Cherokee Counties (King, 1894; Furcron 1960b; Cook, 1978a). These deposits are located in rocks of the New Georgia Group and most are associated with units which have been interpreted as magnesium-aluminum alteration zones (Plate III) within a volcanogenic sequence.

Titanium and Titaniferous Magnetite

Titaniferous magnetite is reported from several localities in Cherokee and Cobb Counties (Haseltine, 1924). These properties lie within the boundaries of the Laura Lake Mafic Complex (this report). Haseltine (1924) reported "ore" to consist of small magnetite pebbles and fragments with TiO_2 amounts ranging from 4.6 to 26.4 percent from the A.D. Kemp property near Marietta (Haseltine, 1924, p. 187-189).

Ilmenite deposits are reported to occur in the area of the Allatoona Dam, U.S. Geological Survey 1:24,000 topographic quadrangle by Elston and others (1970). Those authors report TiO_2 amounts of 2 to 55 percent in heavy minerals obtained from auger samples (Elston and others, 1970, p. 29-33).

Clay

Alluvial clay from the Tallapoosa River was worked for brick production in Haralson County (Veatch, 1909). No commercial workings are presently active in the northern Piedmont (Kline and O'Connor, 1981).

Sand and Gravel

Sand and gravel deposits are located along many creeks and rivers of the area. Active workings are known in the northern Piedmont along the Chattahoochee River in Fulton and Gwinnett Counties and on Big Creek in Fulton County (Kline and O'Connor, 1981).

Crushed Stone

Felsic to intermediate gneisses presently are quarried for aggregate at several locations in the northern Piedmont. These quarries are located within the Austell Gneiss in Douglas County, Sand Hill Gneiss in Carroll County, Kennesaw Gneiss of the Laura Lake Complex in Cobb County, Powers Ferry Formation in Forsyth County and the Dallas gneiss near Dallas in Paulding County. Crushed stone is produced from these quarries to be used primarily as aggregate.

Graphite

In the northern Piedmont, graphite is reported in Carroll, Cobb, Douglas, and Fulton Counties (Cook, 1978a) in schists of the Sandy Springs, and New Georgia Groups. No mining of graphite occurred in these areas, but several abandoned prospects are known in Cobb County (WPA report, 1940-1941).

Pegmatites and Mica

Pegmatites of the northern Piedmont were once mined for mica, but mines are now inactive. Mica was mined from pegmatites in Hall, Paulding and Cherokee Counties (Furcron and Teague, 1943). Portions of Carroll and Cobb Counties were prospected for sheet mica, but none of commercial quality was found (Furcron and Teague, 1943).

SOUTHERN PIEDMONT AND BREVARD ZONE

Mining operations of the southern Piedmont portion of the Greater Atlanta Regional Map are confined predominantly to the production of crushed stone from marbles, granites and gneisses of the area. Sand and gravel and clay production rank second and third respectively, after stone production. Other commodities which were once mined or prospected in the area include soapstone and talc, mica, gold, pyrite, graphite, chlorite, and iron ore.

Granites and Gneisses (Crushed and Dimension)

Granites and gneisses were quarried at one time or another in most counties of the southern Piedmont. Presently active quarries are located within Newton, Henry, Gwinnett and DeKalb Counties in the Lithonia Gneiss; Coweta and Fayette Counties in the Palmetto Granite; Fulton County in the Ben Hill Granite; Gwinnett County in the Norcross Gneiss; Clayton County in gneiss of the Camp Creek Formation (Higgins and Atkins, 1981); and Hall County in biotite granite gneiss. Due to texture, grain size, and mineralogy, stone from these quarries is used primarily as crushed stone. Other uses for granite include building stone, curbing and bulkheading.

The only active dimension stone production in the Greater Atlanta Region occurs at several localities in DeKalb County within the Lithonia Gneiss (Kline and O'Connor, 1981). Dimension and curb stone was produced from the Stone Mountain Granite, but commercial production was terminated as the quarry now lies in a state park.

Clay, Sand and Gravel, and Fill Material

Alluvial, residual and colluvial clays are suitable for the production of building brick, terra cotta, and stoneware (Veatch, 1909). These deposits, in addition to deposits of sand and gravel, are found along the floodplains of many streams and rivers of the southern Piedmont. Many of these deposits were mined in the past, but most production was for local use only. The most notable of the deposits lie along the banks of the Chattahoochee River where excellent sand, gravel, clay and fill material are still actively produced. Fill material and brick clays are produced from the banks of the Chattahoochee River in Fulton and Douglas Counties. Active sand and gravel workings are located along the banks of the Chattahoochee in Cobb, Douglas, and Fulton Counties (Kline and O'Connor, 1981).

Marble

Marble from the Brevard fault zone is actively quarried for crushed stone northeast of Gainesville in Hall County (Kline and O'Connor, 1981). Marble of the area is described as blue or grey dolomite which lies within calcareous schists in what was termed the Gainesville marble belt (Furcron, 1942). Exposures of marble extend from near Flowery Branch, Hall County, northward to Habersham County (Furcron, 1942) outside the boundaries of the Greater Atlanta Regional Map where Hurst and Crawford (1964) described exposures ranging from calcareous quartzite to marble. Marble from this area is high in magnesium and, in addition to use as crushed stone, previously was burned to form lime (Maynard, 1912).

Hatcher (1969, 1971a) includes carbonate of the Brevard fault zone as a member of his Chauga River Formation. His work did not extend into the Greater Atlanta Regional Map area, but Hatcher (1971a) suggested that a carbonate unit forming a "topographic low or lineament" as described by Hurst and Crawford (1964) in Habersham County is equivalent to his Chauga River carbonate member. The marble near Gainesville is on strike with this carbonate.

Graphite

Graphite is reported at several locations in Hall County (Work Projects Administration, 1940-42). The graphite occurs in phyllites and graphitic schists of the Brevard fault zone. Prospecting was limited to three to four pits at the most extensively worked locality.

Soapstone, Asbestos and Talc

Soapstone, asbestos and talc are reported from Clayton, DeKalb, Gwinnett, and Hall Counties in the southern Piedmont (Hopkins, 1914). No commercial production at these sites is known. Deposits differ mineralogically and consist of varying amounts of anthophyllite, relict olivine and pyroxene, talc, chlorite, and actinolite (Hopkins, 1914; Prowell, 1972; Cook, 1978a). The largest of these bodies is located within DeKalb County on Soapstone Ridge.

Pegmatites

Pegmatites are reported in Clayton, Hall, Coweta, DeKalb, Fulton and Henry Counties (Galpin 1915; Furcron and Teague, 1943; Cook, 1978a). Of these, only localities in Hall and Henry Counties were mined or prospected for mica (Galpin, 1915; Cook, 1978a). Furcron (1959) reported beryl and tourmaline from pegmatites near Stone Mountain in DeKalb County, but no commercial deposits are present.

Pyrite

Sulfides and iron ore associated with hornblende gneiss and chlorite schist were mined briefly from a locality known as the Cash Copper Mine in Fulton County (Shearer and Hull, 1918). The term "copper" is a misnomer as little copper was reported and ore was said to consist dominantly of pyrite, magnetite, hematite and limonite (Shearer and Hull, 1918).

Sulfide and gold deposits of the southern Piedmont probably originated as stratabound, syngenetic deposits like deposits of the northern Piedmont. It has been suggested that similar rock sequences exist on both sides of the Brevard fault zone (Hatcher, 1978b; Kline, 1980, 1981; McConnell, 1980b; this report) in the northern and southern Piedmont. Lithologic units defined by Higgins and Atkins (1981) such as spessartine-bearing quartzites (Intrenchment Creek Quartzite) may represent a facies of banded iron formation like that seen in the New Georgia Group of the northern Piedmont (see southern Piedmont stratigraphy for more detailed discussion). Other lithologic units of the southern Piedmont (portions of the Atlanta Group, Higgins and Atkins, 1981) may also be equivalent or coeval with the New Georgia Group and may represent a volcanogenic sequence. More detailed work is needed to establish the origin and extent of base metal and gold mineralization of the southern Piedmont.

Gold

Gold mines and prospects of the southern Piedmont are chiefly confined to Coweta, Fulton and Hall Counties. In each of these counties gold was mined or prospected from both placer and "vein"-type deposits (Yeates and others, 1896; Jones, 1909). Placer deposits of Coweta County were located in auriferous gravels or associated with quartz veins (Jones, 1909). Other "vein" deposits of the area, particularly in Hall County, were associated with milky quartz and sulfides in quartz veins.

SUMMARY

This report accompanying the geologic map of the Greater Atlanta Region is a composite of many smaller reports and investigations. Therefore, conclusions related to this report are, to a large degree, conclusions that were reached in earlier studies that accompanied geologic investigations of smaller areas within the Greater Atlanta Regional Map. The report on the geology of the Greater Atlanta Region combines and relates these previous investigations and unpublished data into a single document on the geology of the Atlanta region.

East of the Cartersville fault, rocks nonconformably overlying the Corbin Gneiss Complex and underlying the Murphy Marble belt group are subdivided into five formations. Clastic rocks in contact with the Corbin Gneiss Complex are termed the Pinelog Formation after Hayes's Pinelog conglomerate. Conformably overlying the Pinelog are interlayered carbonaceous and noncarbonaceous phyllites and sandy marbles of the Wilhite Formation. Stratigraphic position and lithologic similarities suggest that rocks of the Pinelog are lithostratigraphic equivalents of the Snowbird Group in the Great Smoky Mountains National Park, and the Wilhite Formation is equivalent to Wilhite Formation as defined in the National Park. Lying conformably beneath the Murphy Marble belt group are clastic rocks interpreted to be lithostratigraphic equivalents of the Great Smoky Group. Three formations are defined: Etowah, Sweetwater Creek and Dean Formations. Rocks of the Etowah and Wilhite Formations trend around the Emerson reentrant in the Cartersville fault and into what is referred to as the Talladega belt. Rocks of the Talladega belt, at least in the northeastern part of the belt, are believed equivalent to the Great Smoky and Walden Creek Groups and, therefore, are late Precambrian.

Southeast of the Allatoona fault, rocks of the New Georgia Group are the oldest rocks exposed in the northern Piedmont. New Georgia Group rocks are conformably overlain by rocks of the Sandy Springs Group which is divided into an eastern and western belt by the Chattahoochee fault. The New Georgia Group is dominantly a mixed assemblage of felsic and mafic metavolcanic rocks with subordinate amounts of metasedimentary rocks. Rocks of the New Georgia Group are host to most of the massive sulfide and gold deposits known to occur in the Atlanta area. These deposits previously were believed to be epigenetic in origin, but the recognition of banded iron formation in close proximity to most of these deposits, the stratabound nature of the deposits and their association with volcanic assemblages suggest a syngenetic origin. Rocks of the New Georgia Group are traceable to the northeast beyond the boundaries of the Greater Atlanta Regional Map, where they comprise what was termed the "Dahlonega Gold Belt."

The Brevard fault zone in the Atlanta area separates similar rocks and stratigraphic sequences. While undoubtedly a zone of intense ductile shearing, the Brevard zone is not a cryptic suture and does not appear to have large vertical displacement. In this report, the Brevard is interpreted to represent the axial zone of a large recumbent isocline that has undergone intense ductile shearing related to transposition during the (F_1) folding event.

Southeast of the Brevard zone, Higgins and Atkins (1981) defined 12 formations and 3 members of the Atlanta Group (Appendix A). Rocks of this group were interpreted by Higgins and Atkins to represent a eugeosynclinal sequence exposed in a synformal syncline. In this report, rocks of the Atlanta Group are interpreted to be exposed in a synformal anticline and, therefore, Higgins and Atkins' stratigraphy is inverted. Rocks of the Intrenchment Creek Quartzite, Camp Creek Formation and Big Cotton Indian Formation are interpreted to be lithostratigraphic equivalents of the New Georgia Group of the northern Piedmont. Units that stratigraphically overlie the above formations may be lithostratigraphic equivalents of the Sandy Springs Group.

Plutonic rocks present in the Atlanta area can be divided into three major groups based on chemical criteria, depth of intrusion, and their time of intrusion with respect to the major progressive metamorphic event in the Piedmont. Felsic intrusive rocks in the New Georgia Group and possibly biotite-plagioclase gneisses in the Camp Creek and Big Cotton Indian Formations were intruded prior to metamorphism and are, particularly in the case of the former, distinctly low in potassium. Rocks of this category generally are associated with volcanic equivalents and are conformable with the regional trends. Intrusive rocks of the second category are believed to have been emplaced either pre- or syntectonically and all display a metamorphic overprint. Category 2 intrusive rocks generally are concordant with the regional trend, but lack the direct relationship to volcanics that is characteristic of category 1 intrusives. Intrusives of this category also display greater concentrations of potassium than earlier intrusives and define a distinct differentiation trend. Intrusive rocks of the third category are distinctly discordant to the regional structural trends and lack a metamorphic overprint, although some intrusives of this category are sheared locally by movement along the Brevard zone.

Only one major progressive metamorphic event of Paleozoic age is observed in rocks of the Greater Atlanta Region. This event probably occurred approximately 365 m.y. ago and occurred coincidently with the first major fold event. The first major fold event is characterized by large-scale recumbent isoclines. Folds of this generation are not observed in the Valley and Ridge and their absence is a justification for the presence of the Cartersville fault east of Cartersville. F_2 folds overprint F_1 folds and form a series of regional antiforms and synforms that vary from isoclinal near the Brevard zone to open away from the Brevard zone. F_2 folds occur in all geologic provinces in the Greater Atlanta Region. Fold events postdating F_2 vary from province to province.

Twenty-eight rock and mineral commodities (asbestos, barite, bauxite, beryl, chlorite, clay, corundum, flagstone, gold, granite, graphite, iron ore, limonite, limestone, manganese, marble, mica, ocher, pegmatite, quartzite, sand and gravel, sericite, shale, slate, soapstone, sulfides, tripoli, and talc have been mined or prospected within the confines of the Greater Atlanta Regional Map. Of the above commodities only barite, ocher, sand and gravel, granite, marble, limestone, and structural clays are actively mined today. Historically, the Cartersville area in particular and the Valley and Ridge in general are the areas of greatest mining production within the Greater Atlanta Region. Mining near Cartersville has occurred for over 130 years and has involved the mining of brown iron ore, barite, manganese, ocher and umber, and shale and slate. Of the above, only barite and ocher and umber are still actively mined. Elsewhere, the Valley and Ridge portion of the Greater Atlanta Regional Map contains deposits of bauxite, limestone, shale, and iron ore. At the present time, only limestone and shale are actively mined.

Beryl, barite, gold, graphite, iron ore, marble, sericite and mica were mined or prospected in the Blue Ridge portion of the Greater Atlanta Regional Map. Of these, only marble from a recently activated quarry in Cherokee County is actively mined today.

The largest known deposits of base and precious metals within the Greater Atlanta Region occur in rocks of the northern Piedmont. Volcanogenic gold and massive sulfide deposits occur predominantly within metamorphosed felsic and mafic volcanic rocks. Mining for gold and sulfides occurred during the late 1800's and early 1900's. Other commodities previously mined or prospected in the northern Piedmont include: mica, corundum, asbestos, soapstone, graphite, clay, sand and gravel, and crushed stone. Only sand and gravel and crushed stone are actively mined today.

Crushed and dimension stone, sand and gravel, and clay are the only commodities actively mined from rocks of the Brevard fault zone and southern Piedmont. Crushed stone includes marble mined for aggregate in Hall County, granite mined for aggregate in Fulton, DeKalb, and Fayette Counties, and granite gneiss mined in Gwinnett, DeKalb and Rockdale Counties. Other commodities previously mined or prospected in the southern Piedmont and Brevard fault zone include talc, mica, gold, pyrite, graphite, chlorite and iron ore.

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APPENDIX A

Description of Geologic Units

APPENDIX A

This appendix provides a brief description of rock units defined on Plate I. Rock units are described by geologic province from northwest to southeast across the map. References for the description of each rock unit are given in parentheses next to the unit name.

VALLEY AND RIDGE PROVINCE

€chq €chs	**Cambrian Chilhowee Group** (Hayes, 1902; Cressler and others, 1979): includes rocks previously termed Weisner quartzite and is composed dominantly of vitreous quartzite (€chq) with local interbeds of conglomerate and sandy shale (€chs). 771-656 ft. thick (Mack, 1980).
€s	**Cambrian Shady Dolomite** (Butts and Gildersleeve, 1948): bluish-gray, medium to coarsely crystalline dolomite. Host to barite, iron and manganese deposits. 100 ft. thick (Cressler, 1970).
€r	**Cambrian Rome Formation** (Hayes, 1902; Butts and Gildersleeve, 1948): includes thin-bedded, fine-grained sandstones and sandy shales variably colored red, purple, green-yellow and white. Locally contains thin interbeds of limestone. 500-1000 ft. thick (Cressler, 1970).
WB: €csl, €cls, €cs EB: €cd, €c, €cs CA: €cld, €csu, €cl, €csl, €cd	**Cambrian Conasauga Group** (Cressler, 1970; Cressler and others, 1979): includes Western (WB) and Eastern (EB) belts in Floyd County with units of mostly shale and some limestone (€csl), mostly limestone and some shale (€cls), siliceous shale and thin-bedded sandstone (€cs), dolomite (€cd), shale and limestone mixed (€c), and mostly shale (€cs). In the Cartersville area (CA): light- to medium-gray and brown dolomite (€cd); greenish-gray, tan, purplish, and black shale (€csl); limestone (€cl), greenish, gray, and slightly purplish shale (€csu), and gray dolomite (€cld). 1500 ft. thick (Cressler, 1970).
O€k €cr	**Upper Cambrian and Lower Ordovician Knox Group** (Cressler, 1970; Cressler and others, 1979): includes light- to medium-gray, fine-to coarse-grained, thickly to massively bedded cherty dolomite and brownish-gray, medium- to coarse-grained "asphaltic" dolomite of the Copper Ridge Dolomite (€cr and O€k); approximately 500 feet of light-to medium-gray, thick to massively bedded dolomite interbedded with gray and tan, aphanitic limestone and sandstone of the Chepultepec Dolomite; and light- to medium-gray dolomite interbedded with light- to medium-gray, aphanitic to medium-grained, thickly bedded limestone of the Longview Limestone. The Longview Limestone locally weathers to a residuum containing angular chert and sandstone fragments. 3000 ft. thick (Cressler, 1970).
On	**Ordovician Newala Limestone** (Cressler, 1970): includes light-gray to medium dark-gray, thickly bedded limestone and light- to medium-gray, fine- to coarse-grained, massively bedded dolomite. Occurring locally at the top of the Newala is a conglomerate containing clasts of argillaceous limestone. Nodular and bedded chert also occur locally. 300 ft. thick (Cressler, 1970).
Ors Or	**Ordovician Rockmart Slate** (Cressler, 1970): includes dark-gray to black, calcareous slate and micaceous siltstone (Or) and feldspathic sandstone interbedded with slate and conglomerate. Two types of conglomerate occur: one contains limestone, dolomite, slate, sandstone, chert and both sedimentary and metamorphic quartzite cobbles and pebbles; another conglomerate is composed of fine quartz pebbles in a feldspathic sandstone matrix. 0-600 ft. thick (Cressler, 1970).

Oum	**Ordovician, Upper and Middle undivided** (Cressler, 1970): includes calcareous mudstone and light- to medium-gray, thickly to massively bedded limestone of the Murfreesboro Limestone; several feet of cobbly argillaceous limestone and blue-gray flaggy limestone of the Ridley Formation; approximately 100 feet of shale and calcareous mudstone interbedded with thin-bedded reddish siltstone and fine- to medium-grained sandstone of the Moccasin Limestone; and approximately 300 feet of yellow, maroon, and reddish mudstone, thin-bedded red siltstone, and impure fine to coarse sandstone of the Bays Formation. 480 ft. thick (Cressler, 1970).
Srm	**Silurian Red Mountain** (Butts and Gildersleeve, 1948): fine-grained, gray, locally ferruginous and rusty sandstone. Sandstone is dominantly thinly layered with interbedded shale. Basal strata are composed of thick bedded limestone. 600-1200 ft. thick Cressler, (1970).
MDc Mfp Mls Da	**Devonian and Mississippian Chert** (Butts and Gildersleeve, 1948; Cressler, 1970): includes a dense, gray, brittle, evenly bedded chert (Fort Payne Chert, Mfp); a dark, compact, calcareous shale member of the Fort Payne Chert (Lavender Shale, Mls); and a locally sandy and ferruginous dark-gray chert (Armuchee Chert, Da). Also includes the Chattanooga Shale which in this area is too thin to break out. Approx. 270-425 ft. thick (Cressler, 1970).
Mh Mfs Ml	**Mississippian Floyd Shale** (Butts and Gildersleeve, 1948; Cressler, 1970): includes predominantly gray to black, fissile shale (Mfs); beds of limestone (Ml); and near the top of the formation, beds of sandstone or sandy limestone termed the Hartselle Sandstone (Mh). Approx. 300 ft. thick (Cressler, 1970).
Mb	**Mississippian Bangor Limestone** (Butts and Gildersleeve, 1948): approximately 500 feet of thick-bedded, bluish-gray, coarsely crystalline limestone above the Hartselle Sandstone. 300 ft. thick (Cressler, 1970).
Pu	**Pennsylvania Undifferentiated** (Butts and Gildersleeve, 1948; Cressler, 1970): dominantly Pottsville Formation composed entirely of thick sandstone, conglomerate and shale beds with interlayered coal beds. 250-325 ft. thick (Cressler, 1970).

BLUE RIDGE PROVINCE

p€c	**Precambrian Corbin Gneiss Complex** (McConnell and Costello, 1980b): complex association of ortho and paragneisses with compositions varying from granite to granodiorite. Predominant facies is a megacrystic quartz monzonite gneiss. Also includes a pyroxene granulite facies.
p€p	**Precambrian Snowbird Group, Pinelog Formation** (McConnell and Costello, 1980b): interlayered metaconglomerate, quartzite, sericite phyllite, and graphitic phyllite uncomformably overlying Precambrian basement. Lithic metaconglomerate (diamictite) also present locally.
p€wu p€wg p€wc	**Precambrian Walden Creek Group, Wilhite Formation** (McConnell and Costello, 1980b): includes interlayered sericite phyllite and graphitic phyllite (p€wu), graphitic phyllite (p€wg), quartzite, and quartz-rich carbonate (p€wc).
p€et p€sc p€d	**Precambrian Great Smoky Group** (McConnell and Costello, 1980b; this report): includes interlayered metasandstone and sericite phyllite with local calc-silicate granofels pods of the Etowah Formation (p€et); poorly sorted conglomeratic metagreywacke interlayered with graphite phyllite and sericite phyllite of the Sweetwater Creek Formation (p€sc); and quartz pebble metaconglomerate interlayered with quartzite and sericite phyllite with accessory staurolite and chloritoid of the Dean Formation (p€d).

Pzna Pzb Pzmm Pzmb	**Paleozoic Murphy Marble belt group** (Costello and others, 1982): includes carbonaceous phyllite or laminated, dark-colored argillite interbedded with medium-grained metagraywacke of the Nantahala Formation (Pzna); thinly interlayered, gray, biotite schist and micaceous quartzite that weathers to a buff to orange-colored saprolite of the Brasstown Formation (Pzb); calcareous and dolomitic marbles separated by a calc schist composed of hornblende, epidote, calcite, and biotite of the Murphy Marble (Pzmm) (Pzmm also includes rocks of the Marble Hill Hornblende Schist composed of alternating layers of marble and hornblende schist ranging in thickness of from 1 to 10 cm); and interlayered mica schist and garnet mica schist with local occurrences of graphitic and quartz-calc schist of the Mineral Bluff Formation (Pzmb).

NORTHERN PIEDMONT PROVINCE

	New Georgia Group (late Precambrian to early Paleozoic) (stratigraphic order uncertain).
mcu clq mcb vrg	**Mud Creek Formation** (Abrams and McConnell, 1981a): includes locally garnetiferous, equigranular hornblende-plagioclase amphibolite and hornblende gneiss interlayered with garnet-biotite-quartz-plagioclase gneiss, and biotite schist of the Mud Creek Formation undifferentiated (mcu); interlayered magnetite quartzite (banded iron formation) termed the Cedar Lake Quartzite (clq); garnet-biotite gneiss (mcb); and biotite-quartz-plagioclase orthogneiss (metadacite) termed the Villa Rica Gneiss (vrg).
lma rcs	**Univeter Formation** (this report): includes a unit composed of hornblende-plagioclase amphibolite, hornblende gneiss and local lenses and layers of banded iron formation termed the Lost Mountain Amphibolite (lma); and garnet biotite-muscovite schist locally varying to garnet-hornblende-muscovite-quartz schist termed the Rose Creek Schist (rcs).
pcu gfg	**Pumpkinvine Creek Formation** (Crawford, 1976; McConnell, 1980a; this report): includes hornblende-plagioclase amphibolite interlayered with garnet-hornblende-plagioclase gneiss, sericite phyllite, and banded iron formation of the Pumpkinvine Creek Formation undifferentiated (pcu), and hornblende quartz-plagioclase gneiss varying to a biotite muscovite-quartz-plagioclase gneiss with layers of hornblende gneiss and actinolite-chlorite schist termed the Galts Ferry Gneiss (gfg).
cas	**Canton Formation** (Bayley, 1928; this report): garnet-sericite schist interlayered with garnet-graphite schist ± kyanite, micaceous quartzite and metagraywacke.
acg	**Acworth Gneiss** (this report): medium-grained biotite-quartz-plagioclase orthogneiss with accessory muscovite and epidote. Mafic xenoliths occur locally.
kcc	**Kellogg Creek Mafic Complex** (this report): garnet-hornblende-plagioclase amphibolite, metagabbro and lesser amounts of meta-ultramafic rocks.
cs bif kq kqs q amp/hgn/fgn amp/hgn fgn um	**Unnamed rock units**: includes chlorite schist ± garnet and chlorite-anthophyllite schist interpreted to represent relict magnesium-aluminum hydrothermal alteration zones (cs); sulfide, magnetite or manganese-bearing quartzites interpreted as banded iron formation (bif); coarse-grained kyanite-quartz granofels interpreted to represent relict aluminosilicate hydrothermal alteration zones (kq); garnet-kyanite-quartz-sericite schist (kqs); intermixed amphibolite, hornblende gneiss and felsic gneiss of undetermined composition (amp/hgn/fgn); felsic gneiss of undetermined composition (fgn); and meta-ultramafic rocks believed to be both intrusives and relict hydrothermal alteration systems (um).

Sandy Springs Group (late Precambrian to early Paleozoic): includes an eastern and western belt.

Western belt:

dru drs dra bif	**Dog River Formation** (this report: includes undifferentiated muscovite-biotite-quartz-feldspar gneiss (metagraywacke), garnet-muscovite schist, and amphibolite (dru), with mappable units of garnet-muscovite schist (drs), amphibolite (dra) and thin (1 to 3 in.) layers of banded iron formation (bif).
amu amq	**Andy Mountain Formation** (Crawford and Medlin, 1974; Abrams and McConnell, 1981a): biotite-garnet-plagioclase-muscovite-quartz schist ± graphite, staurolite, and kyanite, and feldspathic, micaceous garnet quartzite of the Andy Mountain Formation undifferentiated (amu); and clean, sugary quartzite ± garnet (amq).
ba	**Bill Arp Formation** (Crawford and Medlin, 1974; Abrams and McConnell, 1981a): interlayered garnet-biotite-muscovite-plagioclase-quartz schist; muscovite schist; quartz-muscovite-biotite schist; muscovite-biotite-quartz-plagioclase schist; and metagraywacke (ba). Locally calcareous concretions, possibly limey lenses, occur as elongate features parallel to foliation.

Eastern belt:

pfu pfs bif ma	**Powers Ferry Formation** (Higgins and McConnell, 1978a; this report): undifferentiated biotite-quartz-plagioclase gneiss (metagraywacke), mica schist and amphibolite (pfu); a mappable mica schist unit (pfs); and banded iron formation (bif). One continuous amphibolite was termed the Mableton amphibolite (ma).
cpq	**Chattahoochee Palisades Quartzite** (Higgins and McConnell, 1978a; this report): massive, white, yellowish, or bluish, sugary to vitreous quartzite locally containing accessory mica, feldspar, and elongate garnets (cpq). Graded bedding is apparent locally.
fs	**Factory Shoals Formation** (Higgins and McConnell, 1978a): intercalated light-gray, lustrous, garnet-biotite-oligoclase or muscovite-biotite-plagioclase metagraywacke, kyanite-quartz schist, and staurolite-muscovite quartz schist (fs). Locally, schist grades to a garnet-graphite schist.
cs bif kq ss gms bgms gs amp/hgn ggn um	**Unnamed Rock Units**: includes chlorite schist and chlorite-anthophyllite schist interpreted to represent relict magnesium-aluminum hydrothermal alteration zone (cs); sulfide, magnetite or manganese-bearing quartzites interpreted as banded iron formation (bif); coarse-grained kyanite-quartz granofels interpreted to represent relict aluminosilicate hydrothermal alteration zones (kq); interlayered sericite schist and micaceous quartzite (ss); garnet-muscovite schist (gms); biotite-garnet-muscovite schist (bgms); amphibolite and hornblende gneiss (amp/hgn); blastoporphyritic to nonporphyritic biotite muscovite-quartz-plagioclase-microcline gneiss (ggn), and meta-ultramafic rock (um).
llu lld llg	**Laura Lake Mafic Complex** (McConnell and Costello, 1980b; this report): migmatitic garnet amphibolite of the Laura Lake Mafic Complex undifferentiated llu) with smaller amounts of pyroxene (relict)-bearing metagabbro (llg), meta-quartz diorite (lld), meta-ultramafic rock and banded iron formation. Magnetite occurs as common porphyroblasts in amphibolite and coarse-grained amphibole-quartz-plagioclase rock is common neosome.

ag	**Austell Gneiss** (Abrams and McConnell, 1981a; Abrams, 1983): fine- to coarse-grained blastoporphyritic to nonporphyritic orthogneiss composed of muscovite, biotite, oligoclase, quartz and microcline.
shg	**Sand Hill Gneiss** (this report): fine- to coarse-grained blastoporphyritic to nonporphyritic orthogneiss composed of muscovite, biotite, oligoclase, quartz and microcline. Generally contains more muscovite, quartz and plagioclase and less microcline than Austell Gneiss.
mrg	**Mulberry Rock Gneiss** (this report): medium-grained, equigranular muscovite-quartz-microcline-plagioclase orthogneiss.
d	**Diabase dikes**

SOUTHERN PIEDMONT PROVINCE AND BREVARD FAULT ZONE

Atlanta Group (late Precambrian to early Paleozoic) (stratigraphic order revised after Higgins and Atkins, 1981):

cc	**Camp Creek Formation** (Higgins and Atkins, 1981): massive granite gneiss interlayered with thin, fine-grained, dark-green hornblende-plagioclase amphibolite.
icq	**Intrenchment Creek Quartzite** (Higgins and Atkins, 1981): spessartine quartzite and spessartine-mica schist interpreted in this report to be banded iron formation.
bci	**Big Cotton Indian Formation** (Higgins and Atkins, 1981): intercalated biotite-plagioclase gneiss (locally porphyritic), hornblende-plagioclase amphibolite, and biotite-muscovite schist.
ca tc f	**Clarkston Formation** (Higgins and Atkins, 1981): sillimanite-garnet-quartz-plagioclase-biotite-muscovite schist interlayered with hornblende-plagioclase amphibolite (ca). Includes a unit composed only of schist termed the Fairburn Member (f); and a unit similar to Clarkston undifferentiated termed the Tar Creek Member (tc).
st	**Stonewall Formation** (Higgins and Atkins, 1981): intercalated fine-grained biotite gneiss, hornblende-plagioclase amphibolite and sillimanite-biotite schist.
wac	**Wahoo Creek Formation** (Higgins and Atkins, 1981): includes slabby, medium-grained muscovite-plagioclase-quartz gneiss, amphibolite, mica schist and epidote-calcite-diopside gneiss (calc-silicate).
se	**Senoia Formation** (Atkins and Higgins, 1981): garnet-biotite-muscovite schist interlayered with fine-grained amphibolite, local thin layers of spessartine quartzite (iron formation?), sillimanite schist and biotite gneiss.
cl	**Clairmont Formation** (Higgins and Atkins, 1981): interlayered medium-grained biotite-plagioclase gneiss and fine- to medium-grained hornblende-plagioclase amphibolite.
pl h	**Promised Land Formation** (Higgins and Atkins, 1981): includes massive to thinly layered, medium-grained, gray, banded biotite granite gneiss interlayered with fine-grained, dark-green to greenish black, blocky amphibolite. A thin quartzite and muscovite quartz schist unit near top of the Promised Land Formation is termed the Hannah Member (h).
wc	**Wolf Creek Formation** (Higgins and Atkins, 1981): thinly laminated, fine-grained amphibolite interlayered with lustrous, silvery, gray, biotite-muscovite schist.

iy	**Inman Yard Formation** (Higgins and Atkins, 1981): porphyroblastic biotite-plagioclase gneiss porphyroblastic granite gneiss and sillimanite-muscovite schist.
ng	**Norcross Gneiss** (Higgins and Atkins, 1981): light-gray epidote-biotite-muscovite-plagioclase gneiss locally containing amphibolite.
n l	**Snellville Formation** (Higgins and Atkins, 1981): includes two members, a lower member of interlayered garnet-biotite-muscovite schist, biotite-muscovite schist, thin amphibolites and minor biotite gneiss and quartzite termed the Norris Lake Schist (n) and an upper member composed of quartzite variably containing muscovite, garnet and sillimanite termed the Lanier Mountain Quartzite (l).
pfu cpq fs	**Sandy Springs Group** (Higgins and McConnell, 1978a: Kline, 1980; this report): Similar to sequence observed in northern Piedmont and at least partially equivalent to Atlanta Group (see text). Includes a lower unit of intercalated biotite gneiss, mica schist and amphibolite (pfu); a middle unit composed of micaceous quartzite, mica schist and graphitic schist (cpq); and an upper unit of graphite-garnet-mica schist with lesser amounts of biotite gneiss and amphibolite (fs).
um amp bgn ggn sg bgn/amp/sch q bms m	**Unnamed or unassigned units** (after Grant, unpublished data; this report): includes meta-ultramafic rocks (um); amphibolite (amp); mica schist and biotite gneiss (bgn); granitic gneiss (ggn); interlayered sillimanite-graphite schist and graphitic, feldspathic quartzite (sg); graphitic, micaceous, feldspathic quartzite (q); intercalated biotite gneiss, amphibolite and mica schist (bgn/amp/sch); garnet-mica schist ± staurolite and garnet-biotite gneiss (bms); and marble (m).
Pzss Pzum Pzsa Pzsas	**Soapstone Ridge Complex** (Higgins and Atkins, 1981): includes an actinolite-chlorite-talc schist (Pzss); fine-grained amphibolite (Pzsa), intermixed amphibolite and actinolite-chlorite-talc schist (Pzsas); and coarse-grained ultramafic rock (Pzum). Also present but not defined on Plate I is a mixed amphibolite-metagabbro-ultramafic unit and a sillimanite-quartz blastomylonite and epidosite near the base of the complex.
lig	**Lithonia Gneiss** (Herrmann, 1954): includes evenly banded biotite-quartz-feldspar gneiss, quartz-rich garnetiferous layers and migmatitic muscovite-biotite-plagioclase-microcline-quartz gneiss termed the Mt. Arabia Migmatite (Grant and others, 1980; not outline on Plate I).
Cp	**Palmetto Granite** (Dooley, *in* Atkins and others, 1980a): coarse-grained porphyritic granite composed of microcline, quartz and plagioclase with accessory biotite, muscovite, perthite, sphene, apatite, epidote, and zircon.
Cb	**Ben Hill Granite** (Higgins and Atkins, 1981): coarse-grained, porphyritic muscovite-biotite quartz-plagioclase-microcline granite.
Cpa	**Panola Granite** (Higgins and Atkins, 1981): homogenous, medium-grained biotite-oligoclase-quartz-microcline granite.
Cs	**Stone Mountain Granite** (Herrmann, 1954): fine- to medium-grained granite composed of biotite, muscovite, microcline, quartz and oligoclase with characteristic rosettes of tourmaline.
my bz bzm	**Ductilely sheared rocks:** includes undifferentiated ductilely sheared rocks in the Brevard zone including button schists (bz), mylonites in the Brevard zone (bzm), and mylonite in other areas (my).
d	**Diabase dikes.**

APPENDIX B

Index to Mines, Prospects and Mineral Localities (to accompany Plates II and IIa)

APPENDIX B

Index to Mines, Prospects and Mineral Localities

Sites are listed by commodity in alphabetical order. Under each commodity heading, counties are listed alphabetically and sites are listed by abbreviated commodity symbol (e.g., Bx for bauxite) and numerical designation to correspond to map designations. Sites are numbered consecutively in each county, beginning with number one. Active mines or quarries are notated by an asterisk. Other information given is geologic province (V.R. - Valley and Ridge, B.R. - Blue Ridge, N.P. -Northern Piedmont, S.P. - includes Southern Piedmont and Brevard zone); site type (M-Mine, P-Prospect, L-Locality, etc.); name, if available; and name of the U.S. Geological Survey 7.5 - minute topographic quadrangle in which the site is located. All U.S. Geological Survey topographic quadrangles are number coded to correspond to the numerical coding system of the Georgia Geologic Survey (Fig. 1, Plate Ia). Numbers in parentheses before each site name refer to the numbered reference list for Appendix B. Sites not numbered were located by the authors.

Locations in some cases are approximate due to a lack of detailed location information in older references. Due to the number of localities in the Cartersville area, this area is shown enlarged at 1:24,000 scale on a separate map.

Categories and Abbreviations of Commodities (listed in order of appearance in appendix)

Aluminosilicates
- K kyanite
- St staurolite

Asbestos, talc, soapstone, sericite and chlorite
- A asbestos
- T talc
- Sp soapstone
- Ch chlorite
- Sc sericite

B barite

Bx bauxite

Cly clay

C corundum

F flagstone

Au gold

G granite, crushed and dimension

Gr graphite

Ls limestone

Limonite and other iron ore
- L limonite
- Fe iron ore

Mg magnetite

Mn manganese

Mb marble

Oc ocher

Pegmatites
- Pg pegmatite
- M mica
- Brl beryl

P pyrite, includes chalcopyrite and sphalerite

Q quartzite

Sand and gravel, includes fill materials
- S sand
- SG sand and gravel
- Fm fill materials

Sh shale

Sl slate

T tripoli

ALUMINOSILICATES

SYMBOL		COUNTY	PROVINCE	TYPE	REF.	NAME	# QUADRANGLE
St	60	Cherokee	B.R.	L	(5)	N/A	115 Ball Ground West
K	90	Cherokee	B.R.	L	(5)	N/A	116 Ball Ground East
K	91	Cherokee	B.R.	L	(5)	N/A	116 Ball Ground East
K	102	Cherokee	B.R.	L	(5)	N/A	116 Ball Ground East
K	103	Cherokee	B.R.	L	(5)	N/A	115 Ball Ground West
K	11	Fulton	N.P.	L	(24)	Carter Property	186 Chamblee
K	27	Hall	S.P.	L	(37)	Harrington Property	120 Gainesville

ASBESTOS, TALC, SOAPSTONE, SERICITE AND CHLORITE

SYMBOL		COUNTY	PROVINCE	TYPE	REF.	NAME	# QUADRANGLE
Sp	1	Carroll	N.P.	L	(8)	W.W. Smith Property	256 Bowdon East
Sp	10	Carroll	N.P.	P	(8)	J.W. Stallings Property	257 Carrollton
Sp	11	Carroll	N.P.	P	(8)	W.A. Freeman Property	257 Carrollton
Sp	27	Carroll	N.P.	P	(17)	Rogers and McClendon	232 Villa Rica
A,Sp	40	Carroll	N.P.	P	(8)	McPherson (Lyle) Property	257 Carrollton
A,C	36	Carroll	N.P.	P	(17)	Paschal (Worthy) Property	257 Carrollton
Sp,A	37	Carroll	N.P.	P	(17)	McPherson Property	232 Villa Rica
Sp	38	Carroll	N.P.	P	(8)	J.W. Pitts Property	257 Carrollton
Tc	63	Cherokee	B.R.	L	(8)	Emma A. Cox Property	115 Ball Ground West
Sp	10	Cherokee	N.P.	Q	(20)	Verde Antique Quarry	137 South Canton
SP	9	Cherokee	N.P.	L	(8)	Frank Haws Property	137 South Canton
Sp	108	Cherokee	N.P.	P	(20)	Henry Cole Property	137 South Canton
Sp	116	Cherokee	B.R.	M	(8)	Brady Mine	114 Waleska
Sp	79	Cherokee	N.P.	L	(8)	J.J.Howell Property	138 Canton
Sc, Ch	30	Cherokee	B.R.	Q	(8)	Southern Talc Co.	137 Canton South
Sp	1	Clayton	S.P.	P	(8)	S.D. Moore Property	237 Southeast Atlanta
Tc	13	Cobb	N.P.	L	(35)	John S. Kemp Property	183 Lost Mountain
A	23	Cobb	N.P.	L	(8)	J.H. Cantrell Property	209 Mableton
Sp	40	DeKalb	S.P.	L		Soapstone Ridge	237 Southeast Atlanta
Sp	23	Douglas	N.P.	L	(8)	N/A	208 Austell
Sp	4	Douglas	N.P.	L	(8)	J.L. Walton Property	207 Nebo
Sp	8	Douglas	N.P.	Q	(8)	T.J. Carnes Property	233 Winston
Sp	9	Gwinnett	S.P.	P	(8)	Thomas Doss Property	164 Suwanee
Sp	14	Gwinnett	S.P.	P	(8)	N/A	187 Norcross
A	10	Hall	S.P.	L	(8)	Soapstone Hill	120 Gainesville
Tc	14	Hall	S.P.	L	(37)	Minor Reynolds Property	120 Gainesville
Sp	18	Paulding	N.P.	L	(8)	S.M. Harris Property	182 Dallas
A	32	Paulding	N.P.	P	(8)	Dean and Hunt Prospects	207 Nebo

BARITE

SYMBOL		COUNTY	PROVINCE	TYPE	REF.	NAME	# QUADRANGLE
B	176	Bartow	B.R.	L	(9)	Etowah Dev. Co.	136 Allatoona Dam
B	180	Bartow	B.R.	M	(9)	Iron Hill Mine	136 Allatoona Dam
B	47	Bartow	V.R.	M	(9)	Tucker Hollow Mine	135 Cartersville
B	48	Bartow	V.R.	M	(9)	Bertha Mine	135 Cartersville
B,Oc	49*	Bartow	V.R.	M	(15)	New Riverside Ocher	135 Cartersville
B	50	Bartow	V.R.	M	(9)	Kreb's Pigment and Chemical	135 Cartersville
B	51*	Bartow	V.R.	M	(15)	Paga Mining Co.	135 Cartersville
B,Oc	52	Bartow	V.R.	M	(9)	Ga. Peruvian Ocher Co.	135 Cartersville
B	53	Bartow	V.R.	M	(9)	Paga No. 3 Mine	135 Cartersville
B	54	Bartow	V.R.	M	(9)	Section House Mine	135 Cartersville
B	55	Bartow	V.R.	M	(9)	Nulsen Mine	135 Cartersville
B	56	Bartow	V.R.	M	(9)	DuPont Mine No. 2	135 Cartersville
B	57	Bartow	V.R.	M	(9)	Etowah Dev. Co.	135 Cartersville
B,Mn	58	Bartow	V.R.	M	(9)	Hebble Bros. Mine/ Etowah Dev. Co.	135 Cartersville
B	59	Bartow	V.R.	M	(9)	Etowah Dev. Co.	135 Cartersville
B	61	Bartow	V.R.	M	(9)	Etowah Dev. Co.	135 Cartersville
B	62	Bartow	V.R.	M	(9)	Etowah Dev. Co.	135 Cartersville
B	63	Bartow	V.R.	M	(9)	R.B. Satterfield	135 Cartersville
B	64	Bartow	V.R.	M	(9)	Big Creek Mine	135 Cartersville
B	65	Bartow	V.R.	M	(9)	Thompson-Weinman Co.	135 Cartersville
B	66	Bartow	V.R.	M	(9)	Clayton Mine	135 Cartersville
B	67	Bartow	V.R.	M	(9)	Parrott Springs Mine	135 Cartersville
B	68	Bartow	V.R.	M	(9)	Munford Lot Mine	135 Cartersville
B	69	Bartow	V.R.	M	(9)	Jones Property	135 Cartersville
B,Mn	106	Bartow	V.R.	M	(13)	Hurricane Hollow Mine	135 Cartersville
B	112	Bartow	V.R.	M	(13)	Georgia Barium and Ocher	135 Cartersville
B	116	Bartow	V.R.	M	(13)	N/A	135 Cartersville
B	259	Bartow	V.R.	M	(13)	Apex Mine	135 Cartersville
B	260	Bartow	V.R.	M	(13)	Winterbottom Mine	135 Cartersville
B	261	Bartow	V.R.	M	(13)	Reservoir Hill Mine	135 Cartersville
B	262	Bartow	V.R.	M	(13)	N/A	135 Cartersville
B,Oc	76	Bartow	V.R.	M	(9)	Cherokee Ochre Co.	135 Cartersville
B	71	Bartow	V.R.	P	(9)	Tumlin Lot	135 Cartersville
B	72	Bartow	V.R.	P	(9)	Harrison Chiles Property	135 Cartersville
B	73	Bartow	V.R.	P	(9)	McClatchey Property	135 Cartersville
B	74	Bartow	V.R.	P	(9)	Larey Property	135 Cartersville
B	75	Bartow	V.R.	P	(9)	Abramson Property	135 Cartersville
B	229	Bartow	V.R.	P	(9)	Norris-Hall Property	135 Cartersville
B	292	Bartow	V.R.	P	(9)	Carson Property	135 Cartersville
B	152	Bartow	V.R.	L	(9)	Richey Property	112 White West
B	153	Bartow	V.R.	L	(9)	Saxon Property	112 White West

BARITE (Continued)

SYMBOL		COUNTY	PROVINCE	TYPE	REF.	NAME	# QUADRANGLE
B	165	Bartow	V.R.	L	(9)	Brandon Property	157 Taylorsville
B	166	Bartow	V.R.	L	(9)	McCormick Property	157 Taylorsville
B	168	Bartow	V.R.	Q	(9)	Stephens Property	158 Burnt Hickory Ridge
B,L	169	Bartow	V.R.	Q	(9)	C.M. Jones (Chulafinnee) Property	158 Burnt Hickory Ridge
B	170	Bartow	V.R.	M	(9)	Big Tom Mine	158 Burnt Hickory Ridge
B	171	Bartow	V.R.	P	(9)	Pittsburg-Ga. Mining Co.	158 Burnt Hickory Ridge
B	173	Bartow	V.R.	M	(9)	N/A	158 Burnt Hickory Ridge
B,Mn	228	Bartow	V.R.	P	(9)	Holcombe Property	111 Adairsville
B	120	Cherokee	B.R.	P	(9)	White Property	114 Waleska
B	96	Floyd	V.R.	P	(9)	Whatley Property	110 Shannon
B	97	Floyd	V.R.	P	(9)	Braden Property	110 Shannon
B	12	Floyd	V.R.	P	(9)	Gibson Property	133 Wax

BAUXITE

SYMBOL		COUNTY	PROVINCE	TYPE	REF.	NAME	# QUADRANGLE
Bx	3	Bartow	V.R.	P	(32)	Fountain Prospect	133 Wax
Bx	4	Bartow	V.R.	P	(32)	Carroll (Martin) Prospect	133 Wax
Bx	6	Bartow	V.R.	P	(32)	Hatter Prospect	110 Shannon
Bx	9	Bartow	V.R.	P	(32)	Hawkins Mine	111 Adairsville
Bx	10	Bartow	V.R.	P	(32)	N/A	111 Adairsville
Bx	11	Bartow	V.R.	M	(32)	McGuire Mine	111 Adairsville
Bx	12	Bartow	V.R.	M	(32)	Connesuna Mine	111 Adairsville
Bx	13	Bartow	V.R.	M	(32)	Julia Mine	111 Adairsville
Bx	14	Bartow	V.R.	P	(32)	N/A	111 Adairsville
Bx	15	Bartow	V.R.	P	(32)	N/A	111 Adairsville
Bx	16	Bartow	V.R.	M	(32)	Warner (Waring) Mine	111 Adairsville
Bx	17	Bartow	V.R.	M	(32)	Clemons Mine	111 Adairsville
Bx	18	Bartow	V.R.	P	(32)	Spurlock Prospect	111 Adairsville
Bx	19	Bartow	V.R.	P	(32)	Green Prospect	111 Adairsville
Bx	20	Bartow	V.R.	P	(32)	Montague Prospect	111 Adairsville
Bx	21	Bartow	V.R.	P	(32)	Scott Prospect	111 Adairsville
Bx	22	Bartow	V.R.	M	(32)	Halt Mine	111 Adairsville
Bx	23	Bartow	V.R.	P	(32)	N/A	111 Adairsville
Bx	24	Bartow	V.R.	M	(32)	Mary Mine	111 Adairsville
Bx	25	Bartow	V.R.	P	(32)	N/A	111 Adairsville
Bx	26	Bartow	V.R.	P	(32)	Morrow Prospect	111 Adairsville
Bx	27	Bartow	V.R.	M	(32)	Sheets Mine	111 Adairsville
Bx	28	Bartow	V.R.	M	(32)	Terry Shaw Mine	111 Adairsville
Bx	29	Bartow	V.R.	M	(32)	N/A	111 Adairsville
Bx	30	Bartow	V.R.	P	(32)	N/A	111 Adairsville

BAUXITE (Continued)

SYMBOL		COUNTY	PROVINCE	TYPE	REF.	NAME	# QUADRANGLE
Bx	31	Bartow	V.R.	P	(32)	Davis #1 Prospect	111 Adairsville
Bx	32	Bartow	V.R.	P	(32)	Davis #2 Prospect	111 Adairsville
Bx	33	Bartow	V.R.	P	(32)	Gilreath Prospect	111 Adairsville
Bx	34	Bartow	V.R.	P	(32)	McGuire Prospect	111 Adairsville
Bx	35	Bartow	V.R.	M	(32)	Akin (Chisholm) Mine	111 Adairsville
Bx	36	Bartow	V.R.	M	(32)	Curtis Mine	111 Adairsville
Bx	6	Floyd	V.R.	M	(32)	N/A	133 Wax
Bx	7	Floyd	V.R.	P	(32)	Brannon Prospect	133 Wax
Bx	8	Floyd	V.R.	M	(32)	Cochran Mine	133 Wax
Bx	9	Floyd	V.R.	P	(32)	Freeman Prospect	133 Wax
Bx	11	Floyd	V.R.	P	(36)	Terhune Property	133 Wax
Bx	14	Floyd	V.R.	M	(32)	Minter Mines	132 Rome South
Bx	20	Floyd	V.R.	M	(36)	Kirkland Mine	132 Rome South
Bx	21	Floyd	V.R.	P	(36)	J.D. Erwin Property	132 Rome South
Bx	22	Floyd	V.R.	P	(32)	N/A	132 Rome South
Bx	23	Floyd	V.R.	M	(32)	Jeff Washington Mine	132 Rome South
Bx	24	Floyd	V.R.	P	(32)	Erwin Prospect	132 Rome South
Bx	25	Floyd	V.R.	P	(32)	Duke Prospect	132 Rome South
Bx	26	Floyd	V.R.	P	(32)	N/A	132 Rome South
Bx	27	Floyd	V.R.	P	(32)	Ritch Prospect	132 Rome South
Bx	28	Floyd	V.R.	M	(32)	Fomby Mine	132 Rome South
Bx	29	Floyd	V.R.	M	(32)	Kirkland (M.B. Woods) Mine	132 Rome South
Bx	30	Floyd	V.R.	P	(32)	Evans Mine	132 Rome South
Bx	32	Floyd	V.R.	P	(36)	Jere Dodd Property	132 Rome South
Bx	36	Floyd	V.R.	P	(32)	N/A	132 Rome South
Bx	37	Floyd	V.R.	P	(32)	N/A	132 Rome South
Bx	38	Floyd	V.R.	M	(32)	Howell Mine	132 Rome South
Bx	39	Floyd	V.R.	M	(32)	Fat John Mine	132 Rome South
Bx	40	Floyd	V.R.	M	(32)	Red Warrior Mine	132 Rome South
Bx	41	Floyd	V.R.	P	(32)	Lanham Prospect	132 Rome South
Bx	42	Floyd	V.R.	M	(32)	Bobo Mine	132 Rome South
Bx	84	Floyd	V.R.	M	(32)	Burney Mine	110 Shannon
Bx	79	Floyd	V.R.	M	(32)	Watters (Perry) Mine	110 Shannon
Bx	80	Floyd	V.R.	M	(32)	Maddox Mine	110 Shannon
Bx	78	Floyd	V.R.	P	(32)	Kerce Prospect	110 Shannon
Bx	82	Floyd	V.R.	P	(32)	Watters Prospect	110 Shannon
Bx	83	Floyd	V.R.	M	(32)	Wright Mine	110 Shannon
Bx	81	Floyd	V.R.	M	(32)	Ward Mine	110 Shannon
Bx	85	Floyd	V.R.	P	(32)	N/A	110 Shannon
Bx	86	Floyd	V.R.	P	(32)	N/A	110 Shannon
Bx	87	Floyd	V.R.	M	(32)	Otts Mines	110 Shannon
Bx	88	Floyd	V.R.	M	(32)	New Holland Mine	110 Shannon
Bx	89	Floyd	V.R.	M	(32)	Holland Mines	110 Shannon

BAUXITE (Continued)

SYMBOL		COUNTY	PROVINCE	TYPE	REF.	NAME	# QUADRANGLE
Bx	90	Floyd	V.R.	P	(32)	Ridge Valley No. 1	110 Shannon
Bx	91	Floyd	V.R.	M	(32)	Armstrong Mine	110 Shannon
Bx	92	Floyd	V.R.	M	(32)	Stockade Mine	110 Shannon
Bx	93	Floyd	V.R.	P	(32)	N/A	110 Shannon
Bx	94	Floyd	V.R.	P	(36)	J.S. Roach Property	110 Shannon
Bx	103	Floyd	V.R.	P	(32)	Hiram-Bobo Prospect	155 Cedartown East
Bx	105	Floyd	V.R.	M	(32)	Doyle Mine	155 Cedartown East
Bx	106	Floyd	V.R.	P	(32)	Willis Reynolds	155 Cedartown East
Bx	107	Floyd	V.R.	P	(32)	N/A	155 Cedartown East
Bx	108	Floyd	V.R.	P	(32)	N/A	155 Cedartown East
Bx	109	Floyd	V.R.	M	(32)	Booger Hollow Creek	155 Cedartown East
Bx	110	Floyd	V.R.	P	(32)	Minter Prospect	155 Cedartown East
Bx	112	Floyd	V.R.	M	(32)	Bradshaw (Bonsack) Mine	155 Cedartown East
Bx	113	Floyd	V.R.	M	(32)	North Ware Mt. Mine	155 Cedartown East
Bx	114	Floyd	V.R.	M	(32)	Reese Mine	155 Cedartown East
Bx	115	Floyd	V.R.	M	(32)	Wharton (Mitchell) Mine	155 Cedartown East
Bx	116	Floyd	V.R.	P	(32)	Maggie Burkhalter Prospect	155 Cedartown East
Bx	117	Floyd	V.R.	P	(32)	N/A	155 Cedartown East
Bx	118	Floyd	V.R.	L	(32)	N/A	155 Cedartown East
Bx	119	Floyd	V.R.	P	(32)	Hiram-Bobo Prospect	155 Cedartown East
Bx	120	Floyd	V.R.	P	(32)	Brannon Prospect	155 Cedartown East
Bx	121	Floyd	V.R.	M	(32)	Diamond Mine	155 Cedartown East
Bx	122	Floyd	V.R.	M	(32)	South Ware Mt. Mine	155 Cedartown East
Bx	123	Floyd	V.R.	P	(32)	Bush Washington Prospect	155 Cedartown East
Bx	49	Polk	V.R.	M	(32)	Broadway (Bigelow) Mine	155 Cedartown East
Bx	50	Polk	V.R.	P	(32)	N/A	155 Cedartown East
Bx	51	Polk	V.R.	L	(32)	N/A	155 Cedartown East
Bx	52	Polk	V.R.	P	(32)	Drummond Prospect	155 Cedartown East

CLAY

SYMBOL		COUNTY	PROVINCE	TYPE	REF.	NAME	# QUADRANGLE
Sh/Cly	42	Bartow	V.R.	P	(28)	Boyd Orchard Co.	111 Adairsville
Sh/Cly	124	Bartow	V.R.	P	(28)	Jim Nolan Property	135 Cartersville
Cly	125	Bartow	V.R.	P	(28)	R.E. Adair Property	135 Cartersville
Sh/Cly	155	Bartow	V.R.	Q	(28)	W.D. Pittard Property	112 White West
Sh/Cly	156	Bartow	V.R.	L	(28)	Black, Randolf, Guyton & Ward Property	112 White West
Cly	24	Cobb	S.P.	Q	(28)	Chattahoochee Brick Co.	209 Mableton
Cly	17*	Douglas	S.P.	Pit	(15)	Siskey Hauling Inc.	234 Campbellton
Cly	24*	Douglas	S.P.	Pit	(15)	Jenkins Brick Co.	235 Ben Hill
Sh/Cly	48	Floyd	V.R.	M	(28)	B. Mifflin Hood Property	132 Rome South

CLAY (Continued)

SYMBOL		COUNTY	PROVINCE	TYPE	REF.	NAME	# QUADRANGLE
Sh/Cly	59	Floyd	V.R.	Q	(28)	Romega Clay Products	109 Rome North
Cly	73	Floyd	V.R.	P	(36)	N/A	110 Shannon
Cly	12*	Fulton	S.P.	M	(15)	Chattahoochee Brick Co.	234 Campbellton
Cly	1	Hall	S.P.	P	(37)	O.P. Henderson	142 Flowery Branch
Cly	19	Hall	S.P.	L	(37)	Desoto Mica Mine	120 Gainesville
Cly	61*	Polk	V.R.	Pit	(15)	Marquette Cement Mfg. Co.	156 Rockmart North

CORUNDUM

SYMBOL		COUNTY	PROVINCE	TYPE	REF.	NAME	# QUADRANGLE
C	33	Carroll	N.P.	L	(14)	N/A	258 Hulett
C	10	Cobb	N.P.	L	(14)	N/A	183 Lost Mountain
C	20	Cobb	N.P.	P	(14)	W.B. Turner Farm	208 Austell
C	21	Cobb	N.P.	P	(14)	N/A	208 Austell
C	2	Forsyth	N.P.	P	(14)	Tuggle Property	164 Suwanee
C	11	Hall	S.P.	L	(14)	N/A	120 Gainesville
C	1	Paulding	N.P.	P	(14)	N/A	158 Burnt Hickory Ridge
C	33	Paulding	N.P.	L	(14)	N/A	207 Nebo

FLAGSTONE

SYMBOL		COUNTY	PROVINCE	TYPE	REF.	NAME	# QUADRANGLE
F	294	Bartow	V.R.	Q		N/A	113 White East
F,G	17	Hall	N.P.	Q	(37)	D.L. Evans Quarry	120 Gainesville

GOLD

SYMBOL		COUNTY	PROVINCE	TYPE	REF.	NAME	# QUADRANGLE
Au	123	Bartow	N.P.	P	(39)	Robertson Property	159 Acworth
Au	188	Bartow	B.R.	M	(39)	Avery Mine (Gold Branch)	159 Acworth
Au	132	Bartow	N.P.	P	(39)	Howard Property	159 Acworth
Au	186	Bartow	N.P.	M	(39)	W.M. Goings Property	136 Allatoona Dam
Au	189	Bartow	N.P.	P	(39)	S.D. McDaniel Property	159 Acworth
Au	190	Bartow	N.P.	P	(39)	Allatoona Vein	159 Acworth
Au	191	Bartow	N.P.	M	(39)	Glade Mine	159 Acworth
Au	7	Carroll	N.P.	M	(12)	Bonner Mine	256 Bowdon East
Au	8	Carroll	N.P.	M,P	(12)	Stacy Mine, Stacy Property	257 Carrollton
Au	20	Carroll	N.P.	P	(12)	J.L. Davis Property	232 Villa Rica
Au	21	Carroll	N.P.	M	(12)	Chambers Mine	232 Villa Rica

GOLD (Continued)

SYMBOL		COUNTY	PROVINCE	TYPE	REF.	NAME	# QUADRANGLE
Au	22	Carroll	N.P.	P	(12)	Hixon Property	232 Villa Rica
Au	23	Carroll	N.P.	M	(39)	Hart Mine	232 Villa Rica
Au	24	Carroll	N.P.	M	(12)	Lassetter Property	232 Villa Rica
Au	25	Carroll	N.P.	M	(39)	Clopton (Clompton) Mine	232 Villa Rica
Au	29	Carroll	N.P.	M	(12)	Southern Klondyke Mine	206 New Georgia
Au	30	Carroll	N.P.	M	(12)	Jones Mine	232 Villa Rica
Au	1	Cherokee	N.P.	M	(39)	Stansill Property	136 Allatoona Dam
Au	4	Cherokee	N.P.	M	(39)	301 Mine (Farrar)	137 South Canton
Au	3	Cherokee	N.P.	P	(12)	Lovingood Prospect	137 South Canton
Au	13	Cherokee	N.P.	M	(12)	Haynes Property	137 South Canton
Au	14	Cherokee	N.P.	M	(39)	Haynes Property	137 South Canton
Au	15	Cherokee	N.P.	M	(12)	LaBelle Mine	137 South Canton
Au	16	Cherokee	N.P.	M	(39)	Putnam Mine	137 South Canton
Au	17	Cherokee	N.P.	P	(39)	Macou Prospect	137 South Canton
Au	18	Cherokee	N.P.	M	(39)	Cherokee Mine	137 South Canton
Au	110	Cherokee	N.P.	P	(39)	Casteel Property	137 South Canton
Au	111	Cherokee	N.P.	P	(39)	Cox Property	116 Ball Ground East
Au	112	Cherokee	N.P.	M	(12)	Georgiana Mine	159 Acworth
Au	113	Cherokee	N.P.	P	(39)	Tripp Property	159 Acworth
Au	114	Cherokee	N.P.	M	(12)	Granville Mine	159 Acworth
Au	115	Cherokee	N.P.	P	(39)	Bailey Prospect	161 Mountain Park
Au	22	Cherokee	N.P.	M	(39)	Coggins Property	137 South Canton
Au	23	Cherokee	N.P.	M	(39)	Clarkston Mine	137 South Canton
Au	24	Cherokee	N.P.	M	(39)	Williams Property	137 South Canton
Au	25	Cherokee	N.P.	P	(39)	Evans (Cobb) Prospect	137 South Canton
Au	27	Cherokee	N.P.	L	(39)	William Poor's Property	137 South Canton
Au	32	Cherokee	N.P.	M,P	(12)	Bell Mine (Bell-Star)	160 Kennesaw
P,Au	33	Cherokee	N.P.	M	(12)	Southern Star Mine (Bell-Star)	160 Kennesaw
Au	34	Cherokee	N.P.	L	(39)	Williams-Williamson Property	160 Kennesaw
Au	35	Cherokee	N.P.	M	(39)	Kellogg Mine	160 Kennesaw
Au	36	Cherokee	N.P.	L	(39)	Kitchens Property	160 Kennesaw
Au	44	Cherokee	N.P.	M	(39)	Creighton or Franklin Mine	116 Ball Ground East
Au	50	Cherokee	N.P.	M	(12)	Latham Mine	116 Ball Ground East
Au	51	Cherokee	N.P.	M	(39)	Sandow Mine	116 Ball Ground East
Au	52	Cherokee	N.P.	P	(12)	Richards-Smith Property	116 Ball Ground East
Au	53	Cherokee	N.P.	L	(39)	S.R. Smith Property	116 Ball Ground East
Au	58	Cherokee	N.P.	L	(39)	Frank Burt's Property	116 Ball Ground East
Au	75	Cherokee	N.P.	P	(12)	Chester Prospect	162 Roswell
Au	80	Cherokee	N.P.	M	(39)	Davis Mine (Owl Hollow)	138 Canton
Au	81	Cherokee	N.P.	M	(39)	Whorley Mine	138 Canton
Au	84	Cherokee	N.P.	M	(39)	Rudicil Mine	139 Birmingham
Au	85	Cherokee	N.P.	L	(39)	T.N. Westbrook Property	139 Birmingham
Au	26	Cherokee	B.R.	L	(12)	Case Property	137 South Canton

GOLD (Continued)

SYMBOL		COUNTY	PROVINCE	TYPE	REF.	NAME	# QUADRANGLE
Au	19	Cherokee	N.P.	M	(39)	Downing Creek Placer	137 South Canton
Au	20	Cherokee	N.P.	M	(39)	McCandless Property	137 South Canton
Au	21	Cherokee	N.P.	M	(39)	Sixes Mine	137 South Canton
Au	28	Cherokee	B.R.	P	(12)	Bentley Prospect	137 South Canton
Au	6	Cobb	N.P.	P	(39)	Cox Property	160 Kennesaw
Au	11	Cobb	N.P.	M	(39)	W.H. Hadaway Property	183 Lost Mountain
Au	12	Cobb	N.P.	P	(39)	J.B. Kemp Property	183 Lost Mountain
Au	14	Cobb	N.P.	M	(12)	Mason Mine	183 Lost Mountain
Au	15	Cobb	N.P.	L	(39)	Hathaway Property	183 Lost Mountain
Au	28	Cobb	N.P.	P	(39)	Payne, Kendrick, Randall & Hause Properties	159 Acworth
Au	29	Cobb	N.P.	M	(39)	Hamilton Mine	159 Acworth
Au	30	Cobb	N.P.	M	(12)	Freeman Mine	159 Acworth
Au	7	Coweta	S.P.	M	(12)	Clarke and Hill Property	286 Whitesburg
Au	1	Dawson	N.P.	M	(12)	Kin Mori Mine	117 Matt
Au	2	Dawson	N.P.	P	(12)	Barrett Mining Co.	117 Matt
Au	3	Dawson	N.P.	P	(12)	McGuire Property	117 Matt
Au	4	Dawson	N.P.	P	(12)	Looper Property	117 Matt
Au	3	Douglas	N.P.	M	(12)	Triglone Mine (Astinol Co.)	207 Nebo
Au	6	Douglas	N.P.	P	(39)	Thomas Roach Property	207 Nebo
Au	9	Douglas	N.P.	M	(12)	Roach Mine	233 Winston
Au	10	Douglas	N.P.	P	(12)	Carnes Property	233 Winston
Au	11	Douglas	N.P.	L	(39)	John Baggett Property	233 Winston
Au,P	13	Douglas	N.P.	P	(39)	Durgy Property (Villa Rica Mine)	206 New Georgia
Au	10	Forsyth	N.P.	M	(39)	Strickland Mine	117 Matt
Au	11	Forsyth	N.P.	M	(39)	A.D. Campbell Mine	163 Duluth
Au	7	Fulton	S.P.	P	(12)	N/A	210 NW Atlanta
Au	36	Fulton	S.P.	P	(39)	Little and Goodwin Property	186 Chamblee
Au	2	Fulton	N.P.	P	(12)	Mason or Gold Lot	162 Roswell
Au	38	Fulton	N.P.	P	(12)	McClure Prospect	163 Duluth
Au	3	Fulton	N.P.	P	(12)	N/A	162 Roswell
Au	37	Fulton	N.P.	P	(39)	Brown Property	163 Duluth
Au	1	Gwinnett	N.P.	M	(39)	Piedmont (Newton) Mine	164 Suwanee
Au	2	Gwinnett	N.P.	P	(39)	Shelly Property	164 Suwanee
Au	3	Gwinnett	N.P.	M	(39)	Percy Gold mine	164 Suwanee
Au	4	Gwinnett	N.P.	M	(39)	Moore & Brogden Property	164 Suwanee
Au	5	Gwinnett	N.P.	M	(39)	Moore & Brogden Property	164 Suwanee
Au	6	Gwinnett	N.P.	P	(39)	Roberts Property	164 Suwanee
Au	7	Gwinnett	N.P.	M	(39)	Harris Property	164 Suwanee
Au	11	Gwinnett	N.P.	M	(12)	Richland Gold Mining Co.	141 Buford Dam
Au	12	Gwinnett	N.P.	M	(12)	Owens Mine	141 Buford Dam
Au	12	Hall	N.P.	L	(39)	Longstreet Property	120 Gainesville
Au,M	13	Hall	S.P.	P	(37)	Will Stephens Property	120 Gainesville

GOLD (Continued)

SYMBOL		COUNTY	PROVINCE	TYPE	REF.	NAME	# QUADRANGLE
Au	16	Hall	N.P.	L	(37)	John Harrington Property	120 Gainesville
Au	18	Hall	N.P.	M	(37)	G.A. Elrod & Big Joe Mine	120 Gainesville
Au,M	28	Hall	N.P.	Q	(39)	Merck Property	120 Gainesville
Au	15	Hall	S.P.	L	(37)	Hubert Peck Property	120 Gainesville
Au	20	Hall	S.P.	L	(37)	A.W. Bell Vein	120 Gainesville
Au	24	Hall	S.P.	M	(39)	Joseph Roberts Mine	120 Gainesville
Au	25	Hall	S.P.	M	(39)	Mammoth Mine	120 Gainesville
Au	14	Douglas	N.P.	M	(39)	Pine Mt. (Stockmar) Mine	206 New Georgia
Au	25	Douglas	N.P.	M	(12)	McManus Property (Southern States Mining)	206 New Georgia
Au	26	Douglas	N.P.	M	(39)	212 Prospect (Southern States Mining)	206 New Georgia
Au	28	Douglas	N.P.	P	(12)	N/A	232 Villa Rica
Au	1	Forsyth	N.P.	M	(12)	Harris Property	164 Suwanee
Au	3	Forsyth	N.P.	M	(39)	Collins Property	164 Suwanee
Au	4	Forsyth	N.P.	P	(12)	Little Property	163 Duluth
Au	13	Forsyth	N.P.	P	(34)	Dr. Mashburn Property	141 Buford Dam
Au	6	Forsyth	N.P.	P	(39)	Sawnee Mtn. Property	140 Cumming
Au	7	Forsyth	N.P.	P	(39)	Parks and Fowler Property	139 Birmingham
Au	8	Forsyth	N.P.	P	(39)	Parks and Fowler Property	140 Cumming
Au	9	Forsyth	N.P.	M	(39)	Charles Mine	117 Matt
Au	26	Hall	S.P.	L	(39)	O'Shields Property	120 Gainesville
Au	7	Haralson	N.P.	M	(12)	Edwards Mine	204 Buchanan
Au	9	Haralson	N.P.	L	(39)	J.W. Thomason (Placer)	205 Draketown
Au	12	Haralson	N.P.	L	(39)	McBrayer or Singleton (Placer)	205 Draketown
Au	22	Haralson	N.P.	L	(12)	Dean Property	205 Draketown
Au	1	Heard	S.P.	L	(12)	Hardagree Property	285 Lowell
Au	2	Paulding	N.P.	P	(39)	Sheffield and Heidt	158 Burnt Hickory Ridge
Au	3	Paulding	N.P.	M	(39)	Hodges Property	158 Burnt Hickory Ridge
Au	4	Paulding	N.P.	M	(39)	Hobbs Mine	158 Burnt Hickory Ridge
Au	5	Paulding	N.P.	M	(39)	Austin (Placer) Mines	207 Nebo
Au	7	Paulding	N.P.	P	(39)	Parker Property	159 Acworth
Au	9	Paulding	N.P.	P	(39)	Michigan Gold Mining Co. (Placer)	157 Taylorsville
Au	36	Paulding	N.P.	M	(1)	Dunnaway Mine	158 Burnt Hickory Ridge
Au	37	Paulding	N.P.	M	(1)	Twilley Mine	158 Burnt Hickory Ridge
Au	38	Paulding	N.P.	M	(1)	Russell Mine	158 Burnt Hickory Ridge
Au	39	Paulding	N.P.	M	(1)	Merritt Mine	158 Burnt Hickory Ridge
Au	41	Paulding	N.P.	P	(39)	Mathews Property	157 Taylorsville
Au	12	Paudling	N.P.	M	(39)	J.B. Barton Property	181 Yorkville
Au	13	Paulding	N.P.	M	(39)	Yorkville Mine	181 Yorkville
Au	14	Paulding	N.P.	P	(12)	N/A	182 Dallas

GRANITE, CRUSHED AND DIMENSION

SYMBOL		COUNTY	PROVINCE	TYPE	REF.	NAME	# QUADRANGLE
G	34*	Carroll	S.P.	Q	(15)	County Rock Pit	286 Whitesburg
G	35*	Carroll	N.P.	Q	(15)	Villa Rica Quarry; Vulcan Materials Co.	232 Villa Rica
G	40	Carroll	N.P	Q		N/A	232 Villa Rica
G	5*	Clayton	S.P.	Q	(15)	Forest Park Quarry; Florida Rock Industries	262 Riverdale
G	34*	Cobb	N.P.	Q	(15)	Kennesaw Quarry; Vulcan Materials Co.	160 Kennesaw
G	35	Cobb	N.P.	Q		N/A	160 Kennesaw
G	1	Coweta	S.P.	Q	(30)	Overby Quarry	288 Madras
G	2	Coweta	S.P.	Q		N/A	288 Madras
G	6*	Coweta	S.P.	Q	(15)	Madras or McCollum Quarry; Vulcan Materials Co.	288 Madras
G	4	Coweta	S.P.	Q	(30)	R.D. Cole Quarry	287 Newnan North
G	1	DeKalb	S.P.	Q	(30)	Thomas Quarry	239 Conyers
G	2	DeKalb	S.P.	Q	(30)	Southern Granite	239 Conyers
G	3	DeKalb	S.P.	Q	(30)	Bosier Quarry	239 Conyers
G	4	DeKalb	S.P.	Q	(30)	Weeks Quarry	239 Conyers
G	5	DeKalb	S.P.	Q	(30)	Weeks Quarry	239 Conyers
G	6	DeKalb	S.P.	Q	(30)	Duncan Quarry	239 Conyers
G	7	DeKalb	S.P.	Q	(30)	Johnson Quarry	239 Conyers
G	8	DeKalb	S.P.	Q	(30)	J.H. Chupp Quarry	239 Conyers
G	9	DeKalb	S.P.	Q	(30)	Goddard Quarry	239 Conyers
G	10	DeKalb	S.P.	Q	(30)	Mt. Arabia Quarry	239 Conyers
G	11	DeKalb	S.P.	Q	(30)	Brantley Quarry	239 Conyers
G	12	DeKalb	S.P.	Q	(30)	Cooper Quarry	239 Conyers
G	14	DeKalb	S.P.	Q	(30)	Jenkins Quarry	239 Conyers
G	15	DeKalb	S.P.	Q	(30)	Crossley Quarry	239 Conyers
G	16*	DeKalb	S.P.	Q	(15)	Big Ledge Quarry; Davidson Mineral Properties	239 Conyers
G	17	DeKalb	S.P.	Q	(30)	Braswell Quarry	239 Conyers
G	18	DeKalb	S.P.	Q	(30)	Brand Quarry	239 Conyers
G	19	DeKalb	S.P.	Q	(30)	Mary Reagin Quarry	239 Conyers
G	20	DeKalb	S.P.	Q	(30)	Ga. Railroad Quarry	239 Conyers
G	21	DeKalb	S.P.	Q	(30)	Pine Mt. Quarry	239 Conyers
G	22	DeKalb	S.P.	Q	(30)	Wilson Quarry	239 Conyers
G	23	DeKalb	S.P.	Q	(30)	Whitley Quarry	239 Conyers
G	24	DeKalb	S.P.	Q	(30)	Lee Bros. Quarry	239 Conyers
G	25	DeKalb	S.P.	Q	(30)	Walker Quarry	239 Conyers
G	26	DeKalb	S.P.	Q	(30)	Turner Quarry	239 Conyers
G	27	DeKalb	S.P.	Q	(30)	McDaniel Quarry	239 Conyers
G	28	DeKalb	S.P.	Q	(30)	Stone Mt. Quarry	212 Stone Mountain
G	29	DeKalb	S.P.	Q	(30)	Nash & McCurdy Quarry	212 Stone Mountain
G	30	DeKalb	S.P.	Q	(30)	Veal Quarry	212 Stone Mountain

GRANITE, CRUSHED and DIMENSION (Continued)

SYMBOL		COUNTY	PROVINCE	TYPE	REF.	NAME	# QUADRANGLE
G	31	DeKalb	S.P.	Q	(30)	Thompson Quarry	212 Stone Mountain
G	32	DeKalb	S.P.	Q	(30)	Shepard Quarry	212 Stone Mountain
G	33	DeKalb	S.P.	Q	(30)	Wiggins Quarry	238 Redan
G	34	DeKalb	S.P.	Q	(30)	Floyd Quarry	238 Redan
G	35	DeKalb	S.P.	Q	(30)	Wade Quarry	238 Redan
G	36	DeKalb	S.P.	Q	(30)	Jake Chupp Quarry	238 Redan
G	38	DeKalb	S.P.	Q	(30)	Rock Chapel Mtn. Quarries	213 Snellville
G	40*	DeKalb	S.P.	Q	(15)	Consolidated Quarry	239 Conyers
G	41*	DeKalb	S.P.	Q	(15)	McDowell Materials Co.	239 Conyers
G	42*	DeKalb	S.P.	Q	(15)	North Ga. Quarry; Coffee Granite Co.	238 Redan
G	43*	DeKalb	S.P.	Q	(15)	Reagin Granite Co.	239 Conyers
G	44*	DeKalb	S.P.	Q	(15)	Rennie Granite Co.	239 Conyers
G	19*	Douglas	N.P.	Q	(15)	Consolidated Quarries; Div. Georgia Marble Co.	233 Winston
G	20*	Douglas	N.P.	Q	(15)	Lithia Springs Quarry; Vulcan Materials Co.	208 Austell
G	24	Douglas	N.P.	Q	(15)	N/A	208 Austell
G	3*	Fayette	S.P.	Q	(15)	Tyrone Quarry; Florida Rock Ind.	289 Tyrone
G	5*	Forsyth	N.P.	Q	(15)	Hall Aggregates; Div. Ga. Marble Co.	140 Cumming
G	16*	Fulton	S.P.	Q	(15)	Red Oak Quarry; Vulcan Materials Co.	261 Fairburn
G	34*	Fulton	S.P.	Q	(15)	Ben Hill Quarry; Davidson Mineral Properties	235 Ben Hill
G	35*	Fulton	S.P.	Q	(15)	Bellwood Quarry; C.W. Matthews Construction	210 Northwest Atlanta
G	15*	Gwinnett	S.P.	Q	(15)	Norcross Quarry; Vulcan Materials	187 Norcross
G	16	Gwinnett	S.P.	P	(30)	Tribble and Bennett Prospect	189 Lawrenceville
G	28	Gwinnett	S.P.	P	(30)	McElvany Shoals Property	189 Lawrenceville
G,SG	18	Gwinnett	S.P.	L	(30)	Ewing Property	189 Lawrenceville
G	19	Gwinnett	S.P.	Q	(30)	Bush Quarry	190 Bold Springs
G	20	Gwinnett	S.P.	Q	(30)	Langley Quarry	214 Loganville
G	21	Gwinnett	S.P.	L	(30)	Mayfield Property	214 Loganville
G	22	Gwinnett	S.P.	Q	(30)	Rockmore Quarry	214 Loganville
G	23	Gwinnett	S.P.	Q	(30)	Lawrenceville Quarry	188 Luxomni
G	24	Gwinnett	S.P.	Q	(30)	Cates Quarry	188 Luxomni
G	25	Gwinnett	S.P.	Q	(30)	Sawyer Quarries	213 Snellville
G	26	Gwinnett	S.P.	Q	(30)	Snell Quarry	213 Snellville
G	17*	Gwinnett	S.P.	Q	(15)	Grayson Quarry; Vulcan Materials	189 Lawrenceville
G	29*	Hall	S.P.	Q	(15)	Gainesville Stone Co; Candler Quarry	143 Chestnut Mountain
G	30*	Hall	S.P.	Q	(15)	Hall Aggregates; Div. Ga. Marble Co.	142 Flowery Branch

GRANITE, CRUSHED and DIMENSION (Continued)

SYMBOL		COUNTY	PROVINCE	TYPE	REF.	NAME	# QUADRANGLE
G,F	17	Hall	S.P.	Q	(37)	D.L. Evans Quarry	120 Gainesville
G	2*	Henry	S.P.	Q	(15)	Stockbridge Quarry; Vulcan Materials	264 Stockbridge
G	1	Newton	S.P.	P	(30)	Perry Property	267 Covington
G	2	Newton	S.P.	Q	(30)	Freeman Quarry	267 Covington
G	3	Newton	S.P.	Q	(15)	Consolidated Quarries; Div. Ga. Marble Co.	240 Milstead
G	34	Paulding	N.P.	Q	(15)	Dallas Rock Products	182 Dallas
G	35*	Paulding	N.P.	Q	(15)	Paulding County Comm.	182 Dallas
G	1	Rockdale	S.P.	Q	(30)	Paper-Mill Quarry	239 Conyers
G	2	Rockdale	S.P.	Q	(30)	Redwine & James Quarry	239 Conyers
G	3	Rockdale	S.P.	Q	(30)	Almand Quarry	239 Conyers
G	4	Rockdale	S.P.	Q	(30)	Goode Quarry	239 Conyers
G	5	Rockdale	S.P.	Q	(30)	Pierce Quarry	239 Conyers
G	6	Rockdale	S.P.	Q	(30)	Reagan Quarry	239 Conyers
G	7	Rockdale	S.P.	Q	(30)	Tilly Quarry	239 Conyers
G	1	Walton	S.P.	P	(30)	Braswell Opening	214 Loganville

GRAPHITE

SYMBOL		COUNTY	PROVINCE	TYPE	REF.	NAME	# QUADRANGLE
Gr	172	Bartow	B.R.	Q	(28)	Old Atlanta Vitrified Brick Co.	158 Burnt Hickory Ridge
Gr	232	Bartow	B.R.	M	(13)	American Chemical Mining Co.	159 Acworth
Gr	25	Cobb	N.P.	P	(35)	Mary Moore Property	209 Mableton
Gr	26	Cobb	N.P.	P	(35)	Posey Property	209 Mableton
G	2	Hall	S.P.	P	(37)	G.E. White Property	142 Flowery Branch
Gr,M	4	Hall	S.P.	P	(37)	L.T. Westbrook Property	142 Flowery Branch
Gr	9	Hall	S.P.	P	(37)	Chicopee Mfg. Co.	142 Flowery Branch
Gr	23	Hall	S.P.	L	(37)	Chicopee Mfg. Co.	120 Gainesville

LIMESTONE

SYMBOL		COUNTY	PROVINCE	TYPE	REF.	NAME	# QUADRANGLE
Ls	44	Bartow	V.R.	M	(18)	Howard Hydraulic Cement Co. Mine	111 Adairsville
Ls	45	Bartow	V.R.	Q	(21)	Charle and Jarrett Quarry	111 Adairsville
Ls	46	Bartow	V.R.	Q	(18)	Clifford Lime and Stone	111 Adairsville
Ls	126	Bartow	V.R.	M/Q	(18)	Ladd Lime Co.	135 Cartersville
Ls	127	Bartow	V.R.	Q	(21)	Ladd Lime and Cement Quarry	135 Cartersville
Ls	151	Bartow	V.R.	Q	(21)	Marquette Cement Co. Quarry	134 Kingston
Ls	160	Bartow	V.R.	P	(21)	Sophia Prospect	112 White West

LIMESTONE (Continued)

SYMBOL		COUNTY	PROVINCE	TYPE	REF.	NAME	# QUADRANGLE
Ls	161	Bartow	V.R.	P	(21)	Gum Spring Prospect	112 White West
Ls	162	Bartow	V.R.	Q	(21)	J.H. Perry Quarry	112 White West
Ls	219	Bartow	V.R.	Q	(21)	Stockbridge Stone Quarry	113 White East
Ls	231*	Bartow	V.R.	Q	(15)	Conasauga Lime Corp.; Div. New Riverside Ocher	113 White East
Ls	34	Floyd	V.R.	Q	(36)	County Limestone Quarry	132 Rome South
Ls	49*	Floyd	V.R.	Q	(15)	Rome Quarry; Florida Rock Industries	109 Rome North
Ls	50	Floyd	V.R.	P	(20)	Six Mile Station Prospect	132 Rome South
Ls	51	Floyd	V.R.	P	(18)	J. Scott Property	132 Rome South
Ls	52	Floyd	V.R.	Q	(18)	Six Mile Station Prospect	132 Rome South
Ls	53	Floyd	V.R.	P	(21)	Big Cedar Creek Prospect	132 Rome South
Ls	56	Floyd	V.R.	P	(36)	H.M. Ponder Property	109 Rome North
Ls	57	Floyd	V.R.	P	(36)	A.H. Salmon Property	109 Rome North
Ls	58	Floyd	V.R.	P	(18)	Orsman Prospect	109 Rome North
Ls	65	Floyd	V.R.	Q	(21)	Old Huffaker RR Station Quarry	109 Rome North
Ls	66	Floyd	V.R.	P	(21)	Rome Prospect	109 Rome North
Ls	67	Floyd	V.R.	Q	(21)	Public Works Quarry	132 Rome South
Ls	68	Floyd	V.R.	L	(18)	N/A	109 Rome North
Ls	69	Floyd	V.R.	L	(18)	N/A	109 Rome North
Ls	72	Floyd	V.R.	P	(36)	W.M. Clemmons Property	110 Shannon
Ls	95	Floyd	V.R.	Q	(36)	Pinson Quarry	110 Shannon
Ls	22	Hall	S.P.	Q	(37)	Deal Lime Co. Quarry	120 Gainesville
Ls	7	Polk	V.R.	Q	(18)	Marble Hill Lime Quarries	180 Rockmart South
Ls	8	Polk	V.R.	L	(18)	Morgan Hills	180 Rockmart South
Ls	20	Polk	V.R.	L	(18)	Young's Station	179 Felton
Ls	30	Polk	V.R.	Q	(21)	Marquette Cement Co.	156 Rockmart North
Ls	32	Polk	V.R.	P	(18)	Bald Mt. Portland Cement Co.	156 Rockmart North
Ls	33	Polk	V.R.	L	(18)	Savette Property	156 Rockmart North
Ls	34	Polk	V.R.	L	(18)	Aragon Station (Seabord RR)	156 Rockmart North
Ls	35	Polk	V.R.	Q	(18)	Southern Lime Mfg. Co. Quarry	156 Rockmart North
Ls	36	Polk	V.R.	Q	(18)	Piedmont Cement Co. Quarry	156 Rockmart North

LIMONITE AND OTHER IRON ORE

SYMBOL		COUNTY	PROVINCE	TYPE	REF.	NAME	# QUADRANGLE
L	185	Bartow	B.R.	Q	(7)	J.M. Knight (Iron Hill) Quarry	136 Allatoona Dam
L	178	Bartow	B.R.	Q	(7)	Etowah Dev. and Iron Co.	136 Allatoona Dam
L	179	Bartow	B.R.	Q	(7)	Etowah Dev. Co.; Crow Ore Bank	136 Allatoona Dam
L	184	Bartow	V.R.	Q	(7)	P.M. Mansfield Quarry	136 Allatoona Dam
L	187	Bartow	V.R.	Q	(7)	Tennessee Coal, Iron and Railroad Co.	159 Acworth
L	192	Bartow	V.R.	L	(7)	Dysert Property	113 White East

LIMESTONE and other IRON ORE (Continued)

SYMBOL		COUNTY	PROVINCE	TYPE	REF.	NAME	# QUADRANGLE
L	193	Bartow	V.R.	L	(7)	H. Goode Property	113 White East
L	194	Bartow	V.R.	M	(7)	Conner Ore Bank	113 White East
L	195	Bartow	V.R.	M	(7)	Big Mt. Ore Bank	113 White East
L	196	Bartow	V.R.	M	(7)	J.J. Bennett Property	113 White East
L	197	Bartow	V.R.	M	(7)	J.B. Mahon Property	113 White East
L	134	Bartow	V.R.	M	(13)	Big Mine	136 Allatoona Dam
L	212	Bartow	V.R.	M	(13)	Cemetery Hill Mine	158 Burnt Hickory Ridge
L	267	Bartow	V.R.	M	(13)	Sugar Hill Mines	113 White East
L,Mn	232	Bartow	B.R.	M	(13)	Black Bank Mine	113 White East
L	233	Bartow	V.R.	M	(13)	Wildcat Hollow Mine	113 White East
L	234	Bartow	V.R.	M	(13)	Sloan Mine	158 Burnt Hickory Ridge
L	235	Bartow	V.R.	M	(13)	Kelley Mine	158 Burnt Hickory Ridge
L	236	Bartow	V.R.	M	(13)	Convict Mine	158 Burnt Hickory Ridge
L	237	Bartow	V.R.	M	(13)	Bartow Group	158 Burnt Hickory Ridge
L	238	Bartow	V.R.	M	(13)	N/A	135 Cartersville
L	239	Bartow	V.R.	M	(13)	Kennedy-Franklin Mine	135 Cartersville
L	240	Bartow	V.R.	M	(13)	Felton Mine	135 Cartersville
L,Mn	241	Bartow	V.R.	M	(13)	Lowry Mine	135 Cartersville
L	242	Bartow	V.R.	M	(13)	Bishop Mine	135 Cartersville
L	160	Bartow	V.R.	M	(13)	Larramore Mine	136 Allatoona Dam
L	37	Bartow	V.R.	P	(7)	L.T. Sutton Property	111 Adairsville
L	38	Bartow	V.R.	L	(7)	N/A	111 Adairsville
L	39	Bartow	V.R.	P	(7)	S.E. Bray Property	111 Adairsville
L	40	Bartow	V.R.	P	(7)	Anderson and Bishop Property	111 Adairsville
L,Mn	94	Bartow	V.R.	P	(7)	R.B. Satterfield Property	135 Cartersville
L	108	Bartow	V.R.	P	(7)	J.R. Leachman Property	135 Cartersville
L	109	Bartow	V.R.	M	(7)	W.C. Satterfield Mine	135 Cartersville
L	110	Bartow	V.R.	M	(7)	R.B. Northy Mine	135 Cartersville
L	111	Bartow	V.R.	P	(7)	W.C. Walton Property	135 Cartersville
L,Mn	121	Bartow	V.R.	M	(7)	Guyton Ore Bank	135 Cartersville
L	102	Bartow	V.R.	M	(7)	Munford Mine; Etowah Dev. Co.	135 Cartersville
L,Mn	142	Bartow	V.R.	L,M	(7)	Greenfield Property	134 Kingston
L	144	Bartow	V.R.	L	(7)	G.B. Hulme Property	134 Kingston
L	145	Bartow	V.R.	P	(7)	P.E. Alford Property	134 Kingston
L	146	Bartow	V.R.	L	(7)	A.S. Dunn Property	134 Kingston
L	147	Bartow	V.R.	P	(7)	Etowah Property	134 Kingston
L	177	Bartow	V.R.	Q	(7)	Etowah Dev. Co.; LaFollette Coal and Iron Co.	136 Allatoona Dam
L,B	169	Bartow	V.R.	Q	(13)	C.M. (Chulafinnee) Jones Property	158 Burnt Hickory Ridge
L	181	Bartow	V.R.	Q	(7)	Allatoona Ore Bank	136 Allatoona Dam
L	5	Cherokee	B.R.	L	(7)	Evans Property	137 South Canton
L	6	Cherokee	B.R.	P	(7)	W.C. Hulsey Property	137 South Canton
L	8	Cherokee	B.R.	L	(7)	J.C. Johnson Property	137 South Canton

LIMESTONE and other IRON ORE (Continued)

SYMBOL		COUNTY	PROVINCE	TYPE	REF.	NAME	# QUADRANGLE
L	29	Cherokee	B.R.	L	(7)	James Mayhugh Property	137 South Canton
L	117	Cherokee	B.R.	P	(7)	Hollister Property	114 Waleska
L	121	Cherokee	B.R.	P	(7)	Cagle Property	114 Waleska
L	118	Cherokee	B.R.	P	(7)	Chattahoochee Iron Ore	114 Waleska
L	119	Cherokee	B.R.	P	(7)	Chattahoochee Iron Ore	114 Waleska
L	122	Cherokee	B.R.	P	(7)	Chattahoochee Iron Ore	114 Waleska
L	49	Cherokee	B.R.	P	(7)	Andrew Satterfield Prop.	116 Ball Ground East
L	56	Cherokee	B.R.	P	(7)	L.L. Spence Property	116 Ball Ground East
L	61	Cherokee	B.R.	L	(7)	N/A	115 Ball Ground West
L	62	Cherokee	B.R.	P	(7)	James M. Quarles	115 Ball Ground West
L	66	Cherokee	B.R.	P	(7)	D.C. Keith Property	115 Ball Ground West
L	67	Cherokee	B.R.	M	(7)	James Higgins Property	115 Ball Ground West
L	68	Cherokee	B.R.	P	(7)	G.F. Teasley Property	115 Ball Ground West
L	69	Cherokee	B.R.	P	(7)	J.H. Breedlove Property	115 Ball Ground West
L	70	Cherokee	B.R.	L	(7)	William Worley Property	115 Ball Ground West
L	71	Cherokee	B.R.	P	(7)	G.P. McFarland Property	115 Ball Ground West
L	72	Cherokee	B.R.	P	(7)	S.M. Inman Estate	115 Ball Ground West
L	74	Cherokee	B.R.	P	(7)	S.M. Nelson Property	115 Ball Ground West
L	109	Cherokee	B.R.	P	(7)	Grady Holbert Property	116 Ball Ground East
Fe	2	Floyd	V.R.	L	(36)	Smiley-Johnson Plantation	133 Wax
Fe	4	Floyd	V.R.	L	(36)	W.C. Lloyd Property	133 Wax
Fe	5	Floyd	V.R.	L	(36)	Roy K. Smith Property	133 Wax
L	10	Floyd	V.R.	L	(36)	Terhune Property	133 Wax
Fe	19	Floyd	V.R.	P	(36)	Mrs. Harry Johnson Property	132 Rome South
Fe	76	Floyd	V.R.	P	(36)	A.G. Liphan Property	110 Shannon
Fe	77	Floyd	V.R.	P	(36)	Moat and Carver Property	110 Shannon
Fe	104	Floyd	V.R.	P	(36)	Hiram-Bobo Prospect	155 Cedartown East
Fe	111	Floyd	V.R.	M	(36)	H. Grady Bradshaw Property	155 Cedartown East
L	1	Floyd	V.R.	M	(36)	Sam Ellis Property	133 Wax
L	16	Floyd	V.R.	M	(7)	B.C. Forrester Place	132 Rome South
L	17	Floyd	V.R.	P	(7)	Samuel Johnson Property	132 Rome South
L	18	Floyd	V.R.	P	(36)	Alma Jackson Property	132 Rome South
L	13	Floyd	V.R.	P	(7)	T.H. Peek Property	132 Rome South
L	43	Floyd	V.R.	P	(7)	T.E. Langley Property	132 Rome South
L	74	Floyd	V.R.	P	(7)	Forrester Property	110 Shannon
L	75	Floyd	V.R.	P	(7)	T.R. Rich Prospect	110 Shannon
L	125	Floyd	V.R.	P	(7)	Minter Property	132 Rome South
L	3	Hall	S.P.	P	(37)	A.M. Williams Property	142 Flowery Branch
L	1	Haralson	B.R.	P	(7)	Ezzell Property	180 Rockmark South
Fe,Mn	14	Haralson	N.P.	L	(7)	T.R. King Property	205 Draketown
L	1	Polk	V.R.	L	(7)	Brown Property	157 Taylorsville
L	5	Polk	V.R.	P	(7)	Patterson Property	180 Rockmart South
L	21	Polk	V.R.	L	(19)	Peek Property	179 Felton

LIMESTONE and other IRON ORE (Continued)

SYMBOL		COUNTY	PROVINCE	TYPE	REF.	NAME	# QUADRANGLE
L	22	Polk	V.R.	M	(7)	Curtis Property	179 Felton
L	24	Polk	V.R.	M	(19)	Pulaski Coal and Iron	179 Felton
L	25	Polk	V.R.	M	(19)	J. Watts Randall Property	179 Felton
L	26	Polk	V.R.	P	(7)	Greenfield Property	179 Felton
L	27	Polk	V.R.	M	(7)	Baldwin Property; Pulaski Coal and Iron	179 Felton
L	42	Polk	V.R.	Q	(25)	Porter Property	156 Rockmart North
L	43	Polk	V.R.	P	(7)	J.J Goss Property	156 Rockmart North
L	48	Polk	V.R.	L	(7)	F.L. Clark Property	156 Rockmart North
Fe	53	Polk	V.R.	L	(7)	Richard Gammon Property	155 Cedartown East
L	55	Polk	V.R.	P	(7)	Shackleford Ore Bank	155 Cedartown East
L	56	Polk	V.R.	L	(7)	Garrett Property	155 Cedartown East
Fe	15	Polk	V.R.	P	(25)	Morgan and Wynn Property	180 Rockmart South
Fe	18	Polk	V.R.	L	(19)	E.D. Hightower Property	179 Felton
Fe	23	Polk	V.R.	L	(25)	J.K. Davis Property	179 Felton
Fe	40	Polk	V.R.	L	(25)	Brock Property	156 Rockmart North
Fe	41	Polk	V.R.	P	(25)	Tom Davitte Property	156 Rockmart North
Fe	44	Polk	V.R.	M	(25)	John T. Bennett (Blackrock Mine)	156 Rockmart North
Fe	45	Polk	V.R.	P	(25)	Brewster Place	156 Rockmart North
Fe	46	Polk	V.R.	P	(25)	W.M. Lowery Prospect	156 Rockmart North
Fe	47	Polk	V.R.	P	(25)	T.H. Randall Prospect	156 Rockmart North
Fe	54	Polk	V.R.	L	(25)	Tom Lyons Property	155 Cedartown East
Fe	57	Polk	V.R.	P	(25)	Thomas A. Grey, Jr. Property	155 Cedartown East
Fe	58	Polk	V.R.	P	(25)	A.B. Hogg Property	155 Cedartown East
Fe	59	Polk	V.R.	P	(25)	J.E. Whitaker Property	155 Cedartown East
Fe	60	Polk	V.R.	P	(36)	Teate Property	155 Cedartown East
Fe	65	Polk	V.R.	L	(25)	S.L. Carlton Property	155 Cedartown East

MAGNETITE

SYMBOL		COUNTY	PROVINCE	TYPE	REF.	NAME	# QUADRANGLE
Mg	31	Cherokee	B.R.	L	(7)	George W. Evans Property	137 South Canton
Mg	37	Cherokee	N.P.	L	(7)	W.L. Dean Property	160 Kennesaw
Mg	78	Cherokee	N.P.	L	(7)	Mrs. Fanny Hutcheson Property	138 Canton
Mg	3	Cobb	N.P.	L	(7)	J.W. Gunnin Property	160 Kennesaw
Mg	4	Cobb	N.P.	L	(7)	J.M. Dawson Property	160 Kennesaw
Mg	5	Cobb	N.P.	L	(7)	J.P. Rogers Property	160 Kennesaw
Mg	18	Cobb	N.P.	L	(7)	A.D. Kemp Property	184 Marietta
Mg	11	Haralson	N.P.	L	(7)	Douglas Property	205 Draketown

MANGANESE

SYMBOL		COUNTY	PROVINCE	TYPE	REF.	NAME	# QUADRANGLE
Mn	1	Bartow	V.R.	P	(10)	Virginia Iron, Coal and Coke Company	133 Wax
Mn	2	Bartow	V.R.	P	(31)	Ligon District	133 Wax
Mn	5	Bartow	V.R.	P	(10)	Sherman Property	110 Shannon
Mn	7	Bartow	V.R.	P	(10)	Kerr Property	111 Adairsville
Mn	8	Bartow	V.R.	P	(10)	Kerr Property	111 Adairsville
Mn	41	Bartow	V.R.	P	(10)	Jos. E. Brown Property	111 Adairsville
Mn	60	Bartow	V.R.	M	(10)	Etowah Dev. Co.	135 Cartersville
Mn	243	Bartow	V.R.	P	(10)	Saylor Property	111 Adairsville
Mn,B	58	Bartow	V.R.	M	(10)	Hebble Bros. Mine; Etowah Dev. Co.	135 Cartersville
Mn	70	Bartow	V.R.	M	(31)	Akin Property	135 Cartersville
Mn	77	Bartow	V.R.	P	(10)	C.C. Brown Property	135 Cartersville
Mn	78	Bartow	V.R.	P	(10)	Felton Property	135 Cartersville
Mn	79	Bartow	V.R.	M	(10)	Etowah Dev. Co.; Stiles Lease	135 Cartersville
Mn	241	Bartow	V.R.	M	(13)	Lowry Mine	135 Cartersville
Mn	244	Bartow	V.R.	M	(13)	Ziegler Mine	135 Cartersville
Mn	246	Bartow	V.R.	M	(13)	N/A	135 Cartersville
Mn	256	Bartow	V.R.	M	(13)	N/A	135 Cartersville
Mn	247	Bartow	V.R.	M	(13)	Russell Mine	135 Cartersville
Mn	248	Bartow	V.R.	M	(13)	Vaughn Mine	135 Cartersville
Mn	249	Bartow	V.R.	M	(13)	Peeples Mine	135 Cartersville
Mn	80	Bartow	V.R.	P	(10)	Pitman Property	135 Cartersville
Mn	81	Bartow	V.R.	M	(10)	Knight and Barron Mine Etowah Dev. Co.	135 Cartersville
Mn	82	Bartow	V.R.	M	(10)	Kennedy Lot; Etowah Dev. Co.	135 Cartersville
Mn	83	Bartow	V.R.	P	(10)	N/A	135 Cartersville
Mn	84	Bartow	V.R.	M	(10)	Etowah Dev. Co.	135 Cartersville
Mn	85	Bartow	V.R.	P	(10)	Republic Iron and Steel; Etowah Dev. Co.	135 Cartersville
Mn	86	Bartow	V.R.	M	(10)	Etowah Dev. Co.	135 Cartersville
Mn	87	Bartow	V.R.	M	(10)	C.N. Smith Property	135 Cartersville
Mn	88	Bartow	V.R.	M	(23)	Howard Deposit	135 Cartersville
Mn	89	Bartow	V.R.	P	(31)	Morris Property	135 Cartersville
Mn	90	Bartow	V.R.	P	(10)	Patillo Property	135 Cartersville
Mn	91	Bartow	V.R.	M	(31)	Peacock Lot	135 Cartersville
Mn	92	Bartow	V.R.	P	(31)	Rowan Property	135 Cartersville
Mn	93	Bartow	V.R.	M	(31)	Heath Sisters Property	135 Cartersville
Mn,L	94	Bartow	V.R.	P	(31)	R.B. Satterfield Property	135 Cartersville
Mn	95	Bartow	V.R.	L	(10)	Smith and Peacock Property	135 Cartersville
Mn	250	Bartow	V.R.	M	(31)	Pittsburgh - Ga. Mining; Stegall Property	135 Cartersville
Mn	251	Bartow	V.R.	M	(31)	Mansfield Bros. Property	135 Cartersville
Mn	98	Bartow	V.R.	P	(31)	T.R. James Lot	135 Cartersville

MANGANESE (Continued)

SYMBOL		COUNTY	PROVINCE	TYPE	REF.	NAME	# QUADRANGLE
Mn	99	Bartow	V.R.	P	(31)	N.P. Lanham Property	135 Cartersville
Mn	100	Bartow	V.R.	P	(31)	W.H. Lanham Property	135 Cartersville
Mn	101	Bartow	V.R.	M	(31)	Cherokee Ocher Co. (Gemes Mine)	135 Cartersville
Mn	103	Bartow	V.R.	M	(31)	John Dobbs Property	135 Cartersville
Mn	104	Bartow	V.R.	M	(31)	Norris Mine	135 Cartersville
Mn,Oc	252	Bartow	V.R.	M	(31)	Blue Ridge Ocher	135 Cartersville
Mn,B	106	Bartow	V.R.	M	(13)	Hurricane Hollow Mine	135 Cartersville
Mn	107	Bartow	V.R.	M	(10)	Etowah Dev. Co.	135 Cartersville
Mn	113	Bartow	V.R.	M	(23)	Blue Ridge Deposit	135 Cartersville
Mn	114	Bartow	V.R.	M	(23)	Appalachian Deposit	135 Cartersville
Mn	115	Bartow	V.R.	M	(10)	Ga. Iron and Coal (Ward Mine)	135 Cartersville
Mn	117	Bartow	V.R.	M	(10)	Houck Mine	135 Cartersville
Mn	118	Bartow	V.R.	M	(23)	Dobbins Mines, Pyrolusite Mining, Etowah Iron Co., Bartow Maganese Mining and Mfg. Co.	135 Cartersville
Mn,L	232	Bartow	V.R.	M	(13)	Black Bank Mine	113 White East
Mn	119	Bartow	V.R.	M	(31)	Milner-Harris-Simpson Property	135 Cartersville
Mn	120	Bartow	V.R.	P	(31)	G.W. Satterfield Property	135 Cartersville
Mn,L	121	Bartow	V.R.	M	(31)	Guyton Property	135 Cartersville
Mn	122	Bartow	V.R.	M	(31)	T.S. Bishop (Smith) Property	135 Cartersville
Mn	128	Bartow	V.R.	P	(10)	Calhoun & Locke Property	135 Cartersville
Mn	129	Bartow	V.R.	P	(31)	Jones Brothers' Lot	135 Cartersville
Mn	131	Bartow	V.R.	L	(10)	A. Abramson Property	135 Cartersville
Mn	139	Bartow	V.R.	L	(31)	N/A	135 Cartersville
Mn	253	Bartow	V.R.	M	(10)	Wyvern Mine, Guyton Ore Bank	135 Cartersville
Mn	289	Bartow	V.R.	M	(10)	Mayburn Lot; Etowah Dev. Co.	135 Cartersville
Mn	290	Bartow	V.R.	M	(31)	Franklin Lot	135 Cartersville
Mn	291	Bartow	V.R.	P	(31)	Laramore Property	135 Cartersville
Mn,L	142	Bartow	V.R.	L,M	(10)	Greenfield Property	134 Kingston
Mn	143	Bartow	V.R.	L	(10)	Strickland Property	134 Kingston
Mn	148	Bartow	V.R.	P	(10)	Vincent Property	134 Kingston
Mn	154	Bartow	V.R.	M	(23)	Will Lee Deposit	112 White West
Mn	167	Bartow	V.R.	L	(10)	Puckett Property	158 Burnt Hickory Ridge
Mn	174	Bartow	V.R.	M	(31)	N/A	158 Burnt Hickory Ridge
Mn	175	Bartow	V.R.	M	(10)	Shephens Lot	158 Burnt Hickory Ridge
Mn	182	Bartow	V.R.	Q	(31)	Bartow Iron & Furnace; Tennessee Coal, Iron & RR Co.	136 Allatoona Dam
Mn	183	Bartow	V.R.	P	(10)	Etowah Dev. Co.	136 Allatoona Dam
Mn	198	Bartow	B.R.	P	(10)	Ga. Iron and Coal Co.	113 White East
Mn	199	Bartow	V.R.	M	(31)	P'tree Mine; Ga. Iron and Coal	113 White East
Mn	200	Bartow	V.R.	M	(10)	Red Mt. Mine; Ga. Iron and Coal	113 White East
Mn	201	Bartow	V.R.	M	(10)	Moccasin Mine; Ga. Iron and Coal	113 White East
Mn	202	Bartow	V.R.	M	(10)	Chumley Hill Lot; Ga. Iron and Coal	113 White East

MANGANESE (Continued)

SYMBOL		COUNTY	PROVINCE	TYPE	REF.	NAME	# QUADRANGLE
Mn	203	Bartow	V.R.	M	(10)	Big Spring Lot; Ga. Iron and Coal	113 White East
Mn	204	Bartow	V.R.	M	(10)	Wofford Mine; Ga. Iron and Coal	113 White East
Mn	205	Bartow	V.R.	M	(10)	Bartow Co. Pauper Farm	113 White East
Mn	206	Bartow	V.R.	P	(31)	Collins Lot; Ga. Iron and Coal	113 White East
Mn	207	Bartow	V.R.	M	(10)	Allison Lot	113 White East
Mn	208	Bartow	V.R.	M	(13)	Alexander Mine	113 White East
Mn	210	Bartow	V.R.	P,M	(10)	Vaughan Property	113 White East
Mn	211	Bartow	V.R.	L	(31)	Mrs. N.E. Mahan Lot	113 White East
Mn	213	Bartow	V.R.	M	(13)	Stevenson (Stephenson) Cut	113 White East
Mn	214	Bartow	V.R.	M	(10)	Aubrey Cut; Ga. Iron and Coal	113 White East
Mn	215	Bartow	V.R.	M	(13)	Bufford Cuts; Ga. Iron and Coal	113 White East
Mn	258	Bartow	V.R.	M	(13)	Little Red Mountain Mine	113 White East
Mn	257	Bartow	V.R.	M	(13)	New Chumley Mine	113 White East
Mn	256	Bartow	V.R.	M	(13)	Boneyard Mine	113 White East
Mn	254	Bartow	V.R.	M	(13)	Hogpen Mine	113 White East
Mn	255	Bartow	V.R.	M	(13)	Baker Mine	113 White East
Mn	259	Bartow	V.R.	M	(13)	N/A	113 White East
Mn	263	Bartow	V.R.	M	**	N/A	113 White East
Mn	264	Bartow	V.R.	M	**	N/A	113 White East
Mn	265	Bartow	V.R.	M	**	N/A	113 White East
Mn	266	Bartow	V.R.	M	**	N/A	113 White East
Mn	216	Bartow	V.R.	M	(13)	Will Lee	113 White East
Mn	217	Bartow	V.R.	M	(10)	Satterfield McGinnis Prop.; Paga Mining Co.	113 White East
Mn	227	Bartow	V.R.	M	(31)	Bufford and White Lot; Dade Coal Co.	113 White East
Mn,B	228	Bartow	V.R.	P	(9)	Holcombe Property	111Adairsville
Mn	300	Bartow	V.R.	P	(10)	Greenfield Property	134 Kingston
Mn	39	Cherokee	B.R.	M	(31)	White Lot; Dade Coal Co.	113 White East
Mn	15	Floyd	V.R.	M	(31)	Briscoe Place	132 Rome South
Mn	31	Floyd	V.R.	P	(31)	Hillyer Property	132 Rome South
Mn	35	Floyd	V.R.	P	(36)	Kelley Property	132 Rome South
Mn	101	Floyd	V.R.	P	(10)	Muller-Harper Property	155 Cedartown East
Mn	102	Floyd	V.R.	M	(10)	Reynolds Mt. Mine	155 Cedartown East
Mn,P	124	Floyd	V.R.	P	(10)	Patillo Property	133 Wax
Mn	5	Hall	S.P.	P	(37)	Chester Lynn Property	142 Flowery Branch
Mn	3	Haralson	N.P.	L	(31)	McPherson Property	204 Buchanan
Mn	4	Haralson	N.P.	P	(31)	Tomlinson Property	204 Buchanan
Mn	8	Haralson	N.P.	P	(31)	Griffith Property	205 Draketown
Mn	10	Haralson	N.P.	P	(31)	Draketown Mining Co.; Douglass Prospect	205 Draketown
Mn,Fe	14	Haralson	N.P.	L	(10)	King Property	205 Draketown
Mn	16	Haralson	N.P.	L	(10)	Gober Property	205 Draketown

MANGANESE (Continued)

SYMBOL		COUNTY	PROVINCE	TYPE	REF.	NAME	# QUADRANGLE
Mn	24	Haralson	N.P.	L	(10)	Westbrook Property	231 Temple
Mn	25	Haralson	N.P.	L	(10)	W.M. Raburn Property	231 Temple
Mn	47	Paulding	N.P.	M	(10)	Cochran Property	158 Burnt Hickory Ridge
Mn	11	Paulding	N.P.	L	(31)	Estes and Folsom Property	181 Yorkville
Mn	28	Paulding	N.P.	M	(31)	Statham Property	205 Draketown
Mn	29	Paulding	N.P.	M	(31)	Douglass Prospects	205 Draketown
Mn	30	Paulding	N.P.	L	(31)	Allgood Property	205 Draketown
Mn	31	Paulding	N.P.	L	(31)	Kirk Property	205 Draketown
Mn	19	Polk	V.R.	P	(25)	Commercial Bank of Cedartown	179 Felton

**Leonard Foote, Personal Commun., 1983.

MARBLE

SYMBOL		COUNTY	PROVINCE	TYPE	REF.	NAME	# QUADRANGLE
Mb	293	Bartow	B.R.	Q		County Line Quarry	113 White East
Mb	54	Cherokee	B.R.	L	(20)	Halbert Property	116 Ball Ground East
Mb	55	Cherokee	B.R.	L	(20)	Halbert Property	115 Ball Ground West
Mb	64	Cherokee	B.R.	L	(20)	Stafford Property	115 Ball Ground West
Mb	65	Cherokee	B.R.	L	(20)	Mrs. Stearne's Property	116 Ball Ground East
Mb	89*	Cherokee	B.R.	Q	(15)	Ga. Marble Co.	116 Ball Ground East
Mb	104	Cherokee	B.R.	L	(20)	Crain Property	115 Ball Ground West
Mb	105	Cherokee	B.R.	L	(20)	Cowart Property	115 Ball Ground West
Mb	106	Cherokee	B.R.	L	(20)	Carpenter Property	114 Waleska
Mb	107	Cherokee	B.R.	L	(20)	J.M. White Property	114 Waleska
Mb	31*	Hall	S.P.	Q	(15)	Terrell A. Philyaw Co., Inc.	120 Gainesville
Mb	31	Haralson	N.P.	P	(11)	Bolling Prospect	204 Buchanan
Mb	32	Haralson	N.P.	P	(11)	Saunders Prospect	204 Buchanan

OCHER

SYMBOL		COUNTY	PROVINCE	TYPE	REF.	NAME	# QUADRANGLE
Oc,B	76	Bartow	V.R.	M	(9)	Cherokee Ochre Co.	135 Cartersville
Oc,Mn	252	Bartow	V.R.	M	(9)	Blue Ridge Ocher	135 Cartersville
Oc	49*	Bartow	V.R.	M	(15)	New Riverside Ochre Co.	135 Cartersville
Oc,B	52	Bartow	V.R.	M	(9)	Ga. Peruvian Ocher Co.	135 Cartersville
Oc	255	Bartow	V.R.	M	(13)	American Ocher	135 Cartersville
Oc	256	Bartow	V.R.	M	(13)	Knight Mine	135 Cartersville
Oc	105	Bartow	V.R.	M	(13)	Southern Mine	135 Cartersville

OCHER (Continued)

SYMBOL		COUNTY	PROVINCE	TYPE	REF.	NAME	# QUADRANGLE
Oc	112	Bartow	V.R.	M	(13)	Georgia Barium and Ocher	135 Cartersville
Oc	257	Bartow	V.R.	M	(13)	Howard Mine	135 Cartersville

PEGMATITE, MICA, AND BERYL

SYMBOL		COUNTY	PROVINCE	TYPE	REF.	NAME	# QUADRANGLE
Pg	2	Carroll	N.P.	L	(6)	N/A	256 Bowdon East
Pg	3	Carroll	N.P.	L	(6)	Turkey Creek	256 Bowdon East
Pg	12	Carroll	N.P.	L	(6)	J.A. Potate Property	205 Draketown
Pg,M	13	Carroll	N.P.	P	(17)	Heartley Prospect	231 Temple
M	100	Cherokee	N.P.	P	(4)	Kykendall Prospect	160 Kennesaw
M	101	Cherokee	N.P.	M	(4)	Ledford Mine	160 Kennesaw
Pg	11	Cherokee	N.P.	M	(6)	J.D. Hillhouse Mine	137 South Canton
Pg	12	Cherokee	N.P.	L	(6)	Cole Property	137 South Canton
Pg,M	38	Cherokee	N.P.	M	(6)	Dean Mica Mine	137 South Canton
M	42	Cherokee	B.R.	M	(83)	Amphlett Mine	116 Ball Ground East
M,Brl	48	Cherokee	B.R.	M	(3)	Hendrix Mica Mine	116 Ball Ground East
Brl,M	59	Cherokee	B.R.	M	(33)	Cochran Mine	116 Ball Ground East
Pg	57	Cherokee	B.R.	L	(6)	F.M. Williams Property	116 Ball Ground East
M	92	Cherokee	N.P.	P	(4)	J.D. Hillhouse Prospect	137 South Canton
M	93	Cherokee	B.R.	P	(4)	Weaver Prospect	116 Ball Ground East
Pg,M	86	Cherokee	N.P.	M	(6)	Cook Mine	139 Birmingham
Pg	3	Clayton	S.P.	P	(6)	N/A	237 SE Atlanta
Pg	1	Cobb	N.P.	P	(6)	W.M. Davis Lot	161 Mountain Park
Pg	22	Cobb	N.P.	L	(6)	N/A	208 Austell
Pg	5	Coweta	S.P.	L	(6)	N/A	287 Newnan N.
M	94	Cherokee	B.R.	P	(4)	Densmore Prospect	116 Ball Ground East
M	95	Cherokee	B.R.	P	(4)	Revis Prospect	116 Ball Ground East
M	96	Cherokee	N.P.	M	(4)	Cole Mine	137 South Canton
M	97	Cherokee	N.P.	P	(4)	Hause Prospect	137 South Canton
M	98	Cherokee	N.P.	M	(4)	Wacaster Mine	137 South Canton
M	99	Cherokee	N.P.	M	(4)	Hause Mine	137 South Canton
Pg	39	DeKalb	S.P.	L	(3)	N/A	213 Snellville
Pg	1	Fulton	N.P.	L	(6)	N/A	162 Roswell
Gr,M	4	Hall	S.P.	P	(37)	L.T. Westbrook Property	142 Flowery Branch
Au,M	13	Hall	N.P.	P	(37)	Will Stephens Property	120 Gainesville
M	21	Hall	N.P.	L	(37)	Carter Property	120 Gainesville
M,Au	28	Hall	N.P.	Q	(39)	Merck Quarry	120 Gainesville
M	32	Hall	N.P.	L	(37)	Henry Wallace Property	120 Gainesville
Pg	28	Haralson	N.P.	L	(6)	N/A	231 Temple
Pg	15	Paulding	N.P.	L	(6)	M.J. Petty Property	182 Dallas

PEGMATITE, MICA and BERYL (Continued)

SYMBOL		COUNTY	PROVINCE	TYPE	REF.	NAME	# QUADRANGLE
Pg	16	Paulding	N.P.	L	(6)	Dr. E.W. Dean Property	182 Dallas
Pg	17	Paulding	N.P.	L	(6)	N/A	182 Dallas

PYRITE, INCLUDES CHALCOPYRITE AND SPHALERITE

SYMBOL		COUNTY	PROVINCE	TYPE	REF.	NAME	# QUADRANGLE
P	4	Carroll	N.P.	P	(27)	J.W. Garrett Property	256 Bowdon East
P	5	Carroll	N.P.	L	(27)	John D. Tarpley Property	256 Bowdon East
P	13	Carroll	N.P.	P	(27)	M.A. Heartley Prospect	231 Temple
P	14	Carroll	N.P.	P	(27)	J.S. Michael Prospect	132 Temple
P	15	Carroll	N.P.	P	(27)	Mt. Zion Prospect	230 Bremen
P	16	Carroll	N.P.	L	(27)	M.T. Earnest Property	230 Bremen
P	19	Carroll	N.P.	P	(27)	A.H. Cox Property	230 Bremen
P	26	Carroll	N.P.	P	(27)	Askew Prospect	232 Villa Rica
P	27	Carroll	N.P.	L	(27)	W.T. Raburn Property	231 Temple
P	28	Carroll	N.P.	P	(27)	Watkins Property	232 Villa Rica
P	31	Carroll	N.P.	L	(27)	Bagwell Property	206 New Georgia
P	41	Carroll	N.P.	P	(27)	Lasseter Prospect	232 Villa Rica
P	32	Carroll	N.P.	P	(27)	Jenny Stone Prospect	206 New Georgia
P	39	Carroll	N.P.	P	(17)	Butler Prospect	256 Bowdon East
P,Au	33	Cherokee	N.P.	M	(27)	Bell-Star Mine	160 Kennesaw
P	43	Cherokee	N.P.	M	(27)	Standard Mine	160 Kennesaw
P	45	Cherokee	N.P.	M	(27)	Swift-Blake Mine	116 Ball Ground East
P	46	Cherokee	N.P.	P	(27)	Smith Prospect	116 Ball Ground East
P	47	Cherokee	N.P.	P	(27)	Dickerson Prospect	116 Ball Ground East
P	76	Cherokee	N.P.	L	(27)	McRae Property	116 Ball Ground East
P	77	Cherokee	N.P.	M	(27)	Rich Mine	138 Canton
P	2	Cobb	N.P.	P	(35)	Dawson Property	138 Canton
P	8	Cobb	N.P.	L	(27)	J.J. Kemp Property	161 Mountain Park
P	9	Cobb	N.P.	P	(27)	C.G. Wright Property	183 Lost Mountain
P	16	Cobb	N.P.	P	(27)	C.J. Kamper Property	183 Lost Mountain
P	19	Cobb	N.P.	M	(27)	Marietta Mine	184 Marietta
P	12	Douglas	N.P.	P	(27)	Hancock Prospect	184 Marietta
P	13	Douglas	N.P.	M	(27)	Villa Rica Mine (Durgy Prop.)	206 New Georgia
P	27	Douglas	N.P.	P		N/A	206 New Georgia
P	16	Douglas	N.P.	P	(27)	Keaton-Thomas Prospect	232 Villa Rica
P,Mn	124	Floyd	V.R.	P	(27)	Patillo Property	133 Wax
P	9	Fulton	S.P.	M	(27)	Cash Copper Mine	235 Ben Hill
P	2	Haralson	N.P.	L	(27)	W.M. Rayburn Property	204 Buchanan
P	6	Haralson	N.P.	P	(27)	Jackson-McBride Property	204 Buchanan
P	15	Haralson	N.P.	L	(27)	Blackmon Property	205 Draketown
P	17	Haralson	N.P.	P	(27)	Smith-McCandless Prospect	205 Draketown

PYRITE, includes CHALCOPYRITE and SPHALERITE (Continued)

SYMBOL		COUNTY	PROVINCE	TYPE	REF.	NAME	# QUADRANGLE
P	18	Haralson	N.P.	M	(27)	Tallapoosa mine; Ga. Pyrites Co.	205 Draketown
P	19	Haralson	N.P.	M	(27)	R.F. Pace Property	205 Draketown
P	20	Haralson	N.P.	L	(27)	W.J. Speight Property	205 Draketown
P	23	Haralson	N.P.	L	(27)	J. Humphrey Property	231 Temple
P	26	Haralson	N.P.	L	(27)	W.M. Raburn Property	231 Temple
P	29	Haralson	N.P.	M	(27)	Reed's Mountain Mine	230 Breman
P	8	Paulding	N.P.	L	(27)	Bob Reynolds (Jones) Property	181 Yorkville
P	10	Paulding	N.P.	P	(27)	Rush-Banks Prospect	181 Yorkville
P	19	Paulding	N.P.	M	(27)	Little Bob Mine	182 Dallas
P	20	Paulding	N.P.	M	(27)	Shirley Mine	182 Dallas
P	21	Paulding	N.P.	P	(27)	Berg Prospect	182 Dallas
P	22	Paulding	N.P.	P	(27)	W.W. Hunt and L.A. Moon Prospect	182 Dallas
P	23	Paulding	N.P.	M	(27)	Blake/McClarity (Swift) Mine	205 Draketown
P	24	Paulding	N.P.	M	(27)	W.P. Hutcheson Property	205 Draketown
P	25	Paulding	N.P.	M	(27)	S.O. Brown Property	205 Draketown
P	26	Paulding	N.P.	P	(27)	C.D. Allgood Prospect	205 Draketown
P	27	Paulding	N.P.	L	(27)	G.B. McGarity Property	205 Draketown
P	6	Paulding	N.P.	P	(27)	Ragsdale Prospect	183 Lost Mountain
P	40	Paulding	N.P.	P	(1)	B. McGruder Prospect	157 Taylorsville
P	42	Paulding	N.P.	P	(27)	Mt. Tabor Prospect	182 Dallas
P	43	Paulding	N.P.	P	(27)	N.S. Vaughan Prospect	182 Dallas
P	44	Paulding	N.P.	P	(27)	Mammoth Prospect	182 Dallas
P	45	Paulding	N.P.	P	(27)	B.T. McGarrity Prospect	180 Rockmart South
P	46	Paulding	N.P.	P	(1)	Dever Prospect	180 Rockmart South
P	48	Paulding	N.P.	P	(27)	Helms Prospect	206 New Georgia

QUARTZITE

SYMBOL		COUNTY	PROVINCE	TYPE	REF.	NAME	# QUADRANGLE
Q	87	Cherokee	N.P.	Q		Sweat Mountain Quarry	161 Mountain Park
Q	33	Cobb	N.P.	Q		Blackjack Mountain Quarry	184 Marietta
Q	6	Hall	S.P.	Q	(37)	J.D. Cash Property	142 Flowery Branch

SAND AND GRAVEL, INCLUDES FILL MATERIALS

SYMBOL		COUNTY	PROVINCE	TYPE	REF.	NAME	# QUADRANGLE
SG	140	Bartow	V.R.	L	(29)	N/A	135 Cartersville
Sg	141	Bartow	V.R.	L	(29)	L.A. Jones Property	135 Cartersville
S	230*	Bartow	V.R.	Pit	(15)	Bartow Sand Co.	159 Acworth
S	258*	Bartow	N.P	Dredge		N/A	159 Acworth
Sg	6	Carroll	N.P.	L	(29)	Burwell	256 Bowdon East

SAND and GRAVEL, includes FILL MATERIALS (Continued)

SYMBOL		COUNTY	PROVINCE	TYPE	REF.	NAME	# QUADRANGLE
SG	40	Carroll	S.P.	L	(29)	NA	259 Rico
SG	17	Carroll	N.P.	L	(29)	Bear Creek	230 Bremen
SG	82	Cherokee	N.P.	L	(29)	Town Creek	138 Canton
SG	83	Cherokee	B.R.	L	(29)	N/A	138 Canton
SG	87*	Cherokee	B.R.	Pit	(15)	Blankenship Sand Co.	138 Canton
SG	88*	Cherokee	B.R.	Pit	(15)	Lawson and Quarles Sand Co.	115 Ball Ground West
SG	2	Clayton	S.P.	P	(29)	N/A	262 Riverdale
SG	4	Clayton	S.P.	Q	(29)	Smiley Sand Co.	263 Jonesboro
SG	33*	Cobb	S.P.	Dredge	(15)	Reece Sand and Gravel Co.	210 NW Atlanta
SG	28*	Cobb	S.P.	Pit	(15)	Stamps Sand Co.	209 Mableton
SG	7	Cobb	N.P.	L	(29)	N/A	160 Kennesaw
SG	17	Cobb	N.P.	L	(29)	N/A	184 Marietta
SG	27	Cobb	N.P.	Q	(29)	Smiley Sand Co.	209 Mableton
SG	31	Cobb	N.P.	P	(29)	Acworth-Proctor Creek	159 Acworth
SG	32	Cobb	N.P.	L	(29)	Ga. Railway and Power Co.	210 NW Atlanta
SG	37	DeKalb	S.P.	L	(29)	W.J. Houston Property	211 NE Atlanta
SG	2	Douglas	S.P.	L	(29)	Annewakee Creek	234 Campbellton
SG	54	Floyd	V.R.	Pit	(29)	N.G. Watson Sand Co.	132 Rome South
SG	55	Floyd	V.R.	Pit	(29)	H.A Dean Property	132 Rome South
SG	71	Floyd	V.R.	P	(29)	Rome Sand and Gravel	109 Rome North
SG	99	Floyd	V.R.	P	(29)	N/A	110 Shannon
SG	146	Floyd	V.R.	Pit	(29)	N/A	109 Rome North
FM	13*	Fulton	S.P.	Pit	(15)	Gornwell Hauling Co.	210 NW Atlanta
SG	5	Fulton	S.P.	Dredge	(29)	Acme Sand and Supply Company Plant	210 NW Atlanta
SG	6	Fulton	S.P.	L	(29)	Proctor Creek	210 NW Atlanta
SG	18*	Fulton	S.P.	Dredge	(15)	Johnson and Garrett Sand Co.	234 Campbellton
SG	8	Fulton	S.P.	L	(29)	J.G. Johnson Property	211 NE Atlanta
SG	10	Fulton	S.P.	L	(29)	Utoy Creek	235 Ben Hill
SG	33*	Fulton	S.P.	Dredge	(15)	Stamps Sand Co.	210 NW Atlanta
SG	4	Fulton	N.P.	L	(29)	Walter Thompson Place	162 Roswell
SG	14*	Fulton	N.P.	Dredge	(15)	Ace Sand Co.	186 Chamblee
SG	15*	Fulton	N.P.	Dredge	(15)	Mang-Alloy Steel Co.	162 Roswell
SG	27*	Gwinnett	N.P.	Dredge	(15)	Alpha Asphalt	163 Duluth
SG	8	Gwinnett	S.P.	P	(29)	Suwannee Creek	164 Suwanee
SG	10	Gwinnett	S.P.	P	(29)	Branch Creek	163 Duluth
SG,G	18	Gwinnett	S.P.	L	(29)	Ewing Property	189 Lawrenceville
SG	7	Hall	S.P.	P	(37)	F.P. Dover Property	143 Chestnut Mountain
SG	62*	Polk	V.R.	Pit	(15)	Marquette Cement Mfg. Co.	181 Yorkville

SHALE

SYMBOL		COUNTY	PROVINCE	TYPE	REF.	NAME	# QUADRANGLE
Sh/Cly	42	Bartow	V.R.	P	(28)	Boyd Orchard Co.	111 Adairsville
Sh	43	Bartow	V.R.	L	(28)	Clemmons and Greenfield Property	111 Adairsville
Sh/Cly	124	Bartow	V.R.	P	(28)	Jim Nolan Property	135 Cartersville
Sh	149	Bartow	V.R.	L	(28)	Bishop and Jackson Property	134 Kingston
Sh	150	Bartow	V.R.	L	(28)	Milner and Munford Property	134 Kingston
Sh/Cly	155	Bartow	V.R.	Q	(28)	W.D. Pittard Property	112 White West
Sh/Cly	156	Bartow	V.R.	L	(28)	Black, Randolf, Guyton & Ward Property	112 White West
Sh	158	Bartow	V.R.	L	(28)	Haney and Richards Property	112 White West
Sh	159	Bartow	V.R.	L	(28)	Hamrick and Sullins Property	112 White West
Sh	218	Bartow	V.R.	L	(28)	J.L. Parker Property	113 White East
Sh	45	FLoyd	V.R.	P	(28)	Mrs. P.M Foster Property	132 Rome South
Sh	46	Floyd	V.R.	P	(28)	Mrs. Flora McAfee Jones	132 Rome South
Sh	47	Floyd	V.R.	P	(28)	J.M. Graham Property	132 Rome South
Sh/Cly	48	Floyd	V.R.	M	(28)	B. Mifflin Hood Property	132 Rome South
Sh/Cly	59	Floyd	V.R.	Q	(28)	Romega Clay Product	109 Rome North
Sh	60	Floyd	V.R.	Pit	(28)	W.S. Dickey Clay Mfg. Co.	109 Rome North
Sh	61	Floyd	V.R.	P	(28)	Camp and Knowles Property	109 Rome North
Sh	62	Floyd	V.R.	P	(28)	H.A. Dean Property	109 Rome North
Sh	63	Floyd	V.R.	Q	(21)	Old Summerville Rd. Quarry	109 Rome North
Sh	98	Floyd	V.R.	P	(28)	Walters and Lacy Prospect	110 Shannon
Sh	28	Polk	V.R.	Q	(28)	M.O. Huntington Property	179 Felton
Sh	31	Polk	V.R.	Q	(26)	Southern State Portland Cement Co. Shale Quarries	156 Rockmart North

SLATE

SYMBOL		COUNTY	PROVINCE	TYPE	REF.	NAME	# QUADRANGLE
Sl	133	Bartow	V.R.	L	(26)	N/A	135 Cartersville
Sl	135	Bartow	V.R.	L	(26)	Johnson Property	135 Cartersville
Sl	136	Bartow	V.R.	L	(26)	Daves Property	135 Cartersville
Sl	137	Bartow	V.R.	L	(26)	Walker Property	135 Cartersville
Sl	138	Bartow	V.R.	L	(26)	Headden Property	135 Cartersville
Sl	157	Bartow	V.R.	Q	(26)	American Potash Co. Prop.	112 White West
Sl	163	Bartow	V.R.	P	(26)	Lilly Property	112 White West
Sl	164	Bartow	V.R.	L	(26)	Carpenter Property	112 White West
Sl	220	Bartow	V.R.	Q	(26)	Bolivar Station	113 White East
Sl	221	Bartow	V.R.	P	(26)	Adair Property	113 White East
Sl	222	Bartow	V.R.	L	(26)	McDaniel Property	113 White East
Sl	223	Bartow	V.R.	Pit	(26)	Yancey Property	113 White East
Sl	224	Bartow	V.R.	Pit	(26)	McMillan Property	113 White East
Sl	225	Bartow	V.R.	L	(26)	Rufus Jones Property	

SLATE (Continued)

SYMBOL		COUNTY	PROVINCE	TYPE	REF.	NAME	# QUADRANGLE
Sl	226	Bartow	V.R.	L	(26)	Baker Property	113 White East
Sl	2	Polk	V.R.	Q	(26)	C. Browns South Quarry; Rockmart Brick and Shale	180 Rockmart South
Sl	3	Polk	V.R.	Q	(26)	Sibley Quarry-Southern Slate Co.	180 Rockmart South
Sl	4	Polk	V.R.	Q	(26)	Ellis Davis and Son Quarry	180 Rockmart South
Sl	6	Polk	V.R.	Q	(26)	Cherokee Slate Co.	180 Rockmart South
Sl	9	Polk	V.R.	P	(26)	Dever Property	180 Rockmart South
Sl	10	Polk	V.R.	P	(26)	Philpott Property	180 Rockmart South
Sl	11	Polk	V.R.	Q	(28)	A.G. Rhodes Estate	180 Rockmart South
S	13	Polk	V.R.	L	(28)	Joe Grice Property	180 Rockmart South
Sl	14	Polk	V.R.	Q	(26)	Southern State Portland Cement Co.	180 Rockmart South
Sl	16	Polk	V.R.	P	(26)	Everet Property	180 Rockmart South
Sl	31	Polk	V.R.	Q	(26)	Southern State Portland Cement Co. Shale Quarries	156 Rockmart North
Sl	37	Polk	V.R.	Q	(26)	Columbia Quarry	156 Rockmart North
Sl	38	Polk	V.R.	Q	(26)	Portland Quarry	156 Rockmart North
Sl	39	Polk	V.R.	P	(28)	J.G. Randall Property	156 Rockmart North
Sl	63*	Polk	V.R.	M	(15)	Galite Slate Quarry	180 Rockmart South
Sl	64	Polk	V.R.	Q	(26)	Black Diamond Quarries	156 Rockmart North

TRIPOLI

SYMBOL		COUNTY	PROVINCE	TYPE	REF.	NAME	# QUADRANGLE
T	130	Bartow	V.R.	M	(2)	Paga Mining Co.	135 Cartersville
T	209	Bartow	V.R.	L	(2)	White Manganese Co.	113 White East
T	44	Floyd	V.R	P	(2)	Old Bob Place	132 Rome South

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APPENDIX C

Isotopic Age Dates

by

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APPENDIX C
Isotopic Age Dates

The following table and accompanying map (Plate IV) are a compilation of previously published isotopic ages determined on rocks and minerals within the Atlanta Regional Map area. Unpublished ages were purposely omitted because they lack detailed information regarding isotopic ratios and standards. Most of the listed isotopic ages were extracted from a larger compilation of age dates by O'Connor and Dooley for the entire state of Georgia which was made to accompany the Geologic Map of Georgia (1976). This compilation is available through the Georgia Geologic Survey.

Sample locations as presented on Plate IV are based on the best available information supplied by the various authors or obtained from the publications themselves. In this regard, rock units assigned to some of the isotopic ages are also approximate. Most of the ages presented below represent the data as it was originally published. No attempt was made to update data by using revised decay constants. The reader may refer to the appropriate reference for more detailed information on ages presented in this appendix.

The accompanying map (Plate IV) of the Atlanta region is at a scale of 1:200,000 and is designed so that it can be used independently of the tables. The various methods of age determination are signified by the symbols (i.e., stars = K-Ar, triangles = Rb/Sr, filled circles = $^{40}Ar/^{39}Ar$, and squares = U/Pb and Pb-Pb). Letters in parentheses beside the date indicate either the mineral dated or, in some cases, whole-rock analyses [i.e., (wr)]. In cases involving K-Ar and $^{40}Ar/^{39}Ar$ methods where muscovite and biotite concentrates were analyzed, only the muscovite age is annotated on the map. Where hornblende concentrates were dated also, the hornblende age is annotated on the map. In cases where both K-Ar and $^{40}Ar/^{39}Ar$ ages were reported on the same sample and in the same publication, only the $^{40}Ar/^{39}Ar$ age determination was annotated on the map.

Listing of Ages

Map Number	Age	Map Unit	Method	Materials Dated	Source
1a	289 ± 10	Unknown	K-Ar	Biotite	1
	319 ± 26	Unknown	K-Ar	Muscovite	1
1b	302 ± 12	Unknown	K-Ar	Biotite	1
	281 ± 10		K-Ar	Muscovite	1
1c	414 ± 14	Unknown	K-Ar	Hornblende	1
1d	259 ± 9	Wolf Creek Fm.	K-Ar	Biotite	1
	280 ± 12		K-Ar	Muscovite	1
1e	320 ± 13	Brevard zone	K-Ar	Biotite	1
	280 ± 15		K-Ar	Muscovite	1
1f	275 ± 10	Brevard zone	K-Ar	Biotite	1
	292 ± 10		K-Ar	Muscovite	1
1g	292 ± 10	Powers Ferry Fm.	K-Ar	Biotite	1
	290 ± 15		K-Ar	Muscovite	1
1h	299 ± 12	Powers Ferry Fm.	K-Ar	Biotite	1
1i	292 ± 12	Powers Ferry Fm.	K-Ar	Biotite	1
	295 ± 12		K-Ar	Muscovite	1
1j	289 ± 12	Powers Ferry Fm.	K-Ar	Biotite	1
1k	286 ± 10	Wahoo Creek Fm.	K-Ar	Biotite	1
	321 ± 11		K-Ar	Muscovite	1
1e	277 ± 20	Norcross Gneiss	K-Ar	Whole Rock	1
1m	290 ± 14	Inman Yard Fm.	K-Ar	Muscovite	1
1n	401 ± 18	Norcross Gneiss	K-Ar	Biotite	1
	201 ± 11		K-Ar	Muscovite	1
1o	275 ± 10	Brevard zone	K-Ar	Biotite	1
1p	292 ± 6	Brevard zone	K-Ar	Biotite	1
1q	280 ± 9	Brevard zone	K-Ar	Biotite	1
1r	303 ± 11	Brevard zone	K-Ar	Biotite	1
	298 ± 9		K-Ar	Muscovite	1
1s	303 ± 9	Factory Shoals Fm.	K-Ar	Biotite	1
	310 ± 6		K-Ar	Muscovite	1
1t	286 ± 9	Powers Ferry Fm.	K-Ar	Biotite	1
	311 ± 12		K-Ar	Muscovite	1

Listing of Ages (Continued)

Map Number	Age	Map Unit	Method	Materials Dated	Source
1u	303 ± 13	Powers Ferry Fm.	K-Ar	Biotite	1
	295 ± 13		K-Ar	Muscovite	1
1v	308 ± 12	Powers Ferry Fm.	K-Ar	Biotite	1
	325 ± 10		K-Ar	Muscovite	1
1w	303 ± 10	Unknown	K-Ar	Muscovite	1
1x	284 ± 8	Unknown	K-Ar	Biotite	1
1y	298 ± 9	Unknown	K-Ar	Biotite	1
	295 ± 8	Unknown	K-Ar	Muscovite	1
2a	313 ± 10	Pumpkinvine Creek Fm.	$^{40}Ar/^{39}Ar$	Hornblende	2
3a	533 ± 15	Corbin Gneiss Complex	$^{40}Ar/^{39}Ar$	Biotite	3
	536 ± 12	Corbin Gneiss Complex	K-Ar	Biotite	3
3b	379 ± 15	Corbin Gneiss Complex	$^{40}Ar/^{39}Ar$	Biotite	3
3c	702 ± 15	Corbin Gneiss Complex	$^{40}Ar/^{39}Ar$	Biotite	3
	707 ± 16	Corbin Gneiss Complex	K-Ar	Biotite	3
3d	620 ± 15	Corbin Gneiss Complex	$^{40}Ar/^{39}Ar$	Biotite	3
4a	411 ± 25	Corbin Gneiss Complex	$^{40}Ar/^{39}Ar$	Biotite	3
	430 ± 25	Corbin Gneiss Complex	K-Ar	Biotite	3, 4
4b	320 ± 15	Camp Creek Fm.	K-Ar	Biotite	4
5a	290 ± 10	Brevard zone	K-Ar	Unknown	5
6c	1000	Corbin Gneiss Complex	Pb-Pb	Zircon	6
7a	309 ± 11	Powers Ferry Fm.	K-Ar	Biotite	7
7b	277 ± 10	Lithonia Gneiss (?)	K-Ar	Biotite	7
7c	294 ± 10	Stone Mountain Granite	K-Ar	Muscovite	7
8a	310 ± 5	Factory Shoals Fm.	$^{40}Ar/^{39}Ar$	Biotite	8
8b	317 ± 5	Clairmont Fm.	$^{40}Ar/^{39}Ar$	Biotite	8
	351 ± 5	Clairmont Fm.	$^{40}Ar/^{39}Ar$	Hornblende	8
8c	311 ± 5	Norcross Gneiss	$^{40}Ar/^{39}Ar$	Biotite	8
	355 ± 5	Norcross Gneiss	$^{40}Ar/^{39}Ar$	Hornblende	8
8d	296 ± 5	Clarkston Fm.	$^{40}Ar/^{39}Ar$	Biotite	8
	326 ± 5	Clarkston Fm.	$^{40}Ar/^{39}Ar$	Hornblende	8
	321 ± 7	Clarkston Fm.	K-Ar	Hornblende	8
8e	299 ± 5	Camp Creek Fm.	$^{40}Ar/^{39}Ar$	Biotite	8
8e	323 ± 5	Camp Creek Fm.	$^{40}Ar/^{39}Ar$	Hornblende	8
	301 ± 7	Camp Creek Fm.	K-Ar	Biotite	8
8f	281 ± 5	Stone Mountain Granite	$^{40}Ar/^{39}Ar$	Biotite	8
	283 ± 5	Stone Mountain Granite	$^{40}Ar/^{39}Ar$	Muscovite	8
8g	318 ± 5	Clairmont Fm.	$^{40}Ar/^{39}Ar$	Hornblende	8
	320 ± 8	Clairmont Fm.	K-Ar	Hornblende	8
8k	300 ± 5	Lithonia Gneiss	$^{40}Ar/^{39}Ar$	Hornblende	8
8i	290 ± 5	Amphibolite	$^{40}Ar/^{39}Ar$	Biotite	8
	307 ± 5	Amphibolite	$^{40}Ar/^{39}Ar$	Amphibole	8
8j	284 ± 5	Snellville Fm.	$^{40}Ar/^{39}Ar$	Biotite	8
	308 ± 5	Snellville Fm.	$^{40}Ar/^{39}Ar$	Amphibole	8
	309 ± 7	Snellville Fm.	K-Ar	Amphibole	8
8k	261 ± 5	Lithonia Gneiss	$^{40}Ar/^{39}Ar$	Biotite	8
	266 ± 6	Lithonia Gneiss	K-Ar	Biotite	8
8l	300 ± 5	Biotite gneiss/ amphibolite	$^{40}Ar/^{39}Ar$	Hornblende	8
8m	250 ± 5	Biotite gneiss	$^{40}Ar/^{39}Ar$	Biotite	8
	254 ± 7	Biotite gneiss	K-Ar	Biotite	8
8n	244 ± 5	Biotite gneiss	$^{40}Ar/^{39}Ar$	Biotite	8
9a	311 ± 9	Clairmont Fm.	K-Ar	Biotite	9
10a	342 ± 34	Ben Hill Granite	Rb-Sr	Biotite	10
10b	280 ± 14	Stone Mountain Granite	Rb-Sr	Biotite	10
	283 ± 14	Stone Mountain Granite	Rb-Sr	Biotite	10
	272 ± 30	Stone Mountain Granite	Rb-Sr	Muscovite	10
10c	297 ± 15	Lithonia Gneiss	Rb-Sr	Biotite	10

Listing of Ages (Continued)

Map Number	Age	Map Unit	Method	Materials Dated	Source
10d	282 ± 14	Ben Hill Granite	Rb-Sr	Biotite	10.1
10e	287 ± 15	Lithonia Gneiss	Rb-Sr	Biotite	10.1
	288 ± 20	Lithonia Gneiss	Rb-Sr	Muscovite	10.1
10e	315 ± 20	Lithonia Gneiss	K-Ar	Biotite	10.2
	305 ± 20	Lithonia Gneiss	K-Ar	Muscovite	10.2
10f	300 ± 15	Panola Granite	K-Ar	Biotite	10.2, 10.3
	293 ± 15	Panola Granite	Rb-Sr	Biotite	10.1
	313 ± 47	Panola Granite	Rb-Sr	Muscovite	10.1
11a	485	Lithonia Gneiss	U-Pb	Zircon	11
	475	Lithonia Gneiss	U-Pb	Zircon	11
12	291 ± 7	Stone Mountain Granite	Rb-Sr Isochron	Whole Rock and Minerals	12
13a	325	Panola Granite	U-Pb	Zircon	13
13b	325 (sample localities not given)	Stone Mountain Granite	U-Pb	Zircon	13
13c	375 (sample localities not given)	Lithonia Gneiss	U-Pb	Zircon	13
14a	325 (sample localities not given)	Ben Hill Granite	U-Pb	Zircon	14
14b	325	Palmetto Granite	U-Pb	Zircon	14
15a*	420 ± 8	Diabase	K-Ar	Whole Rock	15
15b*	290 ± 6	Diabase	K-Ar	Whole Rock	15
	299 ± 6	Diabase	K-Ar	Whole Rock	15
15c*	185 ± 4	Diabase	K-Ar	Whole Rock	15
	204 ± 4	Diabase	K-Ar	Whole Rock	15
	208 ± 4	Diabase	K-Ar	Whole Rock	15
15d*	274 ± 5	Diabase	K-Ar	Whole Rock	15
	282 ± 6	Diabase	K-Ar	Whole Rock	15
	242 ± 5	Diabase	K-Ar	Whole Rock	15
	250 ± 5	Diabase	K-Ar	Whole Rock	15
15e*	190 ± 4	Diabase	K-Ar	Whole Rock	15
	190 ± 4	Diabase	K-Ar	Whole Rock	15
15f*	249 ± 5	Diabase	K-Ar	Whole Rock	15
	243 ± 5	Diabase	K-Ar	Whole Rock	15
15g*	191 ± 4	Diabase	K-Ar	Whole Rock	15

*Dooley (1977) has indicated that excess argon is a factor in some of these age determinations.

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APPENDIX D

Data Sources for Geologic Map of the Atlanta Region (to accompany Plate Ia)

APPENDIX D

Data Sources

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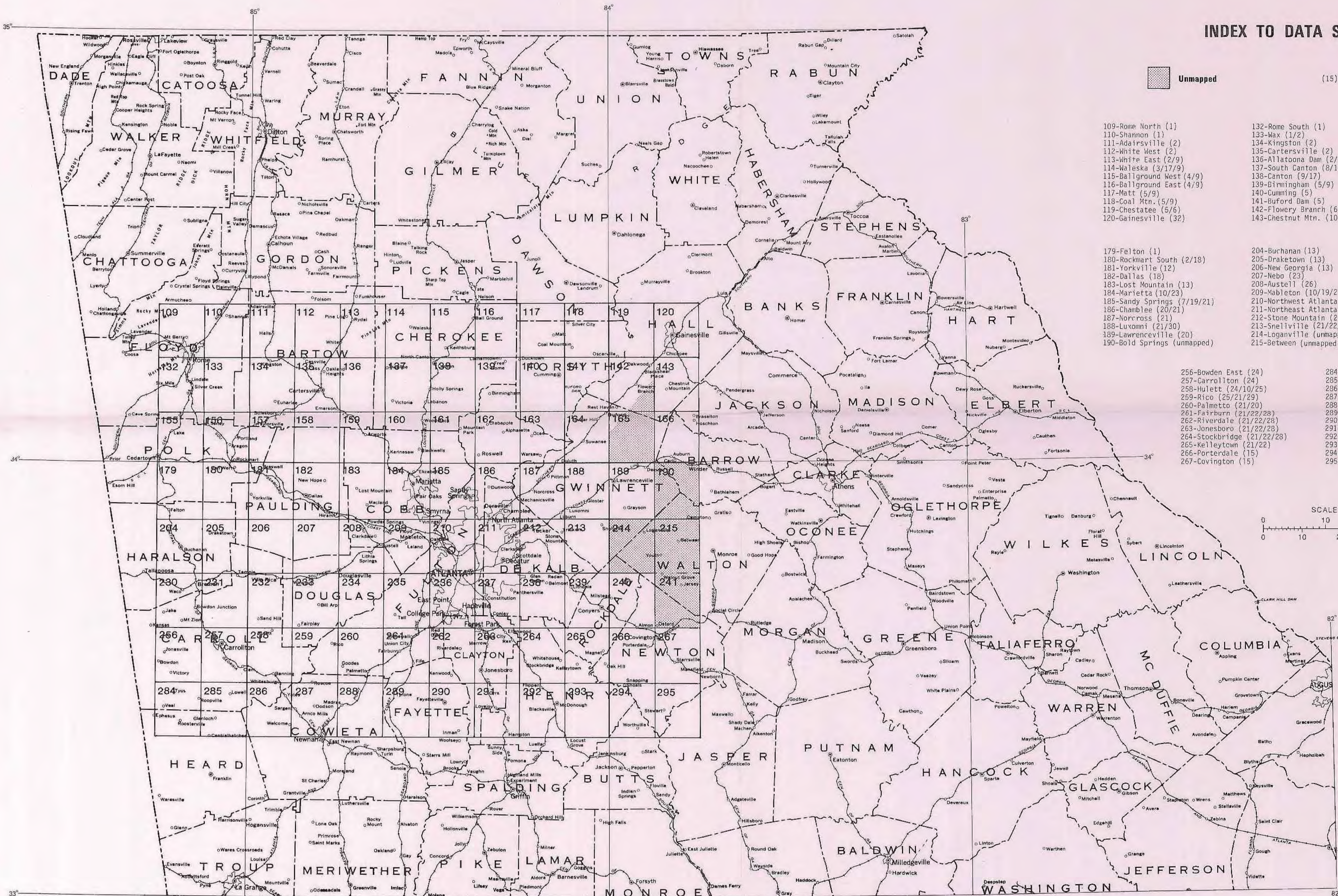
* Robert Atkins (Georgia Geologic Survey) and Michael Higgins (United States Geological Survey) jointly mapped a number of quadrangles in the Atlanta Regional Map area. These maps, as yet unpublished, represent a cooperative effort between the state and federal surveys.



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Unmapped

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109-Rome North (1)
110-Shannon (1)
111-Adairsville (2)
112-White West (2)
113-White East (2/9)
114-Waleska (3/17/9)
115-Ballground West (4/9)
116-Ballground East (4/9)
117-Matt (5/9)
118-Coal Mtn. (5/9)
119-Chestatee (5/6)
120-Gainesville (32)

132-Rome South (1)
133-Wax (1/2)
134-Kingston (2)
135-Cartersville (2)
136-Allatoona Dam (2/7/17)
137-South Canton (8/17)
138-Canton (9/17)
139-Birmingham (5/9)
140-Cumming (5)
141-Buford Dam (5)
142-Flowery Branch (6)
143-Chestnut Mtn. (10)

155-Cedartown East (1)
156-Rockmart (1)
157-Taylorsville (11)
158-Burnt Hickory Ridge (12)
159-Acworth (13/16/17/7)
160-Kennesaw (13/17)
161-Mountain Park (13/3/6)
162-Roswell (5)
163-Duluth (5)
164-Suwannee (14)
165-Hog Mountain (31)
166-Auburn (15)

179-Felton (1)
180-Rockmart South (2/18)
181-Yorkville (12)
182-Dallas (18)
183-Lost Mountain (13)
184-Marietta (10/23)
185-Sandy Springs (7/19/21)
186-Chamblee (20/21)
187-Norcross (21)
188-Luxomni (21/30)
189-Lawrenceville (20)
190-Bold Springs (unmapped)

204-Buchanan (13)
205-Draketown (13)
206-New Georgia (13)
207-Nebo (23)
208-Austell (26)
209-Mableton (10/19/21)
210-Northwest Atlanta (21/20)
211-Northeast Atlanta (21/3)
212-Stone Mountain (21/22/28)
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230-Bremen (33)
231-Temple (33)
232-Villa Rica (13)
233-Winston (26)
234-Campbellton (33/21/29)
235-Ben Hill (21/20)
236-Southwest Atlanta (21/22/28)
237-Southeast Atlanta (21/22/28)
238-Redan (21/22/28)
239-Conyers (21/22/28)
240-Milstead (27)
241-Jersey (unmapped)

256-Bowden East (24)
257-Carrollton (24)
258-Hulett (24/10/25)
259-Rico (25/21/29)
260-Palmetto (21/20)
261-Fairburn (21/22/28)
262-Riverdale (21/22/28)
263-Jonesboro (21/22/28)
264-Stockbridge (21/22/28)
265-Kelleytown (21/22)
266-Porterdale (15)
267-Covington (15)

284-Roopville (24)
285-Lowell (25)
286-Whitesburg (25)
287-Newnan North (21/22/28)
288-Madras (20/21/22/28)
289-Tyrone (21/22/28)
290-Fayetteville (21/22/28)
291-Hampton (21/22/28)
292-McDonough (22/28)
293-Ola (15)
294-Worthville (15)
295-Stewart (27)

EXPLANATION

Valley and Ridge

(after Cressler, 1970; and Cressler and others, 1979)

Carboniferous — Pennsylvanian

- IPu — Pennsylvanian rocks undivided

Carboniferous — Mississippian

- Mb — Bangor Limestone
- Mh, Mfs, Ml — Floyd Shale: includes Floyd Shale undifferentiated (Mfs), Hartselle Sandstone Member (Mh), and limestone (Ml).

Mississippian / Devonian

- MDc, Mfp, Mls, Da — Chert of Mississippian and Devonian age: includes Mississippian and Devonian Chert undifferentiated (MDc), Fort Payne Chert (Mfp), Lavender Shale Member (Mls), and Armuchee Chert (Da).

Silurian

- Srm — Red Mountain Formation

Ordovician

- Oum — Upper and Middle Ordovician undivided: includes Murfreesboro, Ridley, Moccasin, and Bays Formations.
- Ors, Or — Rockmart Slate: includes sandstone, conglomerate, and slate (Ors), and slate and siltstone (Or).
- On — Newala Limestone
- O€k, €cr — Knox Group: includes Knox Group undivided; Longview Limestone, Chepultepec Dolomite, and Copper Ridge Dolomite (O€k), and Copper Ridge Dolomite (€cr).

Cambrian

Western belt	Eastern belt	Cartersville area
		€cld
€csl	€cd	€csu
€cls	€c	€cl
€cs	€cs	€csl
		€cd

- Conasauga Group: includes Western and Eastern belts in Floyd County with units of mostly shale and some limestone (€csl), mostly limestone and some shale (€cls), siliceous shale and thin bedded sandstone (€cs), dolomite (€cd), shale and limestone mixed (€c), and mostly shale (€cs). In the Cartersville area: light to medium gray and brown dolomite (€cd), greenish, gray, tan, purplish and black shale (€csl), limestone (€cl), greenish, gray, and slightly purplish shale (€csu), and gray dolomite (€cld).
- €r — Rome Formation
- €s — Shady Dolomite
- €chq, €chs — Chilhowee Group: includes conglomerate and quartzite with interlayers of graphitic shale and phyllite (€chq), and graphitic shale and phyllite (€chs).

Blue Ridge

(modified after McConnell and Costello, 1980b)

Lower Paleozoic ? — Murphy Belt Group

- P€mb — Mineral Bluff Formation
- P€mm — Murphy Marble and Marblehill Hornblende Schist undifferentiated.
- P€b — Brasstown Formation
- P€na — Nantahala Formation

Proterozoic Z and (or) Lower Paleozoic — Ocoee Supergroup

Great Smoky Group

- p€d — Dean Formation
- p€sc — Sweetwater Creek Formation
- p€et — Etowah Formation

Walden Creek Group

- p€wg, p€wu, p€wc — Wilhite Formation: includes Wilhite Formation undifferentiated (p€wu), carbonaceous phyllite (p€wg), and sandy carbonate (p€wc).

Snowbird Group

- p€p — Pinelog Formation

- tu — Talladega belt rocks undifferentiated

Proterozoic Y

- p€c — Corbin Gneiss Complex

Northern Piedmont

(modified after Crawford and Medlin, 1974; Higgins and McConnell, 1978a; McConnell and Costello, 1980b; and Abrams and McConnell, 1981a)

Mesozoic

- d — diabase dikes

Paleozoic

- ag — Austell Gneiss
- mrg — Mulberry Rock Gneiss
- shg — Sand Hill Gneiss

Proterozoic Z and (or) Lower Paleozoic

Sandy Springs Group (western belt)

- ba — Bill Arp Formation
- amu, amq — Andy Mountain Formation: includes a quartzite member (amq) and undifferentiated schists and gneiss (amu).
- dru, drs, dra — Dog River Formation: includes undifferentiated biotite gneiss, mica schist and amphibolite (dru), a mica schist facies ± kyanite (drs), and amphibolite (dra).

Sandy Springs Group (eastern belt)

- fs — Factory Shoals Formation
- cpq — Chattahoochee Palisades Quartzite
- pfu, pfs, ma — Powers Ferry Formation: includes the Mableton Amphibolite (ma), a mica schist facies (pfs), and undifferentiated biotite gneiss, mica schist and amphibolite (pfu).

- yd — Yellowdirt Gneiss: (age and stratigraphic position uncertain).
- lig — Long Island Gneiss (age and stratigraphic position uncertain).

New Georgia Group (stratigraphic order uncertain)

- acg — Acworth Gneiss
- cas — Canton Formation
- pcu, gfg — Pumpkinvine Creek Formation: includes Pumpkinvine Creek undifferentiated (pcu) and Galts Ferry Gneiss (gfg).
- vrg, mcu, clq, mcb — Mud Creek Formation: includes metadacite (Villa Rica Gneiss, vrg), Cedar Lake Quartzite (clq), Mudd Creek undifferentiated (mcu), and garnet biotite gneiss (mcb).
- lma, rcs — Univeter Formation: includes Lost Mountain Amphibolite (lma) and Rose Creek Schist (rcs).
- kcc — Kellogg Creek Mafic Complex
- llu, llg, lld — Laura Lake Mafic Complex: includes metagabbro (llg), undifferentiated mafic and intermediate rocks (llu), and quartz diorite gneiss (lld).

Unassigned or Unnamed Rocks

- cs — chlorite-bearing schist ± garnet, biotite, or anthophyllite
- bif — magnetite quartzite (banded iron formation)
- kq — muscovite kyanite quartz granofels ± pyrite
- kqs — kyanite muscovite quartz schist and sericite quartzite ± kyanite and pyrite
- gs — carbonaceous schist
- ss/hgn — sericite schist with interlayered quartzite and hornblende gneiss
- ss — sericite schist with interlayered quartzite
- qms — quartz muscovite schist
- gms — garnet muscovite schist
- bgms — biotite garnet muscovite schist
- eq — epidote quartzite
- q — quartzite
- amp — amphibolite/hornblende gneiss undifferentiated
- amp/hgn/fgn — amphibolite, hornblende gneiss, and felsic gneiss
- ggn, fgn — granitic gneiss (ggn) and felsic gneiss (fgn) of unknown composition
- gab — metagabbro
- um — meta-ultramafic rocks, includes anthophyllite-chlorite hydrothermal alteration assemblages

Southern Piedmont and Brevard Fault Zone

(modified after Atkins and Higgins, 1980; and Kline, 1981)

Mesozoic

- d — diabase dikes
- my, bz, bzm — Ductally sheared rocks: includes Brevard fault zone undifferentiated (bz), Brevard zone mylonites (bzm), and other mylonites (my).

Carboniferous

- Cs — Stone Mountain Granite
- Cp — Palmetto Granite: includes the Shake Rag phase (sr), and the Tyrone phase (t).
- Cpa — Panola Granite
- Cb — Ben Hill Granite

Middle Paleozoic

- lig — Lithonia Gneiss

Paleozoic

- Pzuc — Union City Complex

Proterozoic Y and (or) Z and (or) Lower Paleozoic

- Pzss, Pzum, Pzsa, Pzsas — Soapstone Ridge Complex: includes a schist unit (Pzss), an amphibolite unit (Pzsa), an amphibolite and schist unit (Pzsas) and a coarse-grained ultramafic unit (Pzum).
- n, l — Snellville Formation: includes the Norris Lake Schist Member (n) and the Lanier Mountain Quartzite Member (l).

Sandy Springs Group

- fs — Factory Shoals Formation
- cpq — Chattahoochee Palisades Quartzite
- pfu — Powers Ferry Formation undifferentiated

Atlanta Group

- iy — Inman Yard Formation
- ng — Norcross Gneiss
- cl — Clairmont Formation
- pl, h — Promised Land Formation: includes the Hannah Member (h).
- wc — Wolf Creek Formation
- se — Senoia Formation
- wac — Wahoo Creek Formation
- st — Stonewall Formation
- f, tc, ca — Clarkston Formation: includes the Fairburn Member (f), Tar Creek Member (tc), and undifferentiated Clarkston Formation (ca).

New Georgia Group

- bci — Big Cotton Indian Formation
- icq — Intrenchment Creek Quartzite
- cc — Camp Creek Formation

Unassigned and Unnamed Rocks

- um — meta-ultramafic rocks
- amp — amphibolite and hornblende gneiss
- bgn — predominantly biotite gneiss
- ggn — granitic gneiss
- sg — sillimanite-graphite schist
- m — marble
- bgn/amp/sch — biotite gneiss, amphibolite, and mica schist undifferentiated
- q — quartzite
- bms — biotite muscovite schist

Symbols

- Contact, dashed where inferred
- Thrust fault, dashed where inferred
- D/U — Reverse fault, dashed where inferred, dotted where uncertain
- Flinty crush rock
- Strike-slip fault

GEOLOGY OF THE GREATER ATLANTA REGION

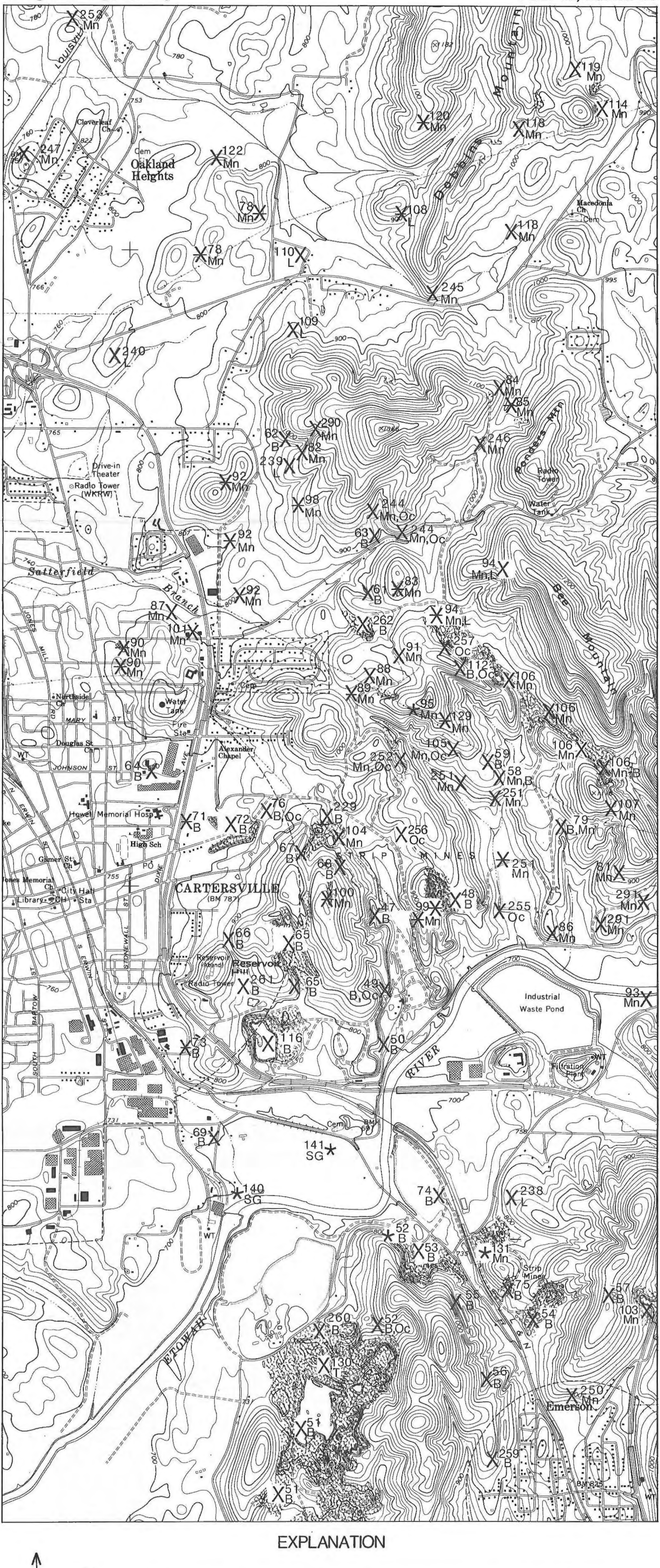
Compiled by K. I. McConnell and C. E. Abrams

GEOLOGY OF THE GREATER ATLANTA REGION

SCALE 1:100,000

Compiled by K. I. McConnell and C. E. Abrams

MINES, PROSPECTS, AND MINERAL LOCALITIES OF THE CARTERSVILLE AREA



EXPLANATION

N

X^{51}_{B} Mine - Coded numerically by county with commodity letter designation.

$\times^{73}_{B}$ Prospect - Coded numerically by county with commodity letter designation.

$\ast^{52}_{B}$ Mineral Locality - Coded numerically by county with commodity letter designation.

0 1 Mile

Plate II East, Bulletin 96

MINES, PROSPECTS, AND MINERAL LOCALITIES OF THE GREATER ATLANTA REGION

Compiled by C. Sullivan, A. T. Coolidge, C. E. Abrams, and K. I. McConnell

Plate II West, Bulletin 96

MINES, PROSPECTS, AND MINERAL LOCALITIES OF THE GREATER ATLANTA REGION

Compiled by C. Sullivan, A. T. Coolidge, C. E. Abrams, and K. I. McConnell

RELATIONSHIP OF BANDED IRON FORMATION AND HYDROTHERMAL ALTERATION ASSEMBLAGES TO MINES AND PROSPECTS OF WESTERN GEORGIA

by

Charlotte E. Abrams and Keith I. McConnell

1984

EXPLANATION

●44 Gold mine or prospect

△57 Sulfide mine or prospect

■84 Manganese mine or prospect

*77 Asbestos mine or prospect

T Tourmaline

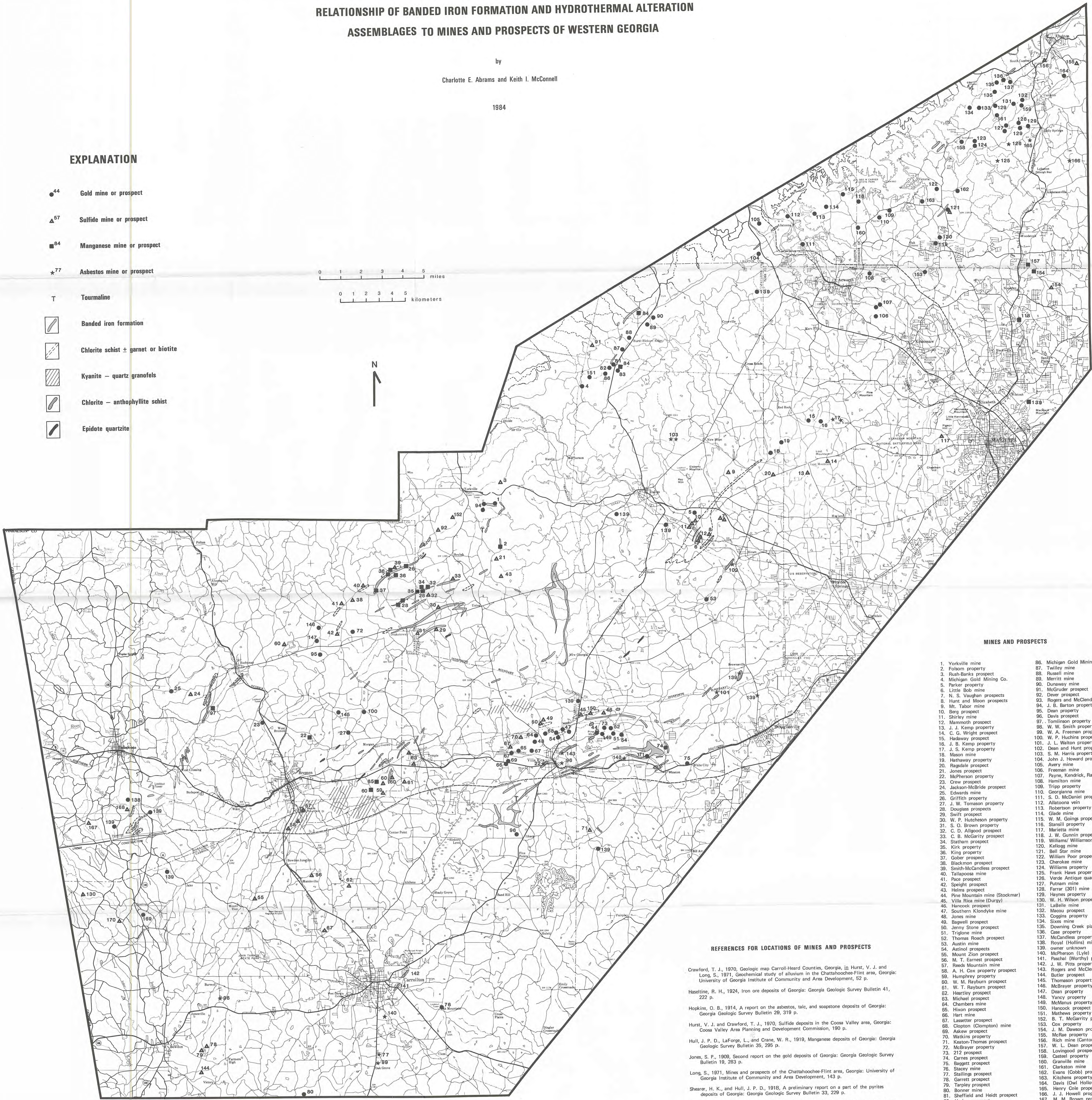
Banded iron formation

Chlorite schist ± garnet or biotite

Kyanite — quartz granofels

Chlorite — anthophyllite schist

Epidote quartzite



MINES AND PROSPECTS

1. Yorkville mine
2. Folsom property
3. Rush-Banks prospect
4. Michigan Gold Mining Co.
5. Parker property
6. Little Bob mine
7. N. S. Vaughan prospects
8. Hunt and Moon prospects
9. Mt. Tabor mine
10. Berg prospect
11. Shirley mine
12. Mammoth prospect
13. J. J. Kemp property
14. C. G. Wright prospect
15. Hadaway prospect
16. J. B. Kemp property
17. J. S. Kemp property
18. Mason mine
19. Hathaway property
20. Ragsdale prospect
21. Jones prospect
22. McPherson property
23. Crew prospect
24. Jackson-McBride prospect
25. Edwards mine
26. Griffith property
27. J. W. Tomason property
28. Douglass prospects
29. Swift prospect
30. W. P. Hutcheson property
31. S. O. Brown property
32. C. D. Allgood prospect
33. C. B. McGarity prospect
34. Statham prospect
35. Kirk property
36. King property
37. Gober prospect
38. Blackmon prospect
39. Smith-McCandless prospect
40. Tallapoosa mine
41. Pace prospect
42. Speight prospect
43. Helms prospect
44. Pine Mountain mine (Stockmar)
45. Villa Rica mine (Durgy)
46. Hancock prospect
47. Southern Klondyke mine
48. Jones mine
49. Bagwell prospect
50. Jenny Stone prospect
51. Triglone mine
52. Thomas Roach prospect
53. Austin mine
54. Astinol prospects
55. Mount Zion prospect
56. M. T. Earnest prospect
57. Reeds Mountain mine
58. A. H. Cox property prospect
59. Humphrey property
60. W. M. Rayburn prospect
61. W. T. Rayburn prospect
62. Heartley prospect
63. Michael prospect
64. Chambers mine
65. Hixon prospect
66. Hart mine
67. Lassetter prospect
68. Clopton (Clompton) mine
69. Askew prospect
70. Watkins property
71. Keaton-Thomas prospect
72. McBrayer property
73. 212 prospect
74. Carnes prospect
75. Baggett prospect
76. Stacey mine
77. Stallings prospect
78. Garrett prospect
79. Tarpley prospect
80. Bonner mine
81. Sheffield and Heidt prospect
82. Hodges prospect
83. Hobbs mine
84. Cochran prospects
85. Westbrook property
86. Michigan Gold Mining Co.
87. Twilley mine
88. Russell mine
89. Merritt mine
90. Dunaway mine
91. McGruder prospect
92. Dever prospect
93. Rogers and McClendon prospect
94. J. B. Barton property
95. Dean property
96. Davis prospect
97. . Tomlinson property
98. W. W. Smith property
99. W. A. Freeman property
100. W. P. Huchins property
101. J. L. Walton property
102. Dean and Hunt properties
103. S. M. Harris property
104. John J. Howard property
105. Avery mine
106. Freeman mine
107. Payne, Kendrick, Randall, and Hause properties
108. Hamilton mine
109. Tripp property
110. Georgianna mine
111. S. D. McDaniel property
112. Allatoona vein
113. Robertson property
114. Glade mine
115. W. M. Goings property
116. Stansill property
117. Marietta mine
118. J. W. Gunnin property
119. Williams/ Williamson property
120. Kellogg mine
121. Bell Star mine
122. William Poor property
123. Cherokee mine
124. Williams property
125. Frank Haws property
126. Verde Antique quarry
127. Putnam mine
128. Farrar (301) mine
129. Haynes property
130. W. H. Wilson property
131. LaBelle mine
132. Macou prospect
133. Coggins property
134. Sixes mine
135. Downing Creek placer
136. Case property
137. McCandless property
138. Royal (Hollins) mine
139. owner unknown
140. McPherson (Lyle) property
141. Paschal (Worthy) property
142. J. W. Pitts property
143. Rogers and McClendon property
144. Butler prospect
145. Thomason property
146. McBrayer property
147. Dean property
148. Yancy property
149. McManus property
150. Hancock prospect
151. Mathews property
152. B. T. McGarrity prospect
153. Cox property
154. J. M. Dawson property
155. McRae property
156. Rich mine (Canton)
157. W. L. Dean property
158. Lovingood prospect
159. Casteel property
160. Granville mine
161. Clarkston mine
162. Evans (Cobb) prospect
163. Kitchens property
164. Davis (Owl Hollow) mine
165. Henry Cole property
166. J. J. Howell property
167. M. M. Brown property
168. R. Robertson prospect
169. Chandler propsect
170. Hearn-McConnell prospect
171. owner unknown

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ISOTOPIC AGE DATES

Compiled by K. I. McConnell