Geology, Geochemistry, and Mineral Resource Assessment of the Southern Nantahala Wilderness and Adjacent Roadless Areas, Rabun and Towns Counties, Georgia, and Clay and Macon Counties, North Carolina

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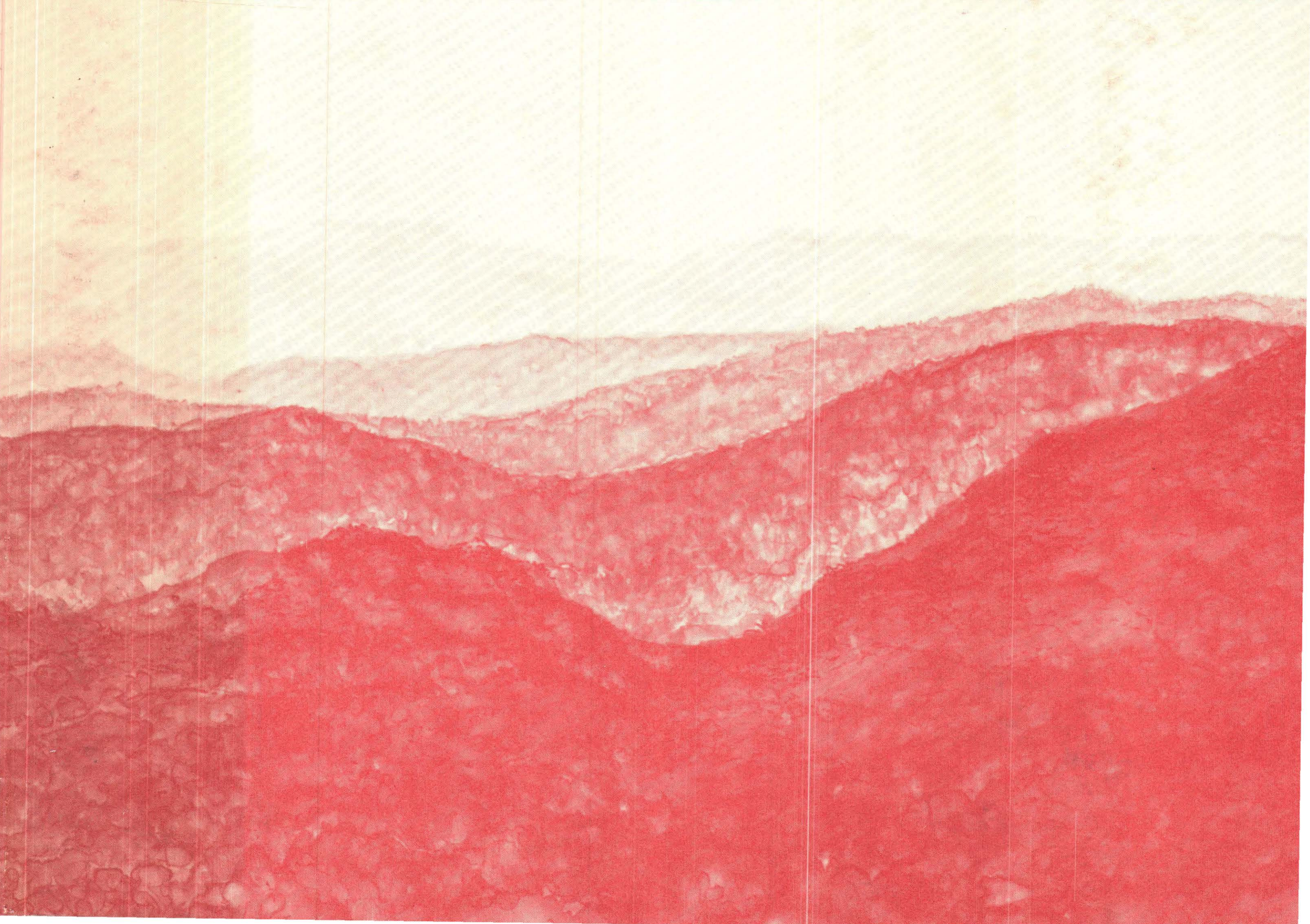

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By John D. Peper, Frank G. Lesure, Leslie J. Cox, *and* John P. D'Agostino

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STUDIES RELATED TO WILDERNESS

The Wilderness Act (Public Law 88–577, September 3, 1964) and related acts require the U.S. Geological Survey and the U.S. Bureau of Mines to survey certain areas on Federal lands to determine the mineral values, if any, that may be present. Results must be made available to the public and be submitted to the President and Congress. This report presents the results of a geologic, geochemical, and mineral resource survey of the Southern Nantahala Wilderness, the Southern Nantahala Roadless Area (U.S. Forest Service no. B8-025), and the Buzzard Knob Roadless Area (08–223). The Southern Nantahala Wilderness, partly in the Nantahala National Forest, Clay and Macon Counties, N.C., and partly in the Chattahoochee National Forest, Rabun and Towns Counties, Ga., was established as a wilderness by the North Carolina Wilderness Act of 1984 (Public Law 98–324, June 19, 1984) and the Georgia Wilderness Act of 1984 (Public Law 98–514, October 19, 1984). The Southern Nantahala Roadless Area, Rabun County, Ga., and Buzzard Knob Roadless Area, Rabun and Towns Counties, Ga., are in the Chattahoochee National Forest just south of the wilderness. These two areas were classified as nonwilderness during the Second Roadless Area Review and Evaluation (RARE II) by the U.S. Forest Service, January 1979. A multiple use classification for both areas was confirmed by the Georgia Wilderness Act of 1984 (Public Law 98–514, October 19, 1984).

CONTENTS

PLATES

[Plates are in pocket]

FIGURES

TABLES

Geology, Geochemistry, and Mineral Resource Assessment of the Southern Nantahala Wilderness and Adjacent Roadless Areas, Rabun and Towns Counties, Georgia, and Clay and Macon Counties, North Carolina

By John D. Peper, Frank G. Lesure, Leslie J. Cox, *and* John P. D'Agostino

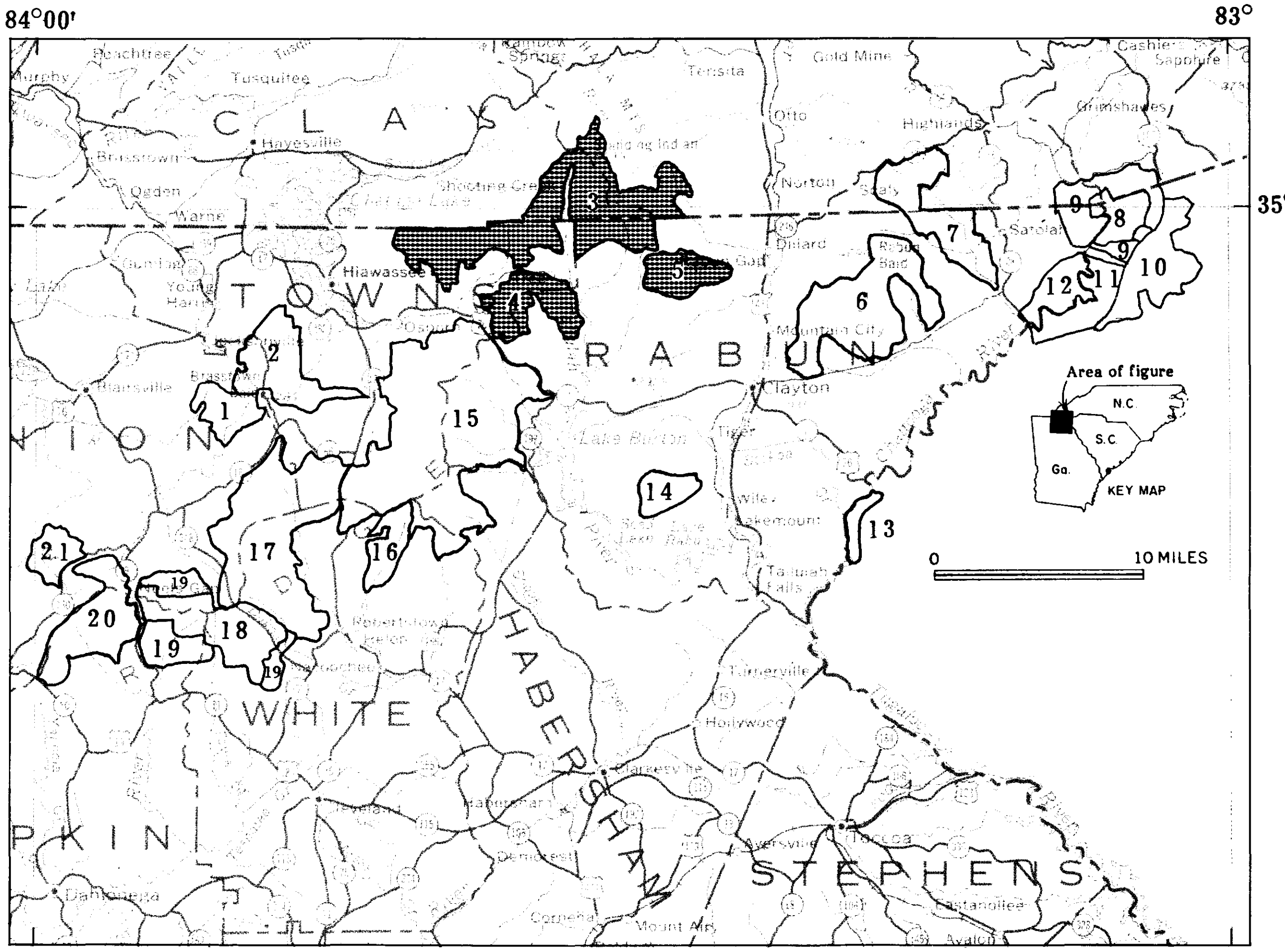
SUMMARY

The Southern Nantahala Wilderness and the Buzzard Knob and Southern Nantahala Roadless Areas are near one another and near the North Carolina—Georgia State line in Rabun and Towns Counties, Ga., and Clay and Macon Counties, N.C. The areas collectively span a region of polydeformed and metamorphosed rocks assigned to three major thrust sheets, from east to west the Tallulah Falls, Helen, and Richard Russell thrust sheets. Outcrop patterns and minor structures in the older sillimanite-grade Richard Russell rocks in the western part of the study area outline an earlier phase of isoclinal folding not apparent in the outcrop pattern of younger kyanite- and staurolite-grade Coweeta Group rocks immediately to the east across the Shope Fork fault in the east-central parts of the study area. Major movement on the Shope Fork fault postdates isoclinal F_1 folding but preceded F_2 isoclinal folding, because F_1 fold traces are covered by rocks above the fault and the fault is folded by F_2 folds. Later shearing along the fault occurred during F_3 cross-folding. Geologic considerations and geochemical sampling and analysis suggest low potential for all mineral resources except common building stone. The potential for some other nonmetallic resources, including corundum, feldspar, sheet mica, and vermiculite, is moderate to low. These are present in limited amounts but are currently of little economic value. The small deposits of soapstone present in the areas are too impure to be considered a resource. Late Archaic-Early Woodland Indian bowl-carving sites in soapstone are an archeological heritage that might deserve conservation. Oil and gas resource potential is unknown but believed to be small. Resource potential for gold is low; for massive sulfide deposits containing some copper and zinc, it is low to moderate. There is little to no resource potential for other metals.

Manuscript approved for publication January 11, 1989.

Character and Setting

The Southern Nantahala Wilderness and the adjacent Buzzard Knob and Southern Nantahala Roadless Areas are in the Blue Ridge Mountains of northeastern Georgia and southwestern North Carolina (fig. 1). The Southern Nantahala Wilderness includes about 10,900 acres of the Nantahala National Forest in Clay and Macon Counties, N.C., and 12,439 acres of the Chattahoochee National Forest in Rabun and Towns Counties, Ga. The Southern Nantahala Roadless Area includes about 5,100 acres of the Chattahoochee National Forest in Rabun County, Ga., and Buzzard Knob covers about 6,440 acres of the Chattahoochee National Forest in Rabun and Towns Counties, Ga. The areas are underlain by variably migmatized gneisses, schists, amphibolites, and calc-silicate granofels that are cut by a few small to large lenses of leuco-granite, granodiorite, and granitic pegmatite. Rocks in the central and western parts of the Southern Nantahala Wilderness and in most of the Buzzard Knob Roadless Area are assigned to the Richard Russell Formation, whereas rocks east of the Shope Fork fault are mapped locally as the Coweeta Group of Hatcher (1979b). These two groups might be partly equivalent to one another to the south or to the north of the area and both lie wholly within the Richard Russell thrust sheet. In the vicinity of the study area, however, there is broad evidence in the outcrop pattern of rock units indicating that the Richard Russell rocks west of the Shope Fork fault are older and that they experienced an earlier phase of isoclinal folding than did the younger rocks of the Coweeta Group to the east. In addition, the Richard Russell rocks are locally metamorphosed to sillimanite-muscovite grade of metamorphism, are variably migmatized, and have been overprinted by a greenschist-facies metamorphism most evident as a variably expressed chloritization and epidotization in mafic rocks. Rocks in the Coweeta Group locally contain kyanite



Base from U.S. Geological Survey
Georgia, 1970, and North Carolina, 1972

EXPLANATION

Wildernesses

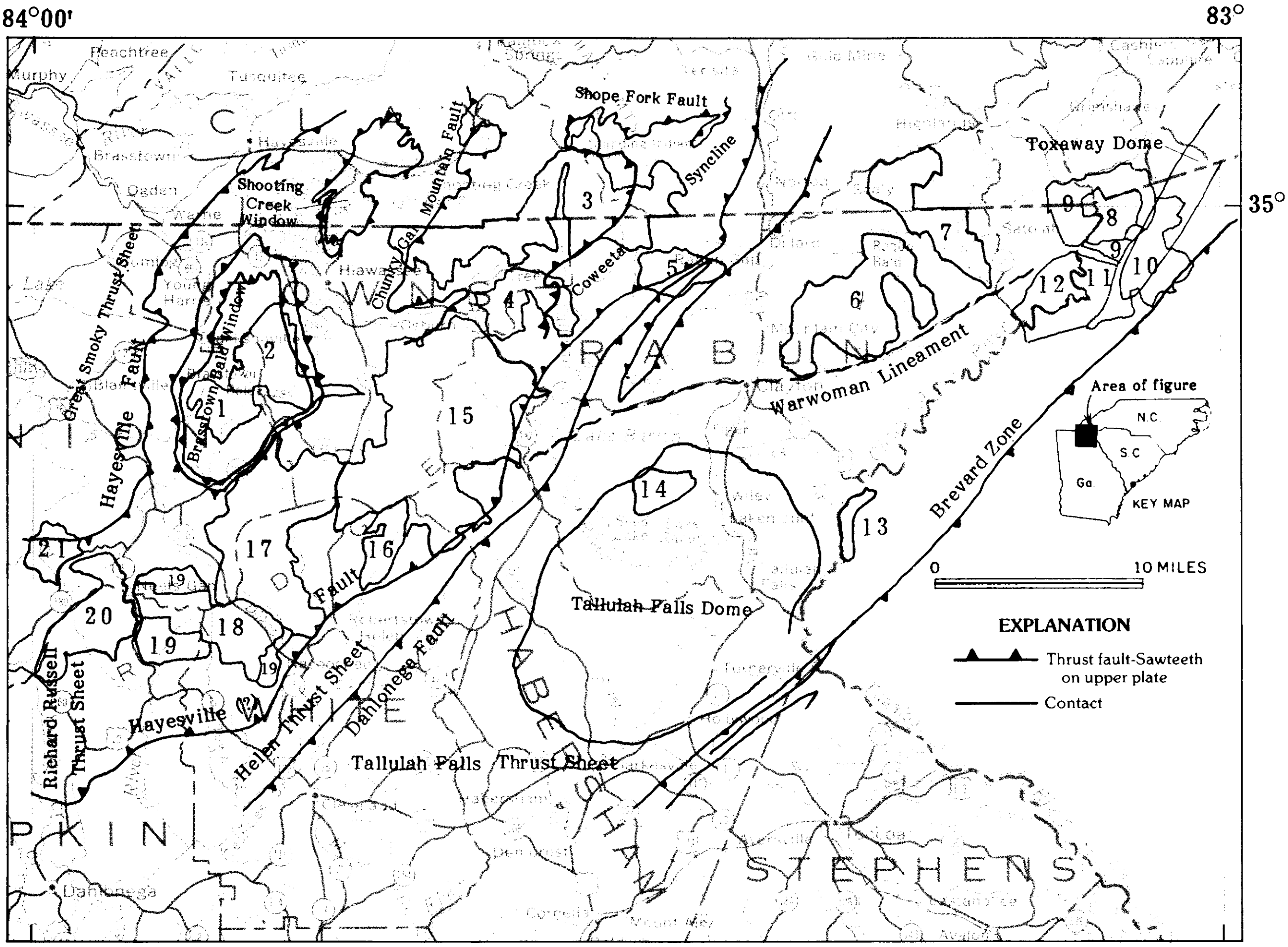
3. Southern Nantahala
8. Ellicott Rock

Roadless Areas

1. Wolf Pen 08–149
2. Brasstown 08–146
4. Buzzard Knob 08–223
5. Southern Nantahala B8025
6. Rabun Bald 08–147
7. Overflow 08–026
9. Ellicott Rock Extension A8031
10. Persimmon Mountain L8116
11. Ellicott Rock Expansion 08112
12. Rand Mountain 08–148
13. Long Creek 08–113
14. Worley Ridge 08–224
15. Tray Mountain 08–030
16. Anna Ruby 08–225
17. Chattahoochee River 08–029
18. Raven Cliff A8028
19. Raven Cliff B8028
20. Blood Mountain 08–027
21. Board Camp 08–145

Figure 1. Locations of wilderness and roadless areas in northeastern Georgia and adjacent North and South Carolina. The Southern Nantahala Wilderness and adjacent roadless areas are stippled. Number after roadless area name is U.S. Forest Service (USFS) identification number.

and staurolite, indicative of higher pressures and probably lower temperatures of metamorphism than rocks in the Richard Russell Formation. The Southern Nantahala Roadless Area span three thrust sheets (fig. 2). The western part is in the Richard Russell thrust sheet, the central part is in the Helen thrust sheet, and the eastern part is in the Tallulah Falls thrust sheet. The Helen thrust sheet, which occupies an isoclinal fold in this area, contains rocks of the Dahlonega gold belt. These have been metamorphosed to kyanite-staurolite grades of regional metamorphism and are highly



Base from U.S. Geological Survey
Georgia, 1970, and North Carolina, 1972

Figure 2. Major structural features in northeastern Georgia and adjacent North and South Carolina, modified after Nelson and others (1987) and Hatcher and Butler (1979).

migmatized. The rocks of the Tallulah Falls thrust sheet are at sillimanite grade of regional metamorphism.

Mineral Resource Potential

The rocks in all three areas have generally low potential for mineral resources. Abundant stone suitable for rough building stone and crushed rock is the only identified mineral resource of economic significance. Other nonmetallic resources are present but have little identified economic potential. These include small deposits of asbestos, corundum, feldspar, sheet mica, and vermiculite. The northern and western parts of Southern Nantahala Wilderness have moderate potential for small sheet mica deposits. Deposits of impure soapstone, used by Indians for potmaking, are too small and impure to be considered sources of soapstone or talc. Oil and gas have unknown potential. There is low potential for gold and low to moderate potential for massive sulfide deposits containing some copper and zinc. Other metals have little or no potential.

Recent seismic studies in the southeastern United States suggest the presence of a thick sequence of younger, less metamorphosed sedimentary rock beneath the thin thrust sheets of older metasedimentary rocks in the Blue Ridge. These younger rocks were once considered a potential source of oil and gas, but their potential is somewhat dubious in view of the inferred thermal maturation that probably reaches greenschist-facies levels of metamorphism. Additional seismic studies and exploratory drilling needed to evaluate the inferred potential seem currently to be unattractive undertakings. Speculative oil and gas leases in the study areas were canceled in 1984.

A narrow belt of the Helen thrust sheet rocks extends through the eastern part of the Southern Nantahala Roadless Area. Southwest of the area, the Helen thrust sheet contains a thick section of gold-bearing strata of the Dahlonega gold belt, but very little gold has been recovered from the belt in the vicinity of the study area.

The Southern Nantahala Wilderness and the Buzzard Knob Roadless Area are west of the Dahlonega gold belt and separated from it by the Hayesville(?) thrust fault. Rocks of the gold belt may be present at great depth below these study areas. A few small placer deposits of gold were worked in drainages west of Buzzard Knob and along the southwest part of Southern Nantahala Wilderness. Geochemical samples of rock, soil, and stream sediments near here, however, contain no gold and indicate a low potential for the occurrence of gold. The presence of a thick series of interlayered felsic and mafic schists and gneiss in the Richard Russell Formation containing at least one small deposit of massive sulfides suggests low to moderate potential for additional massive sulfide deposits, which may contain copper and zinc. There is little or no potential for other metallic mineral resources.

INTRODUCTION

The U.S. Geological Survey (USGS) mapped the geology and made a reconnaissance geochemical survey of the Southern Nantahala Wilderness and adjacent roadless areas to test for indistinct or unexposed mineral deposits that might be recognized by their geochemical halos or patterns formed by the distribution of trace elements. Geologic mapping and chemical analyses of samples indicate that the study areas have low potential for the occurrence of metallic mineral deposits. The metal contents of rock, stream-sediment, and soil samples are near or below average abundances; no significant or anomalous amounts are present.

Location, Size, and Physiography

The Southern Nantahala Wilderness is an elongate, irregular-shaped area, of variable 1 to 6 mi width, and 12 mi long spanning the Georgia-North Carolina border (fig. 1). The Buzzard Knob Roadless Area is a U-shaped area just south of the west-central part of the wilderness, and the Southern Nantahala Roadless Area is a roughly elliptical area just southeast of the southeast corner of the wilderness. The northern part of the Southern Nantahala Wilderness encompasses 10,900 acres of the Nantahala National Forest in Clay and Macon Counties, N.C.; the southern part, divided into two areas by private land along the Tallulah River, comprises 12,439 acres of the Chattahoochee National Forest in Rabun and Towns Counties, Ga. The eastern part of the wilderness is 5 mi west of Dillard and 8 mi northwest of Clayton, Ga.; the western part is 4 mi northeast of Hiawassee, Ga.; and the northern part is 11 mi southwest of Franklin, N.C. The southern and central parts of the wilderness are reached from the Tallulah River Road (U.S. Forest Service Road (FSR) 70 in Georgia and FSR 56 in North Carolina) and the Blue Ridge Gap Road (Georgia secondary road 105), which extends westward from the Tallulah River between the wilderness and the Buzzard Knob Roadless Area to the south. The southwestern part of the wilderness is reached from paved or gravel State secondary and U.S. Forest Service roads that go north from U.S. Highway 76. The northwestern and northern parts of the wilderness have indirect access from U.S. Highway 64 by way of State secondary or U.S. Forest Service roads. The eastern and southeastern parts of the wilderness are accessible by State secondary and U.S. Forest Service roads going west from U.S. Highway 23/441, both south and north of Dillard, Ga. The Appalachian Trail crosses the western segment of the wilderness in Georgia and becomes part of the northwestern boundary of the wilderness in North Carolina. From here northward the trail winds through the wilderness in an inverted U shape along the higher ridges that form the drainage divide at the very headwaters of the Tallulah River. Two miles south of the northern part of the area, the trail turns southeastward and follows the highest ridge in the wilderness for several miles before turning north again and forming another segment of the boundary. The boundary of the wilderness mostly follows the ridge lines, but along much of the southern border the boundary is the 2,600- or 3,000-ft contour line, and the 4,400-ft contour line bounds a salient of wilderness north of the major ridge crests along the northern border.

The wilderness contains many steep, rugged ridges and spurs. The highest point is 5,499 ft above sea level at Standing Indian Lookout Tower; the lowest is 2,400 ft above sea level near the Tallulah River along the south edge. There are many knobs over 4,000 ft above sea level and at least three above 5,000 ft. The ridges are thickly wooded with second-growth hardwood, pine, mountain laurel, and rhododendron.

The wilderness spans the divide between Atlantic (southeastern) and Tennessee Valley (northwestern) drainages. Much of the central part is drained by the southeast-flowing Tallulah River and its tributaries. The northeast part is drained by many small tributaries to the northwest-flowing Little Tennessee River, and the western part is in headwaters of Hightower and Shooting Creeks, tributaries of the northwest-flowing Hiawassee River.

The Buzzard Knob Roadless Area comprises about 6,270 acres of the Chattahoochee National Forest in Rabun and Towns Counties about 9 mi west of Clayton, Ga. (fig. 1). The area includes much of the headwaters of Plumorchard Creek, a tributary of the Tallulah River, and of Little Hightower Creek, a tributary of Hightower Creek. The area is bounded on the east by the Tallulah River Road (FSR 70) or by the river, and on the north by the Blue Ridge Gap Road (Georgia secondary road 105). Part of the southern boundary is the 2,800-ft contour around the headwaters of Plumorchard Creek; the remaining boundary follows ridge lines or U.S. Forest Service property lines.

Figure 3. View looking southeast across the Southern Nantahala Roadless Area from the steep east slope of Scaly Knob in foreground toward Gulf Knob on the right and Penson Knob on the left in the background.

Access from the south is from U.S. Highway 76, from the east by Tallulah River Road (FSR 70), from the north by the Blue Ridge Gap Road (Georgia secondary road 105), and from the west by the Barefoot Road (Georgia secondary road 108). The Appalachian Trail follows the ridge line through the western part of the area from Dicks Gap on U.S. Highway 76 at the south to Blue Ridge Gap at the north edge. The area has steep, narrow valleys and sharp ridges. The highest point is about 3,760 ft above sea level on Buzzard Knob in the west-central part of the area; the lowest point is about 2,160 ft above sea level on the Tallulah River at the southeast end of the area.

The Southern Nantahala Roadless Area comprises about 5,100 acres of Chattahoochee National Forest in Rabun County 2 mi southwest of Dillard and 5 mi northwest of Clayton, Ga. The area is bounded on the north and west by FSR 32, which provides good access. The rest of the border follows ridge lines or U.S. Forest Service property lines and is paralleled along the south and east by county road 5879, which intersects U.S. Highway 23/441 near Dillard. The highest point in the area is Wolf Knob, 3,979 ft above sea level; the lowest point is about 2,200 ft above sea level on Persimmon Creek at the western end of the area. The topography is steep and rugged (fig. 3). The eastern half of the area is drained by several small streams forming the headwaters of the Little Tennessee River. The western part of the area is drained by small tributaries of Persimmon Creek, which flows into the Tallulah River.

Previous Work

Keith (1907) mapped the Nantahala 30-min quadrangle, which includes the northern part of the Southern Nantahala Wilderness in North Carolina, and Galpin (1915, p. 141–144), using Keith's stratigraphy, described the general geology of the Blue Ridge in northeastern Georgia. Teague and Furcron (1948) described the geology and mineral resources of Rabun County, Ga. Crickmay (1952) and Hurst (1973) included the rocks of the area in their general descriptions of the geology of the Blue Ridge in Georgia. Hadley and Nelson (1971) mapped the geology of the Knoxville $1^{\circ}\times2^{\circ}$ quadrangle, which also includes the northern part of the wilderness. Hatcher (1971) remapped the geology of Rabun County in reconnaissance. In more recently completed studies, he mapped the stratigraphy and structure in the Blue Ridge of northeast Georgia and deciphered the tectonic history (Hatcher, 1972, 1974, 1976, 1978, 1979a, 1979b). Hatcher (1980) mapped in more detail the geology of the Prentiss 7½-min quadrangle, N.C., which includes the northeastern part of the wilderness. Nelson (1982) mapped the Tray Mountain Roadless Area, which lies just south of the Buzzard Knob Roadless Area (fig. 1). Nelson and Zietz (1983), Nelson (1985), and Nelson and others (1987) have described the regional tectonic setting and have provided a background for most of our interpretation of the geology of the three areas.

Mineral resources that have been studied in the region around or near the three study areas include asbestos (Hopkins, 1914; Teague, 1956), corundum (King, 1894; Pratt and Lewis, 1905; Keith, 1907), gold (Yeates and others, 1896; Jones, 1909; Nitze and Wilkens, 1897), kyanite (Prindle, 1935; Furcron and Teague, 1945), mica and feldspar (Galpin, 1915; Sterrett, 1923; Furcron and Teague, 1943; Lesure, 1968, Lesure and others, 1968; Lesure and Shirley, 1968), olivine (Pratt and Lewis, 1905; Hunter, 1941), pyrite (Shearer and Hull, 1918), and vermiculite (Prindle, 1935; Hunter and Mattocks, 1936; Murdock and Hunter, 1946). Teague and Furcron (1948) showed the locations of most known mineral deposits in Rabun County. Hannigan (1986) reported the results of U.S. Bureau of Mines (USBM) studies of the Southern Nantahala Wilderness, and Chatman (1985a, b) reported the results of USBM studies of the Buzzard Knob Roadless Area.

Present Work

Peper, Cox, and D'Agostino, assisted by M.K. Brown, E.D. Cron, J.C. Jackson, and Ricardo Lopez, mapped and sampled the Southern Nantahala Wilderness in October–November 1985 and April 1986. Peper and Lesure, assisted by C.A. Edwards and Z.A. Zwiebel, mapped and field checked the western part of the wilderness in September 1987. Lesure and D'Agostino, assisted by J.A. Goss, mapped and sampled the Buzzard Knob Roadless Area in April 1985 and spent a few days field checking and further sampling in April 1986. Cox, assisted by Debby Kay, mapped and sampled the Southern Nantahala Roadless Area in April 1985.

Samples collected for analysis include 353 rocks, 212 soils, 171 fine-grained stream sediments, and 139 heavy-mineral panned concentrates. Semiquantitative spectrographic analyses of all samples were done in USGS laboratories, Denver, Colo., by B.M. Adian, D.E. Detra, M.S. Erickson, Olga Erlich, and R.T. Hopkins. Atomic absorption analyses were done in USGS laboratories, Denver, Colo., by R.J. Fairfield, Tina Hayek, L.S. Laudon, M.A. Pokorny, and T.A. Roemer. References to the complete analytical results are given in table 1. Mineral identifications of heavy mineral suites in the panned concentrates were by D'Agostino using a binocular microscope. Some identifications were checked by scanning electron microprobe analysis by E.J. Dwornik, USGS, Reston, Va.

Petrologic examination of crushed rock fragments and thin-sections augmented the outcrop and hand-sample descriptions of rock units.

GEOLOGY

Lithologic and Structural Setting

Rocks of the study areas (pl. 1) are variably migmatized gneisses, schists, amphibolites, and calc-silicate granofels that were regionally metamorphosed to upper-amphibolite facies. Compositional layering of variable thickness parallels regional foliation in most outcrops, but distinct relic bedding features are rarely preserved. The layering and general compositions suggest that these are probably metamorphosed sedimentary rocks. Reasonable protoliths are graywacke sandstones, shales, mafic to intermediate waterlaid tuffs, and calcareous-cemented sandstones and siltstones. In addition, the thicker masses of metamorphosed mafic and ultramafic rock may be dismembered fragments of ophiolite or ophiolitic melange tectonically emplaced in the sedimentary sequence; or, alternatively, they may be cumulate parts of igneous bodies that were intruded into the sedimentary and volcanic rocks of the eugeosynclinal depositional sequence (Misra and Keller, 1978), or somewhat younger igneous intrusives. The local stratigraphic succession has not been traced or correlated in detail regionally. A few small sills, dikes, and semiconcordant lenses of late-synmetamorphic biotite leuco-granite, granodiorite, and granitic pegmatite ranging from a few to 30 ft thick intrude the metasedimentary rocks but comprise less than 1 percent of the bedrock.

The rocks in all but the eastern half of the Southern Nantahala Roadless Area are part of the Richard Russell thrust sheet immediately northwest of an unnamed fault that probably connects with the Hayesville fault and is shown as Hayesville(?) on figure 2 and plate 1. This westward-dipping fault separates rocks in the Richard Russell thrust sheet from rocks to the southeast in the Helen thrust sheet (Nelson, 1982; Gillon, 1982; Nelson and others, 1987). The eastern half of the Southern Nantahala Roadless Area is locally in the isoclinally folded core of the Helen thrust sheet but includes a narrow down-folded tongue of the Tallulah Falls thrust sheet in the east-central part of the area and a small section of the same thrust sheet along the eastern edge of the area.

Regional Geologic Setting and Names of Rock Units

Rocks of the Southern Nantahala Wilderness and adjacent roadless areas (fig. 2 and pl. 1) lie in the southern

Blue Ridge northwest of the Brevard fault zone. Recent geologic mapping and ancillary studies in the Brevard fault zone have shown that the crystalline rocks lie in a series of westward-directed thrust sheets (Nelson and others, 1987; Nelson, 1985; Hatcher, 1978) that overlie Grenville-aged basement blocks and possibly also Paleozoic sedimentary rocks at depths of up to 10 mi (Cook and others, 1979; Harris and others, 1981). The Paleozoic sedimentary rocks may extend far to the east under the crystalline sheets, which may have been transported westward as much as 179 km (Harris, 1979). Thrust sheets and bounding faults in the immediate vicinity of the map include, from west to east: (1) the Richard Russell thrust sheet, separated by the Hayesville? fault from (2) the Helen thrust sheet, and (3) the Tallulah Falls thrust sheet, separated from the Helen thrust sheet by the Dahlonega fault.

Hayesville and Hayesville(?) Faults

The Hayesville fault, first recognized by Hatcher (1976), separates rocks of the Richard Russell thrust sheet from rocks of the Great Smoky Group (Nelson, 1985). The fault mapped here as the Hayesville(?) fault was mapped earlier by Nelson (1982) as the Shope Fork fault in the Tray Mountain Roadless Area, and as an unnamed fault by Gillon (1982) to the south. More recent work (Nelson and others, 1987) suggests that the fault separating the Richard Russell thrust sheet from the Helen thrust sheet (our Hayesville(?) fault) is not the fault first mapped by Hatcher (1976, p. 22, fig. 2) as the fault along Shope Fork near the North Carolina-Georgia State line. Instead, the Hayesville(?) fault lies southeast of the Shope Fork fault and passes northeastward into North Carolina. To the southwest and outside the map area this eastern fault appears to join the Hayesville fault (Nelson and others, 1987). We therefore show this fault informally as the Hayesville(?) fault on figure 2 and on the geologic map. The Hayesville(?) fault is thought to be a shallowly westward-dipping synmetamorphic to premetamorphic fault that is openly folded near the Anna Ruby Roadless Area (Peper and Lesure, 1987). Neither the amount nor the sense of displacement on the fault is known with certainty. The final movement, however, was probably from east to west (German, 1985; Nelson and others, 1987).

Richard Russell Thrust Sheet

Rocks of the Richard Russell thrust sheet to the southwest include the Richard Russell Formation and the structurally overlying Coweeta Group to the northeast. The Richard Russell Formation was named by Nelson and Gillon (1985) for rocks in good exposures along the Richard Russell Highway about 12 mi southwest of the Southern Nantahala Wilderness. The name was used for rocks in the Anna Ruby (Peper and Lesure, 1987) and Tray Mountain (Nelson, 1982) Roadless Areas. The Richard Russell Formation includes gneisses, schists, layered and massive amphibolite and amphibole gneiss, and calc-silicate-bearing gneiss and granofels that are variably migmatized.

The Coweeta Group, defined locally by Hatcher (1979b), consists of the Persimmon Creek gneiss (oldest), the Coleman River Formation, and the Ridgepole Mountain Formation (youngest). Hatcher (1979b, p. 27) showed their distribution about the Coweeta syncline east of the Shope Fork fault on a small scale map of the eastern part of our geologic map area and mapped these latter units in detail in the Prentiss quadrangle (Hatcher, 1980). The Persimmon Creek gneiss includes massive orthogneiss of quartz-diorite composition as well as layered quartz-plagioclase-biotite gneisses (meta-sandstones) and schist (metamorphosed shales) and some amphibolite. The Coleman River Formation includes mostly metasandstone and lesser schist and calc-silicate rocks (metashales) and metamorphosed calcareous sandstones and siltstones. The Ridgepole Mountain Formation is mostly schists (metashales) and quartz-rich gneisses (metasandstones) with local lenses of metaorthoquartzite.

We believe we can distinguish the Richard Russell Formation rocks from the Coweeta Group rocks in the area of the geologic map, and we use the name Richard Russell Formation for all rocks west of the Shope Fork fault. The local Coweeta Group names are used for rocks in the Richard Russell thrust sheet east of the Shope Fork fault in this map area. Although the Shope Fork fault has not been mapped in detail to the south, it is thought probable that most of the eastern parts of the Richard Russell Formation in this map area are older than most parts of the Coweeta Group and that the Coweeta Group is distinctly younger than the Richard Russell Formation, chiefly because the Richard Russell rocks have experienced a phase of folding earlier than that affecting the Coweeta rocks and are of higher metamorphic grade (see structure and regional metamorphism sections of this report).

Helen Thrust Sheet

Because rocks in the Helen thrust sheet have not been mapped in detail in northeast Georgia, knowledge of the stratigraphy and structure of the belt is imprecise. The sheet includes the Dahlonega gold belt (Yeates and others, 1896; German, 1985) to the southwest, where regional structural and stratigraphic reconstructions suggest that Helen belt rocks occupy a multiply deformed antiform and are at or near the base of the Late Proterozoic stratigraphic succession (McConnell and Abrams, 1984). Northward the structure has been considered homoclinal or indeterminate (Gillon, 1982). The unique mafic, sulfidic-schist, and iron-formation lithologies, the gold-bearing lithologies, and the sheared nature of the belt (Yeates and others, 1896) have long been recognized. The name Robertstown

Formation of the Helen Group, proposed by Nelson and Gillon (1985) for rocks in the belt to the southwest, was used in the Anna Ruby area (Peper and Lesure, 1987). The intervening area to the north, however, has not been mapped in detail, and lithologies in the thrust sheet here are assigned generally to the Helen belt in this report rather than to the Robertstown Formation.

Dahlonega Fault

The Dahlonega fault, as mapped in northeast Georgia by Nelson (1985), roughly coincides with the southern edge of the Dahlonega shear zone (Crickmay, 1952) and the beds in the Dahlonega gold belt (Jones, 1909). The fault separates the highly migmatitic rocks of the Tallulah Falls thrust sheet from the nonmigmatitic rocks of the Helen thrust sheet. Movement along the fault appears to have occurred both during and after metamorphism (Nelson and others, 1987).

In the Southern Nantahala Roadless Area, a sharply folded segment of the Dahlonega fault separates contrasting lithologies of metamorphosed granite (Tallulah Falls thrust sheet) and bedded, metasedimentary units (Helen thrust sheet). A good exposure of the fault appears at 3,120 ft above sea level on the hillside southeast of First Prong Creek, 0.4 mi along an N. 63°E. bearing from the intersection of First Prong and Keener Creeks. East of the fault, the isoclinally folded beds of the Helen Group in the footwall of the thrust are polydeformed and mylonitized. In the roughly 10-ft-wide fault zone, the Helen Group beds are buckle folded, riddled with ptygmatic quartz veins, and broken into blasto-mylonitic breccia blocks. Deformation in the hanging wall granites west of this fault segment is evidenced by thin bands of segregated biotite defining a strong foliation.

Tallulah Falls Thrust Sheet

Rocks in the Tallulah Falls thrust sheet in the southeastern part of the map area are assigned to the Tallulah Falls Formation. The Tallulah Falls Formation of Hatcher (1971, p. 9–12) is a redefinition of the Tallulah Falls Quartzite of Galpin (1915) in the area to the southeast of the map area. Much of the thrust sheet in the immediate vicinity of this map area contains granite or foliated biotite granite identical to the informal Rabun gneiss of Hatcher (1974) (Hatcher, 1976). Although Hatcher used the name Tallulah Falls Formation for rocks generally west of the Shope Fork fault in the Prentiss quadrangle (Hatcher, 1980), we use the name Richard Russell Formation for these rocks here because they are regionally recognized as belonging to an entirely different thrust sheet (Nelson and others, 1987). Although parts of both formations may resemble each other, the relationships of the two formations to each other, if any, have not been evaluated.

Regional Metamorphism

In this part of the southeastern Blue Ridge, earlier fold events were accompanied by a prograde Barrovian metamorphism (Hadley and Nelson, 1971) that reached granulite facies (Force, 1976) north of the map area in North Carolina. The metamorphism occurred about 450–480 Ma (Butler, 1972; Dallmeyer, 1975). Hatcher (1980) mapped detailed isograds in pelitic rocks in the Prentiss quadrangle, including a sillimanite zone containing some relict kyanite in the northwestern third of the quadrangle, kyanite zones in the northeastern part and southwest corner of the quadrangle, and a kyanite-staurolite zone in the southeastern part of the quadrangle. Although the mapping of detailed isograds was beyond the scope of work for our report, several general observations of the areal distribution of mineral stability were garnered during the course of this study. The broad implication of the distribution of these minerals is that a sillimanite-muscovite zone in the western and central parts of the map area overprints a zone to the east in which kyanite and staurolite are stable. The southeast edge of the overprinting occurs very near or at the Shope Fork fault. Regional evidence suggests that rocks in the Talluluah Falls thrust sheet in the extreme eastern parts of the area are in the sillimanite zone (Nelson, 1985, p. 3).

The sillimanite-muscovite-grade metamorphism that affects the rocks of the Richard Russell Formation was accompanied locally by migmatization and metamorphic differentiation and segregation. Gneisses in this unit are to varying degrees banded and differentiated into light- and dark-colored fractions. Pods, lenses, and sills of segregated quartz, stringers of vein quartz, and irregular small bodies of quartzo-feldspathic rock and some granite were noted in many exposures.

Regional Structural Fabric and Minor Fold Sequence

Multiple folding of rocks in the southern Blue Ridge has been documented recently by many workers (Hatcher, 1976, 1978; Hatcher and Butler, 1979; Hatcher, 1980; McElhaney and McSween, 1983; Nelson, 1985; Peper and Lesure, 1987). Northeast- and southwest-plunging folds are accompanied by generally northeast-striking foliation. The major folds are generally associated with two phases of folding identifed from minor folds in outcrops and their associated axial-plane foliations (Hatcher, 1978, figs. 26–28; Nelson, 1985, figs. 3–9; Peper and Lesure, 1987, fig. 2; Peper and Moore, 1988 , figs. 3 and 4). The foliation during the second fold phase is variably developed (Nelson, 1985, p. 8). There is also direct evidence for two phases of northeast-trending folds at map scale in the Southern Nantahala Wilderness, described below. These earlier folds are locally cross-folded by groups of map-scale folds that

Figure 4. Minor F_2 fold exposed in roadcut 1,000 ft south of Boyd Chapel Cemetery and north of Hightower Creek, northeastern Macedonia quadrangle. View is looking about S. 50° W. F_2 synform plunges about 10° N. 40° E, toward observer. S_2 foliation dips 40° to right (about N. 45° E, 40° NW). Note isoclinal flow-folding of layers in hinge area of fold and extreme attenuation of layering on fold limbs.

trend northwest or northeast. Associated minor folds have crenulation cleavage or locally biotite schistosity as axial planes.

As in the Overflow (Nelson and Koeppen, 1983), Rabun Bald (Peper and Moore, 1988), and Anna Ruby (Peper and Lesure, 1987) Roadless Areas (fig. 1) studied recently, Nelson's scheme of fold designation is used here. In this scheme an early phase of isoclinal folding, F_1, was accompanied by pervasive axial-plane foliation, S_1. Later major folding, F_2, was accompanied by some development of foliation S_2 (fig. 4). F_1 and F_2 are mostly coaxial over the region but diverge sharply in some areas, and the S_1 and more weakly developed S_2 foliation are mostly near-coplanar. The younger cross-folds studied areally by Nelson (1985, p. 8) seemed to him to form a conjugate set of northwest- and northeast-trending folds. Axes of these were designated F_3, and associated axial-plane crenulation cleavage (and some biotite schistocity) were designated S_3.

Northwest-trending F_3 minor folds are readily distinguishable because their associated cleavage S_3 crosses S_1 at high angle; but this is not necessarily the case with northeast-trending F_3 minor folds. Nelson noted a few F_3 minor folds that plunged northeast in the northernmost area west of the Shope Fork fault (Nelson, 1985, fig. 12, Area V, and text p. 14). These plunge close to the B axis of S_1. The B axis is a theoretical fold axis that is determined statistically from the distribution of S_1 on a stereo net, that assumes concentric folding, and that should correspond more or less closely with real fold axes depending on such factors as degree of similarity of fold shape, local orientation, and operator variation in determination of fit. In local detail we noted an overwhelming abundance of northwest-trending minor F_3 folds in the map area. It is also possible that we might have mistaken some F_3 folds for F_1 folds where the two are more nearly coaxial and S_1 and S_3 more nearly coplanar. Where the northwest-trending F_3 folds are intensely developed and cross the F_1-F_2 folds at high angles, the mapped geologic units are variably offset across the trend of their northeast strike. In other areas, such as Buzzard Knob, for example, the continuity of individual

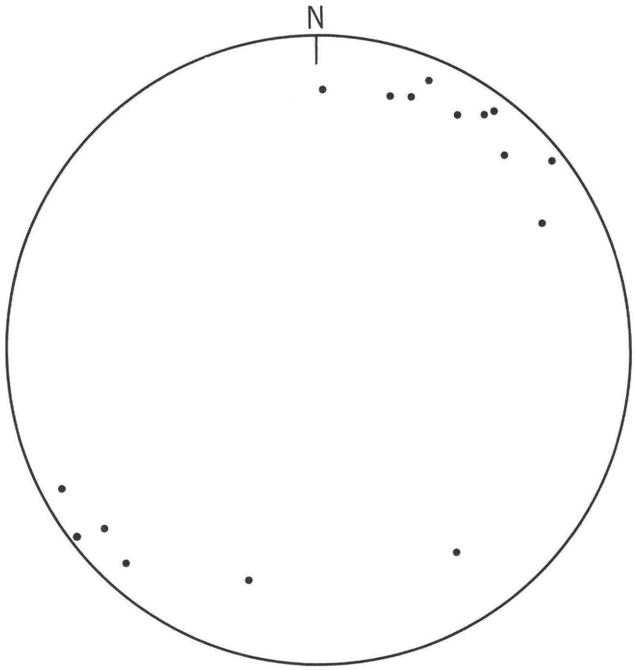


Figure 5. Lower-hemisphere equal-area stereographic projection of F_1 and F_2 fold axes measured in the Southern Nantahala Wilderness and adjacent roadless areas.

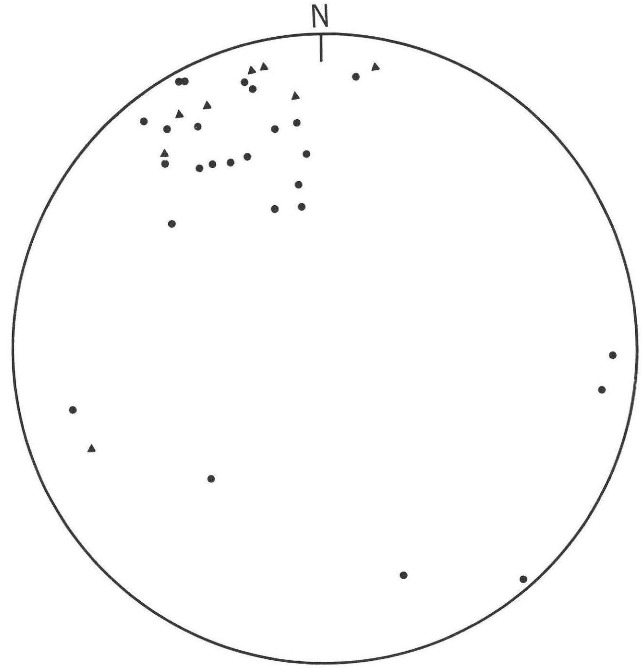


Figure 6. Lower-hemisphere equal-area stereographic projection of F_3 fold axes (circles) and mineral lineations (triangles) measured in the Southern Nantahala Wilderness and adjacent roadless areas.

units breaks down and the units appear in a series of heartshaped or trident patterns.

Although Nelson's scheme is used here, other workers using similar schemes have found as many as five fold phases locally in nearby areas (Hatcher, 1976; McClellan and Hatcher, 1987). In an area as intensely deformed as the southern Blue Ridge, it is to be expected that ongoing studies will continue to add to our interpretations and knowledge of the complexity of orogenic events.

The axes of early minor F_1-F_2 folds (axes not distinguished from one another by symbol) are both shown as small arrows on the geologic map (pl. 1). Their axial orientations are summarized in figure 5. They tend to plunge at low angles to the north-northeast and south-southwest, subparallel to the trend of regional foliation. The axes of later F_3 minor folds are shown on the geologic map as larger arrows, and their axial orientations are summarized in figure 6. Most plunge moderately to steeply to the north-northwest, though a few plunge to the southeast. The various mineral lineations (fig. 6) measured in outcrops plunge to the northwest. These consist of a variety of features that include quartz and feldspar rods; elongate patches of biotite, sillimanite, and hornblende prism long-axes; and mica crenulation. Some of the composite lineations can be seen to be the intersection of S_1 and S_3 in many individual outcrops.

Major Folds and Cross-folds

Fold axes on the geologic map (pl. 1) and in figure 7 outline the major fold axes of F_1 and F_2 folds in and near the Southern Nantahala Wilderness. The axis of the Coweeta syncline was outlined by the distribution of units in the Coweeta Group (Hatcher, 1979b). To the west, offsets and warps in the trace of the Shope Fork fault are crossed by an unnamed syncline west of Dicks Knob; by an unnamed anticline, overturned to the west, east of Cedar Cliff Knob; and by the Buzzard Knob anticline, through Buzzard Knob. Farther to the west the distribution of lithologies in the Richard Russell Formation discontinuously outlines a series of interpreted folds whose general form can be worked out from the shapes of the lithologic patterns and the accompanying plunge of associated minor folds. These provide an interpretative stratigraphy in the Richard Russell Formation. Otherwise, due to extreme deformation, sound facing criteria such as cross-bedding or graded bedding are absent from the area. The axis of the Bly Gap synform is interpreted to be an extension of the Gulf Fork synform, because both are marked by a belt of schist (pl. 1, unit Zrs). Both are considered overturned F_1 folds. The axial plane does not appear in rocks below the Shope Fork fault in the northern part of the map. The synformal nature of the fold pair is evidenced by the northwestward plunge of F_1 axes in the area north of Coleman Gap. The position of the Bly Gap

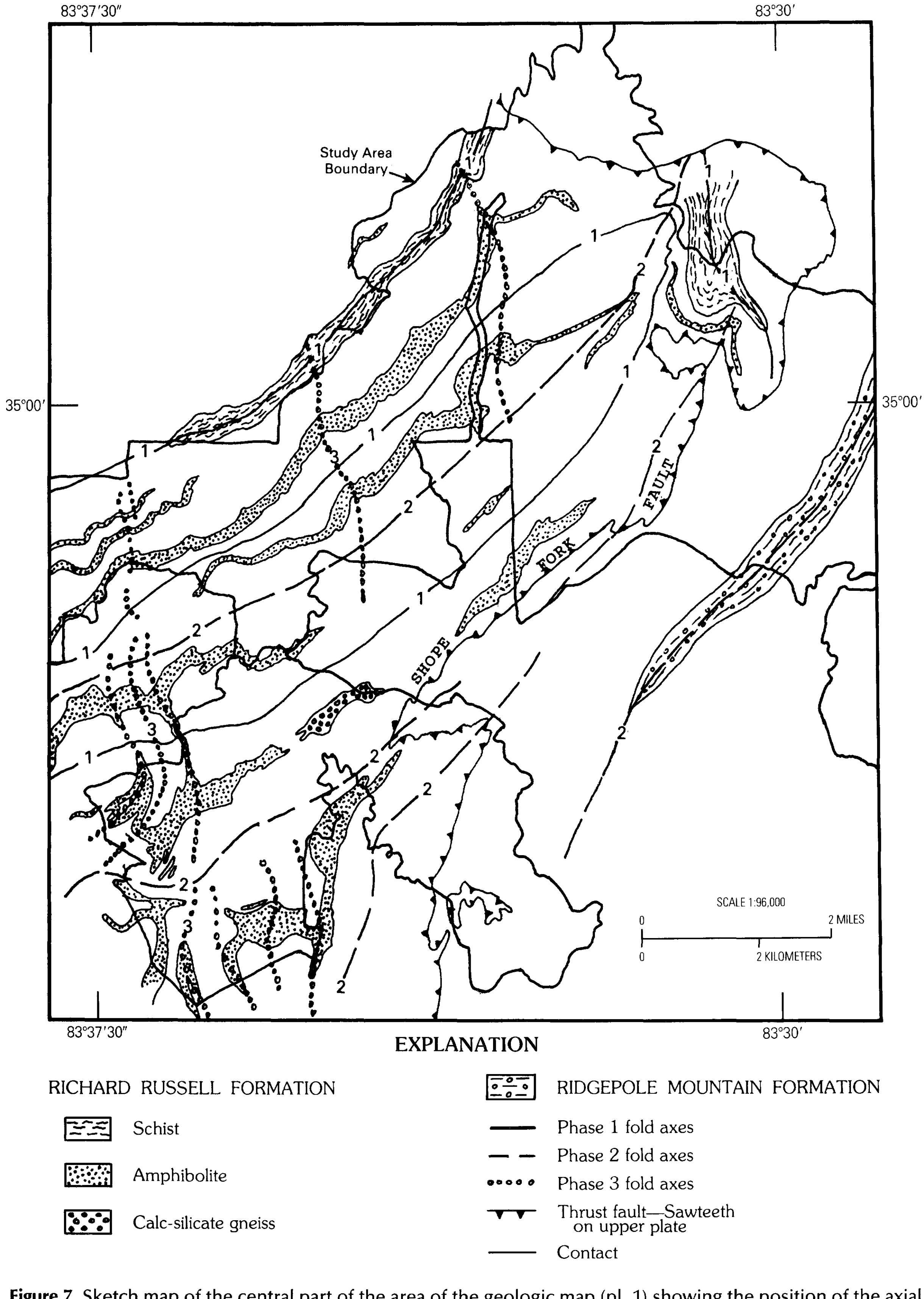


Figure 7. Sketch map of the central part of the area of the geologic map (pl. 1) showing the position of the axial traces of major folds and cross-folds relative to the outcrop patterns of major rock units. See text discussion.

synform axis is inferred to lie between lenses of amphibolite (pl. 1, unit Zra) in the western part of the map area. The axis of the Bly Gap synform, an F_1 axis, is folded by the Beech Gap syncline and the F_2 fold, which folds the Shope Fork fault. The trace of the Smiths Bridge-Diggens Knob antiform, also an F_1 fold, is outlined by discontinuous lenses of amphibolite and calc-silicate gneiss. The antiformal shape of this fold is evidenced southwest of As Knob, where the lenses of amphibolite on either side of the F_1 fold axis approach and retreat from one another in a series of salients and recesses produced by F_3 cross-folding (fig. 7). This same discontinuous lens of amphibolite is repeated to the southeast across the Buzzard Knob anticline. Both discontinuous lenses are repeated to the northwest across the axis of the Beech Gap syncline, considered here an F_2 fold of the style and scale of the Coweeta syncline.

Both the overall tight F_1 isoclinal folding of the Richard Russell rocks inferred here and the apparent termination of the axis of the Gulf Fork-Bly Gap synform across the Shope Fork fault generally suggest that the tight F_1 folding of these rocks preceded movement on the Shope Fork fault and probably even preceded deposition of the Coweeta Group rocks. This is a topic for further regional study and evaluation.

Narrow-wavelength F_3 cross-folds accompanied by associated minor folds are abundant in the Buzzard Knob Roadless Area and locally in areas to the north and west, where they offset the general northeast trend of mapped rock units. The axes of these folds are shown in figure 7.

Shope Fork Fault

The Shope Fork fault was first recognized by Hatcher (1980). (See also earlier Shope Branch fault (Hatcher, 1976, p. 22, fig. 2).) The sinuous trace of the fault along Shope Fork and its broader map distribution in the Prentiss quadrangle clearly identify it as a folded but broadly near-horizontal fault that is parallel to regional foliation and compositional layering in surface exposures. As described above, it is probably a post-F_1, pre-F_2 fault. It may be a back-folded, premetamorphic, tectonic slide (Hatcher, 1979b), a surface along which the younger Coweeta Group rocks moved generally eastward off older rocks to the west.

In the northernmost part of the area of the geologic map, the fault trace forms an elongate C shape (fig. 2 and pl. 1), so that a westward-projecting salient of Coweeta Group rocks pokes through Richard Russell rocks at the north end of the Southern Nantahala Wilderness. Farther south, west of Coleman Gap, another block of younger rocks protrudes upward through gneisses of the Richard Russell Formation. In this northern part of the area of the geologic map, the fault was never seen in outcrop. The position of the fault was identified more or less closely, however, by the strong contrast in lithology between the higher grade, coarser grained, and more migmatized biotite gneiss, thick amphibolites, and rusty sillimanite schists in the Richard Russell rocks, and the more quartz-rich, finer grained gray schists and quartzites, fine-grained gray-green calc-silicates, and pinstriped schists of the Coweeta Group. The fault trace was located between outcrops of these contrasting rock types. These contrasts between the two formations, however, become less distinct progressively southward along the fault, possibly due to generally finer recrystallization of the Richard Russell rocks in the Buzzard Knob Roadless Area.

In the absence of sharp lithologic contrasts, placement of the fault trace becomes progressively more problematical southward; the position of the fault should be considered only probable in the area around Cedar Cliff Knob and in the window southeast of the knob.

South of the Buzzard Knob Roadless Area the Shope Fork fault probably intersects or is cut off by the Hayesville(?) fault. It is not present at the latitude of the Anna Ruby Roadless Area (Peper and Lesure, 1987) where migmatized, sillimanite-grade, biotite gneiss and granite of the Richard Russell Formation are juxtaposed opposite Robertstown Formation schists of the Helen belt across the Hayesville(?) fault.

River Mountain-Mill Creek Shear Zone

The River Mountain-Mill Creek shear zone postdates the regional metamorphic peak and records ductile shearing along a close-spaced cleavage that was developed along a northeast-trending segment of the Shope Fork fault north of the Buzzard Knob Roadless Area and in the south-central part of the Southern Nantahala Wilderness. The zone is about 400 m wide along the unnamed road south of River Mountain and about 150 m wide where the cleavage planes are closely spaced in Mill Creek. Many features of deformation in the zone are shown in an exposure on the west side of Mill Creek (fig. 8), where the regularly spaced cleavage S_3 has been locally rotated into a steep southeast dip. These features, numbered on figure 8, include (1) a near-regular spacing of S_3 planes of cleavage about 3–6 cm apart, into which feldspathic gneiss has been dragged and made schistose; (2) veins of feldspar-quartz (ruled pattern) that have been cross-fractured or aligned; and (3) crenulation and displacement of veins along cleavage, with axes of the crenulations plunging at angles of 10° or less to the northeast and southwest. Thick elongate blocks of (4) metasandstone (stippled pattern) with S_1 foliation parallel to mineral layering "float" in (5) schistose biotite gneiss. Small later (6) cross-faults locally offset the spaced S_3 cleavage and the aligned veins of feldspar and quartz for distances of a foot or less.

The general northeast orientation of the shear zone, as well as its characteristic S_3 cleavage, suggests that it

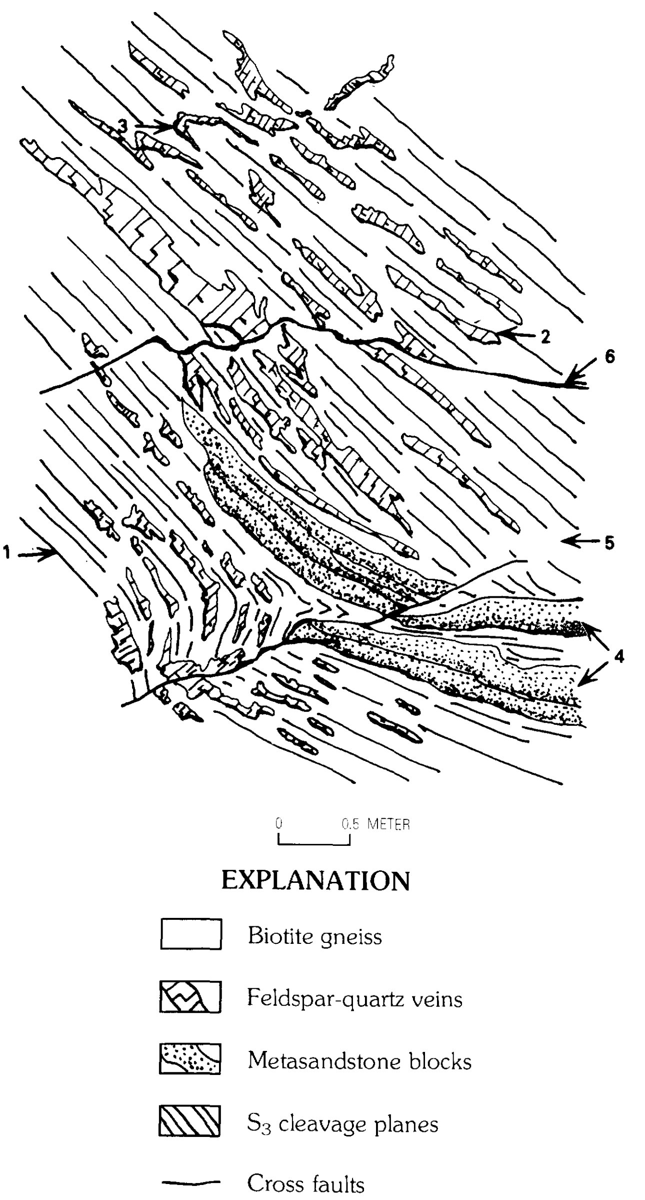


Figure 8. Features in the River Mountain-Mill Creek shear zone. Sketch from an outcrop on the northeast side of Mill Creek at 2,560 ft altitude. View looking N. 45° E. Numbers refer to elements discussed in text.

probably formed along lines of weakness engendered during earlier Shope Fork bedding-plane faulting and that it was rotated into a steep dip by regional folding. The zone was probably reactivated here as a complementary shear-set to the northwest-plunging F_3 folds and associated cleavage, probably in response to east-west compression that occurred distinctly after the thermal peak of metamorphism.

Chunky Gal Mountain Fault

The Chunky Gal Mountain fault, a regional thrust fault within the Richard Russell Formation in the western part of the Southern Nantahala Wilderness, is shown in the position depicted by Nelson and others (1987). The fault was first described by Hatcher and Butler (1979, p. 68–69), who noted the fault and associated zone of mylonite that is 12 m wide in a cut along U.S. Highway 64 about 3 mi north of the area of the geologic map. The fault was extended through the general area to the south on the basis of a sharp change in orientation of S_1 foliation, which is of very gentle westerly dip west of the fault in the study area. In an outcrop just north of the fault, east of Egypt Gap, S_1 foliation strikes N.80° E. and dips 3° to the northwest. The fault surface was not seen in the field in the map area, and the sense and amount of displacement on the fault deserves further regional evaluation. The apparent offset of the lens of amphibolite, (pl. 1, unit Zra) is based on the distribution of lithology and structural attitudes across the fault in the western part of the study area. These offsets suggest post-S_1 movements of a kilometer or less along the fault surface.

GEOCHEMISTRY

Sampling Procedures

Most of the small drainage basins in the study areas were sampled by collecting at random a few handfuls of the finest sediment available at the sample site in the stream (pl. 2A). After being dried in the laboratory, the samples were sieved, and the minus 80-mesh (0.007 in., or 0.177 mm) fraction was pulverized to minus 140-mesh (0.004 in., or 0.105 mm) for analysis. In addition to the fine-grained stream-sediment samples, panned heavy-mineral concentrates were made at most sample sites (pl. 2A). The panned concentrates were further separated into a light and a heavy fraction by using bromoform with a specific gravity of 2.85. The light fraction was discarded. Magnetite was removed from the heavy fraction by use of a hand-held magnet and was not analyzed.

The rock samples (pl. 2B) generally consist of a few chips taken across bedding or layering over a measured thickness. The samples are representative of the major rock types exposed in the area. Most of the rock is partly weathered, but the freshest material available was generally sampled. Rock samples were crushed to approximately 0.25 in. (6 mm) and pulverized to minus 140-mesh (0.004 in., or 0.105 mm) in a vertical grinder with ceramic plates.

The soil samples (pl. 2C) are grab samples from the A_2 or upper B soil zone, just below the dark, organic-rich surface soil (A_1 zone). Soils were dried, sieved to minus 80-mesh (0.007 in., or 0.177 mm), and then pulverized to minus 140-mesh (0.004 in., or 0.105 mm).

Analytical Techniques

Each sample was analyzed semiquantitatively for 31 elements by means of a six-step, D.C. (direct-current) arc, optical-emission spectrographic method (Grimes and Marranzino, 1968) in the U.S. Geological Survey laboratories, Denver, Colo. In addition, most of the samples were analyzed for zinc by an atomic-absorption technique (Ward and others, 1969, p. 20), and the panned-concentrate samples and selected rock samples were analyzed for gold by atomic-absorption methods (Thompson and others, 1968). The semiquantitative spectrographic values are reported as six steps per order of magnitude (1, 0.7, 0.5, 0.3, 0.2, and 0.15 or multiples of 10 of these numbers). They are the approximate midpoints of geometric brackets whose boundaries are 1.2, 0.83, 0.56, 0.38, 0.26, 0.18, 0.12, etc. The expected precision is within one adjoining reporting interval on each side of the reported value 83 percent of the time. It is within two adjoining intervals 96 percent of the time (Motooka and Grimes, 1976). References to the complete analytical data are given in table 1.

Discussion

The analytical data do not outline any areas of potential metallic mineral resources in the study areas. Median values (table 2) for most elements in the various rock types compare closely with data from similar rocks from nearby areas and also with data for average rocks. In the different sample types, the distribution of six elements commonly associated with massive sulfide and other stratabound deposits (B, Ba, Co, Cu, Pb, and Zn) (Slack, 1982; Hutchinson, 1983, p. 34) does not indicate anomalous amounts that might suggest the presence of massive sulfide deposits near the surface in the study areas (pl. 2D). Gold, present in minor amounts in adjacent areas, was detected in two panned-concentrate samples (Sample GA04–005C, 1.7 ppm and Sample GA04–007C, 0.4 ppm).

Boron

The boron content of the rock samples is below or about average for the various rock types (table 2). The panned-concentrate samples contain a little more than the stream-sediment samples, probably present in the mineral tourmaline or, less likely, in garnet or hornblende. Tourmaline is resistant to weathering and is concentrated in the heavy-mineral fraction by panning. Tourmaline, which was not recognized in the panned-concentrate samples, is not abundant in the rocks of the area.

Barium

The barium content in the rock samples of the study area appears normal and is in the range of barium contents in samples from other areas of metamorphic rocks studied previously (table 2). The median barium value for soil samples is lower than that for soils from Craggy Mountain and Shining Rock but greater than that from Anna Ruby and Rabun Bald (table 2). The median for stream sediments is lower than all other areas studied except Rabun Bald.

Cobalt, Copper, Lead, and Zinc

The metals cobalt, copper, lead, and zinc are commonly associated with massive sulfide deposits. These metals are present in normal concentrations in samples from the study areas (table 2 and pl. 2D). Many of the rocks contain meager amounts of disseminated iron sulfide minerals, but there is no concomitant increase in cobalt, copper, lead, or zinc in these sulfide-bearing rocks. The median value for cobalt in gneiss and schist is the same as or less than the median for cobalt in similar rocks in the other areas; compared to the other areas, the median for cobalt in stream sediments is slightly lower and the median for soils is slightly higher (table 2). The other metals have similar comparisons. The few samples with higher-than-background amounts of these metals are scattered throughout the study areas and do not appear to outline mineralized areas.

Tin

Tin was found in amounts ranging from 10 to 300 ppm in 5 out of 12 calc-silicate granofels samples, 2 out of 28 amphibolite samples, 1 out of 89 schist samples, 1 out of 171 stream sediment samples, and 8 out of 139 panned-concentrate samples (pl. 2E and table 3). Similar scattered occurrences of tin were noted in Ellicot Rock (Luce and others, 1985) and Rabun Bald (Moore and others, 1988). The tin-bearing samples do not appear to outline any area that might have a potential for tin resources. The occurrence of tin in the calc-silicate granofels is unusual scientifically, but does not appear to have any economic importance.

MINERAL RESOURCE ASSESSMENT

Stone

Stone suitable for use as rough building stone and crushed rock is the only identified mineral resource in the Southern Nantahala Wilderness and the Southern Nantahala and Buzzard Knob Roadless Areas. Several stone quarries (table 4 and pl. 2C) along or near major roads have supplied local road-building needs. Similar stone is abundant throughout the Richard Russell, Helen, and Tallulah Falls thrust sheets in surrounding areas where it is more readily available. Stream courses are steep and narrow and the potential for sizable quantities of stream gravel and sand is low.

A quarry on Bell Mountain 2 mi southwest of the western edge of the wilderness has supplied quartz aggregate for cast-concrete facing panels and other uses. This quarry is in an unusually large lens of nearly pure quartz 1,600 ft long and several hundred feet thick. No other quartz mass of such size is exposed in the study areas. The numerous quartz veins present are commonly 1–10 ft thick and generally no more than 10–100 ft long.

Other Nonmetallic Commodities

Other nonmetallic resources present in or adjacent to the study areas include asbestos, corundum, feldspar, sheet mica, olivine, and vermiculite. The known deposits are small and have little economic potential.

Asbestos

Small amounts of anthophyllite asbestos and even lesser amounts of chrysotile asbestos occur in the altered borders of ultramafic rocks in or near the Southern Nantahala Roadless Area. The only deposits prospected are outside the roadless area just north and south of Betty Creek (King, 1894, p. 86; Hopkins, 1914, p. 147–148; Teague, 1956, p. 6–7). One dunite body within the roadless area is reported to have some asbestos associated with it (Hopkins, 1914, p. 148), but the only ultramafic body found where the dunite was reported is thoroughly altered to soapstone and asbestos minerals (prospect no. 26, table 4 and pl. 2C). The ultramafic bodies in Buzzard Knob Roadless Area and Southern Nantahala Wilderness are metaperidotites and soapstone of variable mineral content, but these contain little anthophyllite. The small deposits of anthophyllite asbestos in the Blue Ridge area were last worked at least 30 years ago (French and Stansfield, 1968, p. 270), long before the demand for asbestos was lowered because of environmental problems. There is, however, moderate potential for additional small asbestos deposits in the study area.

Corundum

Corundum occurs as small disseminated crystals in a layer of biotite-garnet schist on the south and east sides of Big Scaly in the northern part of Southern Nantahala Wilderness (Pratt and Lewis, 1905, p. 242; Keith, 1907, p. 9.; Hannigan, 1986, p. 8–9) (prospect no. 30, table 4 and pl. 2C). The relatively inaccessible deposit has been prospected in a cut 200 ft long and 50 ft wide, but the reported grade is low—less than 5 percent (Pratt and Lewis, 1905, p. 242) and probably about 1 percent (Hannigan, 1986, p. 9). Corundum is also found in alteration zones in or around some of the ultramafic rocks in nearby areas (Pratt and Lewis, 1905, p. 239–242; King, 1894, p. 77-92). Since the introduction of artificial abrasives about 1900, little corundum has been mined in the United States and none in the Georgia-North Carolina area since 1906 (Thaden, 1973, p. 30). There is moderate potential for additional corundum resource associated with the scattered ultramafic deposits in the three areas. The corundum in the mica schist in the wilderness is apparently too low grade for mining but represents a low-grade resource.

Feldspar and Sheet Mica

Granite pegmatite, in small feldspar and sheet mica lenses and irregular bodies a few feet thick and 100 ft long or more, is scattered throughout the three areas. Quartz, feldspar, and muscovite or biotite are the principal minerals. In sheets greater than a square inch, muscovite has use as sheet mica, and feldspar has use in ceramics and glass. The deposits are too small and too inaccessible for consideration as feldspar resources, but at least four deposits were prospected for sheet mica in the Southern Nantahala Wilderness.

The Big Four or Rough Cove prospect (prospect no. 32, table 4 and pl. 2C), half a mile southeast of Standing Indian lookout tower, consists of at least six small open cuts that expose a pegmatite more than 6 ft thick and more than 50 ft long (Lesure, 1968, p. 120–121). Production during World War II was reported to be 110 lb of sheet mica (Lesure, 1968, Colonial Mica Corporation Files, unpub. data). A second prospect 1 mi north of the lookout tower and a third a mile north of Patterson Gap expose similar pegmatites (Hannigan, 1986, p. 9). These three prospects are at the southwest edge of the Franklin-Sylva pegmatite district, where sheet-mica mining stopped in 1962 with the end of the Government buying program (Lesure, 1968, p. 25–27). The northern and western parts of the wilderness have moderate potential for additional deposits of sheet mica like those prospected. The two roadless areas have low potential for such deposits.

Olivine

Ultramafic rocks in the study areas are mostly metaperidotites or soapstones, but one mass on the northwest slopes of Scaly Knob in the Southern Nantahala Roadless Area is reported to be dunite and only partly altered to anthophyllite, chlorite, and talc (Hopkins, 1914, p. 147–148). Dunite, which is composed mostly of olivine, is mined today for use as a refractory. No dunite was found in the area in the course of our field work, but a large mass of soapstone similar in size to the reported dunite was found in the area where the dunite was reported. Because all the ultramafic bodies found in the study areas are small and thoroughly altered, the potential for olivine resources is low. Likewise the potential for use as soapstone or as a source of talc is limited by the small size and abundant impurities. Resource potential for soapstone or talc is therefore low.

Vermiculite

Vermiculite, which is used as a lightweight aggregate, occurs in altered zones in ultramafic rocks in the Blue Ridge (Bush, 1973, p. 349). One small deposit situated high in Lemons Gap in the western part of the Southern Nantahala Wilderness (prospect no. 7, table 4 and pl. 2C), has been prospected but not developed (Prindle, 1935, p. 45). According to Prindle, vermiculite occurs in an altered zone 80 ft wide and at least 300 ft long. Further prospecting is needed to determine the quantity and quality of the material. The general inaccessibility of much of the three areas limits the economic potential of small deposits of such low-value material.

Potential for Oil and Gas

Recent seismic studies indicate that the Blue Ridge of Georgia contains a thick sequence of younger sedimentary rocks beneath the metamorphosed rocks exposed at the surface (Cook and others, 1979). This inverted rock sequence is the result of the older metamorphic rocks thrusting westward at least 100 mi over the younger rocks, which have unknown potential for oil and gas (Harris and others, 1981, p. 2504). Speculation on the thermal history of the sedimentary rocks below the thrust fault suggests that only gas might be present in areas along the western Blue Ridge west of the study area and that even gas may have been degraded in the central and eastern Blue Ridge in the vicinity of the study areas (Hatcher, 1982, p. 980). Further seismic work and deep exploratory drilling are needed to evaluate the oil and gas potential of the buried sedimentary sequence.

Potential for Gold and Other Metals

Southwest of the study areas the Helen thrust sheet contains rocks of the Dahlonega gold belt. Mines in the gold belt in Lumpkin and White Counties have been the principal producers of gold in northeastern Georgia (Yeates and others, 1896). Very little gold, however, has been produced from the few mines and prospects in the Helen thrust sheet northeast of White County, and the narrow part of the thrust sheet that extends through the eastern part of the Southern Nantahala Roadless Area contains no gold prospects. The nearest gold occurrence is the Moore Girls prospect (no. 25, table 4 and pl. 2C), which is 1 mi southwest of the roadless area. Panned-concentrate samples from streams draining rocks of the Helen thrust sheet in the roadless area contain no visible gold. The potential for gold deposits in the roadless area is probably low.

The Southern Nantahala Wilderness and the Buzzard Knob Roadless Area lie just west of the Dahlonega gold belt but are separated from the rocks of the gold belt by the Hayesville(?) fault. Rocks of the gold belt may lie beneath the fault below these areas but do not offer targets for gold exploration because of the small size and scattered distribution of known deposits in the exposed part of the gold belt to the southwest. Rocks of the Richard Russell thrust sheet also contain traces of gold locally, and a few placer deposits west of the Buzzard Knob Roadless Area have yielded a few hundred ounces of gold (Yeates and others, 1896, p. 108–112). The known deposits are listed in table 4 and their localities are shown on plate 2C. Gold was detected in only two panned-concentrate samples from the study areas and in no stream-sediment, soil, or rock sample. The potential for gold deposits in the two study areas is believed to be low.

Total recorded production of gold from all of Rabun County for the period 1881–1905 as reported by the Director of the U.S. Mint (U.S. Bureau of the Mint, 1882–83 and 1884–1906) is about 1,730 troy oz, and from Towns County for the period 1882–99, 568 troy oz. Little or no gold has probably been produced in either county since 1905. The most productive prospects have been small placer operations on a few short tributaries of the major streams. The small streams in the wilderness and the roadless areas have limited flood plains and small amounts of sand and gravel. The potential for additional placer deposits of gold is therefore low.

Two copper prospects are located inside the boundaries of the study areas (prospects no. 14 and 20, table 4, and pl. 2C). The Rich Knob copper prospect (no. 20), which is small and low grade (Shearer and Hull, 1918, p. 209–210), was not found during our field work. Only secondary copper minerals are present and no iron or copper sulfide minerals were found, according to Shearer and Hull (1918, p. 210). Stream-sediment samples collected from drainage basins that probably contain the prospect area have less than 20 ppm copper, which is normal for areas having unmineralized rock types exposed (pl. 2D).

The Tom Coward prospect (no. 14, table 4, and pl. 2C) is just inside the boundary of the Buzzard Knob Roadless Area. Early exploration was done before the Civil War and again about 1888 (Shearer and Hull, 1918, p. 206). Drilling by the Tennessee Copper Co. in 1963 indicated a small body of massive and disseminated sulfide minerals in interlayered mica gneiss and amphibolite. Sulfide minerals present are mostly pyrite, pyrrhotite, and minor amounts of chalcopyrite and sphalerite(?). The mineralized zone strikes northeast, dips southeast, and plunges southwest. Rock and soil samples collected during our field work just west of the prospect contain 100 ppm copper or less, which is normal for unmineralized rock types in the area (Adrian and others, 1989b).

The presence of two copper occurrences in interlayered felsic and mafic rock types suggests that this part of the Richard Russell Formation has low to moderate potential for additional massive sulfide deposits. The lack of geochemical anomalies of elements commonly associated with massive sulfide deposits suggests that any such deposits, if present, are probably not exposed to weathering or are quite small. The other metallic elements that were looked for are present in normal concentrations for the rock types present.

REFERENCES

Adrian, B.M., D'Agostino, J.P., Roemer, T.A., and Edwards, C.A., 1989a, Analyses and descriptions of geochemical samples, western part of the Southern Nantahala Wilderness, Towns County, Georgia: U.S. Geological Survey Open-File Report 89–101, 18 p.

Adrian, B.M., Peper, J.D., Fairfield, R.J., Laudon, L.S., and Edwards, C.A., 1989b, Analyses and descriptions of geochemical samples, central part of the Southern Nantahala Wilderness, Rabun and Towns Counties, Georgia and Clay and Macon Counties, North Carolina: U.S. Geological Survey Open-File Report 89–103, 24 p.

Bush, A.L., 1973, Lightweight aggregates, *in* Brobst, D.A., and Pratt, W.P., eds., United States Mineral Resources: U.S. Geological Survey Professional Paper 820, p. 333–355.

Butler, J.R., 1972, Age of Paleozoic regional metamorphism in the Carolinas, Georgia, and Tennessee southern Appalachians: American Journal of Science, v. 272, no. 4, p. 319–333.

Chatman, M.L., 1985a, Maps showing mines, prospects, and mineral sites in the Tray Mountain Roadless Area, and vicinity, Northern Georgia: U.S. Geological Survey Miscellaneous Field Studies Map MF-1347-C, scale 1:30,000.

———1985b, Mineral resources of the Buzzard Knob RARE II study area (No. 8–223), Rabun and Towns Counties, Georgia: U.S. Bureau of Mines Open-File Report MLA 56–85, 40 p.

Coe, J.L., 1964, The formative cultures of the Carolina Piedmont: Transactions of the American Philosophical Society, v. 54, part 5, 130 p.

Cook, F.A., Albaugh, D.S., Brown, L.D., Kaufman, Sidney, Oliver, J.E., and Hatcher, R.D., Jr., 1979, Thin-skinned tectonics in the crystalline southern Appalachians—COCORP seismic-reflection profiling of the Blue Ridge and Piedmont: Geology, v. 7, no. 12, p. 563–567.

Cox, L.J., Day, G.W., Adrian, B.M., Welsch, F.P., and Kay, Debby, 1989, Analyses and descriptions of geochemical samples from the Southern Nantahala Roadless Area and vicinity in Rabun County, Georgia, and Clay and Macon Counties, North Carolina: U.S. Geological Survey Open-File Report 89–104.

Crickmay, G.W., 1952, Geology of the crystalline rocks of Georgia: Georgia Geological Survey Bulletin 58, 54 p.

Dallmeyer, R.D., 1975, 40 Ar/39 Ar age spectra of biotite from Grenville basement gneisses in northwest Georgia: Geological Society of America Bulletin 86, p. 1740–1744.

Force, E.R., 1976, Metamorphic source rocks of titanium placer deposits—a geochemical cycle: U.S. Geological Survey Professional Paper 959B, p. B2–B3.

French, A.E., and Stansfield, R.G., 1968, Asbestos, *in* Mineral Resources of the Appalachian Region: U.S. Geological Survey Professional Paper 580, p. 268–270.

Furcron, A.S., and Teague, K.H., 1943, Mica-bearing pegmatites of Georgia: Georgia Geological Survey Bulletin 48, 192 p.

———1945, Sillimanite and massive kyanite in Georgia (a preliminary report): Georgia Geological Survey Bulletin 51, 76 p.

Galpin, S.L., 1915, A preliminary report on the feldspar and mica deposits of Georgia: Georgia Geological Survey Bulletin 30, 190 p.

Georgia Department of Mines, Mining, and Geology, 1951, Mineral Resources of Union, Towns, Lumpkin, and White Counties, Georgia: Georgia Department of Mines, Mining and Geology, map, scale 1:125,000.

German, J.M., 1985, The geology of the northeastern portion of the Dahlonega Gold Belt: Georgia Geological Survey Bulletin 100, 41 p.

Gillon, K.A., 1982, Stratigraphic, structural, and metamorphic geology of portions of the Cowrock and Helen, Georgia, seven and one-half minute quadrangles: Unpublished M.S. Thesis, University of Georgia, Athens, Georgia, 236 p.

Grimes, D.J., and Marranzino, A.P., 1968, Direct-current arc and alternating-current spark emission spectrographic field methods for the semiquantitative analysis of geologic materials: U.S. Geological Survey Circular 591, 6 p.

Hadley, J.B., and Nelson, A.E., 1971, Geologic map of the Knoxville quadrangle, North Carolina and Tennessee, and South Carolina: U.S. Geological Survey Miscellaneous Investigations Map Series I-65H, scale 1:250,000.

Hannigan, B.J., 1986, Mineral investigation of the Southern Nantahala Wilderness Area, Rabun and Towns Counties, Georgia, and Clay and Macon Counties, North Carolina: U.S. Bureau of Mines Open-File Report MLA 19–86, 16 p.

Harris, L.D., 1979, Similarities between the thick-skinned Blue Ridge anticlinorium and the thin-skinned Powell Valley anticline: Geological Society of America Bulletin, v. 90, no. 6, p. 525–539.

Harris, L.D., Harris, A.G., de Witt, Wallace, Jr., and Bayer, K.C., 1981, Evaluation of southern eastern overthrust belt beneath Blue Ridge-Piedmont thrust: American Association of Petroleum Geologists Bulletin, v. 65, no. 12, p. 2497–2505.

Hatcher, R.D., Jr., 1971, The geology of Rabun and Habersham Counties, Georgia: Georgia Geological Survey Bulletin 83, 48 p.

———1972, Developmental model for the southern Appalachians: Geological Society of America Bulletin, v. 83, no. 9, p. 2735–2760.

———1974, Introduction to the tectonic history of northeastern Georgia: Georgia Geological Survey Guidebook 13-A, p. 59–60.

———1976, Introduction to the geology of the Eastern Blue Ridge of the Carolinas and nearby Georgia: Carolina Geological Society Guidebook, Oct. 23–24, 1976, 53 p.

———1978, Structural style of the Blue Ridge: Geological Society of America Penrose Research Conference Field Trip, Guidebook, May 12–13, 1978, 17 p.

———1979a, Structural styles of the Cumberland Plateau, Valley and Ridge, and Blue Ridge: Tennessee Division of Geology Report of Investigations No. 37, p. 5–23.

———1979b, The Coweeta Group and Coweeta syncline—Major features of the North Carolina-Georgia Blue Ridge: Southeastern Geology, v. 21, no. 1, p. 17–29.

———1980, Geologic map of the Prentiss quadrangle, North Carolina: North Carolina Department of Natural Resources and Community Development, Geologic Map GM 167-SW, scale 1:24,000.

———1982, Hydrocarbon resources of the eastern overthrust belt—a realistic evaluation: Science, v. 216, p. 980–982.

Hatcher, R.D., Jr., and Butler, J.R., compilers, 1979, Guidebook for Southern Appalachian field trip in the Carolinas, Tennessee, and northeastern Georgia: Project 27, Caledonide Orogen, IGCP, IUGS, and UNESCO International Geological Correlation Program.

Hopkins, O.B., 1914, Asbestos, talc, and soapstone deposits of Georgia: Georgia Geological Survey Bulletin 29, 319 p.

Hopkins, R.T., Erickson, M.S., Lesure, F.G., Pokorny, M.A., Roemer, T.A., and Edwards, C.A., 1989, Analyses and descriptions of geochemical samples, Buzzard Knob Roadless Area, Rabun and Towns Counties, Georgia: U.S. Geological Survey Open-File Report 89–109, 16 p.

Hunter, C.E., 1941, Fosterite olivine deposits of North Carolina and Georgia: Georgia Geological Survey Bulletin 47, 117 p.

Hunter, C.E., and Mattocks, P.W., 1936, Vermiculites of western North Carolina and north Georgia: Tennessee Valley Authority, Division of Geology Bulletin 5, p. 1–10.

Hurst, V.J., 1973, Geology of the southern Blue Ridge belt: American Journal of Science, v. 273, no. 8, p. 643–670.

Hurst, V.J., and Horton, G.R., 1964, The Bell Mountain silica deposit, Towns County, Georgia: U.S. Department of Commerce, Area Redevelopment Administration Final Report Contract Cc-6094, pt. 1, Geology, 40 p.

Hutchison, C.S., 1983, Economic deposits and their tectonic setting: John Wiley and Sons, New York, 365 p.

Jones, S.P., 1909, Second report on the gold deposits of Georgia: Georgia Geological Survey Bulletin 19, 283 p.

Keith, Arthur, 1907, Description of the Nantahala quadrangle [North Carolina-Tennessee]: U.S. Geological Survey Geologic Atlas, Folio 143, 11 p.

King, F.P., 1894, A preliminary report on the corundum deposits of Georgia: Georgia Geological Survey Bulletin 2, 138 p.

Koeppen, R.P., and Nelson, A.E., in press, Geochemical survey of the Blood Mountain Roadless Area, Union and Lumpkin Counties, Georgia: U.S. Geological Survey Miscellaneous Field Studies Map MF-1503-B, scale 1:30,000.

———in press, Geochemical survey of the Chattahoochee Roadless Area, Towns, Union, and White Counties, Georgia: U.S. Geological Survey Miscellaneous Field Studies Map MF-1502-B, scale 1:30,000.

———in press, Geochemical survey of the Overflow Roadless Area, Rabun County, Georgia, and Macon County, North Carolina: U.S. Geological Survey Miscellaneous Field Studies Map MF-1618-C, scale 1:48,000.

———1988, Geochemical survey of the Tray Mountain Roadless Area, Rabun, Habersham, Towns, and White Counties, Georgia: U.S. Geological Survey Miscellaneous Field Studies Map MF-1347-B, scale 1:30,000.

Lesure, F.G., 1968, Mica deposits of the Blue Ridge in North Carolina: U.S. Geological Survey Professional Paper 577, 124 p.

———1981, Geochemical survey of the Shining Rock Wilderness, Haywood County, North Carolina: U.S. Geological Survey Miscellaneous Field Studies Map MF-1290-B, scale 1:48,000.

Lesure, F.G., D'Agostino, J.P., and Peper, J.D., 1987, Geochemical survey and mineral resource assessment of the Anna Ruby Roadless Area, White County, Georgia: U.S. Geological Survey Miscellaneous Field Studies Map MF-1908-B, scale 1:48,000.

Lesure, F.G., Feitler, S.A., and Stansfield, R.G., 1968, Feldspar, *in* Mineral resources of the Appalachian Region: U.S. Geological Survey Professional Paper 580, p. 277–280.

Lesure, F.G., Grosz, A.E., Williams, B.B., and Gazdik, G.C., 1982, Mineral resources of the Craggy Mountain Wilderness Study Area and extension, Buncombe County, North Carolina: U.S. Geological Survey Bulletin 1515, 27 p.

Lesure, F.G., and Shirley, L.E., 1968, Mica, *in* Mineral resources of the Appalachian Region: U.S. Geological Survey Professional Paper 580, p. 311–325.

Luce, R.W., Bell, Henry, III, and Gazdik, G.C., 1985, Geochemical maps of the Ellicott Rock Wilderness and additions, South Carolina, North Carolina, and Georgia: U.S. Geological Survey Miscellaneous Field Studies Map MF-1287-A, scale 1:48,000.

McClellan, Beth, and Hatcher, R.D., Jr., 1987, Stratigraphy and structure of a portion of the Hayesville thrust sheet, NE Georgia: Geological Society of America Abstracts with proram 1987, Southeastern Section, v. 19, p. 117.

McConnell, K.I., and Abrams, C.E., 1984, Geology of the Greater Atlanta Region: Georgia Geological Survey Bulletin 96, 127 p.

McElhaney, Stuart, and McSween, H.Y., Jr., 1983, Petrology of the Chunky Gal Mountain mafic-ultramafic complex, North Carolina: Geological Society of America Bulletin, v. 94, no. 7, p. 855–874.

Misra, K.C., and Keller, F.B., 1978, Ultramafic bodies in the Southern Appalachians: American Journal of Science, v. 278, no. 4, p. 389–418.

Moore, W.J., Peper, J.D., and Jackson, J.C., 1988, Geochemical survey and mineral resource assessment of the Rabun Bald Roadless Area, Rabun County, Georgia: U.S. Geological Survey Miscellaneous Field Studies Map, MF-1946B, scale 1:48,000.

Motooka, J.M., and Grimes, D.J., 1976, Analytical precision of one-sixth order semiquantitative spectrographic analysis: U.S. Geological Survey Circular 738, 25 p.

Murdock, T.G., and Hunter, C.E., 1946, The vermiculite deposits of North Carolina: North Carolina Division Mineral Resources Bulletin 50, 44 p.

Nelson, A.E., 1982, Geologic Map of the Tray Mountain Roadless Area, Northern Georgia: U.S. Geological Survey Miscellaneous Field Studies Map MF-1347-A, scale 1:30,000.

———1985, Major tectonic features and structural elements in the northwest part of the Greenville quadrangle, Georgia and North Carolina: U.S. Geological Survey Bulletin 1643, 22 p.

Nelson, A.E., and Gillon, K.A., 1985, Stratigraphic nomenclature in the Richard Russell and Helen thrust sheets, Georgia and North Carolina, in Stratigraphic Notes, 1984: U.S. Geological Survey Bulletin 1605-A, p. A59–A62.

Nelson, A.E., Horton, J.S., Jr., and Clarke, J.W., 1987, Generalized tectonic map of the Greenville 1°x2° quadrangle Georgia, South Carolina, and North Carolina: U.S. Geological Survey Miscellaneous Field Studies Map MF-1898, scale 1:250,000.

Nelson, A.E., and Koeppen, R.P., 1983, Geologic map of the Overflow Roadless Area, Rabun County, Georgia, and Macon County, North Carolina: U.S. Geological Survey Miscellaneous Field Studies Map MF-1608-A, scale 1:48,000.

Nelson, A.E., and Zietz, Isidore, 1983, The Clingman Lineament, other aeromagnetic features and major lithotectonic units in part of the Southern Appalachian Mountains: Southeastern Geology, v. 24, no. 3, p. 147–157.

Nitze, H.B.C., and Wilkens, H.A.J., 1897, Gold mining in North Carolina and adjacent south Appalachian Regions: North Carolina Geological Survey Bulletin 10, 164 p.

Pardee, J.T., and Park, C.F., Jr., 1948, Gold deposits of the southern Piedmont: U.S. Geological Survey Professional Paper 213, 156 p.

Peper, J.D., and Lesure, F.G., 1987, Bedrock Geologic Map of the Anna Ruby Roadless Area, White County, Georgia: U.S. Geological Survey Miscellaneous Field Studies Map MF-1908-A, scale 1:24,000.

Peper, J.D., and Moore, W.J., 1988, Geologic Map of the Rabun Bald Roadless Area, Chattahoochee National Forest, Rabun County, Georgia: U.S. Geological Survey Miscellaneous Field Studies Map MF-1946-A, scale 1:48,000.

Pettijohn, F.J., 1963, Chemical composition of sandstones, excluding carbonate and volcanic sands, chap. 5 of Fleischer, Michael, ed., Data of geochemistry, 6th ed.: U.S. Geological Survey Professional Paper 440-S, p. S1–S21.

Pratt, J.H., and Lewis, J.V., 1905, Corundum and the peridotites of western North Carolina: North Carolina Geological Survey, v. 1, 464 p.

Prindle, L.M., 1935, Kyanite and vermiculite deposits of Georgia: Georgia Geological Survey Bulletin 46, 50 p.

Shearer, H.K., and Hull, J.P.D., 1918, A preliminary report on a part of the pyrites deposits of Georgia: Geological Survey of Georgia Bulletin 33, 229 p.

Slack, J.F., 1982, Tourmaline in Appalachian-Caledonian massive sulfide deposits and its exploration significance: Institute of Mining and Metallurgy Transactions, v. 91, sec. B, p. B81–B89.

South, S.A., 1976, Indians in North Carolina: North Carolina Department of Cultural Resources, Division of Archives and History, 69 p.

Sterrett, D.B., 1923, Mica deposits of the United States: U.S. Geological Survey Bulletin 740, 342 p.

Teague, K.H., 1956, Georgia [asbestos] occurrences described: Georgia Mineral Newsletter, v. IV, no. 1, p. 4–7.

Teague, K.H., and Furcron, A.S., 1948, Geology and mineral resources of Rabun and Habersham Counties, Georgia: Georgia Department of Mines, Mining and Geology, map, scale 1:125,000.

Thaden, R.E., 1973, Abrasives, *in* Brobst, D.A., and Pratt, W.P., eds., United States Mineral Resources: U.S. Geological Survey Professional Paper 820, p. 27–33.

Thompson, C.E., Nakagawa, H.M., and Van Sickle, G.H., 1968, Rapid analysis for gold in geologic materials, *in* Geological Survey Research, 1968: U.S. Geological Survey Professional Paper 600-B, p. B130–B132.

Turekian, K.K., 1977, Geochemical distribution of elements, *in* McGraw-Hill Encyclopedia of Science and Technology (4th ed.), v. 4: New York: McGraw-Hill Inc., p. 627–630.

U.S. Bureau of the Mint, 1882–83, Report of the Director of the Mint upon the statistics of the production of the precious metals in the United States [for the calendar years 1881–82].

———1884–1906, Report of the Director of the Mint upon the production of the precious metals in the United States [for the calendar years 1883–1905].

Ward, F.N., Nakagawa, H.M., Harms, T.F., and Van Sickle, G.H., 1969, Atomic-absorption methods of analysis useful in geochemical exploration: U.S. Geological Survey Bulletin 1289, 45 p.

Yeates, W.S., McCallie, S.W., and King, F.P., 1896, A preliminary report on a part of the gold deposits in Georgia: Georgia Geological Survey Bulletin 4-A, 542 p.

TABLES 1-4

Table 1. Summary of types and number of geochemical samples and references to analytical data for the three study areas

	Stream sediments	Panned-concentrates	Rock	Soil	References
Southern Nantahala Wilderness					
Eastern part	11	12	31	39	Cox and others, 1989
Central part	29	27	191	10	Adrian and others, 1989b
Western part	65	50	47	44	Adrian and others, 1989a
Southern Nantahala Roadless Area	36	28	12	48	Cox and others, 1989
Buzzard Knob Roadless Area	30	22	72	71	Hopkins and others, 1989
Totals	171	139	353	212	

Table 2. Range and median concentrations of 24 elements in rock, soil, panned-concentrate, and stream-sediment samples. The data from the Southern Nantahala Wilderness and Buzzard Knob and Southern Nantahala Roadless Areas and vicinity are compared with the median values for similar samples from the Anna Ruby Roadless Area, White County, Ga. (AR), Blood Mountain Roadless Area, Lumpkin and Union Counties, Ga. (BM), Chattahoochee Roadless Area, Union and White Counties, Ga. (C), Craggy Mountain Wilderness Study Area, Buncombe County, N.C. (CM), Ellicott Rock Wilderness, S.C.-N.C.-Ga. (ER), Overflow Roadless Area, Rabun County, Ga., and Macon County, N.C. (O), Rabun Bald Roadless Area, Rabun County, Ga. (RB), Shining Rock Wilderness, Haywood County, N.C. (SR), and Tray Mountain Wilderness Study Area, Habersham, Rabun, Towns, and White Counties, Ga. (TM).

[All analyses of samples from Southern Nantahala and adjacent roadless areas are by semiquantitative, optical-emission, spectrographic methods by B.M. Adrian, D.E. Detra, R.T. Hopkins and M.S. Erickson, USGS laboratories, Denver, Colo., except zinc, which is by atomic absorption by R.J. Fairfield, L.S. Laudon, and M.A. Pokorny, USGS laboratories, Denver, Colo. Spectrographic analyses are reported as six steps per order of magnitude (1, 0.7, 0.5, 0.3, 0.2, 0.15, or multiples of 10 of these numbers) and are approximate midpoints of geometric brackets whose boundaries are 1.2, 0.83, 0.56, 0.38, 0.26, 0.18, 0.12, etc. The expected precision is within one adjoining reporting interval on each side of the reported value 83 percent of the time and within two adjoining intervals 96 percent of the time (Motooka and Grimes, 1976). Detection limits for samples are shown in parentheses after element symbol; first number is for rock, soil, and stream-sediment samples, second number is for panned concentrates. Symbols used: <, amount detected is below the lower limit of determination, or was not detected at limit of detection which is number shown; >, amount is greater than number shown; —, no data. Elements looked for spectrographically but not found and their lower limits of detection in ppm are Ag (0.5; 1), As (200; 500), Au (20; 20), Bi (10; 20), Cd (20; 50), Sb (100;200), and, W (50; 100). The complete data are given in references listed in table 1.]

Mica schist									
Number of samples	Southern Nantahala and adjacent roadless areas 89			AR[1] 32	CM[2] 18	ER[3] 13	RB[4] 82	SR[5] 33	Average in shale
Element	Low	High	Median	Median	Median	Median	Median	Median	
Percent									
Ca (0.05; 0.1)	<0.05	3	0.5	0.3	0.5	0.7	0.2	0.5	2.2
Fe (0.05; 0.1)	.15	20	5	3	7	5	3	10	4.7
Mg (0.02; 0.05)	<.02	3	1	.7	1.5	1	1	2	1.5
Ti (0.002; 0.005)	.02	1	.5	.5	.5	.5	.3	.5	.46
Parts per million (ppm)									
B (10; 20)	<10	30	10	<10	<10	15	<10	10	100
Ba (20; 50)	<20	2,000	500	300	700	1,000	500	1,000	580
Be (1; 2)	<1	3	<1	1.5	1.5	2	<1	1	3
Co (5; 10)	<5	70	10	10	20	15	10	15	19
Cr (10; 20)	<10	150	50	50	70	100	30	100	90
Cu (5; 10)	<5	150	15	25	30	20	15	30	45
La (20; 50)	<20	500	50	30	100	70	50	100	92
Mn (10; 20)	50	5,000	1,000	500	1,500	1,000	500	1,500	850
Mo (5; 10)	<5	<5	<5	<5	<5	<5	<5	<5	2
Nb (20; 50)	<20	50	<20	<20	<20	<20	<20	20	11
Ni (5; 10)	<5	150	20	20	30	30	20	20	68
Pb (10; 20)	<10	100	20	30	20	50	15	30	20
Sc (5; 10)	<5	70	15	7	20	10	10	20	13
Sn (10; 20)	<10	10	<10	<10	<10	<10	<10	<10	.x[12]
Sr (100; 200)	<100	500	150	<100	150	150	150	150	300
Th (100; 200)	<100	100	<100	<100	--	<100	<100	<100	12
V (10; 20)	<10	200	70	70	150	100	150	150	130
Y (10; 20)	<10	150	50	30	70	30	50	50	26
Zn (200; 500)	<200	200	<200	<200	<200	<200	<200	<200	95
Zr (10; 20)	<10	1,000	200	200	150	150	200	200	160
AAZn (5; 10)	5	140	35[13]	50	90	70	--	120	

Table 2.—Continued

	Gneiss									
				BM[7]	CM[2]	C[8]	ER[3]	RB[4]	SR[5]	Average[6,9] sandstone
		148		15	16	10	10	47	37	
Element	Low	High	Median	Median	Median	Median	Median	Median	Median	
Percent										
Ca	<0.05	5	0.5	1	0.7	0.3	1	0.5	1	3.9
Fe	.15	20	3	10	2.5	5	5	2	5	.98
Mg	<.02	5	1	1	.7	1	1	.7	1	.7
Ti	.007	1	.5	.5	.5	.3	.5	.3	.5	.15
Parts per million (ppm)										
B	<10	50	10	<10	<10	<10	<10	<10	10	35
Ba	<20	2,000	500	700	500	1,000	700	500	1,000	300
Be	<1	3	1	2	1	2	1	1	1	2
Co	<5	70	10	10	10	10	7	7	10	.3
Cr	<10	200	30	100	30	100	60	50	50	35
Cu	<5	200	10	30	10	30	10	5	15	10-20
La	<20	300	50	50	30	150	50	<20	50	7
Mn	20	2,000	700	500	700	500	500	500	700	500
Mo	<5	5	<5	<5	<5	<5	<5	<5	<5	.2
Nb	<20	50	<20	<20	<20	<20	<20	<20	<20	.0X[12]
Ni	<5	70	15	30	15	10	10	15	20	2
Pb	<10	150	15	20	13	30	40	20	20	7
Sc	<5	100	10	15	10	15	10	7	10	1
Sn	<10	<10	<10	<10	<10	<10	<10	<10	<10	.X[12]
Sr	<100	500	200	100	180	200	150	150	200	20
Th	<100	<100	<100	<100	--	--	<100	<100	<100	5.5
V	<10	300	50	100	70	100	85	50	100	20
Y	<10	200	30	70	30	50	20	15	30	10
Zn	<200	200	<200	<200	<200	<200	<200	<200	<200	16
Zr	<10	>1,000	200	700	200	100	300	150	200	220
AAZn	15	140	55[14]	--	40	--	60	--	100	

	Biotite gneiss and schist					
				AR[1]	ER[3]	TM[10]
		16		32	23	14
Element	Low	High	Median	Median	Median	Median
Percent						
Ca	0.15	2	0.6	0.3	1	0.6
Fe	3	10	5	3	5	7
Mg	.7	2	1	.7	1	1.5
Ti	.5	1	.6	.5	.5	.3
Parts per million (ppm)						
B	<10	15	<10	<10	10	<10
Ba	200	2,000	600	300	1,000	700
Be	<1	1.5	1	1.5	2	2
Co	10	50	18	10	10	10
Cr	30	150	70	50	100	100
Cu	<5	100	20	25	15	30
La	<20	100	50	30	50	50
Mn	500	1,500	850	500	700	500
Mo	<5	<5	<5	<5	<5	<5
Nb	<20	<20	<20	<20	20	<20
Ni	15	100	30	20	20	20
Pb	<10	20	30	30	50	30
Sc	7	30	15	7	10	15
Sn	<10	<10	<10	<10	<10	<10
Sr	<100	300	125	<100	150	100
Th	<100	<100	<100	<100	<100	<100
V	70	200	100	70	100	100
Y	20	100	50	30	30	50
Zn	<200	200	<200	<200	<200	<200
Zr	100	500	200	200	200	300
AAZn	25	85	60[15]	50	65	--

	Amphibolite					
				ER[3]	RB[4]	Average[6] basalt
		48		6	40	
Element	Low	High	Median	Median	Median	
Percent						
Ca	0.2	10	5	3	2	7.6
Fe	1	20	10	9	7	8.65
Mg	.05	10	3	3	2	4.6
Ti	.15	>1	.5	.4	.7	1.38
Parts per million (ppm)						
B	<10	30	<10	10	<10	5
Ba	<20	1,000	70	100	100	330
Be	<1	3	<1	1	1	1
Co	5	100	50	30	50	48
Cr	10	1,000	100	185	50	170
Cu	<5	300	70	15	30	87
La	<20	100	<20	40	<20	17
Mn	15	5,000	1,500	1,500	1,000	1,500
Mo	<5	5	<5	<5	<5	1.5
Nb	<20	<20	<20	<20	<20	19
Ni	<5	1,000	70	60	70	130
Pb	<10	30	<10	10	10	6
Sc	5	70	30	20	30	30
Sn	<10	15	<10	<10	<10	1.5
Sr	<100	700	100	100	100	465
Th	<100	<100	<100	<100	<100	2.7
V	30	700	200	250	200	250
Y	<10	50	30	25	20	25
Zn	<200	200	<200	<200	<200	105
Zr	<10	300	50	85	100	140
AAZn	5	100	15[16]	10	--	--

Table 2.—Continued

	Granite and granite pegmatite							
				AR[1]	RB[4]	SR[25]	Average granite[6]	
		21		7	20	27	High Ca	Low Ca
Element	Low	High	Median	Median	Median	Median		
Percent								
Ca	<0.05	1.5	0.5	0.05	.5	1.5	2.5	0.5
Fe	.15	5	1	1	1	5	3	1.4
Mg	<.02	2	.2	.3	.2	1	.94	.16
Ti	.007	1	.07	.1	.1	.5	.34	.12
Parts per million (ppm)								
B	<10	100	<10	<10	<10	<10	9	10
Ba	<20	1,000	500	300	300	1,000	420	840
Be	<1	2	1	2	1	1.5	2	3
Co	<5	70	5	<5	5	10	7	1
Cr	<10	150	<10	10	<10	30	22	4.1
Cu	<5	100	<5	7	5	10	30	10
La	<20	100	<20	<20	<20	70	84	55
Mn	10	>5,000	200	200	150	500	540	390
Mo	<5	<5	<5	<5	<5	<5	1	1.3
Nb	<20	30	<20	<20	<20	<20	20	21
Ni	<5	50	5	5	<5	20	15	4.5
Pb	<10	50	15	30	20	20	15	19
Sc	<5	20	5	<5	<5	10	14	7
Sn	<10	<10	<10	<10	<10	<10	1.5	3
Sr	<100	500	200	100	200	200	440	100
Th	<100	<100	<100	<100	<100	<100	8.9	20
V	<10	150	20	15	20	100	88	44
Y	<10	1,500	<10	<10	<10	20	44	41
Zn	<200	<200	<200	<200	<200	<200	60	39
Zr	<10	700	100	50	100	200	140	175
AAZn	<5	130	30[18]	30	--	85		

	Ultramafic rocks			
		6		Average[6] ultramafic rock
Element	Low	High	Median	
Percent				
Ca	0.05	1.5	1	2.5
Fe	7	15	10	9.4
Mg	5	10	9	20.4
Ti	.3	.3	.3	.03
Parts per million (ppm)				
B	<10	10	<10	3
Ba	<20	70	<20	.4
Be	<1	1	<1	.X[12]
Co	50	200	100	110
Cr	1,000	5,000	5,000	2,980
Cu	30	100	30	10
La	<20	20	<20	4.5
Mn	1,000	1,500	1,250	1,040
Mo	<5	<5	<5	.3
Nb	<20	<20	<20	16
Ni	700	1,000	1,000	2,000
Pb	<10	10	<10	1
Sc	10	20	18	16
Sn	<10	<10	<10	.5
Sr	<100	<100	<100	5.8
Th	<100	<100	<100	.004
V	70	150	100	40
Y	10	30	18	5
Zn	<200	<200	<200	50
Zr	15	50	40	45
AAZn	15	85	20[17]	--

	Calc-silicate rocks		
		12	
Element	Low	High	Median
Percent			
Ca	<0.05	10	5
Fe	2	10	6
Mg	.02	7	.6
Ti	.15	.7	.4
Parts per million (ppm)			
B	<10	10	<10
Ba	<20	700	50
Be	<1	7	1
Co	5	50	10
Cr	10	150	25
Cu	<5	150	20
La	<20	300	50
Mn	300	>5,000	1,850
Mo	<5	<5	<5
Nb	<20	20	<20
Ni	15	100	20
Pb	<10	50	20
Sc	7	30	10
Sn	<10	30	<10
Sr	<100	1,000	130
Th	<100	<100	<100
V	30	300	90
Y	20	300	30
Zn	<200	200	<200
Zr	30	500	150
AAZn	5	105	35[19]

Table 2.—Continued

	Stream sediments											
				AR[1]	BM[7]	C[8]	CM[2]	ER[3]	O[11]	RB[4]	SR[5]	TM[10]
		171		19	57	51	30	103		57	94	87
Element	Low	High	Median	Median	Median	Median	Median	Median	Median	Median	Median	Geometric mean
Percent												
Ca	<0.05	2	0.5	0.3	0.3	0.15	0.6	0.3		0.15	1	0.3
Fe	1	20	5	2	2	3	5	2		3	7	2.5
Mg	0.1	2	0.7	.5	1	.5	0.5	.3		0.5	1	.3
Ti	0.2	>1	1	.5	1	.5	0.7	.3		.3	.5	.4
Parts per million (ppm)												
B	<10	50	<10	<10	<10	10	10	10		<10	15	10
Ba	100	1,000	300	500	1,000	700	500	500		200	700	330
Be	<1	2	1	2	1.5	1	1.5	<1		<1	1.5	1
Co	<5	30	10	10	20	15	20	7		7	15	15
Cr	10	200	70	70	100	50	50	20		20	100	50
Cu	<5	70	15	20	50	20	20	7		15	20	20
La	<20	500	50	100	300	150	150	30		150	100	50
Mn	100	3,000	1,000	700	700	500	2,000	300		500	1,500	550
Mo	<5	<5	<5	<5	<5	<5	<5	<5		<5	<5	<5
Nb	<20	<20	<20	<20	15	<20	<20	<20		<20	<20	20
Ni	5	70	20	15	15	20	20	10		15	20	30
Pb	<10	70	15	30	20	20	30	20		15	50	15
Sc	<5	30	7	7	20	15	15	7		10	15	10
Sn	<10	30	<10	<10	<10	<10	<10	<10		<10	<10	<10
Sr	<100	500	100	<100	<100	<100	200	<100		100	150	100
Th	<100	<100	<100	<100	--	<100	--	<100		<100	<100	--
V	15	300	100	50	100	100	100	50		50	100	70
Y	10	500	50	70	100	70	70	30		50	50	30
Zn	<200	300	<200	<200	<200	<200	<200	<200		<200	<200	260
Zr	100	>1,000	500	700	1,000	700	300	500		300	300	400
AAZn	20	100	50[22]	65	--	--	70	--		--	100	--

	Vein quartz						
				CM[2]	ER[3]	RB[4]	SR[5]
		13		8	13	8	9
Element	Low	High	Median	Median	Median	Median	Median
Percent							
Ca	<0.05	0.7	<0.05	0.2	0.3	<0.05	<0.05
Fe	<.05	2	.15	.5	2	.1	5
Mg	<.02	1	<.02	.05	.2	<.02	.5
Ti	<.002	.5	.01	.018	.2	.01	.5
Parts per million (ppm)							
B	<10	20	10	<10	<10	10	10
Ba	<20	1,000	<20	100	200	70	100
Be	<1	1.5	<1	<1	1	<1	<1
Co	<5	10	<5	<5	<5	<5	<5
Cr	<10	20	<10	10	<10	<10	10
Cu	<5	70	<5	10	<5	<5	<5
La	<20	50	<20	<20	<20	<20	20
Mn	<10	1,000	20	125	200	15	70
Mo	<5	<5	<5	<5	<5	<5	<5
Nb	<20	<20	<20	<20	<20	<20	<20
Ni	<5	15	5	<5	5	5	<5
Pb	<10	50	<10	<10	20	<10	<10
Sc	<5	10	<5	<5	5	<5	<5
Sn	<10	<10	<10	<10	<10	<10	<10
Sr	<100	200	<100	<100	100	<100	<100
Th	<100	<100	<100	--	<100	<100	<100
V	<10	50	<10	<10	30	<10	<10
Y	<10	30	<10	<10	10	<10	<10
Zn	<200	<200	<200	<200	<200	<200	<200
Zr	<10	500	<10	<10	<10	<10	<10
AAZn	<5	60	<5[20]	5	20	--	<5

	Soil						
				AR[1]	CM[2]	RB[4]	SR[5]
		212		42	20	56	70
Element	Low	High	Median	Median	Median	Median	Median
Percent							
Ca	<0.05	2	<0.05	<0.05	0.08	<0.05	0.2
Fe	.5	10	2	2	3	1.5	5
Mg	.03	2	.3	.2	.5	.15	.5
Ti	.07	1	.5	.3	.7	.3	.5
Parts per million (ppm)							
B	<10	100	10	13	18	15	20
Ba	<20	1,000	300	200	700	200	500
Be	<1	5	1	1.5	3	<1	2
Co	<5	70	10	<5	18	7	7
Cr	<10	700	50	50	70	30	50
Cu	<5	200	20	30	50	10	15
La	<20	300	30	50	125	70	100
Mn	50	2,000	300	175	500	150	700
Mo	<5	<5	<5	<5	<5	<5	<5
Nb	<20	20	<20	<20	<20	<20	20
Ni	<5	150	20	18	40	15	15
Pb	10	50	20	30	50	30	50
Sc	<5	30	<10	7	15	10	10
Sn	<10	<10	<10	<10	<10	<10	<10
Sr	<100	300	<100	<100	<100	<100	100
Th	<100	<100	<100	<100	--	<100	<100
V	20	300	70	70	150	70	100
Y	<20	150	30	60	70	30	30
Zn	<200	200	<200	<200	<200	<200	<200
Zr	30	>1,000	200	500	300	200	300
AAZn	5	220	70[21]	68	100	--	85

Table 2.—Continued

	Panned concentrates							
				AR[1]	C[8]	CM[2]	ER[3]	RB[4]	TM[10]
		139		12	41	10	76	50	78
Element	Low	High	Median	Median	Median	Median	Median	Median	Geometric mean
Percent									
Ca	<0.1	10	0.2	0.3	0.15	0.07	0.5	0.2	0.2
Fe	.1	20	.7	.5	.7	2	15	.3	.3
Mg	<.05	1	.07	.2	.1	.5	.15	<.02	.1
Ti	.07	>2	2	1.4	1.5	>1	>1	2	1.2
Parts per million (ppm)									
B	<20	200	20	20	<5	20	20	20	--
Ba	<50	700	50	300	70	125	100	70	90
Be	<2	5	<2	<2	<2	<1	<1	<2	--
Co	<10	30	<10	<10	<10	7	15	<10	20
Cr	<20	500	100	50	70	200	100	<20	80
Cu	<10	100	<10	<10	--	7	<5	<10	20
La	<50	1,500	100	200	50	400	500	300	130
Mn	30	3,000	100	100	150	300	5,000	70	80
Mo	<10	<10	<10	<10	<10	<10	<5	<10	--
Nb	<50	200	<50	<50	100	25	50	<50	70
Ni	<10	50	<10	<10	10	10	<5	10	30
Pb	<20	100	<20	<20	20	<10	<10	<10	45
Sc	<10	150	<10	<10	70	5	30	50	30
Sn	<20	300	<20	<20	<20	<20	<10	<20	--
Sr	<200	1,000	<200	200	<200	<200	<100	<200	--
Th	<200	200	<200	<200	<200	--	<100	<200	--
V	20	1,000	70	100	200	200	150	70	90
Y	<20	1,000	100	500	700	50	700	300	600
Zn	<500	500	<500	<500	<500	<200	<200	<200	650
Zr	500	>2,000	>2,000	>2,000	>2,000	600	>1,000	>1,000	>2,000
AAZn	<10	20	<10[23]	--	--	--	20	--	--

[1] AR-Anna Ruby Roadless Area (Lesure and others, 1987)

[2] CM-Craggy Mountain Wilderness Study Area (Lesure and others, 1982, p. 13–16)

[3] ER-Ellicott Rock Wilderness (Luce and others, 1985)

[4] RB-Rabun Bald Roadless Area (Moore and Peper, 1988)

[5] SR-Shining Rock Wilderness (Lesure, 1981)

[6] Turekian, 1977, p. 629

[7] BM-Blood Mountain Roadless Area (Koeppen and Nelson, in press)

[8] C-Chattahoochee Roadless Area (Koeppen and Nelson, in press)

[9] Pettijohn, 1963, p. S11

[10] TM-Tray Mountain Roadless Area (Koeppen and Nelson, 1988)

[11] O-Overflow Roadless Area (Koeppen and Nelson, in press)

[12] Order of magnitude estimate indicated by symbol (Turekian, 1977, p. 629)

[13] 42 samples

[14] 38 samples

[15] 11 samples

[16] 22 samples

[17] 5 samples

[18] 14 samples

[19] 9 samples

[20] 8 samples

[21] 202 samples

[22] 150 samples

[23] 64 samples

Table 3. Tin in geochemical samples

Sample No.	Sn[1] (ppm)	Sn[2] (ppm)	Sample description
GA03–603R	15	--	1-m chip sample, siliceous epidote-feldspar-hornblende gneiss.
GA04–202R	30	35	Composite sample from several boulders of gossan formed on calc-silicate granofels of sample GA04–203R.
GA04–203R	20	16	Composite sample of quartz-epidote rock, or calc-silicate granofels.
GA04–221R	15	12	Composite sample of epidote-quartz-hornblende gneiss.
GA04–238R	20	12	Composite sample of quartz-epidote-carbonate gneiss, partly weathered.
GA05–655R	10	--	Greenish-gray, coarse-grained, strongly foliated, interlayered garnet-staurolite-kyanite-mica schist and quartz-biotite schist.
KH04–473R	15	--	2-m chip sample, massive hornblende-plagioclase amphibolite.
KH04–503R	15	--	2-m chip sample, dark-gray, medium-grained, thickly layered hornblende-plagioclase amphibolite.
GA03–031C	300	--	Panned-concentrate sample.
GA03–053C	20	--	Panned-concentrate sample.
GA03–059C	20	--	Panned-concentrate sample.
GA03–061C	30	--	Panned-concentrate sample.
GA04–009C	70	--	Panned-concentrate sample.
GA05–002C	20	--	Panned-concentrate sample.
GA05–006C	20	--	Panned-concentrate sample.
GA05–008C	30	--	Panned-concentrate sample.
GA05–007S	30	--	Stream-sediment sample.

[1] Semiquantitative spectrograph analyses by B.M. Adrian, M.S. Ericksen, and R.T. Hopkins.
[2] Energy dispersive X-ray fluorescence analyses by J.C. Jackson, U.S.Geological Survey Laboratories, Reston, Va.

Table 4. Some mines, prospects, and mineral occurrences in and near the Southern Nantahala Wilderness and adjacent roadless areas.

[Localities shown on Plate 2C.]

Locality No.	Name	Commodity	Comments	References
1	Bell Mountain quarry	Quartz aggregate	Large open cut in massive vein quartz. Mined during 1960's for aggregate in cast concrete panels.	Hurst and Horton, 1964.
2	Jethro Burrell prospect	Vermiculite	Prospecting shows disseminated vermiculite for 1 mi along strike. Not visited.	Prindle, 1935, p. 44.
3	W.A. Henson mine	Sheet and scrap mica	Worked in 1919 and 1931, production reported as 3,000–4,000 lb sheet and 3 tons scrap. Not visited.	Furcron and Teaque, 1943, p. 148.
4	Barnett Denton prospect	Chromite	This may be the same prospect shown as a magnetite mine on the Georgia Department of Mines, Mining and Geology map (1951). Not visited.	Chatman, 1985a.
5	Wills Creek placer	Gold	Small placer production in 1850(s). Not visited. Reported to be in Lot 102, 18th District.	Yeates and others, 1896, p. 113.
6	Unnamed prospect	Mica	Not found.	Georgia Department of Mines, Mining and Geology, 1951.
7	Lemons Gap prospect	Vermiculite	Several small prospect pits north of Lemons Gap for 300 ft along trend of altered ultramafic rock in amphibolite. Pits not seen in 1987.	Prindle, 1935, p. 45.
8	Hooper-Berrong prospect and Skeet Hooper placer	Gold	Reported to be in Lot 102, 18th District. Not visited.	Pardee and Park, 1948, p. 127.
9	Newton placer	Gold	Production reported to be 250–500 oz. Not visited. Reported to be in Lot 131, 18th District.	Yeates and others, 1896, p. 108–111; Chatman, 1985b, p. 9.
10	Chastain Branch placer	Gold	Deposit reported to be in Lot 136, 19th District and to have had production similar to Newton placer. Not visited.	Yeates and others, 1896, p. 111–112; Chatman, 1985b, p. 9.
11,12,13	Rock quarries	Crushed stone		Chatman, 1985a.
14	Tom Coward prospect	Massive sulfide, copper	Shaft 60 ft deep, short adit, caved. Five drill holes by Tennessee Copper Co. totalled 2,850 ft of coring. Site not found.	Shearer and Hull, 1918, p. 205–206; Chatman, 1985b, p. 10.
15	Unnamed prospect	Gold(?)	Several small prospect pits in gossan formed on calc-silicate granofels. Two samples (GA04–202R and 203R) contain 16–35 ppm tin.	This study, table 3; Hopkins and others, 1988, p. 12.
16	Unnamed prospect	Gold(?)	Trench, 50 ft long, trends S. 45°E.; barren quartz vein, 2–3 ft thick in garnetiferous biotite schist. Sample GA04–105R contains no detectable gold at detections limit of 0.05 ppm.	This study; Hopkins and others, 1988, p. 10.
17	Unnamed prospect	Gold(?)	Small pits along both walls of vertical quartz vein, 10 ft thick, trending N. 40°E. Sample GA04–106R contains no detectable gold at detection limit of 0.05 ppm.	This study; Hopkins and others, 1988, p. 10.
18	Soapstone occurrence	Soapstone	Indian quarry site; several partly made soapstone bowls seen in float and on outcrop. Vessels of this type were commonly used in Late Archaic to Early Woodland cultures (Coe, 1964, p. 113, 119; South, 1976, p. 9 and 61).	This study.
19	Smith placer	Gold	Placer reported in Lot 94, 18th District. Not visited.	Yeates and others, 1896, p. 112.

Table 4. Some mines, prospects, and mineral occurrences in and near the Southern Nantahala Wilderness and adjacent roadless areas.—Continued

Locality No.	Name	Commodity	Comments	References
20	Rich Knob prospect	Copper	Small pit on southwest slope of Rich Knob at altitude of 3,200 ft. Not found during this study.	Shearer and Hull, 1918, p. 209–210.
21	Unnamed prospect	Gold(?)	Two prospect pits, 8 ft × 10 ft, in mica gneiss and schist. No gold detected in rock sample GA04–436R at detection limit of 0.05 ppm.	This study.
22	Unnamed prospect	Gold(?)	Adit, 134 ft long; two small pits. Not visited this study.	Chatman, 1985b, p. 10.
23	H.W. Bartley prospect	Gold	Two adits and two caved shafts.	Yeates and others, 1896, p. 97; Chatman, 1985b, p. 10.
24	Quarry	Crushed rock	No data.	
25	Moore Girls prospect	Gold	Open cut 30 ft diameter, 15–20 ft deep. Massive quartz vein 20–30 ft thick, contains minor iron sulfides and small amounts of gold.	Yeates and others, 1896, p. 96–97; Chatman, 1985b, p. 10.
26	Soapstone occurrence	Soapstone	Indian quarry site; remains of several partly made soapstone bowls on outcrop.	This study.
27	Quarry	Crushed rock	No data.	
28	Unnamed prospect	Mica	Four shallow trenches, combined length 100 ft. Not visited.	Hannigan, 1986, p. 9.
29	Quarry	Crushed rock		Hatcher, 1980.
30	Unnamed prospect	Corundum	Open cut, 200 ft long, 50 ft wide. Not found.	Keith, 1907, p. 9; Hannigan, 1986, p. 7.
31	Unnamed prospect	Mica	Two shallow trenches, 50 ft long. Not visited.	Hannigan, 1986, p. 9.
32	Big Four (Rough Cove) Mine	Mica	Six or more small cuts. World War II production 110 lb, sheet mica. Not visited.	Lesure, 1968, p. 120–121.