GOLD AND BASE METAL MINERALIZATION HOST ROCKS IN THE DAHLONEGA AND CARROLL COUNTY GOLD BELTS, GEORGIA

Keith I. McConnell
Jerry M. German
Charlotte E. Abrams

with a Prologue by
Gilles O. Allard

21st Annual Field Trip
Georgia Geological Society
November 21-23, 1986
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TABLE OF CONTENTS

Prologue: Gilles O. Allard ........................................... 1

Acknowledgments ....................................................... 4

Geology of the Dahlonega and Carroll County Gold Districts
In West-Central Georgia: Keith I. McConnell and
Charlotte E. Abrams ................................................. 5

Geology of the Northeastern Portion of the Dahlonega Gold Belt:
Jerry M. German ...................................................... 41

Massive Sulfide Deposits Associated With Gold Mineralization
In the Dahlonega and Carroll County Gold Districts:
Charlotte E. Abrams and Keith I. McConnell ....................... 65

Road Log:
  Day 1 ....................................................................... 89
  Day 2 ....................................................................... 105
1986 GEORGIA GEOLOGICAL SOCIETY FIELD TRIP

PROLOGUE

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The gold fever which has hit the mineral exploration fraternity during the last five years is intensifying with each rise in the price of gold and/or decrease in the price of base metals and petroleum. The recent minting of the American Eagle gold coin and its availability to the American public is sure to intensify this fever. Throughout the world, gold-bearing terrains are being reevaluated and discoveries made. We feel that the Dahlonega gold belt and its extension to the southwest deserve your attention. The area is dotted with former gold producing properties and base metal prospects. The recent work of German, Abrams, and McConnell has done much to improve our understanding of the complex stratigraphy and structure of the area. The identification of volcanic protoliths for many of the quartzofeldspathic gneisses, amphibolites, iron formations and other rocks of the area, enhances the potential of the prospects.

The 1983 Society of Economic Geologists meeting in Atlanta and the field trip west of Atlanta served notice to geologists that Georgia had excellent prospecting ground for gold and/or base metals within high grade metamorphic terrains similar to those of Australia (Broken Hill), South Africa (Gamsberg, Aggeneys, etc.) and Canada (Anderson Lake, Geco, Hemlo, etc., etc.). We felt that geologists
interested in the Southeast gold potential should have an opportunity to study the Dahlonega area at the annual Geological Society field trip.

To the academically-oriented eternal pessimists who can recall only the large number of small low grade properties or ignore them completely, I would like to remind them that the recently-discovered NEVES CORVO deposit in Portugal lies in the famous Iberic belt, a region mined and intensely prospected for 2000 years, well known for its very large deposits of massive pyrite and extremely low grades in copper and zinc. Neves Corvo, discovered in the last ten years, is a world class deposit and probably the highest grade large tonnage copper deposit in the world!!!

Within the circle of gold afficionados, one cannot avoid mentioning HEMLO, the gold discovery of the century, found within 100 feet of a deep brown "sulfide burnt" outcrop on the Trans-Canada Highway. But Hemlo (over 70 million tonnes proven of 0.20 oz Au/tonne) did not sprout out of the moose pasture overnight.... exploration began in 1869. The area was mapped in the early thirties and favorable recommendations were made by Thompson in his report. Properties were staked, restaked, options taken and dropped, up to 15 times between 1940 and 1980. Limited drilling, some of it successful!, was done by a number of companies and individuals. Vancouver-generated funds (VSE) flowed in the Hemlo area and drilling was done on a scale known only in the Canadian Shield where widows and orphans, prodded by convincing promoters, invest in a multitude of promising "junior companies". The discovery hole which located the Main Zone at Hemlo was hole 81-76 with an intersection of 3 meters assaying 11 grams per tonne....this was after 75 holes
totaling 8,000 meters of "lively rocks" but no ore grade were drilled by patient geologists and promoters.

For the other pessimists who argue that many of the showings in the area of western Georgia are massive sulfides without any gold reported, I would like to suggest a retrospective look at the Montauban mine history. Montauban is located west of Quebec City within the Grenville Province. The area is underlain by sillimanite gneisses, marbles, and schists. Lead and zinc sulfides were produced in the fifties. A few years ago, the area was reinvestigated and gold ore was found at roughly the same stratigraphic horizon and within a very short distance of the former massive sulfide deposit. Gold has been produced for the last three years at Montauban.

The diversity of geological settings where gold has been found makes it impossible to formulate a unique model satisfactory for every exploration geologist. Some cherish the presence of a classical banded iron formation (Agnico Eagle, Quebec; Lupin, N.W.T.; Campbell Red Lake, Ontario), others prefer an altered body of ultramafic rocks, a porphyritic intrusive, an ankeritized shear zone, a sericite-quartz-pyrite schist within a volcanic pile, quartz veins within a greenstone assemblage, etc., etc. The Dahlonega belt and its extension to the southwest are underlain by many of the rocks mentioned above... whatever your favorite genetic theory, we feel certain that this field trip will challenge you and interest you!!!
ACKNOWLEDGEMENTS

We would like to thank Gilles Allard, Robert Carpenter, and Travis Paris for their constructive reviews of this guidebook. We also express our appreciation to Gilles Allard and Robert Power for their assistance in organizing this field trip. Finally we thank Mr. Glenn Hay for the kind offer of his farm as a lunch stop.
GEOLOGY OF THE DAHLONEGA AND CARROLL COUNTY GOLD
DISTRICTS IN WEST-CENTRAL GEORGIA

by
Keith I. McConnell*
Charlotte E. Abrams*

INTRODUCTION

Gold mineralization in western Georgia occurs in two distinct belts: the southwestern extension of the Dahlonega gold district in Cherokee, Cobb, Bartow, Paulding, and Haralson Counties and the Carroll County gold district in Carroll, Douglas, Paulding, and Cobb Counties (Fig 1). Both of these districts lie north of the Brevard fault zone and south of the Allatoona-Hayesville fault in what we have termed northern Piedmont (McConnell and Abrams, 1984). Gold mining and prospecting of lode and placer deposits was extensive in western Georgia from prior to the Civil War until about 1920. Much of this activity occurred as a result of the extension of prospecting southwestward from the main gold producing district in the Dahlonega area. After 1920, mining in the area essentially stopped.

A major thesis of this report is that the stratabound precious metal deposits of western Georgia are volcanogenic and formed syngenetically within a dominantly bimodal volcanic sequence. The dominantly volcanic sequence is composed primarily of mafic to felsic volcanic rocks and hydrothermally altered assemblages interlayered with clastic and volcaniclastic rocks. These rocks were subsequently metamorphosed to lower to middle amphibolite facies to form amphibolite, hornblende gneiss, feldspathic biotite gneiss, and choritic and sericitic schists. Exhalite, primarily in the form of banded iron formation, is interlayered with other lithologies and is generally found in close association with, or is the host for, many known gold mines and prospects in the northern Piedmont.

*Present Address: U.S. Nuclear Regulatory Commission, Mail Stop 623-SS, Washington, DC 20555
Figure 1.

Map showing the various gold districts in the northern Piedmont of Georgia and Alabama (Modified after Jones 1909). 1 = Dahlonega district, 2 = Hall County district, 3 = Carroll County district, 4 = Culifinnee-Arbacoochee district, 5 = Idaho district, 6 = West Chilton County district, 7 = Eagle Creek-Devils Backbone district, 8 = Hog Mountain-Goldville district, 9 = Cragford district.
Although rocks of the northern Piedmont have been affected by at least four fold events and several localized thrusting events, we believe that the volcanic rocks represent a relatively intact sequence of rocks denoting a distinct tectonic and depositional environment.

STRATIGRAPHY

Most rocks of the northern Piedmont of Georgia are encompassed in two major units (Fig. 2): the Sandy Springs Group (McConnell and Abrams, 1984, as modified from Higgins and McConnell, 1978) and New Georgia Group (McConnell and Abrams, 1984). No fossils and only isolated occurrences of facing criteria (Abrams and McConnell, 1984) are present in rocks of the New Georgia and Sandy Springs Groups. While facing criteria are locally present, their significance is limited to outcrop considerations due to evidence for multiple deformation and the potential for reversal of grading during regional metamorphism. In the absence of definitive age and stratigraphic relationships, the orientation of stratigraphic units subjected to high-grade metamorphism and multiple deformation is open to speculation.

Based primarily on our tectonic and structural models of the northern Piedmont (see Tectonics section), we speculate that the volcanic dominated sequence termed New Georgia Group (McConnell and Abrams, 1984) is the oldest post-Grenville rock unit in the northern Piedmont. The New Georgia Group is interpreted to be, at least locally, conformably overlain by the dominantly metasedimentary Sandy Springs Group. The contact between the two groups is expressed by the decrease in volcanic rocks from the older to younger sequence. While deformation has folded and locally faulted these rock units, gradational relationships between the Sandy Springs and New Georgia Groups are readily apparent in the Villa Rica-Bremen area where a dominantly volcanic to dominantly sedimentary transition occurs. In northeast Georgia, German (1985) has observed a gradational contact between New Georgia Group and Tallulah Falls Formation rocks.
Figure 2. Lithologic association map of the northern Piedmont of Georgia and Alabama.
NEW GEORGIA GROUP

The New Georgia Group in western Georgia is exposed in the axial
zone of a large folded and faulted nappe that is overturned to the
northwest (McConnell and Abrams, 1984) (Fig. 3). Subsequent
deformational events folded the nappe into a series of synforms and
antiforms. New Georgia Group rocks form an irregular outcrop belt
that extends from central Carroll County on the southwest
northeastward to Canton where the outcrop belt narrows considerably
and continues northeastward to form what is referred to as the
Dahlonega gold belt (Fig. 4). The majority of the gold deposits in
western Georgia are located within this area, which is at least 94
miles long and 17 miles wide, at its widest. The base of the New
Georgia Group is not exposed and the exact thickness of the group is
unknown. The exposed portion of the New Georgia Group is composed of
an intermingled sequence of metamorphosed felsic to mafic volcanic
and subvolcanic rocks, exhalites, metamagmatic rocks, and inter-
layered metamorphosed volcaniclastic and sedimentary rocks.

Three areas within the outcrop belt of the New Georgia Group
provide some understanding of the lithology and internal stratigraphy
of the group. Two of these areas occur on the borders of the New
Georgia Group and include the Villa Rica area on the southeast and
Pumpkintwine Creek Formation on the northwest. The third area is in
the center of the belt, extending from just southeast of Dallas
northeastward through Canton.

In the Villa Rica area (Fig. 5), Abrams and McConnell (1981)
were able to subdivide the New Georgia Group into several distinct
rock units included in the Mud Creek Formation. 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 (now expressed predominantly as magnetite quartzite), and
metadacite. Banded iron formation in the Villa Rica area and
elsewhere in the northern Piedmont is an excellent stratigraphic
marker (Abrams and McConnell, 1982). We believe that iron formation
Figure 3. Diagrammatic cross section through the northern Piedmont of Georgia.
Figure 4. Distribution of major rock units in the northern Piedmont of Georgia.
Figure 5. Geologic map of the Villa Rica area.
represents a distinct depositional environment denoting coprecipitation of silica and iron/or manganese from emanations from a submarine volcanic vent. Therefore, volcaniclastic and epiclastic rocks now expressed as schists associated with the iron formation are omitted from what we have termed the Cedar Lake Quartzite (Abrams and McConnell, 1981). The Cedar Lake Quartzite is locally interlayered with amphibolite and is composed of layers and disseminated grains of magnetite and specular hematite in a coarse to micro-crystalline quartzite. Manganese oxides are present in distinct zones. This oxide facies grades locally into a sulfide and an aluminous facies commonly containing almandine garnet.

A distinctive feature of the Villa Rica area is the Villa Rica antiform. The Villa Rica Gneiss (Abrams and McConnell, 1981) is exposed in the crest of the anticlinorium. This gneiss is an equigranular biotite-quartz-oligoclase (An_{26} to An_{30}) gneiss characterized by low concentrations of K_2O (Sanders, 1977) (Table 1). Relationships observed in the field and examination of cores from several mines and prospects in the area suggest that the Villa Rica Gneiss is interlayered with surrounding mafic metavolcanic and metasedimentary rocks. Core resulting from a regional drilling program by Tennessee Copper Co. (Tennessee Chemical Corp.) displays interlayering of felsic gneiss and other lithologies on nearly all scales. No evidence of major faulting is observed between lithologies and we, therefore, believe that metamorphosed sedimentary and felsic and mafic volcanic rocks represent a relatively intact sequence. Locally, enclaves or inffolds of mafic metavolcanic rocks are present in the main outcrop belt of the Villa Rica gneiss. The relationships between the Villa Rica Gneiss and its country rock are interpreted to suggest that the Villa Rica gneiss represents either a metamorphosed subvolcanic felsic intrusive (McConnell and Abrams, 1983) or volcanic rock.

On the northwestern border of the New Georgia Group, a sequence remarkably similar to the Mud Creek Formation was defined by McConnell (1980). This sequence includes the Pumpkinvine Creek Formation (Fig. 6) and is exposed in the limbs of another antiform
Table 1. Chemical and normative analyses of the Galts Ferry (GF) and Villa Rica (VR) Gneisses (Oxides in weight percent)

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Analyses performed in the Laboratory of the Georgia Geologic Survey
Analyst: Roger Landrum.
Figure 6. Geologic map showing the distribution of the Pumpkinvine Creek, Canton and Univeter Formations in north-central Georgia.
termed the Auraria antiform by German (1985). The Galts Ferry Gneiss Member of the Pumpkinvine Creek Formation, like the Villa Rica Gneiss to the southwest and the Barlow Gneiss (German, 1985) to the north, is exposed in the crest of this fold and is characterized by low concentrations of $K_2O$ (Table 1). The Galts Ferry Gneiss is a hornblende-quartz-plagioclase gneiss that shows distinct mesoscopic banding due to variation in hornblende content (Fig. 7). The hornblende-plagioclase gneiss varies to a biotite-muscovite-quartz-plagioclase gneiss with 12-18" layers of hornblende gneiss and actinolite-chlorite schist (Crawford, 1976). Locally, the Galts Ferry Gneiss is characterized by rocks containing ellipsoidal blue quartz phenocrysts and subhedral feldspar grains in a fine-grained matrix (crystal tuff). Gradationally above the Galts Ferry Gneiss in the Pumpkinvine Creek Formation is an interlayered sequence of predominantly fine-grained amphibolite, garnet-hornblende-quartz-albite gneiss, and sericite phyllite (McConnell, 1980; McConnell and Abrams, 1984). The garnet-quartz-albite gneiss, is chemically and mineralogically similar to the Galts Ferry Gneiss. Also present in the Pumpkinvine Creek Formation is discontinuous, but regionally mappable banded iron formation. The presence of banded iron formation, quartz-eye gneisses in the Galts Ferry, and locally well preserved pillow and amygdular structures (Hurst and Jones, 1973, McConnell and Abrams, 1983) confirm a volcanic origin for the Pumpkinvine Creek Formation.

Higgins and others (1984) have implied that amphibolites of the Pumpkinvine Creek Formation are separated from the Galts Ferry Gneiss by major faults perhaps related to local shearing present within the felsic gneiss. However, we see no evidence to support major faulting within this sequence of rocks. The contact between the two units is exposed along the shores of Lake Allatoona (McConnell, 1980) and does not show evidence for extensive faulting.

Another distinct sequence of rocks in the New Georgia Group are rocks of the Univeter Formation (McConnell and Abrams, 1984). Centrally located in the New Georgia Group outcrop area, the Univeter Formation (Fig. 4) is a sequence of amphibolite, hornblende gneiss,
Figure 7. Photograph showing the compositional banding in the Galts Ferry Gneiss at the type locality.
garnet-biotite-muscovite schist and banded iron formation that occurs in a belt extending from Dallas on the southwest through the Dahlonega area (German, 1985) and at least as far northeast as Nacoochee, Georgia (Gillon, 1982; German, 1985). The Univeter Formation consists largely of two hornblende-oligoclase amphibolites (Lost Mountain Amphibolite; McConnell and Abrams, 1984) separated by a garnet-biotite-muscovite schist ± hornblende (Rose Creek Schist; McConnell and Abrams, 1984). This same sequence, although locally cut out by faulting, is recognizable for a distance of over 80 miles (John Costello, pers. comm., 1982; Gillon, 1982; McConnell and Abrams, 1984; German, 1985).

Similar rock assemblages (i.e., banded iron formation, felsic gneisses and amphibolites) are observed throughout the New Georgia Group, but stratigraphic relationships are complicated by deformation. Other rock types known to occur in the New Georgia Group include: aluminous schist, graphitic schists, quartzite, chlorite-amphibole rocks, pyritic sericite-quartz schist, coarse garnet-chlorite rocks, chlorite-anthophyllite rocks, tourmalinite and kyanite-quartz granofels.

SANDY SPRINGS GROUP

The Sandy Springs Group is a metasediment-dominated sequence with substantial volcanic material only in the lowermost unit. McConnell and Abrams (1984) divided the Sandy Springs Group into an eastern and western belt (Fig. 4). Although similar rock units are present in both areas, the type area for the Sandy Springs Group (eastern belt) lies east of a major structural discontinuity termed the Chattahoochee fault. However, the western belt of the Sandy Springs Group (Fig. 4), like the type Sandy Springs Group as modified by McConnell and Abrams (1984), is divided into three formations (Table 2). The uppermost unit, the Bill Arp Formation, is an intermixed sequence of schists and metagreywackes and contains no major mineral occurrences and little volcanic material. The lower two units of the Sandy Springs Group (western belt) do contain mineral occurrences. The lowermost unit termed the Dog River Formation
Table 2. Stratigraphic correlation chart for the northern Piedmont of Georgia (after McConnell and Abrams, 1984).

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<td>Bill Arp Formation</td>
<td>Factory Shoals Formation</td>
<td>Greywacke, schist Quartzite, schist</td>
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<td>Sandy Springs Group</td>
<td>Andy Mountain Formation</td>
<td>Aluminous schist</td>
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*Hurst (1973) interpreted the Wedowee to be older than Ashland.
Abrams and McConnell, 1981) is an interlayered sequence of amphibolite, metagreywacke, biotite gneiss, and garnet-biotite-muscovite schist. These lithologies grade into the rocks of the New Georgia Group. Also present in the Dog River Formation are thin (1-3 in.) layers of banded iron formation. Thinning of iron formations in the Dog River Formation in comparison with those of the Mud Creek Formation of the New Georgia Group and the relative decrease in mafic volcanic rocks in the Dog River Formation, is the basis for defining the contact between the New Georgia and Sandy Springs Groups as gradational.

Conformably above the basal member of the Sandy Springs Group is the Andy Mountain Formation (Abrams and McConnell, 1981). The Andy Mountain Formation is composed predominantly of quartzite, medium-grained staurolite-garnet-muscovite-quartz schist, and garnet muscovite-graphite-quartz schist. Also present in lesser amounts is an equigranular garnet-biotite-oligoclase gneiss. Locally, garnet-graphite schist makes up the largest portion of the Andy Mountain Formation. Garnet bearing graphite schists on the northwestern margin of the New Georgia Group (Fig. 8) are interpreted to be Andy Mountain equivalents and near Buchanan these schists contain an approximately 6 ft. section of graphitic banded iron formation. No known gold mineralization is present in the Andy Mountain Formation, but the presence of banded iron formation suggests that a hydrothermal system was operative during deposition.

METAMORPHISM AND DEFORMATION

Only one major period of post-Grenville prograde regional metamorphism is recognized in rocks of the Piedmont north of the Brevard fault zone. This metamorphic event occurred coincident with the first major deformational event in the area which is characterized by isoclinal folds, transposition of original layering and the formation of a regional foliation. The timing of this event is believed to have been between approximately 370 m.y.a. (McConnell, unpublished data) and 310 m.y.a. (based on an $^{40}\text{Ar}/^{39}\text{Ar}$ age of a metamorphic amphibole in the Pumpkinvine Creek Formation; McConnell,
Figure 8. Sketch map showing the relationship of iron formation to other lithologies in the Andy Mountain Formation near Buchanan, Georgia.
1980). Folds related to this first deformational event were recumbent to overturned to the northwest and trend to the northeast. Metamorphic grade in the northern Piedmont is generally kyanite, but exposures along the northern Piedmont-Blue Ridge boundary from Allatoona to the southwest are upper greenschist facies to lower amphibolite facies (McConnell, 1980).

Subsequent to the first major deformation, at least three other deformational events occurred. The most significant of these deformational events was the second (F$_2$) which refolded earlier isoclinal F$_1$ folds into a series of broad open antiforms and synforms. This deformational event is primarily responsible for outcrop patterns in the field trip area. F$_2$ folds trend northeast-southwest and are generally upright to overturned to the northwest. Locally, F$_2$ folds are observed to be slightly overturned to the southeast. Deformation related to the second fold event was intense enough to reorient base and precious metal ores (Abrams and others, 1981).

Third generation folding is not consistent in orientation across the outcrop area of the New Georgia Group. In the southeastern part of the New Georgia Group, F$_3$ folds trend north-northeast and are upright to overturned to the northwest (Abrams and McConnell, 1981) while in the northeastern part of the group, F$_3$ folds trend to the southeast and are overturned to the southwest (McConnell and Costello, 1980). Late stage, northwest trending warping has affected all rocks in the field trip area. Neither F$_3$ nor F$_4$ folding events apparently were intense enough to have substantial impact on the location of ore horizons.

The northern Piedmont is bounded on the south by the Brevard fault zone. On the northwestern boundary, northern Piedmont rocks are separated from Talladega belt and Ocoee Supergroup rocks by a fault termed the Allatoona-Hayesville fault (McConnell and Costello, 1980). The Hayesville fault as defined by Hatcher and Odom (1980) is a probable cryptic suture separating a volcanic, ultramafic, felsic gneiss bearing terrain to the southeast from a largely nonvolcanic, abundant basement-bearing terrain on the northwest. In the field trip
area, the dominantly volcanic New Georgia Group is in sharp contact with metasedimentary rocks of the Ocoee Supergroup and Talladega belt. The abrupt change in lithology and tectonic environment across this boundary as well as the local absence of the Canton Formation along this boundary and sporadic occurrences of mylonite and retrogressive mineral assemblages support a fault interpretation along the New Georgia-Ocoee Supergroup contact. McConnell and Costello (1980) termed this fault the Allatoona fault (modified after Hurst, 1973) and correlated it with the Hayesville fault because of similarities between relationships across the Allatoona fault with the definition of the Hayesville.

To the southwest near the Alabama line, the nature of the contact between the northern Piedmont and Talladega belt becomes questionable. In this area (Fig. 4), rocks of the Sandy Springs Group western belt are in contact with Talladega belt rocks with no apparent offset or metamorphic grade change across the boundary. The nature, and to some degree the existence of the Allatoona-Hayesville fault in this area is uncertain. Recent drilling of the contact by the Georgia Geologic Survey may shed some light on the relationship between these two contacts.

TECTORIC ENVIRONMENT AND REGIONAL CORRELATION

TECTORIC ENVIRONMENT

We relate the formation of the New Georgia Group to the attenuation and rifting of the North American continental margin in the late Precambrian to early Paleozoic. Rifting of the North American continental margin is apparent during the late Precambrian in the southern Appalachians (Gair and Slack, 1984) and we believe that New Georgia Group rocks are an artifact of this rifting episode and form "basement" where the Grenville terrain was severely attenuated.

A rifting interpretation is supported by similarities between New Georgia Group rocks and Archean greenstone belts (McConnell and Abrams, 1983) which Sangster (1980) has suggested formed in areas of crustal tension. Some of the similarities between the New Georgia
Group and greenstone belts are: predominance of mafic over felsic volcanics; dacitic composition of felsic volcanics; chemical sediments located near the top of sequences that are possibly at the end of a volcanic cycle; bimodal volcanic chemistry; Cu-Zn dominated massive sulfide deposits and the presence of subvolcanic plutons within the volcanic pile.

Geochemical similarities between amphibolites in the New Georgia Group and basalts formed in rifted basins (McConnell, 1980; McConnell and Abrams, 1984; German, 1985) also support an extensional tectonic environment of formation for the New Georgia Group. A similar tectonic environment has been proposed for amphibolites of the northern Piedmont of Alabama (including those of the Ashland Supergroup) (Stow and others, 1984) and amphibolites of the Ashe Formation in North Carolina (Gair and Slack, 1984). Amphibolites in the northern Piedmont of Alabama, the New Georgia Group and Ashe Formation occur along a northeast-southwest regional trend that parallels the trend of the Appalachian orogen. We suggest that this trend (i.e., belt) marks the locus, now allochthonous, of a rifted basin that formed along the continental margin of North America.

McConnell (1980) indicated that the bimodal character of the volcanic sequence of the New Georgia Group and the influx of sediments into the rifted basin suggest that the basin was a back-arc or marginal basin (Karig, 1974). We suggest that the back-arc basin may have formed behind an Andean-type arc, perhaps in part represented by rocks of the Kings Mountain belt which display affinities to island arc type rocks. In this interpretation, the subduction zone was dipping to the west and back-arc rifting occurred above a zone of partial melting below the tectonically thinned continental crust. Volcanism resulting from rifting was overtaken by deposition into the basin from both the arc to the east and continental land mass to the west.

REGIONAL CORRELATION

Due to a lack of distinct age relationships within rocks of the northern Piedmont, regional correlations are subject to wide
speculation. Many workers (among others, Higgins and McConnell, 1978; Hatcher and Butler, 1979; McConnell and Abrams, 1984) have correlated rock units in the northern Piedmont or eastern Blue Ridge belt (as some workers term the area here called northern Piedmont) with units along structural trend to the northeast and southwest. These correlations are based to a large extent on the regional continuity of a distinctive sequence of intermixed meta-igneous and metasedimentary rocks which in central and western Georgia is termed the Sandy Springs Group. Along trend to the northeast similar lithologies and stratigraphic sequences are present including the Tallulah Falls Formation (Hatcher, 1974) in northeastern Georgia and South Carolina and the Ashe Formation (Rankin and others, 1973) in North Carolina. To the southwest similar sequences are also observed in Alabama (Bentley and Neathery, 1970).

We suggest that there is additional evidence for this northeast-southwest regional correlation primarily in the similarity of ore deposits common in Ashland-New Georgia-Ashe sequence. These three units contain most of the major massive sulfide and gold deposits of the southern Appalachian orogen outside of the Carolina "Slate" belt. Mineralization of these rock units is now believed in all areas to be volcanogenic and syngentic (Gair and Slack, 1984; Abrams and McConnell, 1984; Neathery and Hollister, 1984; German, 1985) and the lithologic associations with mineralization (most notably exhalites) are common to all three areas.

Regional correlation along a northeast-southwest trend (i.e., "beltist" philosophy) is supported by stratigraphy, amphibolite geochemistry, and base and precious metal mineralization. In a recent report, Higgins and others (1984) have attempted to avoid the classical "belt" terminology common to the southern Appalachians, replacing the belts with a thrust sheet terminology. They suggest that the Piedmont and Blue Ridge is composed of a series of stacked thrust sheets originating to the southeast. A southeast-northwest trending thrust terminology is substituted for the northeast-southwest trending belt terminology. In the thrust interpretation, contacts previously interpreted as stratigraphic, in some cases
gradational (e.g., the contact between the Wahoo Creek and Clairmont Formations, Higgins and Atkins, 1981, p. 12), are now interpreted as faults (Higgins and others, 1984). Rocks of the New Georgia and Sandy Springs Group are broken into a series of klippen related to the various thrust sheets which, in part, were defined south of the Brevard zone (Higgins and others, 1984).

While we agree that thrust faulting and the resulting stacking of lithologic sequences has played an important role in the development of the northern Piedmont and Blue Ridge (McConnell and Costello, 1979), we disagree with the hypothesis presented by Higgins and others (1984). Primarily, we see little to no evidence of, or justification for, the presence of major faults separating well-defined and easily recognized members of stratigraphic units such as the Pumpkintown Creek Formation or Univeter Formation from other members of the formations. For example, the Ropes Creek thrust is defined as having little to no felsic volcanic material and only minor amounts of manganiferous pelagic rock (Higgins and others, 1984). This definition of the thrust sheet is based primarily on the absence of felsic rocks in the Ropes Creek Metabasalt (Ropes Creek formation of Sears, Cook and Brown, 1981) which occurs in the southern Piedmont near LaGrange. Rocks of the Pumpkintown Creek Formation according to Higgins and others' are part of the Ropes Creek thrust sheet, but by definition must be separated from felsic rocks of the Galts Ferry Gneiss and pelagic sediments of the Canton Formation by faults. The contact between the Pumpkintown Creek and Canton Formations will be observed at Stop 8 and appears to be locally sheared but overall gradational. Evidence found along the shores of Lake Allatoona and evidence in core from massive sulfide mines indicate that the felsic volcanic rocks (of calc-alkaline character, McConnell and Abrams, 1984) of the Galts Ferry Gneiss are an intimate part of the volcanic sequence much as they are in major gold producing areas such as the Abitibi Greenstone belt district in Canada (Baragar and Goodwin, 1969; MacGeehan and MacLean, 1980).

The Ropes Creek thrust sheet of Higgins and others (1984) is also defined in part on the basis of the type (iron rich) of banded
iron formation present. In the guidebook area, magnetite-rich iron formation has been mapped in at least three of the thrust sheets outlined by Higgins and others (1984), the Zebulon (magnetite iron formation in the Canton Formation, this guidebook), Sandy Springs (magnetite bearing iron formation in the Dog River and Powers Ferry Formation, McConnell and Abrams, 1983), and Ropes Creek (this guidebook). The question then arises that if using Higgins and others' (1984) method of classifying thrust sheets based on lithologic associations or non-associations, faults are required around these occurrences of iron-rich banded iron formation not now defined as being in the Ropes Creek thrust sheet. We believe that the evidence currently available does not support a classification of thrust sheets based on iron formation composition and/or other lithologic associations or non-associations.

While chemical similarities exist between the amphibolites and other lithologies of the Ropes Creek and Pumpkinvine Creek areas (McConnell and Abrams, 1986), there are distinct differences between the two sequences. In addition to the apparent absence of a significant felsic volcanic component in the Ropes Creek basalts, there is also a significant absence of gold or base metal mineralization (McConnell and Abrams, 1986). Hydrothermal activity in association with the Ropes Creek Metabasalt also appears to be significantly different containing substantially more boron alteration (McConnell and Abrams, 1986).

GOLD DEPOSITS

Four facts are evident with respect to the gold deposits of western Georgia in particular and gold deposits in the Dahlonega and Carroll County belts in general:

1) lode gold deposits are restricted to certain well defined stratigraphic units;
2) metavolcanic rocks in general and banded iron formation in particular are common associates to the presence of gold (McConnell and Abrams, 1983);
3) the linear character of gold districts or belts is largely the result of the linear trend of stratigraphic units that host the deposits; and
4) mineralization occurs within mafic volcanic sequences, felsic to intermediate volcanic to subvolcanic sequences, and mixed volcanic-sedimentary sequences.

Lode gold deposits in the Dahlonega and Carroll County districts of western Georgia are largely restricted to five units within the New Georgia and Sandy Springs Groups: Pumpkinvine Creek Formation, Univerter Formation, Mud Creek Formation, and Canton Formation of the New Georgia Group and Dog River Formation of the Sandy Springs Group. All of the above rock units contain a significant portion of volcanic rocks and all have associated iron formation.

GOLD DEPOSITS IN MIXED VOLCANIC-SEDIMENTARY HOST ROCKS

A compilation of known gold mines in the northern Piedmont of Georgia (Fig. 9) indicates that the overwhelming majority of gold deposits are present in interlayered metasedimentary and metavolcanic sequences whereas lesser numbers of mines and prospects are present in predominantly mafic or felsic host rocks. The mixed metasedimentary and metavolcanic host rocks are primarily the Canton Formation of the New Georgia Group and the Dog River Formation of the Sandy Springs Group.

The Canton Formation (McConnell and Abrams, 1984) contains the majority of mines and prospects and is the single most important unit for gold mineralization in the northern Piedmont. Until recently, the Canton Formation (Canton Schist of Bayley, 1928) was believed to be a metasedimentary unit with gold mineralization derived from some unknown granite at depth (Jones, 1909). However, recent work (McConnell and Abrams, 1984; German, 1985) has shown that the Canton Formation contains widespread occurrences of banded iron formation, amphibolite, and quartz-sericite schists (interpreted as metamorphosed, hydrothermally altered felsic volcanic rocks).
Figure 9. Gold mine and prospect distribution in the northern Piedmont of Georgia by lithology.

Figure 10. Gold mine and prospect distribution in the northern Piedmont of Georgia by stratigraphic unit.
Therefore the interpretation of the Canton Formation has changed from sedimentary to mixed volcano-sedimentary.

Gold in the Canton Formation has been previously reported to occur in association with quartz "veins" (Yeates and others, 1896). However, it is evident from reading the old literature and from recent work in the Canton Formation, that while many of these gold-bearing "veins" represent remobilization of gold into quartz veins during metamorphism, other "veins" are probably metamorphosed exhalites (e.g., magnetite sandstones of Yeates and others, 1896). These probable exhalites include rocks that we have interpreted as sulfide, aluminous and oxide facies banded iron formation.

The presence of banded iron formation and other volcanic lithologies in association with gold mines in the Canton Formation is well documented at such mines as the Charles, Cherokee and further to the northeast the Kin Mori (Abrams and McConnell, 1984; German, 1985). The direct association with exhalative units in the Canton Formation suggests that the gold was formed synchronously with deposition of the volcanic rocks and that exhalative activity played an important role in the formation of the deposits. However, in many cases gold mineralization cannot be directly linked to banded iron formation or hydrothermally altered rock. In those cases, it is possible that erosion of the clastic-volcanic sequence of the Canton Formation following deposition may have led to the formation of paleo-placers deposited in basins away from volcanic centers (Robert Carpenter, personal comm., 1986)

Another unit that is host to the large number of gold prospects in mixed volcano-sedimentary rocks is the basal member of the Sandy Springs Group, the Dog River Formation. The Dog River Formation is composed of interlayered amphibolite, metagreywacke, and mica schist. Banded iron formation and chlorite schist (magnesium alteration assemblage) are locally present. Three major gold mines are known to be present in the Dog River Formation: Royal Vindicator, Bonner and Yorkville (Table 3). All three mines associated with the Dog River Formation have banded iron formation in close proximity to the ore bodies. Units associated with gold mines in the Dog River Formation
<table>
<thead>
<tr>
<th>Mine</th>
<th>Lithologies Present</th>
<th>Group or Formation</th>
<th>Grade</th>
<th>(Oz/ton)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Franklin-Creighton</td>
<td>Hornblende gneiss(1) amphibolite, mica schist, chlorite schist, iron formation.</td>
<td>Univetor Formation</td>
<td>6.5</td>
<td>(2)</td>
</tr>
<tr>
<td>Cherokee</td>
<td>Amphibolite, mica schist and auriferous quartz vein.</td>
<td>Canton and Pumpkinvine Creek Formations</td>
<td>7.35</td>
<td>(3)</td>
</tr>
<tr>
<td>Sixes</td>
<td>Amphibolite, hornblende gneiss, mica schist and auriferous quartz vein.</td>
<td>Pumpkinvine Creek and Cantor Formations</td>
<td>.07</td>
<td>(3)</td>
</tr>
<tr>
<td>Bell-Star</td>
<td>Hornblende gneiss, sericite and chorite schist and iron formation</td>
<td>Univetor Formation</td>
<td>4.95</td>
<td>(3)</td>
</tr>
<tr>
<td>Pine Mountain</td>
<td>Muscovite-paragonite quartzite ± pyrite and kyanite.</td>
<td>Mud Creek Formation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yorkville</td>
<td>Mica schist, amphibolite and iron formation.</td>
<td>Dog River Formation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Royal</td>
<td>Chlorite-amphibole schist, mica schist and iron formation.</td>
<td>Dog River Formation</td>
<td>.32</td>
<td>(3)</td>
</tr>
<tr>
<td>Bonner</td>
<td>Mica schist and felsic gneiss.</td>
<td>Dog River Formation</td>
<td>.05-.25</td>
<td>(2)</td>
</tr>
<tr>
<td>Charles</td>
<td>Amphibolite, graphitic</td>
<td>Canton Formation schist, and iron formation (1).</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Barlow Cut</td>
<td>Leucocratic biotite gneiss and amphibolite (1).</td>
<td>Barlow Gneiss/Pumpkinvine Creek Formation (1)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lockhart</td>
<td>Leucocratic biotite gneiss, sericite schist, amphibolite, and iron formation (1).</td>
<td>Pumpkinvine Creek and Cantor Formations</td>
<td>3.0</td>
<td>(2)</td>
</tr>
</tbody>
</table>
Table 3: Continued

<table>
<thead>
<tr>
<th>Kin Mori</th>
<th>Garnet muscovite schist and iron formation.</th>
<th>Proctor Creek/Canton Formation</th>
</tr>
</thead>
</table>

* These grades may not be accurate representations of the ore grade at the mine or prospect.
1) German, 1985.
2) Yeates and others, 1896
3) Georgia Geologic Survey Mineral Files (unpub.)

in western Georgia trend southwestward into Alabama and include prospects east of the Arbacoochee district in Cleburne and Randolph Counties (Fig. 1).

GOLD DEPOSITS AND MAFIC VOLCANIC HOST ROCKS

Mafic volcanic rocks host the second largest number of gold mines and prospects in the northern Piedmont of Georgia (Fig. 9). Mafic hosts occur predominantly in two major units in the New Georgia Group: the Univeter and Pumpkinvine Creek Formation. Both the Univeter and Pumpkinvine Creek Formations are amphibolite dominated units; with the amphibolites in both representing metamorphosed tholeiitic basalts (McConnell and Abrams, 1984; German, 1985). Relict pillows and amygdules have been recognized in both the Pumpkinvine Creek and Univeter Formations (Hurst and Jones, 1973; McConnell and Abrams, 1983). Also common to both the Univeter and Pumpkinvine Creek Formations is the presence of banded iron formation. However, differences exist between the Univeter and Pumpkinvine Creek Formations. In particular, a large mass of felsic to intermediate gneiss (i.e., the Galt's Ferry Gneiss) is associated with the Pumpkinvine Creek Formation. Based on the presence of quartz-eye texture, this material is interpreted as representing felsic to intermediate volcanic rock interlayered with the basalts. In contrast, the Univeter Formation is known to contain limited amounts of felsic rock (German, this report, indicates more felsic material has been found) and is only present in localized areas such as the felsic material hosting the massive sulfide deposit at the
Little Bob mine near Dallas. This suggests that felsic occurrences in the Univeter represent volcanic centers of only limited lateral extent.

Gold deposits associated with the Pumpkinvine Creek Formation (Fig. 10) are present in two separate lithologic associations: with banded iron formation and amphibolite, and with the felsic member of the Pumpkinvine Creek. The felsic association will be discussed in a later section. Of the thirteen mines known to be primarily associated with mafic end members of the Pumpkinvine Creek Formation, twelve have associated banded iron formation. Mines occurring with iron formation are primarily in the Dahlonega area and include the Consolidated, Crown Mountain, Findley and Singleton mines (German, 1985). This association of gold mineralization and banded iron formation in the Pumpkinvine Creek Formation cannot be considered coincidental because many of the gold mines have banded iron formation visible in the pits, and other mines and prospects have iron formation spatially associated. This suggests that a genetic relationship exists between banded iron formation and some of the gold deposits. We believe that the iron formation in many cases hosts gold deposits similar to the relationship seen at the Vubachikwe gold mine in Zimbabwe (Fripp, 1976). Gold deposits at the Vubachikwe mine are hosted by thin layers of banded iron formation which are interlayered with mafic and felsic volcanic rocks (Fripp, 1976). Similar associations are found at the Agnico-Eagle mine in Quebec (Barnett and others, 1982).

With respect to gold deposits present in the Univeter Formation, the distinct association with banded iron formation is less apparent. Of the nineteen gold mines known to be located in the Univeter, only five are known to have associated iron formation. Several of the largest gold deposits in the Univeter are known to be associated with banded iron formation. These include the Bell-Star and Creighton mines (Table 3). While oxide facies iron formation is present at the Creighton gold mine, photographs of the ore at the Creighton (see Jones, 1909) also suggest that the ore may represent sulfide facies
banded iron formation. Further work in the Univerter may reveal that more gold deposits are associated with banded iron formation.

While iron formation is, in many cases, host to gold deposits in mafic volcanic units, other gold mines and prospects show only a geographic association with iron formation. We believe that iron formation denotes the presence of a hydrothermal system characteristic of volcanogenic gold mineralization. Therefore, iron formation, whether host or indicator, provides an extremely useful exploration tool in the northern Piedmont.

GOLD DEPOSITS AND FELSIC TO INTERMEDIATE HOST ROCKS

Another lithologic association in which gold deposits occur in Georgia is with felsic to intermediate gneisses within the New Georgia Group. Major units included within this category are the Villa Rica Gneiss (Abrams and McConnell, 1981) in the Carroll County district and the Galts Ferry Gneiss (McConnell and Abrams, 1984) and Barlow Gneiss (German, 1985) members of the Pumpkinvine Creek Formation. The Villa Rica, Galts Ferry, and Barlow Gneisses are interpreted to represent metamorphosed felsic to intermediate volcanic to subvolcanic rocks. Gold in these units generally occurs in association with quartz "veins". These quartz "veins" vary from the massive, bedded quartz granofels (possibly a siliceous sinter) present at the Pine Mountain mine in the Villa Rica Gneiss to thin quartz stringers in the Barlow Gneiss.

CONCLUSIONS

Gold deposits in the northern Piedmont of Georgia and Alabama are largely restricted to three associated rock sequences: mixed volcanic-sedimentary ± iron formation; mafic volcanic sequences ± iron formation; and felsic volcanic-subvolcanic sequences ± iron formation. Deposits hosted by mixed volcano-sedimentary sequences and mafic volcanic sequences are almost invariably spatially related to some facies of banded iron formation. This association of banded iron formation with gold deposits extends the entire length of the northern Piedmont in Georgia and must be considered more than a
coincidence. The proximity of iron formation in mixed and mafic-volcanic hosts to gold deposits is an obvious indicator of exhalative activity within the volcanic sequence and lends strong support to the conclusion that these gold deposits formed syngenetically with the volcanic host rocks. While some remobilization of gold into dilatant zones occurred during metamorphism, it is believed to have been minor, similar to remobilization relationships seen at the Homestake mine in South Dakota (Rye and Rye, 1974). At the Homestake mine, the ore deposit is interpreted to have formed syngenetically with the Homestake formation by exhalative activity, and subsequent concentration in dilatant zones occurred during metamorphism (Rye and Rye, 1974).

Felsic gneisses hosting gold deposits in the northern Piedmont are interpreted to represent volcanic to sub-volcanic complexes that formed contemporaneously with other volcanic rocks in the area. All of the felsic gneisses associated with gold deposits are low-potassium gneisses (i.e., metadacites or metatronjhemites). Gold deposits are hosted by exhalites associated with low potassium gneisses as at the Pine Mountain mine in Georgia and by quartz stringers suggestive of stockwork-type deposits in the Barlow Gneiss of the Dahlonega area.
REFERENCES CITED


Crawford, T.J., 1976, Geologic map of the Burnt Hickory Ridge
quadrangle, Georgia: Georgia Geologic Survey Open-File Map, 1:24,000.


37
and related rocks in the Georgia Piedmont-nomenclature and
stratigraphy, in Sohl, N.F., and Wright, W.B., eds., Changes
in stratigraphic nomenclature by the U.S. Geological Survey,
Hurst, V.J., 1973, Geology of the southern Blue Ridge belt:
Hurst, V.J., and Jones, L.M., 1973, Origin of amphibolites in the
Cartersville-Villa Rica area, Georgia: Geological Society of
Karig, D.E., 1974, Evolution of arc systems in the western Pacific:
Jones, S.P., 1909, Second report on the gold deposits of Georgia:
MacGeehan, P.J., and MacLean, W.H., 1980, Tholeiitic basalt-rhyolite
magmatism and massive sulphide deposits at Matagami, Quebec:
McConnell, K.I., 1980, Origin and correlation of the Pumpkinvine
Creek Formation: a new unit in the Piedmont of northern
Georgia: Georgia Geologic Survey Information Circular 52,
19 p.
McConnell, K.I., and Abrams, C.E., 1983, Geology of the New
Georgia Group and associated sulfide and gold deposits:
west-central Georgia: Society of Economic Geologists Annual
Meeting, 27 p.
—, 1984, Geology of the Greater Atlanta Region: Georgia
—, 1986, Base and precious metal mineralization in two similar
terranes in the Piedmont of Georgia: Geological Society of
America Abstracts with Programs, v. 18, no. 3, p. 254.
a traverse through the Blue Ridge and Piedmont provinces of
north Georgia, in Frey, R.W., ed., Excursions in southeastern
—, 1981, Large scale crustal shortening in the southwestern
Georgia Blue Ridge and adjacent Piedmont: Geological Society of America Abstracts with Programs, v. 11, p. 205.


Sanders, R.P., 1977, Major element chemical variation in several bodies of granite gneiss of the Piedmont of west Georgia (abs.): Georgia Journal of Science, v. 35, no. 2, p. 89.


278, p. 442-460.
THE GEOLOGY OF THE NORTHEASTERN PORTION
OF THE DAHLONEGA GOLD BELT

by

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INTRODUCTION

The Dahlonega gold belt, named for the town of Dahlonega, Georgia, is a narrow sequence of rock units that can be mapped from near the Georgia-Alabama State line northeastward to the Georgia-North Carolina State line, a distance of approximately 152 mi (approximately 243 km). The belt varies in width from a maximum of approximately 12.8 mi (approximately 21.2 km) in Cobb and Paulding Counties to less than 0.6 mi (approximately 1 km) in Rabun County. Although Jones (1909) defined the Dahlonega belt simply as a belt of gold occurrences, recent studies (McConnell and Abrams, 1984; Abrams and McConnell, 1984; German, 1985; German, in prep) have shown the belt to be predominantly confined to the New Georgia Group (Fig. 1). For over 100 years this area was the major gold-producing region in Georgia. Previous reports (Yeates and others, 1896; Jones, 1909; Pardee and Park, 1948) gave detailed descriptions of individual mines and prospects but gave little information on regional geologic relationships. Therefore, the purpose of this guidebook and recent investigations (McConnell and Abrams, 1984; Abrams and McConnell, 1984; German 1985, German, in prep.) is to show regional geologic relationships in the Dahlonega and Carroll County gold belt and the controls for the occurrence of gold and base metal deposits.

STRATIGRAPHY

INTRODUCTION

The Dahlonega gold belt (from Paulding County northeastward to Rabun County) comprises rocks of the Canton, Pumpkinvine Creek and
Figure 1 Geographic extent of the New Georgia Group (after McConnell and Abrams, 1984 and German, 1985). Dahlonega gold belt (shaded, after Jones, 1909) is superimposed for comparison.
Univeter Formations of the New Georgia Group (Fig. 2). This sequence of rocks is composed of metavolcanic and metasedimentary rock units of considerable variability. Thickness of these units are impossible to ascertain reliably due to faulting and multiple folding but are estimated to range from less than 100 m to several kilometers. For the same reasons, stratigraphic order is problematical; however, units below are described in a probable ascending order. They are assigned a Late Proterozoic or early Paleozoic age based on radiometric age dates determined by Dallmeyer (1978) for the southern (or inner) Piedmont and extrapolated into the study area (northern Piedmont) by Abrams and McConnell (1981).

PUMPKINVINE CREEK FORMATION

The Pumpkinvine Creek Formation is a fine-grained amphibolite with interlayered thin units of felsic gneiss and sericite phyllite (McConnell, 1980). The Pumpkinvine Creek Formation is exposed in a regional antiform (Auraria antiform, German, 1985) from central Paulding County to central Cherokee County where it plunges northward beneath the Canton Formation on the eastern edge of Canton, Georgia (McConnell, 1980; McConnell and Abrams, 1984; German, 1985) and reappears approximately 15.6 mi (approximately 25 km) to the northeast. From that point it is exposed continuously northeastward to Dahlonega where it again plunges beneath the Canton Formation. Cook and Burnell (1983) presented a similar structural interpretation regarding the outcrop pattern of this unit in the Dahlonega area and referred to it informally as the Findley Ridge amphibolite.

PUMPKINVINE CREEK FORMATION UNDIFFERENTIATED

Rocks designated as Pumpkinvine Creek Formation undifferentiated consist of amphibolite with lesser amounts of garnet-biotite-hornblende-quartz-plagioclase gneiss ± calcite and/or staurolite, muscovite-biotite-plagioclase-quartz gneiss, and iron formation. The amphibolite overall has a homogeneous texture, but megacrysts that may be meta-amygdules are locally present. In the northeastern part of the Dahlonega belt hornblende is the dominant mafic mineral with
Figure 2 Diagrammatic stratigraphic section of rock units in the northeastern portion of the Dahlonega gold belt (after German, 1985). All rock units are part of the New Georgia Group except the Tallulah Falls Formation.
chlorite and epidote increasing in abundance to the southwest. Relict pillows have been recognized at the type locality and vicinity (Hurst and Jones, 1973; McConnell and Abrams, 1984). Whole rock and trace element chemistry of the amphibolites indicates an abyssal tholeiite affinity (McConnell, 1980; McConnell and Abrams, 1984; German, 1985). Garnet-biotite-hornblende-quartz-plagioclase gneiss ± calcite and/or staurolite is locally interlayered with the amphibolite near the contact with the Canton Formation. Striking features of this rock are radiating laths (rosettes) of hornblende several centimeters across and large rolled garnets up to 1.5 cm in diameter. The muscovite-biotite-plagioclase-quartz gneiss was formally termed the Barlow Gneiss by German (1985). A conspicuous feature of this felsic gneiss is the occurrence of flattened megacrysts of blue quartz and/or plagioclase. This unit is probably a metamorphosed crystal tuff. Iron formation units associated with the Pumpkinvine Creek Formation are relatively thin (less than 1 meter) quartzites that locally may contain magnetite, hematite, pyrite, arsenopyrite, mica, garnet, or unidentified manganese minerals.

CANTON FORMATION

This unit was originally called the Canton Schist by Bayley (1928). McConnell and Abrams (1984) redefined this unit as the Canton Formation when it was recognized that several lithologies were present in this unit. Southwest of the type locality at Canton, Georgia, graphitic mica schist ± garnet is the predominant lithology with only local occurrences of metagreywacke and non-graphitic schist. However, northeast of the type locality graphite schist becomes a minor constituent and other lithologies become predominant. Lithologies northeast of the type locality include garnet-biotite-muscovite-quartz schist, muscovite-garnet-biotite-quartz schist, hornblende-biotite-quartz schist, biotite-plagioclase-quartz gneiss (metagreywacke), plagioclase-biotite quartzite, felsic gneiss, amphibolite and iron formation. German (1985) was able to recognize four members within the Canton Formation.

45
Proctor Creek Member

The Proctor Creek Member (German, 1985) is composed of a lustrous, fine-to medium-grained muscovite-garnet-biotite-quartz schist. Accessory minerals include magnetite, chlorite, and calcite. Thin lenses of calc-silicate material (i.e., garnet-hornblende-quartz-plagioclase granofels) 1 to 5 cm thick are present locally. In the Dahlonega area the schist grades into a medium- to coarse-grained muscovite-plagioclase-garnet-biotite-quartz rock that contains coarse megacrysts of altered plagioclase rimmed by garnet and biotite. At several locations, distinct layers with coarse megacrysts 4 to 8 mm in diameter alternate with layers having fine megacrysts 1 to 3 mm in diameter.

The Proctor Creek Member is in sharp stratigraphic contact with the Pumpkinvine Creek Formation and grades into the structurally overlying Palmer Creek Member. Characteristics of this member at most exposures suggest a shale as its protolith; however, the coarsely megacrystic facies exposed in the vicinity of Dahlonega could be interpreted as a metatuff.

Palmer Creek Member

The Palmer Creek Member (German, 1985) consists of biotite-quartz schist ± hornblende and/or garnet (metasiltstone) with minor garnet-biotite-muscovite-quartz schist and amphibolite present locally. The biotite-quartz schist is fine- to medium-grained and cleaves readily into thin plates. It locally contains small almandine garnet crystals approximately 2 mm in diameter. Hornblende crystals locally occur as somewhat ragged laths up to 1.5 cm long randomly oriented along the foliation planes. Accessory minerals are epidote, plagioclase, magnetite, and chlorite. The garnet-biotite-muscovite-quartz schist is most abundant in the Dahlonega area and is similar texturally to the biotite-quartz schists. The Palmer Creek Member probably is a metamorphosed sequence of fine-grained sediments and minor mafic tuffs or flows.
Chestatee Member

The Chestatee Member (German, 1985) is a sequence of lithologies that include, in order of abundance, amphibolite, muscovite-biotite-quartz-plagioclase gneiss, and muscovite-pyrite-plagioclase-quartz gneiss. The amphibolite is dark green to black and exhibits textures ranging from finely equigranular to coarsely megacrystic. In the coarsely megacrystic rock, leucocratic megacrysts occur either as single plagioclase crystals resembling metamorphosed phenocrysts or as crystal aggregates of clinozoisite resembling metamorphosed amygdules. The muscovite-biotite-quartz-plagioclase gneiss is a medium-grey rock with a generally homogeneous texture. Megacrysts of quartz and/or plagioclase approximately 1 to 3 mm in diameter are conspicuous. This lithology closely resembles the Barlow Gneiss Member of the Pumpkinvine Creek Formation. The muscovite-pyrite-plagioclase-quartz gneiss is a very leucocratic rock with a uniform texture. Fine lamination of pyrite and muscovite are locally present. The Chestatee Member probably represents a metamorphosed sequence of felsic and mafic crystal tuffs and mafic flows.

Helen Member

The Helen Member (German, 1985) consists of biotite-muscovite-quartz schist ± garnet and biotite-plagioclase-quartz gneiss (metagreywacke) with minor plagioclase-biotite quartzite and amphibolite. The schist and gneiss occur as an intricately interlayered sequence where alternation of layers of equal thicknesses is common. The schist is light grey to light brown in color and overall fine- to medium-grained. It is richer in garnet and muscovite in the southwestern half of its exposed length, becoming garnet-poor, slightly feldspathic and biotite-rich to the northeast. Where garnetiferous, the largest garnets are approximately 0.5 cm in diameter, euhedral and exhibit a rolled (pinwheel) texture. Staurolite, chlorite, magnetite and tourmaline are accessory minerals. Graphite is locally abundant. The gneiss is medium grey in color with an overall "salt and pepper" appearance. The gneiss is locally conglomeratic with metaclasts consisting of
quartz or plagioclase less than 0.5 cm in longest dimension. Matrix material consists of a fine-grained mixture of quartz and plagioclase plus lesser amounts of biotite, muscovite, garnet and epidote. Fine laminations and graded beds are observable in hand samples and thin sections. In some exposures northeast of Dahlonega, the quartz content is high enough (greater than 79 percent) to classify this lithology as a quartzite. The amphibolites occur as thin units interbedded with the above mentioned schist and gneiss. Some amphibolites are easily mapped over long distances and, therefore, were used as stratigraphic marker horizons. Their mineralogy consists predominantly of plagioclase and hornblende with accessory sphene, epidote, chlorite and magnetite. Locally, chlorite and epidote are abundant.

The mineralogy, textures, and internal stratigraphy of the Helen Member strongly suggest a predominantly sedimentary origin. The repetitive nature of the gneiss-schist sequence resembles part of a turbidite sequence. This member probably was deposited in a rapidly subsiding basin that had an occasional episode of volcanic activity.

UNIVETER FORMATION

The Univeter Formation is exposed from near Dallas, Georgia, in Paulding County to Lake Burton in Habersham County, its trace forming a regional topographic lineament. Southwest of Canton, Georgia, the Univeter Formation consists of amphibolite, hornblende gneiss, garnet-biotite-muscovite schist, banded iron formation, and garnet-chlorite schist and is divided into the Lost Mountain Amphibolite and Rose Creek Schist Members (McConnell and Abrams, 1984). Recent mapping (German, in prep.) south and southwest of Canton has revealed the occurrence of felsic gneiss in addition to those lithologies reported by McConnell and Abrams (1984). Northeast of Canton to just northeast of Dahlonega separately mappable units within the Univeter Formation are rare. Between these points, the Univeter consists of fine-grained amphibolite with minor interlayered plagioclase-hornblende-biotite-quartz gneiss, biotite-muscovite-
quartz schists and iron formation.

Northeast of Dahlonega, Georgia, other facies within the Univeter Formation are recognizable and are mappable for short distances. These include fine-grained amphibolite, garnet-biotite-muscovite-quartz schist and biotite-plagioclase-quartz gneiss.

Northeast of Helen, Georgia, the Univeter Formation grades into rocks previously mapped as undifferentiated Tallulah Falls Formation (Hatcher, 1971, 1974) and as Great Smoky Group (Hatcher, 1976). These rocks can be traced along the western shore of Lake Burton and through Rabun County to the Georgia-North Carolina State line. They consist of a complex assemblage of plagioclase-biotite-quartz gneiss (metagreywacke), plagioclase-garnet-biotite-muscovite-quartz schist, biotite-quartz schist ± garnet, hornblende-plagioclase gneiss, and amphibolite ± biotite and/or garnet. The overall composition of this assemblage is similar to the lowermost member of the Tallulah Falls Formation (Hatcher, 1971; 1974; 1976).

INTRUSIVE ROCKS

Three metamorphic rock bodies intrude the Canton Formation in the Dahlonega area (Fig. 3). These units are leucocratic, medium- to coarse-grained rocks composed principally of quartz (65-70%) and plagioclase (20-25%) and were tentatively called metatrondjhemites by Cook and others (1984). Two of the bodies contain muscovite and biotite as varietal minerals, whereas the other body contains amphibole as its varietal mineral. All three bodies are sericitized and kaolinized and have a weakly to moderately well-developed foliation. All have associated fine- to medium-grained felsic to intermediate gneisses that are interpreted to be metamorphosed extrusive phases. These plutons probably intruded the Canton Formation shortly after the peak of regional metamorphism.

Mafic intrusive bodies present in the northeastern part of the Dahlonega gold belt are diabase dikes. Almost all dikes are confined to the extreme northeastern end of the Dahlonega belt and are clearly
Figure 3  Geologic map of a portion of Dawson and Lumpkin Counties with locations of mines and prospects (after German, 1986).
the youngest rocks in the Dahlonega belt as demonstrated by their
crosscutting nature and lack of metamorphic overprint. All dike
rocks examined contain from 10 to 23 percent olivine, are less than 3
m wide and strike northwest. A few can be traced for several
kilometers. One diabase dike located within the boundaries of the
Ball Ground East Quadrangle in Cherokee County cuts the trace of the
Allatoona fault.

STRUCTURE

The structural complexity of the Dahlonega gold belt has long
been recognized. Crickmay (1952) characterized this area as a
complex zone of pervasive shearing and suggested the existence of
extensive faulting. Because of this, he referred to this area as the
Dahlonega shear zone. Observations made by German (1985; in
preparation) tend to corroborate Crickmay's remarks of shearing;
however, the primary cause for shearing appears to be extremely tight
folding rather than faulting. Faulting is present but is largely
confined to the borders of the gold belt.

Three major faults form portions of the boundaries of the gold
belt. The Chattahoochee fault forms most of the southeastern
boundary, whereas the Allatoona and Shope Fork faults form part of
the northwestern boundary. All juxtapose significantly different
geologic terrains.

The Chattahoochee fault was first proposed by Hurst (1973) and
its trace was subsequently modified by McConnell and Abrams (1982).
This fault forms a distinct boundary between the weakly to highly
migmatized Sandy Springs Group and unmigmatized schists,
amphibolites, and felsic gneiss of the Univeter Formation. Bowen
(1961) described cataclastic textures associated with this boundary
in southeastern Dawson County and McConnell and Abrams (1984)
described this boundary as a metamorphic isograd and migmatitic
front. This fault was traced by the author from just southwest of
Lake Burton in Habershaw County southwestward to central Cherokee
County. McConnell and Abrams (1984) traced it farther southwestward
where it is overridden by the Blairs Bridge fault.
Hatcher (1978) proposed that one of the faults on the northwestern boundary of the Dahlonega belt was a continuation of the Hayesville fault which had been observed farther to the northeast in North Carolina. This fault was subsequently called the Allatoona-Hayesville fault by McConnell and Costello (1980) and simply the Allatoona fault by McConnell and Abrams (1984) and German (1985). Movement along this fault probably occurred shortly after the peak of regional metamorphism since it truncates the northwestern limb of the Auraria antiform (Fig. 3 and 4). Along the Allatoona fault, rocks of the Dahlonega gold belt with a substantial volcanic component was thrust over the predominantly sedimentary Great Smoky Group, forming a distinct boundary between dissimilar terrains. This fault terminates northeast of Dahlonega near the trace of the Shope Fork fault (German, 1985, Plate 1).

The Shope Fork fault was mapped by Hatcher (1976) through Towns and Rabun Counties and was extended into White County by Gillon (1982). Hatcher (1976, 1979) considered movement along this fault to have been pre- or symmetamorphic. The Shope Fork fault can be traced across Lumpkin County north of Dahlonega and separates lithologies resembling the Canton Formation from the Richard Russell formation (Arthur E. Nelson, personal commun., 1984).

The only major fault observed within the interior of the Dahlonega belt is a reverse fault that extends from just southeast of Dawsonville to northeast of Dahlonega where it merges with the Allatoona fault (Figs. 3 and 4). Movement along this fault transported the Chestatee Member to its present position and is believed responsible for the discontinuity in strikes between units on either side. This fault may represent a splay off the Allatoona fault.

The major structural feature of the Dahlonega belt is the Auraria antiform, a large, asymmetrical, isoclinal antiform (Fig. 4). This fold is northwest-vergent and plunges alternately northeastward and southwestward along strike. This antiform extends from Paulding County (McConnell, 1980; German, in prep.) northeastward to just east of Dahlonega in Lumpkin County and is responsible for the outcrop
Figure 4. Cross-section (A-A') of the Dahlonega gold belt in Dawson County (after German, 1985). See figure 3 for explanation and location of cross-section.
patterns of major rock units in this area. In Paulding, Bartow and Cherokee Counties the Auraria antiform is cored by the Galts Ferry Gneiss Member of the Pumpkinvine Creek Formation (McConnell, 1980; McConnell and Abrams, 1984), but in Dawson and Lumpkin Counties it is cored by structurally overlying, undifferentiated amphibolite of the Pumpkinvine Creek Formation (German, 1985).

The fabric of the rocks in the Dahlonega belt reflects several episodes of deformation. Collectively, they record a succession of events of initially strong ductile deformation followed by episodes of relatively weak brittle deformation. The ductile phase is expressed by flexural flow folds, whereas the brittle phase is expressed by slickensides and small faults.

The earliest recognizable deformational event ($D_1$) produced isoclinal recumbent folds ($F_1$) and a regional foliation ($S_1$). This foliation was subsequently transposed by $F_2$ isoclinal folding and is only observable locally as rootless isoclinal mainly in the southwestern part of the Dahlonega belt (McConnell, 1980; German, in prep.)

$F_2$ folding ($D_2$) produced a pervasive northeast-striking foliation ($S_2$) that is axial planar to these folds. Minor and major folds (i.e., Auraria antiform) produced during this event are extremely tight isoclinal lines that are northwest-vergent southwest of the Dahlonega area and southeast-vergent northeast of Dahlonega and plunge either southwestward or northeastward. Thickening of units in the axial areas and thinning in the limbs suggest a flexural flow type of folding.

Subsequent to $D_2$ was another episode of deformation ($D_3$) of greatly reduced intensity although quite widespread. This event ($D_3$) is characterized by small folds more open than $F_2$. These folds ($F_3$) are co-axial with $F_2$ folds and also plunge either southwestward or northeastward. They have a wavelength of less than 1 meter and are commonly the most easily recognizable folds at individual outcrops. These folds ($F_3$) deform $F_2$ axial planar foliation ($S_2$).

The last deformational event ($D_4$) had a subtle effect on the outcrop patterns of certain units. This event is characterized by
southeast-trending (?) open folds \( F_4 \). This event appears to be responsible for the somewhat abrupt reversal of foliation dips northeast of Dahlonega in the vicinity of the Lumpkin-White County line (Fig. 5) and the sinusoidal trace of the Auraria antiform also in the vicinity of Dahlonega (Fig. 3). Also associated with this event are small, high-angle normal faults with displacements of only a few centimeters. The fault planes are generally parallel to a regional joint set and probably reflect movement along previously established joint sets. Numerous steeply dipping slickensides accompany these faults.

![Diagram](image)

**Figure 5** Comparison of foliation attitudes southwest and northeast of the Dahlonega area.

**METAMORPHISM**

Several workers have noted that the Dahlonega gold belt exhibits a distinct mineral assemblage indicative of a slightly lower metamorphic grade than the surrounding terrains (Gillon, 1982; Nelson, 1983; McConnell and Abrams, 1984). This feature is constant
throughout the Dahlonega belt and serves as partial criteria for the
delineation of the boundaries of the gold belt.

Rocks in the Dahlonega belt, for all practical purposes, are at
staurolite grade (lower amphibolite facies) although kyanite has been
found in schists of the Charles mine in Forsyth County (Travis Paris,
personal communication, 1985) and at the Rich mine in Cherokee County
(Shearer and Hull, 1918). Mineral assemblages of schists in the
Dahlonega belt consist of quartz, muscovite, almandine, biotite,
plagioclase and staurolite. Those of felsic gneisses consist of
quartz, plagioclase, muscovite, biotite and hornblende, and those of
mafic rocks consists of hornblende, chlorite, plagioclase
($\text{An}_{10}^{10}-\text{An}_{20}^{20}$), almandine and epidote.

One period of prograde regional metamorphism is recognized in
the Dahlonega belt. This event reportedly occurred in the northern
Piedmont approximately 365 m.y. ago (Dallmeyer, 1978; Abrams and
McConnell, 1981) and was marked by a combination of dynamic and
thermal processes.

A very weak episode of retrograde metamorphism also can be
observed. This episode manifests itself in the slight alteration of
biotite and/or garnet to chlorite in the schistose lithologies. This
alteration is present throughout the Dahlonega belt and was reported
in adjoining terrains (Hatcher, 1979; McConnell, 1980; McConnell and
Abrams, 1984).

ECONOMIC GEOLOGY

Gold was mined in Georgia almost continuously from about 1829 to
1934 (Pardee and Park, 1948). The intensity of mining activity
during this period varied widely, however, due to the price of gold,
the political climate, the depletion of certain types of deposits and
the introduction of new mining technologies. Recorded production
during this period for the entire State was just over one-half
million ounces (Pardee and Park, 1948). The production breakdown for
specific areas of the State is not possible, but clearly the
Dahlonega belt accounted for the majority of this amount. Production
overall was probably considerably higher than that reported since records were not always kept.

MINING HISTORY AND METHODS

As in most gold-producing regions, mining methods evolved in response to the depletion of certain types of deposits and the discovery of others. Mining activity in the Dahlongea belt began as placer mining of stream gravels, and subsequently, extensive areas in the gold belt were mined in this fashion; some placers were reworked several times. Placer mining was commonly followed by open-cut, hydraulic mining in saprolite. This hydraulic mining method originated in the Dahlongea area and was often referred to as the Dahlongea method. This mining method greatly increased production and was the technique of choice for mining in saprolite. Hydraulic mining was not effective in unweathered rock; therefore, miners then turned to conventional underground mining techniques once unweathered rock was reached.

This full progression of mining methods seems to have occurred in only a few areas. Overall, placer mining was the most widespread followed by hydraulic mining of saprolite. Two reasons for the preponderance of these two mining methods over underground mining in fresh rock was that the cost of placer and hydraulic mining was much less and problems were encountered in extracting the gold from unweathered, sulfide-bearing ore. Another reason was that the weathered portions of the deposits and the placer deposits derived from them tended to contain more gold than fresh rock, probably as a result of mechanical and supergene enrichment. Leslie (1971) was able to demonstrate supergene enrichment of the weathered part of the gold deposit at the Calhoun mine in Lumpkin County and suggested that this characteristic of the deposit determined the type of mining methods employed there. Supergene enrichment can be assumed for many gold deposits in the Dahlongea belt, but this does not necessarily indicate that unweathered deposits will have a gold content below ore-grade. A prime example of an unweathered, high-grade deposit is the lode at the Franklin-Creighton mine in Cherokee County that
contained gold in amounts up to 1.49 oz/ton (Jones, 1909) to a depth of several hundred feet, a depth well below the effects of weathering.

OCCURRENCE AND GENESIS OF GOLD

In the Dahlonega belt gold occurs in veins that conform, in most cases, to the foliation of the enclosing rock. These veins are composed predominantly of quartz with lesser amounts of sericite, biotite, carbonate, pyrite, pyrrhotite, silver and garnet. Galena, sphalerite, arsenopyrite, chalcopryrite, amphibole, iron oxide minerals, and feldspar may also be present (Pardee and Park, 1948). The geometry of the veins varies widely but is generally tabular, lenticular, or in rare instances, rod-shaped or very irregularly shaped. The veins occur singularly or as a zone of several bodies.

The abandoned mines and prospects of the Dahlonega belt tend to be concentrated in certain areas. These concentrations mainly occur near the contacts between amphibolite and mica-quartz schist, within certain felsic gneisses, and in close association with iron formation units. This apparent lithologic association can be observed at many places throughout the study area but is best exemplified by Findley Ridge at Dahlonega and the area around Auraria (Fig. 3).

Figure 3 shows the distribution of abandoned mines associated with the Pumpkinnie Creek Formation and adjacent rocks. Most mines are concentrated in the Barlow Gneiss Member of the Pumpkinnie Creek Formation and at several points along the Pumpkinnie Creek-Canton Formation contact.

A notable concentration of mines can be observed north of Auraria where open-cut and underground mining was confined almost exclusively to the Barlow Gneiss. This felsic gneiss was mined at the Barlow Cut mine for a continuous distance of approximately 1 km (0.6 mi) along strike and in intermittent areas for several more kilometers at mines to the southwest and northeast.

Another large concentration occurs along Findley Ridge at Dahlonega where twelve mines are located along a sequence of rocks (rock unit igf, Fig. 3) that lies between massive amphibolites of the
Pumpkinvine Creek Formation and schists of the Canton Formation. Mines occur along the entire length of this sequence which consists of interlayered iron formation, biotite-plagioclase-quartz gneiss, sericite-quartz schist, and amphibolite and is interpreted to be part of the Pumpkinvine Creek Formation. Cook and Burnell (1983) also recognized this sequence and informally called it the Singleton formation.

Coincident with several concentrations of abandoned mines is the axis of the Auraria antiform. The occurrence of gold along the antiformal axis in addition to occurrences along certain contacts, could be interpreted that gold was selectively introduced at these structural and stratigraphic positions from some outside source during an episode of deformation. An alternate interpretation, which is best supported by the data, is that the gold was incorporated into rocks formed in a volcanic or mixed volcanic/sedimentary environment aided by exhalative processes. This is strongly reflected in the obvious lithologic control for most of the gold occurrences. These occurrences are within or are associated with lithologies that are interpreted to be volcanic in origin. It seems unlikely that gold would be selectively introduced into these specific lithologies during some later mineralization event.

As these volcanic lithologies were metamorphosed and deformed, the gold was remobilized and concentrated in veins. Locally, gold was concentrated in crosscutting veins, in veins parallel to the foliation (Pardee and Park, 1948), or in veins in the axes of minor F_2 and F_3 folds; however, the regional concentration of gold along the axis of the Auraria antiform is due to the presence of metavolcanic rocks in that position.

**SUMMARY**

The rocks that constitute the Dahlonega gold belt reflect a complex interaction between volcanic and sedimentary processes. The identification of metamorphosed pillows in the Pumpkinvine Creek Formation (Hurst and Jones, 1973; McConnell and Abrams, 1984) and
chemical data given by McConnell (1980), Burnell and Cook (1984), McConnell and Abrams (1984) and German (1985) for rocks of the Pumpkinvine Creek and Univeter Formations indicate that felsic gneisses and amphibolites in the Dahonega belt were originally interlayered subaqueous basalt flows and felsic and mafic tuffs. These rocks were deposited with sedimentary rocks of the Canton Formation in a back-arc basin and were subsequently metamorphosed to at least staurolite grade approximately 365 million years ago.

Gold deposition was originally syngenetic and is predominantly associated with iron formation, felsic gneisses, and rocks at or near the contacts between metavolcanic and metasedimentary sequences. During regional metamorphism and deformation gold was remobilized and concentrated in sulfide-bearing quartz veins that largely conform to the foliation of the enclosing rock. In the Dahlenega belt the overall occurrence of gold is lithologically controlled, whereas its local concentrations in these rocks are controlled by small-scale structures (cleavages, folds, etc.). Erosion and weathering of gold bearing rocks has accounted for a mechanical concentration of gold in placers and an apparent supergene enrichment in saprolite.
REFERENCES CITED


SULFIDE DEPOSITS OF THE NORTHERN PIEDMONT
OF GEORGIA

by
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INTRODUCTION
Because gold deposits of the northern Piedmont are closely associated to sulfide deposits no discussion of gold can exclude a discussion of sulfide mines and mining. Both gold and sulfide deposits of the northern Piedmont are hosted by the same lithologic units and are volcanogenic. Many gold mines later became sulfide mines or were exploited for sulfides along with gold.

Prospecting for sulfide deposits in Georgia did not become intensive until the discovery of the Ducktown, Tennessee, deposits in the late 1840's (Shearer and Hull, 1918). After the Civil War until about 1880 some attempts were made to mine copper, but it was not until the early 1880's that the Little Bob and Tallapoosa Mines were opened to mine pyrite for sulfur production (Shearer and Hull, 1918). These mine openings were followed in the late 1890's by the opening of the Villa Rica, Southern Star, Reeds Mountain and Swift Mines. Many sulfide mines were either located at the site of a former gold mine or associated with a gold mine such as the Villa Rica Mine (Durgy Gold Mine), Standard Pyrites (Franklin Gold, Pyrites and Power Company and Creighton Gold Mining Company), and Bell-Star or Southern Star Mine (Bell Gold Mine).

Both gold and sulfide deposits of the northern Piedmont are associated with the same geologic formations. These geologic units are: the Pumpkinvine Creek, Canton, Univeter, and Mud Creek Formations and undifferentiated rocks of the New Georgia Group and

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the Dog River Formation of the Sandy Springs Group (western belt, Fig. 1).

The Pumpkinvine Creek and Canton Formations occur on the northeastern border of the New Georgia Group and contain the Rich (Canton Copper Mine) and Chestatee sulfide mines. The Univeter Formation is in the center of the New Georgia Group and contains the Little Bob, Standard (Franklin-Creighton), and Bell Star (Southern Star) sulfide mines. The Mud Creek Formation at the southern boundary of the New Georgia Group contains the Villa Rica Mine and the Jenny Stone and Lasseter sulfide prospects. Rocks of the Dog River Formation contain the Tallapoosa Mine and the Smith-McCandless and Rush-Banks sulfide prospects.

Within these five formations named above, sulfide deposits are hosted by a variety of lithologies. Although most sulfide deposits of the northern Piedmont are closely associated with mafic volcanic rocks, sulfide deposits occur in mixed mafic and felsic volcanic piles, as at the Little Bob and Swift (McClarity) deposits, or in mixed assemblages of felsic and mafic metavolcanic and metasedimentary rocks such as the Villa Rica and Rich deposits. In addition to association with mafic volcanics, most sulfide deposits of this area are associated with some form of banded iron formation and alteration zone.

**Banded Iron Formation**

Banded iron formation is associated both spatially and genetically with most sulfide and gold deposits of the northern Piedmont (Abrams and McConnell, 1982; McConnell and Abrams, 1984). For this reason, iron formation is an important aid to exploration for base and precious metals. This association of massive sulfide deposits with iron formation is also found in other parts of the world. For example, Stanton (1972) noted a similar relationship between banded iron formation and sulfides at Broken Hill, Australia. Iron formation also serves as a thin (several inches to 6 feet), but
Figure 1. Map showing the distribution of major stratigraphic units in the western Georgia Piedmont.
easily traceable stratigraphic marker and, therefore, is a valuable aid in determining structural and stratigraphic relationships of the northern Piedmont.

Throughout the New Georgia Group banded iron formation is generally interlayered with amphibolite (mafic volcanics) and felsic gneiss and schist (felsic volcanics, McConnell and Abrams, 1983a; Abrams and McConnell, 1984; German, 1985). Iron formation also occurs in association with metamorphosed felsic and mafic volcanics (amphibolite and sericite schist) of the basal unit of the Sandy Springs Group (both the Dog River and Powers Ferry Formations) and in association with carbonaceous schist of the overlying Andy Mountain Formation (Table 1).

Due to complex folding the exact number of individual stratigraphic layers of iron formation is difficult to ascertain. Thicknesses of individual units are also sometimes difficult to determine due to isoclinal folding and thickening of iron formation in the noses of folds and thinning along limbs of folds. Iron formation is easily traced in the field from outcrop and abundant float and forms distinct, easily recognized, low ridges. Iron formation in the northern Piedmont is discontinuous, probably due both to nondeposition and attenuation due to folding.

Five facies of iron formation have been recognized (Abrams and McConnell, 1984; Table 2). The five facies which include sulfide, aluminous, oxide, manganese, and silicate facies are gradational into one another and gradational zones may contain characteristics of more than one facies. The most regionally extensive facies is oxide (Table 2). Oxide facies iron formation is composed primarily of magnetite, specular hematite, and quartz with accessory garnet, biotite, and epidote. Magnetite and/or specular hematite occur as distinct layers alternating with quartz or as disseminated grains.
Table 1. Stratigraphic correlation chart for the northern Piedmont of Georgia (after McConnell and Abrams, 1984).

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Emuckfaw Formation</td>
<td>Bill Arp Formation</td>
<td>Greywacke, schist Quartzite, schist</td>
<td>Wedowee Formation</td>
</tr>
<tr>
<td>Sandy Springs Group</td>
<td>Factory Shoals Formation</td>
<td>Aluminous schist</td>
<td></td>
</tr>
<tr>
<td>Wedowee Group</td>
<td>Andy Mountain Formation</td>
<td>not present</td>
<td></td>
</tr>
<tr>
<td>Mad Indian and Hatchet Creek Groups</td>
<td>Chattahoochee Palisades Quartzite</td>
<td>Greywacke, schist, amphibolite</td>
<td></td>
</tr>
<tr>
<td>Ashland Supergroup</td>
<td>Dog River Formation</td>
<td>Hornblende gneiss, amphibolite</td>
<td></td>
</tr>
<tr>
<td>Higgins Ferry and Poe Bridge Mountain Formations</td>
<td>Powers Ferry Formation</td>
<td>Basement</td>
<td>Ashland Group</td>
</tr>
</tbody>
</table>

*Hurst (1973) interpreted the Wedowee to be older than Ashland.
Table 2. Facies of banded iron formation.

<table>
<thead>
<tr>
<th>Facies</th>
<th>Major Minerals</th>
<th>Formation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1) Fe oxide</td>
<td>quartz, magnetite,</td>
<td>Mud Creek, Univeter, Canton, Pumpkinvine Creek, Dog River, and Powers Ferry Formations and New Georgia Undiff.</td>
</tr>
<tr>
<td></td>
<td>and hematite</td>
<td>Andy Mountain Formation</td>
</tr>
<tr>
<td></td>
<td>+graphite</td>
<td></td>
</tr>
<tr>
<td>2) Mn oxide</td>
<td>quartz and spessartine</td>
<td>Mud Creek, Univeter, and Pumpkinvine Creek Formations and New Georgia undiff.</td>
</tr>
<tr>
<td>3) Sulfide</td>
<td>quartz, pyrrhotite,</td>
<td>Univeter, Mud Creek, Canton, and Andy Mountain Formations</td>
</tr>
<tr>
<td></td>
<td>pyrite, arsenopyrite</td>
<td></td>
</tr>
<tr>
<td>4) Aluminous</td>
<td>quartz, muscovite,</td>
<td>Mud Creek and Pumpkinvine Creek Formations</td>
</tr>
<tr>
<td></td>
<td>biotite, and garnet</td>
<td></td>
</tr>
<tr>
<td>5) Silica</td>
<td>quartz and cummingtonite</td>
<td>Univeter Formation</td>
</tr>
<tr>
<td>6) Carbonate</td>
<td>calcite, garnet, quartz,</td>
<td>Canton and Pumpkinvine Creek Formations</td>
</tr>
<tr>
<td></td>
<td>hornblende, and plagioclase</td>
<td></td>
</tr>
</tbody>
</table>

surrounded by quartz. Iron oxide layers range from .1 to 4 in. thick and iron content varies from 10 to 60 percent. Zones within the oxide facies are high in Al₂O₃ and contain abundant biotite and garnet. These zones of aluminous facies may represent areas of clay
sedimentation or deposition of fine tuff in the volcano-sedimentary environment (Abrams, 1983; Abrams and McConnell, 1984).

Gradational with oxide facies are sulfide, manganiferous iron, and silicate facies iron formation. Due to complex folding and/or facies changes, several facies can be identified within a single outcrop area. Manganiferous iron formation is present throughout the New Georgia Group, but is best represented in the Draketown area, eastern Haralson and western Paulding Counties, where this facies was prospected extensively around the turn of the century from a host rock which Watson (1909, p. 184) described as a "banded quartzite carrying a variety of magnetite grains." Manganiferous iron formation generally occurs as a black-stained quartzite in which other minerals are indistinguishable. Where fresh and unweathered, the rock is composed predominantly of layers of fine- to medium spessartine garnet and quartz with accessory magnetite.

Sulfide facies iron formation is composed of layers of pyrite cubes, or limonite pseudomorphs after pyrite, within a coarse-grained, recrystallized quartzite. This facies of iron formation is common throughout the New Georgia Group and is found exposed in mine workings at several of the area mines. A sample of sulfide facies iron formation collected from near the Little Bob Mine yielded 0.41 ppm of gold. The sulfide facies may be the source for some of the gold mined from the New Georgia Group (McConnell and Abrams, 1983b).

Silicate facies iron formation is less commonly observed and appears mainly as float. This facies is characterized by the presence of cummingtonite within a coarse-grained quartzite.

**TOURMALINITE**

Tourmalinite has been recognized as an indicator of sulfide mineralization and commonly overlies ore zones (Slack, 1982). In the northern Piedmont this important indicator to ore mineralization consists of a poorly foliated tourmaline-quartz rock. Tourmaline crystals are the dravite variety and vary from 0.1 to 1.5 in. in length. In the northern Piedmont of Georgia tourmaline or
tourmalinite is spatially associated with massive sulfide and gold occurrences and banded iron formation. The most extensive of these tourmalinites ranges up to approximately 1.5 ft thick and occurs within the Canton Formation (German, 1985). Massive tourmalinite zones are also present at Turkey Heaven Mountain in the northern Piedmont of Alabama (Schafer and Coolen, 1986) in rocks correlative with the New Georgia Group.

In comparison, in the southern Piedmont in Troup County, Georgia, McConnell and Abrams (1986) reported well developed, laterally continuous tourmalinite zones. These tourmalinites occur along with iron formation within interlayered amphibolite and schist of the Ropes Creek formation (Sears and others, 1981). Although the Troup County area contains tourmalinite, banded iron formation, and felsic and mafic metavolcanics, there are distinct differences between the two areas (see McConnell and Abrams, this guidebook), most notably is the lack of any known gold or sulfide deposits in this area of the southern Piedmont.

ALTERATION ZONES

Aluminosilicate and magnesium-aluminum-silicate alteration assemblages characterized by kyanite-quartz granofels, sericite quartzite/schist, chlorite schist ± coarse (0.25 to 3 in.) garnets, and chlorite-anthophyllite schist ± talc and cummingtonite are of particular significance within the New Georgia Group. These type assemblages are interpreted as metamorphosed hydrothermally altered zones and are spatially associated with gold and sulfide deposits of the northern Piedmont (Abrams and McConnell, 1982, 1984; McConnell and Abrams, 1984). Al-Si and Mg-Al assemblages associated with volcanic rock sequences are recognized to be important exploration tools in the southeastern U.S. and other parts of the world (Riverin and Hodgson, 1980; Carpenter and Allard, 1982).

Aluminosilicate assemblages of the northern Piedmont are commonly nonfoliated, coarse-grained rock containing quartz and kyanite (up to 5 in. in length) with varying amounts of muscovite and pyrite and minor amounts of staurolite, chlorite, and garnet. These
coarse kyanite-quartz zones commonly grade into sericite-quartz schist and sericitic quartzite that is locally pyritic and kyanitic. The sericite schist and quartzite probably represent hydrothermally altered and metamorphosed felsic tuffs. Similar assemblages within metavolcanic terranes in the southeastern U.S. occur at Graves Mountain, Georgia, and Willis Mountain, Virginia. Both Graves and Willis Mountains are associated with occurrences of base and precious metal mineralization and may result from paleogeothermal alteration (Carpenter and Allard, 1982). The Otake geothermal field in Japan has been suggested as a modern analog for development of these type alteration assemblages (Allard and Carpenter, 1981, 1982; Carpenter and Allard, 1982).

Minerals characteristic of magnesium-aluminum alteration assemblages of the northern Piedmont are chlorite, anthophyllite, talc, garnet, and cummingtonite. In the Villa Rica area, Pate (1980) reported the presence of enstatite in rock interpreted as Mg-Al alteration zone (Abrams and McConnell, 1984). Chlorite is common to all zones of magnesium-aluminum alteration in the northern Piedmont. Chloritic alteration of wall rocks surrounding massive sulfide deposits is well documented in the Abitibi greenstone belt of Canada (Riverin and Hodgson, 1980). In the Northern Piedmont of Georgia most major sulfide occurrences, such as the Little Bob, Villa Rica, Tallapoosa, and Bell-Star (Southern Star), are associated with chlorite schist, garnet-chlorite schist (garnets up to 3 in. in diameter), or chlorite-anthophyllite schist. Chlorite-anthophyllite zones are weakly- to non-foliated and contain magnesium chlorite and anthophyllite or gedrite (up to 3 in. in length) ± talc and disseminated sulfides.

In the northern Piedmont linear zones of chloritic rock were previously recognized and attributed to development by hydrothermal activity following regional metamorphism (Hurst and Crawford, 1970). The apparent linear trend of these zones results from the linkage of isolated exposures which may be present only as alteration zones surrounding separate deposits of base or precious metals (McConnell and Abrams, 1983a). Although the extent of these Mg-Al alteration
zones is uncertain, they do occur on trend with one another and this linear trend may be a reflection of a primary fracture system such as that influencing alteration in the Noranda district of Canada (Scott, 1980). The chlorite alteration zones are, therefore, interpreted as primary features formed by alteration by a "sea water dominated hydrothermal system" (Riverin and Hodgson, 1980). Carpenter and Allard (1982) recognized magnesium-aluminum assemblages as footwall alteration zones associated with exhalative-type massive sulfide deposits in the southeastern U.S.

HOST ROCK ASSEMBLAGES

Although sulfide deposits occur throughout the northern Piedmont, most deposits are concentrated in the same five formations that are host to gold deposits. These are: the Pumpkinvine Creek, Canton, Univeter, Mud Creek, and Dog River Formations. Within these five formations sulfide deposits occur in a wide range of lithologies (Table 3). This observation deviates from previously held views that amphibolite or other mafic metavolcanic rocks are host to nearly all sulfide deposits of the northern Piedmont (Gair and Slack, 1980). Most sulfide deposits of Georgia are closely associated with some form of mafic volcanism, but sulfide deposits also occur within mixed felsic and mafic volcanic piles, as at the Little Bob, Swift (McClarity), Standard, and Bell-Star Mines, or in mixed assemblages of mafic and felsic metavolcanic and metasedimentary rocks, as at the Villa Rica Mine and Jenny Stone Prospect. For this reason, no single lithologic common denominator exists for sulfide deposits of the Northern Piedmont of Georgia. Features that are common to most sulfide deposits of the area are: 1) association with mafic volcanics, 2) association with banded iron formation, and 3) association with some form of an alteration zone.

MIXED MAFIC AND FELSIC VOLCANIC ROCKS

Sulfide deposits hosted by mixed mafic and felsic volcanic rocks are positioned within dominantly felsic volcanics, such as the Little
<table>
<thead>
<tr>
<th>Mine or Prospect</th>
<th>County</th>
<th>Lithologies Present</th>
<th>Group or Formation</th>
<th>Ore type or grade</th>
<th>Production</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chestatee</td>
<td>Lumpkin</td>
<td>Amphibolite, garnet biotite, muscovite quartz schist, and metagreywacke (1)</td>
<td>Univeter Formation</td>
<td>Pyrite, chalcopyrite calcite; Cu 1.6% (?)</td>
<td>200 tons pyrite shipped, 1983; 844 tons, 1917(2)</td>
</tr>
<tr>
<td>Little Bob</td>
<td>Paulding</td>
<td>Garnet hornblende schist and gneiss, sericite quartzite and schist and chlorite schist + garnet</td>
<td>Univeter Formation</td>
<td>pyrite, pyrrhotite, chalcopyrite, sphalerite and garnet; Cu 6.4%, Zn 3.43% (2)</td>
<td>14,516 long tons for sulfuric acid from 1918 to 1919 (3)</td>
</tr>
<tr>
<td>Reeds Mountain</td>
<td>Haralson and Carroll</td>
<td>Sericite quartzite and schist + kyanite, chlorite schist and hornblende and biotite gneisses</td>
<td>New Georgia Group Undifferentiated</td>
<td>pyrite</td>
<td>4,000 tons pyrite concentrate (2)</td>
</tr>
<tr>
<td>Rich (Canton)</td>
<td>Cherokee</td>
<td>Hornblende schist, graphitic mica schist and chlorite schist (7)</td>
<td>Pumpkinvine Creek and Canton Formations</td>
<td>pyrite, chalcopyrite, sphalerite, galena, garnet; Zn 2.12% Pb 0.15% (2)</td>
<td>nr</td>
</tr>
<tr>
<td>Rush Banks</td>
<td>Paulding</td>
<td>Chlorite hornblende schist and sericite schist (2)</td>
<td>Dog River Formation</td>
<td>pyrite, pyrrhotite, and chalcopyrite; Cu 3.60% (2)</td>
<td>3 car loads of ore shipped (2)</td>
</tr>
<tr>
<td>Smith-McCandless</td>
<td>Haralson</td>
<td>Muscovite and biotite schists and chlorite schist + garnet</td>
<td>Dog River Formation</td>
<td>pyrite, pyrrhotite, chalcopyrite, sphalerite; Cu 0.3-3.6%, Zn 0.6-4.09%, Ag 0.25-1.0 oz/ton, Au 0.04 oz/ton (2)</td>
<td>nr</td>
</tr>
<tr>
<td>Bell-Star</td>
<td>Cherokee</td>
<td>Hornblende gneiss and sericite and chlorite schists</td>
<td>Univeter Formation</td>
<td>Gold, pyrite, chalcopyrite, sphalerite and magnetite (2)</td>
<td>8000 tons 45% sulfur concentrates shipped (2)</td>
</tr>
<tr>
<td>Standard</td>
<td>Cherokee</td>
<td>Hornblende gneiss (1), amphibolite, mica schist, and chlorite schist</td>
<td>Univeter Formation</td>
<td>Pyrite and gold</td>
<td>22,000 tons pyrite concentrates shipped</td>
</tr>
<tr>
<td>Swift</td>
<td>Cherokee</td>
<td>Hornblende gneiss and amphibolite (1)</td>
<td>Univeter Formation</td>
<td>Pyrite (2)</td>
<td>4000 tons pyrite concentrates shipped prior to 1911 (2)</td>
</tr>
<tr>
<td>Swift</td>
<td>Paulding</td>
<td>Chlorite amphibole schist and felsic gneiss</td>
<td>New Georgia Group Undifferentiated</td>
<td>Pyrite, pyrrhotite, chalcopyrite, and magnetite (2)</td>
<td>nr</td>
</tr>
<tr>
<td>Tallapoosa</td>
<td>Haralson</td>
<td>Hornblende schist, garnet muscovite schist + graphite, and dolomite</td>
<td>Dog River Formation</td>
<td>Pyrite, chalcopyrite, sphalerite, and gold; Cu 0.1-4.75%, Zn 0.5-5.1%, Au 0.45 oz/ton, Ag 1.4 oz/ton (2)</td>
<td>7450 tons at avg. 3.5% Cu; 50,000 lbs. secondary ore (calcite) (2)</td>
</tr>
<tr>
<td>Villa Rica</td>
<td>DeKalb</td>
<td>Hornblende gneiss + garnet, leukocrotic gneiss, and garnet biotite gneiss + kyanite</td>
<td>Mud Creek Formation</td>
<td>Pyrite, pyrrhotite, chalcopyrite, and sphalerite</td>
<td>400,000 tons pyrite ore (4)</td>
</tr>
</tbody>
</table>

1) German, 1985  
2) Shearer and Hull, 1918  
3) Hurst and Crawford, 1970  
4) Cook, 1970
Bob deposit, or near the boundary between mafic and felsic volcanics, as at the Swift, Standard, and Bell-Star deposits. All four deposits are associated with some form of alteration zone and all have some facies of iron formation at or in close proximity to the workings.

The Swift deposit, near Draketown, Georgia, is located at the contact between metatonalite (Cook, 1970) and hornblende gneiss of the New Georgia Group. Chlorite-amphibole schist ± garnet is also present at the surface at the deposit. The schist locally contains flattened felsic inclusions which may represent deformed felsic volcanic explosion breccia. Oxide facies banded iron formation of predominantly quartz and magnetite occurs in proximity to the now filled and covered abandoned workings. Adjacent to the filled workings are large exposures of gossan and massive quartz which may represent a large silicous sinter deposit.

The Little Bob deposit (Figs. 2 and 3) was worked intermittently between 1860 and 1920 (Shearer and Hull, 1918) and is probably one of the largest and best known sulfide deposits of Georgia. The Little Bob deposit occurs in felsic and mafic volcanic rocks of the Univeter Formation (McConnell and Abrams, 1984) and is associated with an alteration zone characterized by large (up to 3 in. in diameter) garnets surrounded by chlorite. Deformation has reversed the stratigraphy in the Little Bob area and the chlorite-garnet alteration zone, interpreted as a feeder pipe for ore-bearing solutions, now structurally overlies the sulfide ore zone. The massive sulfide occurs predominantly within what Cook (1970) termed as an arkosic quartzite and which we interpret as a felsic metatuff (Abrams and McConnell, 1984). The felsic rock contains high concentrations of potassium (Cook, 1970) and may also represent a metamorphosed aluminosilicate alteration assemblage in the volcanic alteration model of Allard and Carpenter (1982). Also present at the workings of the Little Bob deposit are interlayered chloritic amphibolite/hornblende gneiss ± pyrite and garnet, pyritic quartz-sericite schist ± gahnite, and sulfide facies iron formation.

Iron formation of both sulfide and oxide facies is exposed in railroad cuts near the mine and stratigraphically overlies the ore
Figure 2. Generalized geologic map of the Little Bob mine area (after McConnell and Abrams, 1984)

Figure 3. Map of the Little Bob mine workings (from Shearer and Hull, 1918).
zone. Cummingtonite quartzite (silicate facies iron formation) is present locally as float at the abandoned workings. Adjacent to the ore zone alteration was intense and amphiboles reach 3 inches in length. Ore includes pyrite, pyrrhotite, chalcopyrite, sphalerite, gahnite and magnetite. Cook (1970) also noted the presence of cubanite and galena.

The Bell-Star mine, previously known as the Bell gold mine and the Southern Star gold and pyrite mine, was mined from approximately 1900 to 1908 for pyrite (Shearer and Hull, 1918). Sulfide ores are hosted by hornblende gneiss of the Univeter Formation with adjacent and parallel oxide facies iron formation and foot and hanging wall alteration zones of sericite and chlorite schist ± disseminated pyrite. Shearer and Hull (1918, p. 148) described the iron formation at the Bell-Star Mine as "finely crystalline, strongly banded rock made up of quartz, magnetite, and garnet." Those same authors also noted the presence of hematite and manganiferous zones within the iron formation adjacent to the Bell-Star workings.

The Standard Pyrites Company Mine was also worked for gold under the names of Franklin Gold, Pyrites, and Power Company and Creighton Gold Mining Company (Shearer and Hull, 1918). Sulfide ores at the Standard Mine were present in three parallel "veins" with the northernmost of these known as the Standard vein (Shearer and Hull, 1918). Host rock at the Standard Mine includes hornblende gneiss, amphibolite, and mica schist of the Univeter Formation. Alteration zone rock is chlorite schist and lies adjacent to ore zones. Rock resembling sulfide facies iron formation was mined in conjunction with gold mining activity at this site (Jones, 1896, p. 48).

MIXED VOLCANIC AND SEDIMENTARY PILES

The Villa Rica mine, Chestatee mine (see Stop 1, first day of field trip) and Jenny Stone and Lasseter Prospects occur within mixed metasedimentary and metavolcanic (mafic and felsic) rocks. Like the sulfide deposits discussed previously they each occur associated with mafic volcanics, banded iron formation, and an alteration zone.
The Villa Rica sulfide mine (Fig. 4) was worked from approximately 1890 to 1917, first as the Durgy gold mine (Yeates and others, 1896) and after 1895 for pyrite. At the Villa Rica mine metamorphosed mafic and felsic volcanic rocks of the Mud Creek Formation predominate over metasediments. Rock at the mine dump is mainly amphibolite and hornblende-plagioclase gneiss ± fine to coarse garnet. Felsic volcanics (leucocratic biotite gneiss) interfinger with mafic metavolcanics (amphibolite, hornblende gneiss) and metasediments (garnet-biotite gneiss/schist ± kyanite) in drill core from the Villa Rica property drilled by Tennessee Copper Company. Chlorite schist alteration zone and oxide facies iron formation occur adjacent and parallel to the Villa Rica deposit within amphibolite and hornblende gneiss (Fig. 4).

The Jenny Stone and Lasseter prospects occur within the Mud Creek Formation on trend with the Villa Rica mine. Both prospects, along with the Watkins and Askew prospects, were developed about the same time to meet an anticipated demand for pyrite from the Villa Rica district (Shearer and Hull, 1918). Host rock at both the Jenny Stone and Lasseter prospects includes metamorphosed interlayered mafic and felsic volcanics (amphibolite, hornblende gneiss, leucocratic gneiss) and minor amounts of associated metasediments. A well developed chlorite alteration zone occurs at or adjacent to each prospect and iron formation, continuing on trend from the Villa Rica mine area, is adjacent and parallel to each prospect.

OTHER ASSEMBLAGES

The Reeds Mountain and Tallapoosa deposits occur within predominantly mixed volcanic sequences and are associated with some form of alteration zone. While these two deposits fit the denominators common to most deposits of the Northern Piedmont, both are unusual to some degree.

Figure 4. Generalized geologic map of the Villa Rica area (after McConnell and Abrams, 1984).
alteration is common near the orebody. Neathery and Hollister (1984) also report extensive epidotization adjacent to the ore zone. Unlike any other deposits reported in the Northern Piedmont of Georgia the Tallapoosa deposit is associated with dolomite (Shearer and Hull, 1918). This occurrence of carbonate lead early workers (Shearer and Hull, 1918) to interpret ore deposition as a replacement of limestone.

The pyrite deposit at Reeds Mountain occurs within a large, well-developed aluminosilicate alteration zone. Rocks present at the mine include amphibolite, chlorite schist, sericite schist/quartzite ± kyanite, biotite gneiss, hornblende gneiss and kyanite-quartz granofels. Kyanite crystals range from 1/2 to 4 in. in length. Pyrite occurs as disseminated grains throughout all lithologies reported at this site, but is locally abundant (up to 60%, Shearer and Hull, 1918) as deformed cubes (approximately 1/8 in.) within the sericite schist/quartzite.

The kyanite-quartz granofels is interpreted as a metamorphosed aluminosilicate hydrothermal alteration zone (Abrams and McConnell, 1984). The granofels is coarsely crystalline, nonfoliated, and, in addition to quartz and kyanite, includes minor amounts of muscovite, pyrite, and chlorite.

COMPARISON WITH BLUE RIDGE DEPOSITS

The largest and best known sulfide mining operation in the southeastern U.S. is at the Ducktown deposits. Other lesser known, but significant sulfide deposits on trend with the Ducktown deposits are the #20 and Mobile deposits in Fannin County, Georgia. Ore mineralogy of the Blue Ridge and northern Piedmont deposits are similar with pyrrhotite and pyrite forming the major part of the ore followed by lesser amounts of chalcopyrite, sphalerite, magnetite and minor amounts of galena. Features common to the sulfide deposits of Fannin County and the northern Piedmont are:

1) association with some form of aluminosilicate or magnesium-aluminum alteration zone.
2) association with mafic volcanic rocks. Major differences between deposits of the two areas are:

1) The deposits in the Blue Ridge lie within a thick sequence (Great Smoky Group) of predominantly metasedimentary rocks; northern Piedmont deposits lie within a thick sequence of predominantly metavolcanic rocks (New Georgia Group and basal Sandy Springs Group).

2) Many northern Piedmont deposits were at one time mined for gold, contain gold in varying amounts, or are associated with gold deposits; the Blue Ridge deposits contain only minor or trace amounts or gold.

Mines of the Ducktown district, including the #20 and Mobile, and prospects all occur in association with some form of alteration zone. In addition, several mines and prospects are associated with tourmaline-bearing rock units and/or banded iron formation. Alteration zones include Al/Si ± Fe assemblages and Mg/Al +Ca assemblages formed as a result of footwall hydrothermal alteration associated with the sulfide ore bodies (Abrams and others, 1986). Al/Si ± Fe assemblages are characterized by the presence of staurolite and/or garnet; Mg/Al +Ca assemblages are characterized by tremolite and/or actinolite, talc, chlorite, and calcite. Coarse staurolite zones within schist are spatially associated with most mines and prospects of the area.

Mg/Al+Ca alteration assemblages are well developed at the #20 and Mobile Mines and are present at most deposits of the area. These alteration zones are characterized by tremolite/actinolite granofels ± chlorite and talc. Like the Mg/Al alteration zones of the northern Piedmont, these zones are interpreted as primary feeder pipes for ore bearing solutions.

Unlike the northern Piedmont where ore deposits are hosted within predominantly a mafic to felsic volcanic sequence, deposits of the Blue Ridge, although volcanogenic, lie within a thick metasedimentary sequence with minor associated mafic and felsic volcanics. Amphibolite (metabasalt, Abrams and others, 1986; Abrams,
1986) is spatially associated with most mines and prospects in the area (Slater and others, 1985). Sericite and chlorite schists possibly represent metamorphosed volcanic tuffs (Gair and Slack, 1980; Slater, 1982; Abrams and others, 1986). All of these volcanic rocks form a relatively minor portion of the thick sedimentary pile (Great Smoky Group).

SUMMARY

Sulfide deposits, like gold deposits, of the northern Piedmont lie within a highly deformed and metamorphosed sequence of interlayered mafic and felsic volcanic rocks with subordinate metasediments. Ores are syngenetic and occur in both felsic and mafic volcanic rocks. Lithologic and stratigraphic indicators to ore zones such as aluminosilicate and magnesium-aluminum alteration zones, banded iron formation, and tourmalinite are valuable tools for exploration in the complex terrane.

Sulfide deposits located to the north in the Blue Ridge are also associated with volcanic hosts, but lie within a predominantly sedimentary sequence. While these deposits could be coeval with ore deposits of the northern Piedmont, differences in host rocks and ores suggest a continentally proximal (miogeoclinal) tectonic environment for the deposits of the Blue Ridge versus a eugeoclinal environment for deposits of the northern Piedmont.
REFERENCES


meeting, Winnipeg, Abstracts with Programs, p. 1.
Carpenter, R.H., and Allard, G.O., 1982, Aluminosilicate
assemblages: an exploration tool for metavolcanic terrains of
the southeast, in Allard, G.O., and Carpenter, R.H., convenors,
Exploration for metallic resources in the southeast: University
of Georgia Department of Geology and Center for Continuing
Cook, R.B., Jr., 1970, Geologic history of massive sulfide bodies in
west-central Georgia (Ph.D thesis): Athens, University of
Georgia, 163 p.
Gair, J.E., and Slack, J.F., 1980, Stratabound massive sulfide
deposits of the U.S. Appalachians, in Vokes, F.M., and
Zachrisson, E., eds., Review of Caledonian-Appalachian
stratabound sulphides: Geological Survey of Ireland Special
Paper 5, p. 67-81.
German, J.M., 1985, The geology of the northeastern portion of the
Dahlonega Geoid belt: Georgia Survey Bulletin 100, 41 p.
Hatcher, R.D., Jr., 1974, An introduction to the Blue Ridge tectonic
history of northeast Georgia: Georgia Geologic Survey Guidebook
13-A, 60 p.
Hurst, V.J., 1973, Geology of the southern Blue Ridge belt: American
Hurst, V.J., and Crawford, T.J., 1970, Sulfide deposits in the
Coosa Valley area, Georgia: Coosa Valley Area Planning and
Development Commission, 190 p.
Jones, S.P., 1909, Second report on the gold deposits of Georgia:
McConnell, K.I., and Abrams, C.E., 1983a, Geology of the New Georgia
Group and associated sulfide and gold deposits: west-central
Georgia: Guidebook for the Society of Economic Geologists
Annual Meeting, Atlanta, 27 p.
_____ , 1983b, Geochemistry of metamorphosed banded iron formation
and aluminosilicate assemblages of western Georgia: Geological
Society of America Abstracts with Programs, v. 15, p. 90.


Slack, J.F., 1982, Tourmaline in Appalachian-Caledonian massive sulfide deposits and its exploration significance: Institute of
Generalized geologic map of the excursion area for day 1 of the field trip.
### ROAD LOG AND STOP DESCRIPTIONS—DAY 1

Field Trip Leader: Jerry German

<table>
<thead>
<tr>
<th>CUM. MI</th>
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<th>DESCRIPTION</th>
</tr>
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<tbody>
<tr>
<td>0.0</td>
<td>0.0</td>
<td>Leave Journeys End Motel, on Delk road heading east.</td>
</tr>
<tr>
<td>0.9</td>
<td>0.9</td>
<td>Intersection with Powers Ferry Road, turn right.</td>
</tr>
<tr>
<td>1.4</td>
<td>0.5</td>
<td>Intersection with Terrel Mill Road, proceed straight - south.</td>
</tr>
<tr>
<td>3.5</td>
<td>2.1</td>
<td>Intersection with Frontage Road, turn left - east.</td>
</tr>
<tr>
<td>3.8</td>
<td>0.3</td>
<td>Chattahoochee River; Fulton County line.</td>
</tr>
<tr>
<td>4.7</td>
<td>0.9</td>
<td>Intersection with Northside Drive, turn right.</td>
</tr>
<tr>
<td>4.8</td>
<td>0.1</td>
<td>Intersection with Interstate 285, turn left, east on I-285.</td>
</tr>
<tr>
<td>9.6</td>
<td>4.8</td>
<td>Intersection with GA 400, head north on GA 400.</td>
</tr>
<tr>
<td>27.8</td>
<td>18.2</td>
<td>Forsyth County line.</td>
</tr>
<tr>
<td>35.9</td>
<td>8.1</td>
<td>Intersection with GA 20, continue north on GA 400.</td>
</tr>
<tr>
<td>39.4</td>
<td>3.5</td>
<td>Lake Lanier.</td>
</tr>
<tr>
<td>56.7</td>
<td>17.3</td>
<td>Lumpkin County line.</td>
</tr>
<tr>
<td>60.6</td>
<td>3.9</td>
<td>Chestatee River.</td>
</tr>
<tr>
<td>60.8</td>
<td>0.2</td>
<td>Intersection with GA 60, continue straight ahead.</td>
</tr>
<tr>
<td>62.3</td>
<td>1.5</td>
<td>Placer operation on right.</td>
</tr>
</tbody>
</table>
Figure 1  Geologic map of Stop 1 and vicinity, Dahlonega
U.S.G.S. 7.5-minute quadrangle.  h, Helen Member; unu, Univeter
Formation undifferentiated; spg, Sandy Springs Group.
66.0 3.7 Intersection with GA 52, continue straight ahead.

68.3 2.3 STOP 1: CHESTATEE COPPER MINE

STOP 1: CHESTATEE COPPER MINE

At this stop (Fig. 1) we will examine a rare fresh exposure of the Univeter Formation (McConnell and Abrams, 1984), excellent exposures of the Helen Member (German, 1985) of the Canton Formation (McConnell and Abrams, 1984), and the massive sulfide deposit and workings of the Chestatee Copper Mine. This mine was operated sporadically from 1892 until 1919, and during that time interval recorded production was just over 50,000 tons of ore containing approximately 3% copper and 0.7% zinc.

The first outcrops we will examine are exposures of the Univeter Formation on the east side of the paved road. Here, the Univeter Formation consists of fine-medium grained amphibolite with thin (2-5cm) felsic lenses. After examining these outcrops, walk towards the river down a dirt road on the opposite side of the paved road. As you walk observe the amphibolite saprolite of the Univeter Formation, plagioclase-biotite-muscovite quartzite of the Helen Member, and iron formation and gossan along the contact. Core drilling by the Bureau of Mines in the late 1940's revealed that the massive sulfide orebody straddles the contact.

The rapids in the river afford excellent exposures of the quartzite. The Univeter Formation and the Helen Member are more siliceous here than other exposures to the northeast or southwest, probably due to the exhalative process that produced the iron formation.

LEAVE STOP 1. RETRACE ROUTE TO GA 52.

70.6 2.3 Intersection with GA 52 - continue straight ahead.

74.3 3.7 Placer operation on left.

75.8 1.5 Intersection with GA 60 - turn right.

75.9 0.1 Type locality of the Helen Member of the Canton Formation.

78.6 2.7 Chestatee River.

79.5 0.9 Yahoola Creek.
FIGURE 2  Geologic map of Stop 2 and vicinity, Dahlonega U.S.G.S. 7.5-minute quadrangle.  plc, Palmer Creek Member;  amp, amphibolite;  bg, biotite metatroctohjemite;  igf, interlayered iron formation, manganiferous magnetite-sericite-quartz schist, amphibolite, and felsic gneiss;  pcu, Pumpkintown Creek Formation undifferentiated;  blg, Barlow Gneiss Member;  cp, coarsely porphyroblastic facies of Proctor Creek Member.
80.3 0.8 Dahlonega City limits.
80.7 0.4 STOP 2: FINDLEY RIDGE

STOP 2: FINDLEY RIDGE

This stop (Fig. 2) will provide an opportunity to examine the mine workings of the Findley Mine and a sequence of rocks along the Pumpkinvine Creek Formation/Canton Formation contact that is host for at least fifteen abandoned gold mines in the Dahlonega area. Gold was mined sporadically in this area from about 1830 to about 1935.

Walk to the Findley Mine along Findley Ridge, a prominent topographic feature on the south side of Dahlonega which is made up of interlayered iron formation, manganiferous magnetite-sericite-quartz schist, amphibolite and felsic gneiss. This sequence is located on the southeastern limb of a regional overturned antiform. Most of these lithologies are exposed in the Findley Mine workings.

The most spectacular feature of the Findley Mine is the large hydraulic cut which, like other cuts along the ridge, follows the strike of the above mentioned sequence of rocks, particularly the iron formation. The protoliths of these rocks were enriched in gold by exhalative processes as they were deposited on the seafloor near a volcanic vent. Subsequent metamorphism remobilized gold into quartz veins that are generally parallel to the regional foliation although some veins follow a secondary cleavage at a low angle to the regional foliation.

RETURN TO GA 60 AND PROCEED NORTH.

81.4 0.7 North Georgia College.
81.9 0.5 Smith House
     Resturant-Lunch Stop.
     Following lunch, go right around square.
     Note gold museum in center of town.
82.0 0.1 Highway 52; go west on highway 52.
83.6 1.6 Cane Creek.
83.7 0.1 Highway 9E; turn left onto Highway 9E.
84.6 0.9 Exposure of pyritic-sericite schist.
Figure 3 Geologic map of Stop 3 and vicinity, Campbell Mountain and Dawsonville U.S.G.S. 7.5-minute quadrangles. plc, Palmer Creek Member; pss, pyrite-sericite-quartz schist; pc, Proctor Creek Member; amp, amphibolite; pcu, Pumpkinvine Creek Formation undifferentiated; blg, Barlow Gneiss Member; cp, coarsely porphyroblastic facies of the Proctor Creek Member.
STOP 3: BARLOW MINE

This stop (Fig. 3) is the type locality of the Barlow Gneiss (German, 1985) a muscovite-biotite-plagioclase-quartz gneiss. The type locality is within the Barlow Cut which is a hydraulic cut approximately 1 km long that follows the strike of the gneiss. Exposed in the base and along the east wall of the cut is fresh and weathered gneiss locally interlayered with amphibolite. Slightly flattened megacrysts up to 1 cm in diameter are conspicuous in the felsic gneiss and are composed of blue quartz and/or plagioclase. This felsic gneiss is chemically a dacite and is interpreted to be a metamorphosed crystal tuff.

The Barlow Gneiss is an important host for gold deposits in this area of the gold belt as witnessed by the large number of workings, including the Barlow Cut, that are confined to this unit. The protolith of the Barlow Gneiss probably became enriched in gold that was present in the subaqueous volcanic environment when this unit was deposited.

Also, at this stop one can see at least part of the progression of mining techniques employed in this area at any given mine over time. Placer mining in some of the adjacent valleys probably was the first mining technique employed. This technique was followed by open cut, hydraulic mining of saprolite which was in turn followed by underground mining once fresh rock was reached.

LEAVE STOP 3 AND HEAD WEST ON 9E.

86.9 0.5 Exposures of Pumpkivine Creek amphibolite.
87.1 0.2 Gordon Cut on the right.
87.5 0.3 Whim Hill Mine on the right.
87.8 0.4 Exposures of Pumpkivine Creek amphibolite.
88.1 0.3 Auraria Church. Hedwig Cut behind church.
88.3 0.2 Community of Auraria, turn right.
Figure 4  Geologic map of Stop 4 and vicinity, Dawsonville U.S.G.S. 7.5-minute quadrangle. plc, Palmer Creek Member; pss, pyrite-sericite-quartz schist; pc, Proctor Creek Member; pcu, Pumpkinvine Creek Formation undifferentiated; blg, Barlow Gneiss Member.
89.2  0.9  STOP 4: CASTLEBERRY BRIDGE

STOP 4: CASTLEBERRY BRIDGE:

Rock exposed at this stop (Fig. 4) is a pyrite-sericite-quartz schist that crops out over a large area here and to the north. Locally, this rock contains abundant chlorite and hornblende and is locally interlayered with amphibolite. Zones within this rock unit contain up to 50% pyrite. The contact between the pyrite-sericite-quartz schist and muscovite-biotite-quartz schist on the western end of the cut is sharp.

The pyrite-sericite-quartz schist is common along the gold belt but generally does not occur on the scale of a mappable unit. The unit displayed at this exposure is by far the most extensive. The large percentage of pyrite in this rock makes it attractive economically as a possible host for base or precious metal deposits. However, no known mines or prospects are directly associated with this unit in this area. The protolith of this rock probably was a felsic tuff that was hydrothermally altered prior to metamorphism.

LEAVE STOP 4, CONTINUE WEST ON CASTLEBERRY BRIDGE ROAD.

89.6  0.4  Site of Battle Branch mine on left.
91.5  1.9  Trace of the Allatoona fault.
92.7  1.2  Intersection with GA. 9, turn left.
93.6  0.9  Dawson County line.
95.0  1.4  Junction GA 136, continue straight on GA 9.
96.8  1.8  Dawsonville City limits.
97.3  0.5  Junction with GA 53, continue straight ahead.
97.5  0.2  Dawsonville Courthouse and square. Proceed around square, go south on GA 9.
101.4  3.9  Exposures of Helen Member of the Canton Formation.
Figure 5  Geologic map of Stop 5a and vicinity, Matt U.S.G.S. 7.5-minute quadrangle. plc, Palmer Creek Member; pc, Proctor Creek Member; blg, Barlow Gneiss Member; pcu, Pumpkinvine Creek Formation undifferentiated; h, Helen Member; unu, Univeter Formation undifferentiated; spg, Sandy Springs Group.
102.1  0.7  Trace of the Chattahoochee fault.
102.9  0.8  Etowah River.
103.4  0.5  Junction with GA 318, turn right.
105.0  1.6  Enter Dawson Forest.
108.9  3.9  STOP 5A: PUMPKINVINE CREEK FORMATION: (Optional).

STOP 5A: PUMPKINVINE CREEK FORMATION:

The purpose of this stop is to emphasize the geographic extent of the Pumpkinvine Creek Formation in the northeastern part of the Dahlonega belt. As was seen at Stops 2 and 3, this formation is an important host for gold deposits. Important mines immediately northeast and southwest of this stop include the Kin Morì and Charles mines.

Rocks exposed at this stop (Fig. 5) are undifferentiated amphibolite of the Pumpkinvine Creek Formation and felsic gneiss of the Barlow Gneiss member. These cuts were made for a railroad right-of-way when the U.S. Air Force built a facility here for studying disposal techniques for nuclear waste. The facility has long been abandoned and is now a game preserve.

The amphibolite exposed here is a dark green to black, fine- to medium-grained rock that is typical of the Pumpkinvine Creek Formation in the northeastern part of the Dahlonega gold belt. The amphibolite is cut by numerous veins composed of quartz and calcite (or ankerite?). Also visible here are northeast plunging folds and small northwest-striking, high-angle normal faults (displacements less than 1 foot). Outcrops of the Barlow Gneiss, like those seen at Stop 3, are visible on the southwestern end of the cuts at road level.

LEAVE AND RETRACE ROUTE.

111.2  2.3  Turn right on dirt road.
111.4  0.2  Leave Dawson Forest by south gate.
111.5  0.1  Shiloh Church on left.
111.8  0.3  Turn left onto pavement, Kelly Bridge Road.
Figure 6 Geologic map of Stop 5 and vicinity, Matt U.S.G.S. 7.5-minute quadrangle. pgs, Great Smoky Group; pcu, Pumpkinsvine Creek Formation undifferentiated; ctu, Canton Formation undifferentiated; amp, amphibolite; unu, Univeter Formation undifferentiated; spg, Sandy Springs Group.
<table>
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<th>Distance</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>111.9</td>
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<td>Intersection with paved road; cross paved road and proceed straight on Freeman road (gravel).</td>
</tr>
<tr>
<td>113.4</td>
<td>1.5</td>
<td>Intersection of Freeman road and Mount Tabor Road; turn right on Mount Tabor road.</td>
</tr>
<tr>
<td>114.1</td>
<td>0.7</td>
<td>Migmatitic Sandy Springs Group saprolite.</td>
</tr>
<tr>
<td>116.4</td>
<td>2.3</td>
<td>Intersection with GA 369; turn right.</td>
</tr>
<tr>
<td>116.6</td>
<td>0.2</td>
<td>Turn right on gravel road (Hightower Road).</td>
</tr>
<tr>
<td>117.0</td>
<td>0.4</td>
<td>Etowah River; Sandy Springs Group rocks on left.</td>
</tr>
<tr>
<td>118.9</td>
<td>1.9</td>
<td>Exposures of Canton Formation.</td>
</tr>
<tr>
<td>119.2</td>
<td>0.3</td>
<td><strong>STOP 5: CHARLES MINE:</strong></td>
</tr>
</tbody>
</table>

**STOP 5: CHARLES MINE:**

At this stop (Fig. 6) we will examine the rocks and the associated workings at the Charles gold mine. Rocks exposed here are graphite-garnet-biotite-muscovite-quartz schist, garnet-sericite-quartz schist ± kyanite, amphibolite, and iron formation. Of particular interest is one of the units that is interpreted to be sulfide facies of iron formation. This unit is exposed on the crest of the ridge and is composed of metachert(?) and arsenopyrite.

Also of interest at this stop is the relationship between gold mineralization and the occurrence of iron formation. In pits on the south side of the ridge, oxide facies iron formation is present. This relationship between iron formation and gold deposits is common throughout the Dahlonega gold belt and was particularly evident at Stop 2. The almost invariable occurrence of iron formation and gold in the Dahlonega belt strongly suggests that gold was incorporated into the iron formation at the time of its deposition.

**LEAVE STOP 5 AND CONTINUE ON HIGHTOWER ROAD.**
120.0  0.8  Cherokee County line.
120.6  0.6  Intersection with Yellow Creek Road; turn left.
121.3  0.7  Trace of Allatoona fault.
122.5  1.2  Ridge to left is iron formation.
122.8  0.3  Etowah River; Franklin Creighton mine to left.
123.4  0.6  Franklin mine commissary on left.
123.6  0.2  Workings of Franklin-Creighton mine left on hill.
123.9  0.3  Intersection with GA 369; turn right.
124.4  0.5  Hightower Baptist Church.
125.8  1.4  Junction with GA 372; continue straight.
128.0  2.2  Junction with GA 20; turn right.
129.1  1.1  Community of Orange.
129.8  0.7  Community of Macedonia.
130.3  0.5  Macedonia Church on left.
131.4  1.1  Trace of Chattahoochee fault.
134.1  2.7  Community of Buffington.
136.2  2.1  Canton City limits.
136.8  0.6  Junction with Interstate 575; turn right and head south on I-575.
137.2  0.4  Trace of Allatoona fault.
138.6  1.4  Take Exit 9—Canton/Roswell.
138.9  0.3  Turn left onto GA 140.
139.1  0.2  Turn left onto I-575 north.
149.7  0.6  STOP 6: CANTON—PUMPKINVINE CREEK FORMATIONS:

Figure 7  Geologic map of Stop 6 and vicinity, Canton U.S.G.S. 7.5-minute quadrangle. pEgs, Great Smoky Group; ctu, Canton Formation undifferentiated; pcu, Pumpkinvine Creek Formation undifferentiated; unu, Univeter Formation undifferentiated; rcs, Rose Creek Schist Member.
STOP 6: CANTON AND PUMPKINVINE CREEK FORMATIONS:

Most of this series of cuts (Fig. 7) expose the Canton Formation. German (1985) interprets rocks at the extreme southwestern end of the cut as part of undifferentiated Pumpkinvine Creek Formation. This unique rock is a garnet-biotite-hornblende-quartz-plagioclase gneiss ± calcite and/or staurolite. McConnell and Abrams (this report) consider these rocks to be part of the Canton Formation possibly representing the metamorphic equivalent of a carbonate facies iron formation. Conspicuous features of this rock are large rolled garnets up to 1.5 cm in diameter and spectacular radiating laths of hornblende several centimeters across. In sharp contact with this rock is lustrous garnet-biotite-muscovite-quartz schist ± graphite of the Canton Formation. Also, directly across the interstate are exposures of pyrite-sericite-quartz schist like that seen at Stop 4.

Approximately 2.2 km to the southwest at approximately the same stratigraphic interval are workings of the Canton (Rich) Copper mine. This mine was worked before the Civil War, however, no production records are available. The mine reportedly produced copper, zinc, and lead in small quantities.

LEAVE STOP 6 AND CONTINUE NORTH ON I-575.

140.9 1.2 Exit I-575 north onto GA 20; return to I-575 south and continue south to I-75 and then to the Journey’s End Motel.

END OF FIRST DAY.
### ROAD LOG AND STOP DESCRIPTIONS-DAY 2

**Field Trip Leaders:** Keith I. McConnell  
Charlotte E. Abrams

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<th>INC. MI.</th>
<th>DESCRIPTION</th>
</tr>
</thead>
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<td>0.0</td>
<td>Leave Journey's End Motel, Delk road, go north on Interstate 75.</td>
</tr>
<tr>
<td>6.3</td>
<td>6.3</td>
<td>Kennesaw Mountain on left, site of a Civil War battlefield and underlain by rocks of the Laura Lake Mafic Complex.</td>
</tr>
<tr>
<td>6.6</td>
<td>0.3</td>
<td>Exposures of the Laura Lake Mafic Complex on left.</td>
</tr>
<tr>
<td>7.0</td>
<td>0.4</td>
<td>Junction of Interstate 75 and 575; bear right on Interstate 575.</td>
</tr>
<tr>
<td>7.8</td>
<td>0.8</td>
<td>More Laura Lake Mafic Complex exposures.</td>
</tr>
<tr>
<td>10.8</td>
<td>3.0</td>
<td>Bells Ferry Road exit; take exit and turn left onto Bells Ferry Road.</td>
</tr>
<tr>
<td>14.1</td>
<td>3.3</td>
<td>Junction of Bells Ferry road and state highway 92; continue north on Bells Ferry Road.</td>
</tr>
<tr>
<td>14.4</td>
<td>0.3</td>
<td>Saprolite exposures of migmatitic Sandy Springs Group rocks on left.</td>
</tr>
<tr>
<td>16.4</td>
<td>2.0</td>
<td>Topographic expression of Univeter Formation; Rose Creek Church on left with saprolite exposures of Rose Creek Schist to north; Bell Star gold mine to right.</td>
</tr>
<tr>
<td>16.6</td>
<td>0.2</td>
<td>Intersection with Kellogg Creek road; turn left onto Kellogg Creek road.</td>
</tr>
<tr>
<td>17.9</td>
<td>1.3</td>
<td>Kellogg Creek; type locality of the Kellogg Creek Mafic Complex.</td>
</tr>
<tr>
<td>18.1</td>
<td>0.2</td>
<td>Turn left into parking area;</td>
</tr>
</tbody>
</table>
Figure 8. Geologic map of Stops 7, 7a, and 7b and vicinity; Kennesaw, South Canton, Allatoona Dam, and Acworth, Georgia, U.S.G.S. 7.5 minute topographic quadrangles. pcu = Pumpkintown Creek Formation undifferentiated; gfg = Galts Ferry Gneiss; cf = Canton Formation; kcc = Kellogg Creek Mafic Complex; agn = Acworth Gneiss; uf = Univeter Formation undifferentiated.
STOP 7: GALTS FERRY GNEISS:

Walk west on Kellogg Creek Road to a small dirt road on the right leading to the Boy Scout camp. Follow dirt road to lakeshore. Note saprolite exposures of Canton Formation (McConnell and Abrams, 1984) along roadside.

At this stop (Fig. 8), rocks of the Galts Ferry Gneiss member of the Pumpkinvine Creek Formation (McConnell, 1980; McConnell and Abrams, 1984) are exposed. This stop presents an opportunity to observe the felsic gneiss (Galts Ferry Gneiss member) and its relationship to mafic members of the Pumpkinvine Creek Formation, and to observe the deformation that this unit has undergone. The felsic rock (i.e., the Galts Ferry Gneiss) is interpreted as metavolcanic based largely on the presence of opalescent blue quartz grains and euhedral feldspar grains locally found within this unit. The Galts Ferry Gneiss is interpreted to be a lithostratigraphic equivalent to the Barlow Gneiss (German, 1985) seen yesterday in the Dahlonega area.

STOP 7A: KELLOGG CREEK MAFIC COMPLEX:
(Optional)

Return to the lakeshore south of the Kellogg Creek parking lot. Along the lakeshore (Fig. 8) are good exposures of amphibolite associated with the Kellogg Creek Mafic Complex (McConnell and Abrams, 1984). More typical, coarse-grained metagabbroic rocks of the Kellogg Creek are exposed on the opposite side of the lake. Metagabbroic rocks are composed of amphibole and zoisite with accessory clinopyroxene and lawsonite (?). These rocks may represent an anorthositic member of the Kellogg Creek Mafic Complex.

LEAVE STOPS 7 AND 7A, RETURNING TO KELLOGG CREEK ROAD. TURN LEFT, WEST ON KELLOGG CREEK ROAD.

19.0 0.9 Intersection with Recreation Lane; turn right.

19.4 0.4 STOP 7B: GALTS FERRY GNEISS:
(Optional)

STOP 7B: GALTS FERRY GNEISS:

Walk up road to gate and then down hillside. This stop (Fig. 8) provides an alternate look at the Galts Ferry Gneiss. At this locality the Galts Ferry Gneiss varies from a leucocratic hornblende-biotite-quartz-feldspar gneiss to a hornblende-rich gneiss which supports the interpretation of a gradational relationship between the Galts Ferry Gneiss and mafic members of the Pumpkinvine
Figure 9. Geologic map of Stop 8 and vicinity, Acworth, Georgia, U.S.G.S. 7.5 minute topographic quadrangle. cf = Canton Formation; bif = banded iron formation; gfg = Galts Ferry Gneiss; pcu = Pumpk`vine Creek Formation undifferentiated; kcc = Kellogg Creek Mafic Complex.
Creek Formation. Banding, possibly original layering in the volcanic sequence, is readily apparent in this exposure. Small-scale brittle faults, healed by secondary quartz, are common in this exposure.

**LEAVE STOP 7B.**

<table>
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<th>Mileage</th>
<th>Distance</th>
<th>Description</th>
</tr>
</thead>
<tbody>
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<td>19.8</td>
<td>0.4</td>
<td>Retrace route to Kellogg Creek Road, turn right.</td>
</tr>
<tr>
<td>21.2</td>
<td>1.4</td>
<td>Junction with New Hope road. Bear left continue on Kellogg Creek road.</td>
</tr>
<tr>
<td>22.4</td>
<td>1.2</td>
<td>Junction with Highway 92; turn right head south on GA 92.</td>
</tr>
<tr>
<td>23.4</td>
<td>1.0</td>
<td>Junction with Interstate 75; turn right head north on I-75.</td>
</tr>
<tr>
<td>23.7</td>
<td>0.3</td>
<td>Bartow County line.</td>
</tr>
<tr>
<td>26.9</td>
<td>3.2</td>
<td>Lake Allatoona; exposures of Kellogg Creek Mafic Complex on west side of road.</td>
</tr>
<tr>
<td>28.0</td>
<td>1.1</td>
<td><strong>STOP 8: PUMPKINVINE CREEK FORMATION:</strong></td>
</tr>
</tbody>
</table>

**Stop 8: PUMPKINVINE CREEK FORMATION:**

This is the type locality of the Pumpkinvine Creek Formation (Fig. 9). At this stop the Pumpkinvine Creek Formation is composed primarily of chloritic amphibolite, but also contains thin (1 ft.) layers of garnet-hornblende-plagioclase gneiss, blue-quartz bearing gneiss (interpreted to be a crystal tuff) and banded iron formation. The Pumpkinvine Creek Formation and structurally overlying Canton Formation are host to numerous small gold mines (e.g., Kin Mori) and at least one major massive sulfide deposit (Rich deposit).

The trend of the Pumpkinvine Creek Formation is NE-SW. The Pumpkinvine Creek Formation is traceable to Canton to the north where it plunges beneath the surface in a major F2 fold. German (1985) has determined that the Pumpkinvine Creek Formation again comes to the surface in Dawson County between Canton and Dahlonega where the Pumpkinvine Creek Formation is again exposed and host to many of the gold mines in that area.

Relict volcanic features such as amygdules composed predominantly of epidote and deformed pillows are visible at this stop. Exposures to the west on Route 41 are where Hurst and Jones (1973) first reported volcanic features (pillows) in amphibolites of the Cartersville area. Whole rock and trace element analyses of amphibolites from the Pumpkinvine Creek Formation indicate that they were formed in either
a back-arc basin or ocean ridge tectonic environment (McConnell, 1980). The authors favor the former environment. Based on chemical and lithologic similarities, McConnell (1980) equated the Pumpkinvine Creek Formation to the Hillabee Greenstone in Alabama.

At the south end of the exposure weathered schist of the Canton Formation is present. Although locally sheared this contact appears to be gradational suggesting continuity of the Pumpkinvine Creek-Canton Formations.

Also note the felsic interlayers in the amphibolites of the Pumpkinvine Creek Formation. These blue-quartz bearing felsic rocks are chemically and mineralogically similar to the Galts Ferry Gneiss which suggests that felsic and mafic volcanism occurred, at least in part, contemporaneously.

LEAVE STOP 8 - CONTINUE NORTH ON INTERSTATE 75.

<table>
<thead>
<tr>
<th>Mile</th>
<th>Distance</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>29.0</td>
<td>1.0</td>
<td>Exposures of Etowah Formation (Great Smoky Group after McConnell and Costello, 1984) on right.</td>
</tr>
<tr>
<td>29.4</td>
<td>0.4</td>
<td>Exposures of Walden Creek Group (McConnell and Costello, 1984) on left. Junction with Emerson-Allatoona Road; exit Interstate 75 and go left on Emerson-Allatoona Road.</td>
</tr>
<tr>
<td>30.0</td>
<td>0.6</td>
<td>Pits of abandoned iron mines in Chilhowee Group rocks on left.</td>
</tr>
<tr>
<td>30.5</td>
<td>0.5</td>
<td>Junction with U.S. 41; go left (south) on U.S. 41.</td>
</tr>
<tr>
<td>31.2</td>
<td>0.7</td>
<td>Saprolite exposures of Shady Formation on right.</td>
</tr>
<tr>
<td>32.4</td>
<td>1.2</td>
<td>Pumpkinvine Creek.</td>
</tr>
<tr>
<td>33.0</td>
<td>0.6</td>
<td>Pumpkinvine Creek.</td>
</tr>
<tr>
<td>33.1</td>
<td>0.1</td>
<td>Pumpkinvine Creek Formation on left.</td>
</tr>
<tr>
<td>34.0</td>
<td>0.9</td>
<td>Exposures of Kellogg Creek Mafic Complex (McConnell and Abrams, 1984).</td>
</tr>
<tr>
<td>35.4</td>
<td>1.4</td>
<td>Junction Ga. 92; turn right onto Ga. 92.</td>
</tr>
</tbody>
</table>
STOP 9: LITTLE BOB MINE

The Little Bob Mine (Fig. 10) was worked sporadically from 1860 to approximately 1920. Total production from the mine for a one year period, 1918 to 1919, was 14,516 long tons of sulfides for the production of sulfuric acid (Hurst and Crawford, 1970). An earlier report (Shearer and Hull, 1918) gave a production figure of 1000 tons of ore for sulfur in 1885. Ore at the mine consists predominantly of pyrite and pyrrhotite with lesser amounts of chalcopyrite, sphalerite, and magnetite. Shearer and Hull (1918) reported analyses as high as 6.5% Cu and 3.4% Zn from samples taken from the mine. Cook (1970) noted the presence of cubanite and minor galena. Gahnite is recognized in disseminated grains within the pyritic quartz-sericite schist. Cook also recognized gahnite within chloritic zones at the mine.

Coarse garnet chlorite schist is exposed on the hill directly south of Little Bob Mine. Because of the abundant garnets which range up to approximately 2 cms. in diameter, the hill has been called locally "Garnet Hill". The rocks at Garnet Hill are located on strike with the units present at the Little Bob Mine and probably represent an
extension of the alteration zone or feeder pipe for ore bearing solutions (McConnell and Abrams, 1983). Due to large scale folding the garnet hill alteration zone now structurally overlies the ore zone at the Little Bob mine.

Units in the area strike to the northeast with a varying dip to the southeast. Rock at the mine consists of interlayered felsic and mafic volcanics now expressed as chloritic amphibolite/hornblende gneiss ± garnet, feldspathic quartzite, pyritic quartz sericite schist and sulfide facies iron formation. Minor amounts of cummingtonite are also present in some zones. Adjacent to the ore zone, chloritization becomes more intense and amphiboles increase in size up to 3 inches in length. Although intensely weathered, the same units are exposed in the railroad cut near the mine. Also present in the railroad cut is a narrow exposure of magnetite quartzite (banded iron formation).

Figure 10. Generalized geologic map of Stop 9 and vicinity, Dallas, Georgia, U.S.G.S. topographic quadrangle. lma = Lost Mountain Amphibolite; cs/az = chlorite schist ± garnet and altered mafic and felsic volcanic rocks; blf = banded iron formation.
Northwest of the mine along the Seaboard Coast Line railroad track, exposures are somewhat less weathered and consist of interlayered mafic and felsic volcanics and iron formation. Both sulfide and oxide facies iron formation are present. Sulfide facies banded iron formation is exposed on the northeast side of the tracks near the mine, whereas oxide facies iron formation is exposed on both sides of the track in a second generation fold. Additional iron formation float also can be traced through the woods to the north of the sulfide facies exposure.

Amphibolite in this area contains deformed lapilli. Fresh lapilli were recognized in core examined from an area to the south of Little Bob Mine. Amygdules and deformed and flattened pillows are also present in mafic exposures along the railroad tracks.

RETRACE ROUTE TO GA 61.

<table>
<thead>
<tr>
<th>Mileage</th>
<th>Distance</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>53.6</td>
<td>2.2</td>
<td>Junction with Ga. 61, turn left onto Ga. 61 south.</td>
</tr>
<tr>
<td>56.3</td>
<td>2.7</td>
<td>Junction Ga. 120 connector; continue south on 61.</td>
</tr>
<tr>
<td>61.3</td>
<td>5.0</td>
<td>Community of New Georgia.</td>
</tr>
<tr>
<td>63.5</td>
<td>2.2</td>
<td>Douglas County line.</td>
</tr>
<tr>
<td>64.3</td>
<td>0.8</td>
<td>Junction Highpoint road; continue south on Ga. 61. Villa Rica Mine. on left.</td>
</tr>
<tr>
<td>65.0</td>
<td>0.7</td>
<td>Carroll County line.</td>
</tr>
<tr>
<td>65.1</td>
<td>0.1</td>
<td>Outcrops of Villa Rica Gneiss on right.</td>
</tr>
<tr>
<td>65.5</td>
<td>0.4</td>
<td>Villa Rica City limits.</td>
</tr>
<tr>
<td>65.55</td>
<td>0.05</td>
<td>Turn left onto Stockmar Road.</td>
</tr>
<tr>
<td>65.85</td>
<td>0.03</td>
<td>Douglas County line.</td>
</tr>
<tr>
<td>67.1</td>
<td>1.25</td>
<td>Bear right onto Brewer Road.</td>
</tr>
<tr>
<td>68.4</td>
<td>1.3</td>
<td>Power lines; exposures of Villa Rica Gneiss.</td>
</tr>
<tr>
<td>69.5</td>
<td>1.0</td>
<td>Junction Mann Road; bear right.</td>
</tr>
<tr>
<td>70.3</td>
<td>0.8</td>
<td>Junction Cedar Mountain Road; continue right on Mann Road.</td>
</tr>
</tbody>
</table>
71.1 0.8 Junction Richardson Road; turn right.
71.9 0.8 Junction Conners Road; turn right.
71.95 .05 Driveway to Cedar Lake.

LUNCH STOP.
RETURN TO CONNERS ROAD.

STOP 10: CEDAR LAKE QUARTZITE:

STOP 10: CEDAR LAKE QUARTZITE AT THE TYPE LOCALITY.

At this stop (Fig. 11), 1-3 foot layers of banded iron formation are interlayered with amphibolite, biotite gneiss, and muscovite schist. Vein quartz, apparently remobilized silica from the iron formation, is also present. Iron formation at this locality is dominantly oxide facies and is composed chiefly of specular hematite, magnetite, and quartz. Amphibolite and iron formation layers display small scale parasitic F₂ folds related to the Villa Rica antiform. The trend of these folds has been altered to approximately N 05° E from essentially east-west by subsequent (F₃) deformation.

A small (gold?) prospect is present in the banded iron formation at this stop. As with other parts of the gold belt, iron formation is a key horizon for gold deposits and is commonly known to host gold deposits.

Compare the iron formation at this stop with that observed at the Findley mine yesterday. Also take note of the folds and compare with folds to be seen at stop 12.

LEAVE STOP 10, HEAD EAST ON CONNERS ROAD TO RICHARDSON ROAD.

72.0 0.5 Junction Richardson Road; turn left.
72.8 0.8 Junction Mann Road; turn left.
74.3 1.5 Junction Brewer Road; bear left.
75.3 1.0 STOP 11: VILLA RICA GNEISS:
Figure 11. Geologic map of Stop 10 and vicinity, Winston, Georgia, U.S.G.S. 7.5 minute topographic quadrangle. mcf = Mud Creek Formation undifferentiated; clq = Cedar Lake Quartzite; gbs/gn = garnet biotite schist/gneiss; amf = Andy Mountain Formation undifferentiated; amq = Andy Mountain Quartzite; ag = Austell Gneiss.
Figure 12. Geologic map of Stops 11 and 12 and vicinity, Nebo and New Georgia, Georgia, U.S.G.S. 7.5 minute topographic quadrangles.  *drf* = Dog River Formation undifferentiated;  *az* = Mg/Al alteration zone;  *mcf* = Mud Creek Formation undifferentiated;  *clq* = Cedar Lake Quartzite;  *vrg* = Villa Rica Gneiss;  *q* = quartz granofels.
STOP 11: VILLA RICA GNEISS (METADACITE).

The Villa Rica Gneiss (Fig. 12) is a low potassium, leucocratic biotite-quartz- oligoclase (An$_{26-30}$) gneiss. It contains accessory muscovite, epidote and hornblende. The gneiss is interpreted to be a metadacite (Abrams and McConnell, 1981a). Recent field mapping and examination of the Villa Rica Gneiss show that the gneiss is not a large independent body, but interfingers with surrounding amphibolite. This interfingering relationship with surrounding lithologies along with the dacitic composition of the body and the association with other volcanic lithologies, ore deposits and banded iron formation, strongly supports a volcanic origin. We, therefore, term the body a metadacite and suggest it represents an intrusive/extrusive complex.

Outcrops of gneiss at this stop, while generally less weathered than typical outcrops, are representative of the body. No primary mineralogical or textural features are preserved due to recrystallization during kyanite grade metamorphism. The Villa Rica Gneiss is exposed in the crest of a major second generation ($F_2$) anticlinorium.

Foliation at this stop ($S_1$) is nearly horizontal and is a reflection of the position of the gneiss in the anticlinorium.

Siliceous areas within the metadacite were mined or prospected for gold. Most mining was by hydraulic methods, but underground workings are present at the Pine Mountain Mine (Stop 12).

LEAVE STOP 11; CONTINUE WEST ON BREWER ROAD.

76.7  1.4  STOP 12: PINE MOUNTAIN GOLD MINE:

STOP 12: PINE MOUNTAIN GOLD MINE:

Follow the road up the hillside. Pine Mountain (Fig. 12) is the site of one of the major gold mines present in western Georgia (i.e., Pine Mountain or Stockmar gold mine). Several other gold mining operations were located nearby in the same rock unit. Host rock at this deposit is a coarse paragonite-muscovite-quartz rock ± kyanite with accessory pyrite. Adjacent to and on either side of the quartz rock are exposures of chlorite-anthophyllite schist (magnesium-aluminum alteration zone). All of the above mentioned rocks are surrounded by the Villa Rica Gneiss (metadacite). Rocks in and around Pine Mountain form a series of second generation antiforms and synforms. All of the major trenches and adits at the Pine Mountain mine follow the axial trend of these folds.

The coarse mica-quartz rock present at this stop is interpreted as a fumarolic deposit or an alumino-silicate alteration zone which has formed a saddle reef type deposit along the Villa Rica antiform. Pate
(1980) reported gold values ranging from .02 to .3 oz/ton from the Pine Mountain Mine.

The Pine Mountain mine used a cyaniding process for extraction of the gold. Much of the processing facilities remain in the form of cyaniding vats strung along the hillside.

END OF TRIP.
REFERENCES CITED


Generalized geologic map of the excursion area for day 2 of the field trip.
1981 Upper Cretaceous and Lower Tertiary geology of the Chattahoochee River Valley, western Georgia and eastern Alabama. by J. Reinhardt and T. G. Gibson. (Georgia Geological Society, $5.00)

1982 Geology of Late Precambrian and Early Paleozoic rocks in and near the Cartersville District, Georgia. by J. O. Costello, K. I. McConnell, and W. R. Power. (Georgia Geological Society, $5.00)

1983 Geology of Paleozoic rocks in the vicinity of Rome, Georgia. T. M. Chowns, ed. (Georgia Geological Society, $5.00)

1984 A brief excursion through two thrust stacks that comprise most of the crystalline terrane of Georgia and Alabama. by M. W. Higgins, R. L. Atkins, T. J. Crawford, and R. B. Cook. (out of print, available as spiral bound photo copy for $12.00.)

1985 Coastal processes and barrier islasnd development, Jekyll Island, Georgia. by V. J. Henry, and W. J. Fritz, and An examination of the Altamaha formation near Oak Park, Emanuel County, Georgia. by P. Huddlestun. ($5.00)


1986 Stratigraphy and sedimentology of continental, nearshore, and marine Cretaceous sediments of the eastern Gulf Coastal Plain. ed. by Juergen Reinhardt. Field trip no. 3, SEPM Annual Meeting. ($10.00)

1986 Depositional systems of Pennsylvanian rocks in the Cumberland Plateau of southern Tennessee. by H. G. Churnet, and R. E. Burgenback. Field trip no. 4, SEPM Annual Meeting. ($5.00)

1986 Gold and base metal mineralization host rocks in the Dahlonega and Carroll County Gold Belts, Georgia. by K. I. McConnell, J. M. German, and C. E. Abrams, with a prologue by G. O. Allard. ($10.00)