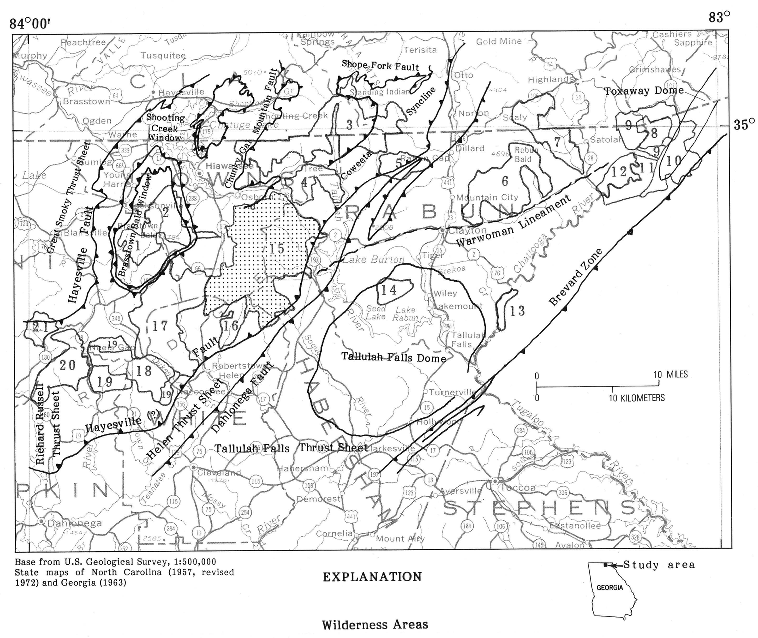


Figure 1.—Index map showing locations of wilderness and roadless areas and major structural features in northeastern Georgia and adjacent North and South Carolina. The Tray Mountain Roadless Area is shown by a pattern. Number after roadless area name is U.S. Forest Service identification number. Geology modified from Hatcher and Butler (1979) and Nelson and others (1987).

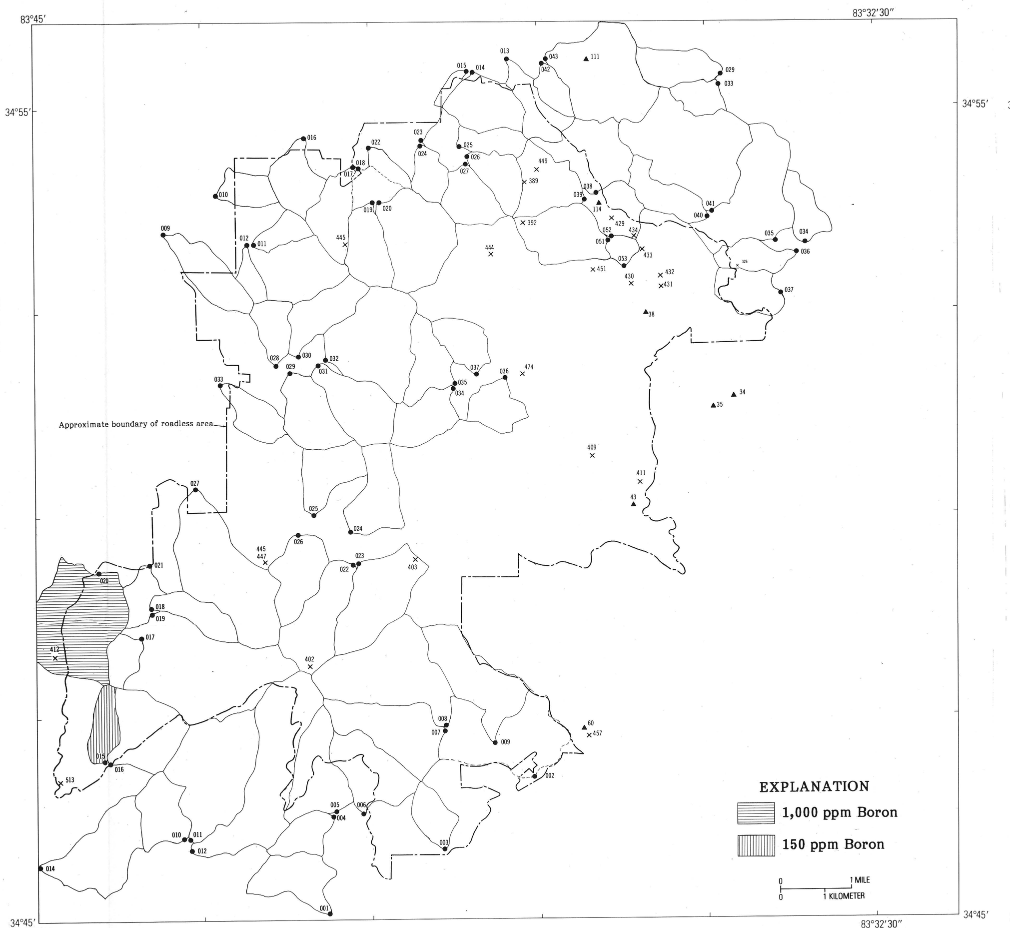


Figure 3.—Map showing panned-concentrate sample location and drainage basins containing anomalous concentrations of boron.

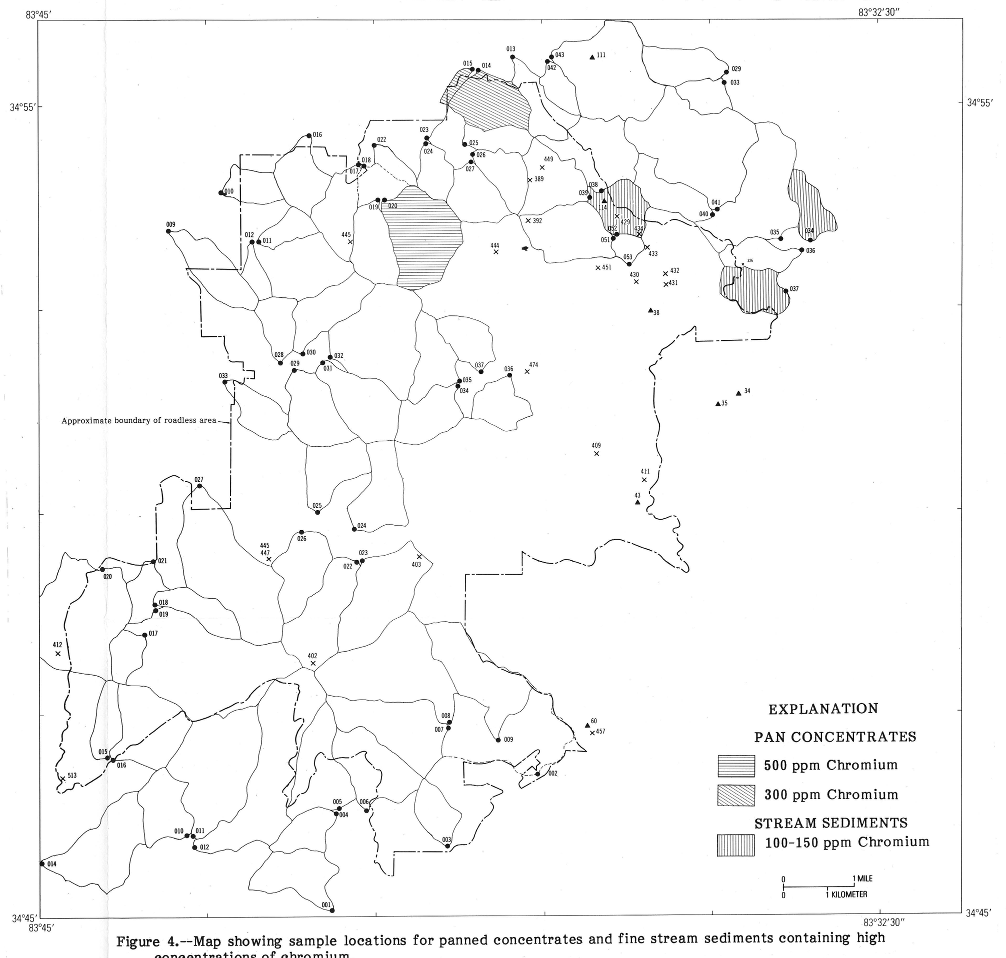


Figure 4.—Map showing sample locations for panned concentrates and fine stream sediments containing high concentrations of chromium.

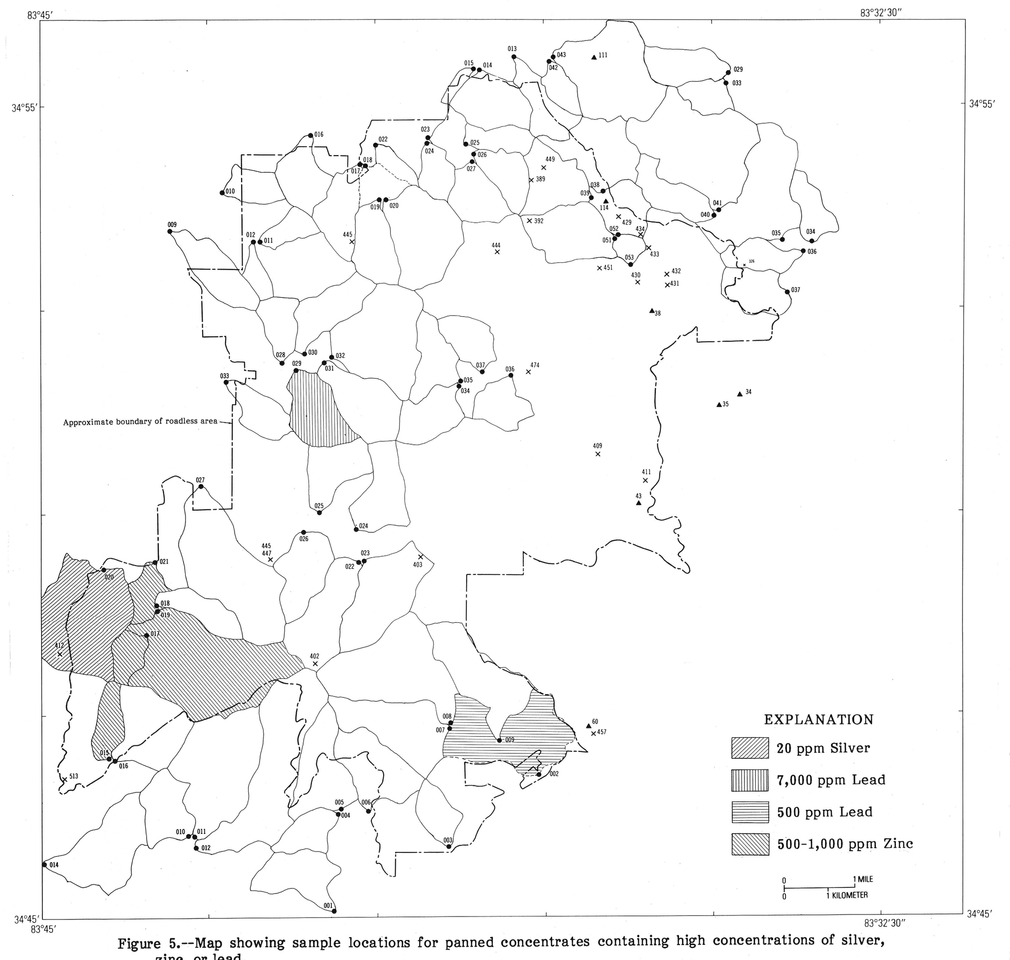


Figure 5.—Map showing sample locations for panned concentrates containing high concentrations of silver, zinc, or lead.

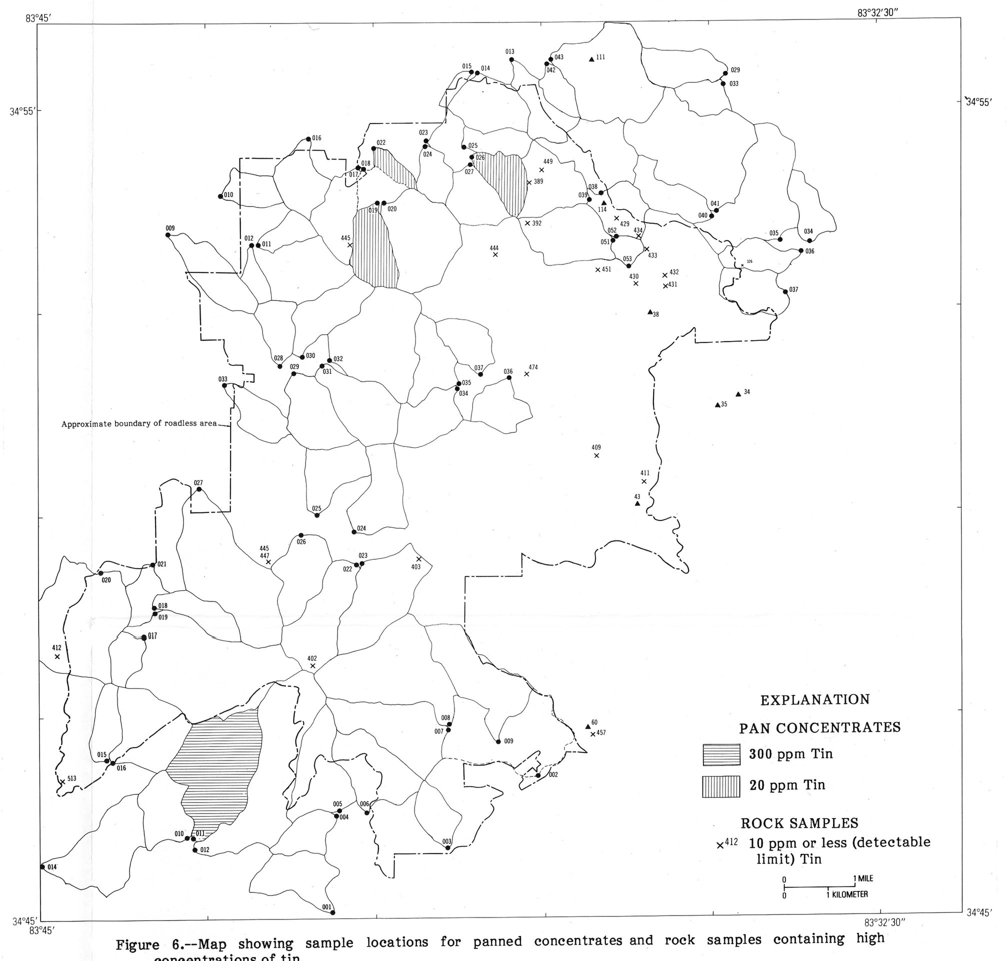
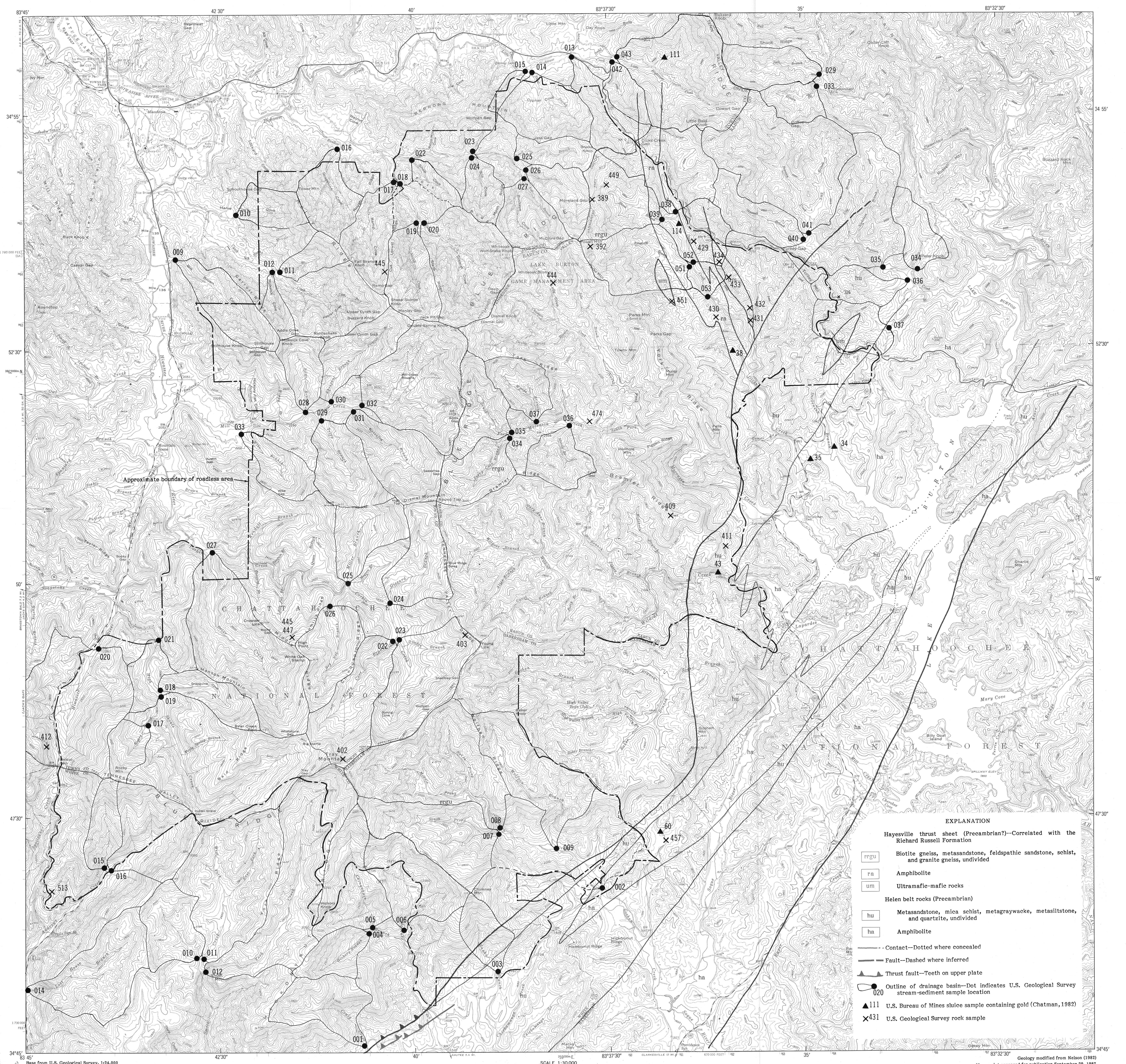


Figure 6.—Map showing sample locations for panned concentrates and rock samples containing high concentrations of tin.



Base from U.S. Geological Survey, 1:24,000
Lake Burton (1967), Tray Mountain (1967),
U.S. Geological Survey and Tennessee Valley Authority, 1:24,000
Macedonia (1966), Hightower Bald (1966)

Geology modified from Nelson (1982)
Manuscript approved for publication September 29, 1987

Figure 2.—Sample location map showing drainage basin outlines for stream-sediment and panned-concentrate samples, and major geologic units.

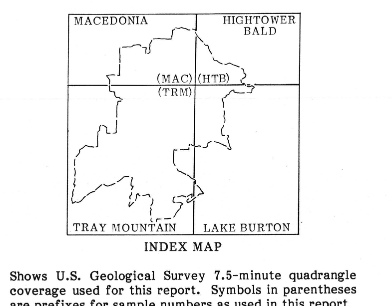
Table 1.—Range and geometric means for 34 elements in stream-sediment and panned-concentrate samples from Tray Mountain Roadless Area, northern Georgia, and geometric means for stream-sediment samples and panned-concentrate samples from the immediate vicinity including Tray Mountain, Chattahoochee River, and Blood Mountain Roadless Areas (TCR), all in northern Georgia.

Element	TMRA[1] Stream Sediments 87 samples Low	High	Geometric Mean	TCR[2] Stream Sediments 267 samples Geometric Mean	TMRA Panned Concentrates (NM) 79 samples Low	High	Geometric Mean	TCR Panned Concentrates (NM) 144 samples Geometric Mean	TMRA Panned Concentrates (M.5) 36 samples Low	High	Median	TCR Panned Concentrates (M.5) 96 samples Mean	TMRA Panned Concentrates (M1) 48 samples Low	High	Geometric Mean	TCR Panned Concentrates (M1) 61 samples Geometric Mean
[illegible]																

[1]Tray Mountain Roadless Area
[2]Tray Mountain - Chattahoochee River - Blood Mountain Roadless Areas, combined

Table 2.—Analyses of selected samples. Heavy-mineral concentrates, nonmagnetic (NM) fractions containing high values of one or more elements. Symbols used: N, not detected; L, less than value shown; --, not analyzed.

	Silver	Boron	Barium	Chromium	Copper	Lead	Tin	Zinc
TRM 2 NM	[illegible]							
TRM 11 NM	[illegible]							
TRM 13 NM	[illegible]							
TRM 17 NM	[illegible]							
TRM 19 NM	[illegible]							
TRM 20 NM	[illegible]							
TRM 21 NM	[illegible]							
TRM 29 NM	[illegible]							
MAC 14 NM	[illegible]							
MAC 15 NM	[illegible]							
MAC 16 NM	[illegible]							
MAC 17 NM	[illegible]							
MAC 9 NM	[illegible]							
MAC 20 NM	[illegible]							



INDEX MAP

Shows U.S. Geological Survey 7.5-minute quadrangle coverage used for this report. Symbols in parentheses are prefixes for sample numbers as used in this report and in Siems and others (1988).

STUDIES RELATED TO WILDERNESS

The Wilderness Act (Public Law 88-577, September 3, 1964) and related acts require the U.S. Geological Survey and U.S. Bureau of Mines to survey certain areas on Federal lands to determine their mineral values, if any, that might be present. Results must be made available to the public and be submitted to the President and to the Congress. This report presents the results of a geochemical survey of the Tray Mountain Roadless Area (08-030) in the Chattahoochee National Forest, in Rabun, Habersham, Towns, and White Counties, Georgia. The area was classified as a further planning area during the Second Roadless Area Review and Evaluation (RARE II) by the U.S. Forest Service, January 1979.

INTRODUCTION

The U.S. Geological Survey (USGS) made a reconnaissance geochemical survey of the Tray Mountain Roadless Area to determine if unexposed mineral deposits exist which might be indicated by geochemical signatures in the abundance or distribution patterns of trace elements. Eighty-seven fine-grained stream-sediment samples and 78 panned concentrates of alluvial gravels were collected in Tray Mountain study area (fig. 1). A.E. Nelson, in conjunction with detailed geologic mapping, collected 25 rock-chip samples for geochemical analysis, in addition to a large number of hand specimens for thin-section study. R.P. Koeppen collected several additional panned-concentrate, stream-sediment, and rock samples from the area in 1985 in order to evaluate isolated anomalies from the earlier sampling. Nelson's geologic study (1982), combined with this geochemical survey, provide the basis for our mineral-resource assessment of the Tray Mountain Roadless Area (Nelson and others, 1983).

Geologic Setting

The Tray Mountain Roadless Area is underlain by metamorphic rocks from two lithotectonic units, the Hayesville thrust sheet and the Helen thrust sheet (Nelson, 1982; Nelson and others, 1987). A major northeast-trending fault (Hatcher, 1974) separates the Hayesville sheet on the northwest from the Helen sheet on the southeast. Most of the roadless area is underlain by the rocks of the Hayesville sheet, which include interlayered biotite gneiss and schist, fine-grained biotite-feldspar gneiss, metasandstone, amphibolite, hornblende gneiss, and numerous variably sized veins and pods of pegmatite. Only a small part of the study area is underlain by the rocks of the Helen sheet; they include an interlayered succession of locally sulfidic metagraywacke, metasandstone and metaquartzite, mica schist, graphite schist, amphibolite, and hornblende gneiss. Several mafic-ultramafic bodies have been emplaced along faults into rocks of both the Hayesville sheet and the Helen sheet. The bodies contain serpentinite, dunite, pyroxenite, gabbro, and amphibolite; locally, some of these rocks are magnetite rich. The youngest rock in the roadless area is an unmetamorphosed diabase dike of probable Triassic or Jurassic age that intrudes both Helen sheet and Hayesville sheet rocks.

PROCEDURES

Most of the small drainage basins within and immediately adjacent to the study area were sampled by collecting a few handfuls of the finest sediment available and by pan concentrating the heavy minerals in alluvial gravels from the active stream channels.

Fine-grained stream sediments were dried and sieved to minus 80-mesh (0.006 in.), then pulverized to minus 140-mesh (0.004 in.) Panned-concentrate samples were washed in bromoform to remove light minerals, then passed by a hand magnet to remove most magnetite. The remaining material was then split into high-, low-, and nonmagnetic fractions on a Frantz separator at settings of 0.5 amp, and 1.0 amp. The three fractions were crushed and pulverized to minus 140-mesh. Rock samples were crushed to minus 140-mesh for analysis.

Each sample was analyzed semiquantitatively for 31 elements by a six-step, D.C. (direct current)-arc, optical-emission spectrographic method (Grimes and Marranzino,1968) by D.F. Siems at the U.S. Geological Survey laboratories in Denver, Colo. In addition, 14 low-magnetic (M1) monazite-rich fractions of panned concentrates from the Tray Mountain quadrangle were analyzed for zinc by an atomic absorption technique (method of Ward and others, 1969, p. 20 and p. 33), also by Siems. Semiquantitative spectrographic analytical values are reported as six steps per order of magnitude (1.0, 0.7, 0.5, 0.3, 0.2, 0.15, or multiples of 10 of these numbers) and are approximate geometric midpoints of the concentration ranges. The precision is shown to be 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). The complete data are reported in Siems and others (1988). Locations of samples and associated drainage basins are shown in figure 2. A statistical summary of the data is given in table 1. Partial geochemical data for select samples discussed in the text is given in table 2.

DISCUSSION

Our reconnaissance geochemical survey of the Tray Mountain Roadless Area found no clear evidence of mineral deposits or of significant mineralization. Data for seven elements (boron, chromium, lead, nickel, silver, tin, and zinc)show a few high concentrations in stream-sediment or panned-concentrate samples. Sources of local concentrations of trace elements are not known.

Boron

Boron contents are low both for rocks (0-50 ppm) and for fine-grained stream sediments (10-15 ppm) in the area (table 1). The geometric mean of boron values for panned concentrates is about 30 ppm; however, two samples from the southwest corner of the area are enriched in boron, containing 1,000 ppm and 150 ppm (fig. 3), respectively. Extremely high boron values also occur for magnetic fractions of panned concentrates from these streams. The boron may be in the form of tourmaline, but the exact source and nature of occurrence (vein, pegmatite, fossil placer, or other) is unknown and only a matter of speculation.

Chromium and nickel

Fine-grained stream-sediment samples from three streams along the northeast boundary of the roadless area contain high background values of chromium (150 ppm) and nickel (70-100 ppm) (fig. 4). No unusual chromium or nickel abundances were detected in panned-concentrate samples from these drainage basins, but chromium contents of 300-500 ppm were measured in samples from three other streams in the north-central part of the area. Ultramafic rocks are exposed within the catchment basins of the fine-grained samples containing chromium and nickel enrichment (fig. 2). These rocks have normal chromium and nickel contents of 1,500-3,000 ppm and 300-700 ppm, respectively, which are about 10-20 times the median values for the dominant rock types in the area (mica schist and gneiss). The higher chromium and nickel concentrations in the fine-grained stream sediments are probably related to this local variation in bedrock units rather than to chromite deposits. The source of high chromium concentrations in the panned concentrates is not known but may be related to other ultramafic bodies too small to be detected during reconnaissance geologic mapping.

Silver

Silver was detected spectrographically in only one sample, a heavy-mineral panned concentrate from a stream on the southwest edge of the roadless area (table 2, fig. 5). This sample is clearly anomalous based on the absence of silver in all other samples from the area, and is curious for its spatial association with a cluster of tin- and zinc-enriched streams. Resampling did not reproduce the silver anomaly. Silver was not found in any rocks or other sample media from the area, and the significance of this single sample is not understood.

Tin

Tin was detected both in rock samples and heavy-mineral panned concentrates from the area. A panned concentrate (TRM11, table 2) from a drainage basin near the southwest corner of the area contained 300 ppm tin, but additional samples from this stream contained no detectable tin (Lesure and others, 1987). Five other concentrates from streams in the area, including one adjacent to the one mentioned above, contain tin at or just below the 20 ppm lower limit of determination for concentrates (table 2). In the Chattahoochee Roadless Area, several miles to the southwest, there are similar unexplained tin anomalies in panned concentrates. Because the tin occurs in the nonmagnetic fraction of the panned concentrates, it is likely to be in the form of cassiterite and not as a solid-solution component in magnetite. Four samples of schist and gneiss from the eastern edge of the area contain 10 ppm or less tin (fig. 6). No other rocks contained detectable tin. Notably, none of these tin-bearing samples come from catchments which have tin-enriched panned concentrates. Except for the one high-value sample (TRM11), whose tin content was not reproduced in later sampling, all the samples have values at or near the limit of determination and may be a result of analytical bias. The clustering of these values, however, suggests a possible stratigraphic or structural relationship rather than analytical problems.

Zinc

Panned concentrates from four streams in the southwest corner of the area contain 500-1,000 ppm zinc (table 2, fig. 5), which is anomalously high. M.5 fractions of many of these concentrates also carry detectable zinc. No zinc was detected in the fine-grained stream-sediment samples. Zinc was measured at uniformly low concentrations (200-300 ppm) in eight rocks, detected but below the level of determination (200 ppm) in four rocks, and not detected at all in the eleven other samples. The source of the anomalously high zinc concentration in the panned concentrates is not known.

Lead

Lead was found in low concentrations (0-70 ppm) in virtually all samples from the area with the exception of two panned concentrates, one (TRM29, table 2) from a stream along the central-western area boundary containing 7,000 ppm lead, the other (TRM2) from a stream near the southeast corner of the area containing 500 ppm lead (fig. 5). Because the lead contents in these two samples are 10-20 times that found for all other samples in the area, they are clearly anomalous. The nature and source of the lead anomalies is not known but lack of associated anomalies in base and precious metals, or of any geologic association suggests that the anomalous lead values may be due to contamination (for example, lead shot in the sample).

Gold

Gold was not detected in any of the USGS sample media. However, five panned-concentrate samples, collected near low-grade placers in the Dahlonega Gold Belt and analyzed by U.S. Bureau of Mines personnel, yielded gold concentrations in the 1-10 ppm range (Chatman, 1985). Distribution of these gold occurrences (fig. 2) is restricted to streams along the eastern boundary of the roadless area and is similar to that described above for trace metals in stream sediments; this may reflect bedrock control related to the distribution of amphibolites. It seems unlikely that significant gold deposits exist or will be discovered in the area.

CONCLUSIONS

Anomalous concentrations of trace metals occur in heavy-mineral panned concentrates and rock samples from the Tray Mountain Roadless Area, but they apparently are not related geologically and probably are not of economic significance. The trace-element-enriched panned concentrates are from six streams clustered near one another in the southwest corner of the area: one contains 10 ppm silver, another contains 300 ppm tin, and four others contain 500-1,000 ppm zinc. Two rock samples of gneiss contain 10 ppm tin, but both samples were collected far beyond the catchment basin from which the anomalous tin-enriched panned concentrate was derived. These anomalous metal concentrations possibly could be related to low-grade mineralization processes; if so, it seems unlikely that the results of these processes would be of significant size or of economic importance. Further investigation involving a more thorough and detailed geochemical sampling design would be required to corroborate and determine the significance and size of the anomalous trace-element concentrations reported here.

REFERENCES CITED

Chatman, M.L., 1982, Mineral investigation of Tray Mountain Rare II Further Planning Areas, Rabun, Habersham, Towns, and White Counties, Georgia: U.S. Bureau of Mines Open-File Report MLA 145-82, 39 p.
_____1985, 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.
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.
Hatcher, R.D., Jr., 1974, An introduction to the Blue Ridge tectonic history of northeast Georgia: Georgia Geological Survey Guidebook 13-A, 60 p.
Hatcher, R.D., Jr., and Butler, J.R., compilers, 1979, Guidebook for Southern Appalachian field trip in the Carolinas, Tennessee, and northeastern Georgia; field trip held Sept. 9-15,1979 as part of The Caledonides in the USA, Field conferences and Symposium of the Caledonide Orogen Project (International Geological Correlation Program Project No. 27), Aug. 30-Sept. 15, 1979: Raleigh, N.C., North Carolina Geological Survey, 117 p.
Lesure, F.G., D'Agostino, J.P., and Peper, J.D., 1987, Geochemical survey of the Anna Ruby Roadless Area, White County, Georgia: U.S. Geological Survey Miscellaneous Field Studies Map MF-1908-B, 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.
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.
Nelson, A.E., Horton, J.W., Jr., and Clarke, J.W., 1987, Generalized tectonic map of the Greenville 1° x 2° quadrangle, Georgia, South Carolina, and North Carolina: U.S. Geological Survey Miscellaneous Field Studies Map MF-1898, scale 1:250,000.
Nelson, A.E., Koeppen, R.P., and Chatman, M.L., 1983, Mineral resource potential map of the Tray Mountain Roadless Area, northern Georgia: U.S. Geological Survey Miscellaneous Field Studies Map MF-1347-D, scale 1:30,000.
Siems, D.F., Forn, C.L., Koeppen, R.P., and Nelson, A.E., 1988, Analyses and descriptions of geochemical samples, Tray Mountain Wilderness, Chattahoochee Roadless Area, and Blood Mountain Wilderness, northeastern Georgia: U.S. Geological Survey Open-File Report 88-563, 90 p.
Turekian, K.K., and Wedepohl, K.H., 1961, Distribution of the elements in some major units of the Earth's crust: Geological Society of America Bulletin, v. 72, no. 2, p. 175-191.
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.

GEOCHEMICAL SURVEY OF THE TRAY MOUNTAIN ROADLESS AREA, NORTHERN GEORGIA

By
Robert P. Koeppen and Arthur E. Nelson
1988

INTERIOR—GEOLOGICAL SURVEY, RESTON, VA—1988
For sale by U.S. Geological Survey Map Distribution, Box 25286, Federal Center, Denver, CO 80225