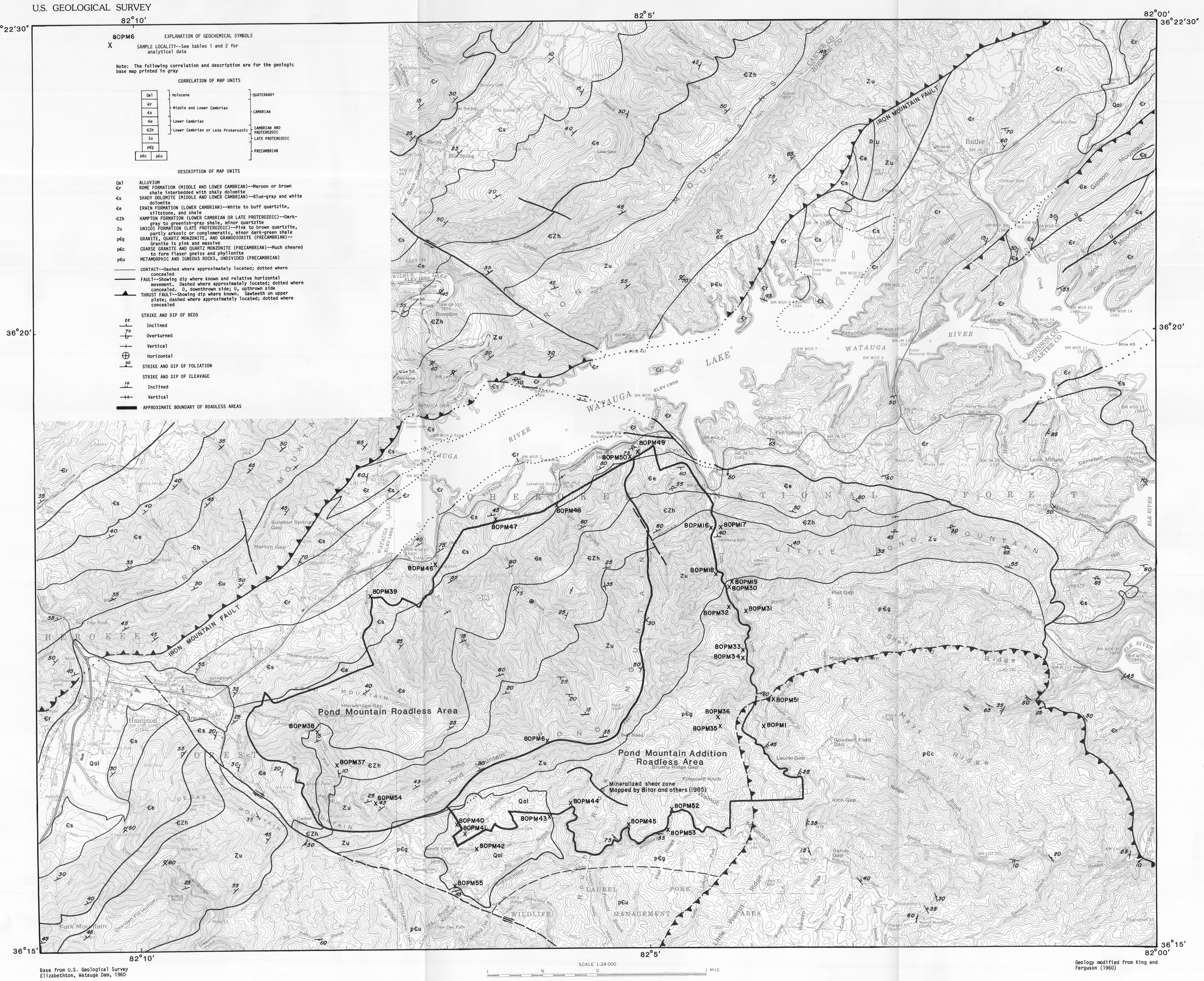
DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

MISCELLANEOUS FIELD STUDIES
MAP MF-1648-B



EXPLANATION OF GEOCHEMICAL SYMBOLS

80PM6 X SAMPLE LOCALITY--See tables 1 and 2 for analytical data

Note: The following correlation and description are for the geologic base map printed in gray

CORRELATION OF MAP UNITS

Unit	Age	System
Qal	Holocene	QUATERNARY
€r, €s	Middle and Lower Cambrian	CAMBRIAN
€e	Lower Cambrian	CAMBRIAN
€Zh	Lower Cambrian or Late Proterozoic	CAMBRIAN AND PROTEROZOIC
Zu		LATE PROTEROZOIC
p€g, p€c, p€u		PRECAMBRIAN

DESCRIPTION OF MAP UNITS

Qal	ALLUVIUM
€r	ROME FORMATION (MIDDLE AND LOWER CAMBRIAN)--Maroon or brown shale interbedded with shaly dolomite
€s	SHADY DOLOMITE (MIDDLE AND LOWER CAMBRIAN)--Blue-gray and white dolomite
€e	ERWIN FORMATION (LOWER CAMBRIAN)--White to buff quartzite, siltstone, and shale
€Zh	HAMPTON FORMATION (LOWER CAMBRIAN OR LATE PROTEROZOIC)--Dark-gray to greenish-gray shale, minor quartzite
Zu	UNICOI FORMATION (LATE PROTEROZOIC)--Pink to brown quartzite, partly arkosic or conglomeratic, minor dark-green shale
p€g	GRANITE, QUARTZ MONZONITE, AND GRANODIORITE (PRECAMBRIAN)--Granite is pink and massive
p€c	COARSE GRANITE AND QUARTZ MONZONITE (PRECAMBRIAN)--Much sheared to form flaser gneiss and phyllonite
p€u	METAMORPHIC AND IGNEOUS ROCKS, UNDIVIDED (PRECAMBRIAN)

CONTACT--Dashed where approximately located; dotted where concealed

FAULT--Showing dip where known and relative horizontal movement. Dashed where approximately located; dotted where concealed. D, downthrown side; U, upthrown side

THRUST FAULT--Showing dip where known. Sawteeth on upper plate; dashed where approximately located; dotted where concealed

STRIKE AND DIP OF BEDS

55 Inclined

70 Overturned

Vertical

Horizontal

30 STRIKE AND DIP OF FOLIATION

STRIKE AND DIP OF CLEAVAGE

10 Inclined

Vertical

APPROXIMATE BOUNDARY OF ROADLESS AREAS

Base from U.S. Geological Survey
Elizabethton, Watauga Dam, 1960

SCALE 1:24 000

1 ½ 0 1 MILE

1 .5 0 1 KILOMETER

CONTOUR INTERVAL 40 FEET
NATIONAL GEODETIC VERTICAL DATUM OF 1929

Geology modified from King and Ferguson (1960)

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 their mineral resource potential. Results must be made available to the public and be submitted to the President and the Congress. This report presents the results of a geochemical survey of the Pond Mountain Roadless Area (08035) and Pond Mountain Addition Roadless Area (08273) in the Cherokee National Forest, Carter County, Tenn. The Roadless Areas were classified as further planning areas during the Second Roadless Area Review and Evaluation (RARE II) by the U.S. Forest Service, January 1979.

INTRODUCTION

In the spring of 1980, K. A. Duttweiler, J. W. Whitlow, and W. R. Griffitts of the U.S. Geological Survey conducted a reconnaissance geochemical survey of the Pond Mountain and Pond Mountain Addition Roadless Areas. The purpose of the study was to determine the geochemical nature of the study area as part of the mineral resource assessment. This report presents a brief summary of the geochemistry of the study area. The evaluation of the mineral resource potential is covered in a separate report (Griffitts, Bitar, and Chatman, in press).

The Pond Mountain and Pond Mountain Addition Roadless Areas encompass 6,668 acres in the Cherokee National Forest in northeastern Tennessee. They are approximately 7 mi southeast of Elizabethton, and 1 mi east of Hampton, Tenn. (fig. 1).

The study area is fairly accessible by U.S Highway 321 north of the area and Forest Service Route 50 along the southern boundary. Relief is moderate, but the vegetation is very thick in most places.

GEOLOGY

The study area consists of a sequence of sedimentary rocks of early Paleozoic age unconformably overlying Precambrian basement rocks (see map).

Basement rocks exposed in the southeastern part of the study area consist of Precambrian granitic rocks, ranging from quartz monzonite to granodiorite and smaller amounts of micaceous metamorphic rocks (unit PCg). Coarse-grained, massive, pink granite is predominant, but small bands of fine-grained, red granite and fine-grained porphyritic granite are contained within the coarse-grained granite, as are some steeply dipping phyllite layers in places.

Older basement rocks thrust over the granitic rocks consist of a complex of quartz monzonite and granite (unit PCc) that has been highly sheared, resulting in flaser gneiss, phyllonite, and mylonite. In addition, these rocks were cut by pegmatites, quartz veins, and dikes. The plutonic metamorphism that formed the flaser gneiss, mylonite, and phyllite occurred in Precambrian time. The thrusting, folding, and local shearing occurred after the metamorphism in late Paleozoic time (King and Ferguson, 1960).

A mineralized shear zone was mapped by Bitar and others (1985) in the headwaters of Firescald and Big Branches (see map). This shear zone consists of an ultramylonite zone that is adjacent to alternating zones of granite, altered granite, and phyllonite and contains anomalously high values of columbium (niobium), tantalum, yttrium, and ytterbium (Bitar and others, 1985).

Sedimentary rocks lie unconformably on the basement rocks. They include the thick basal Chilhowee Group of clastic rocks of Late Proterozoic to Early Cambrian age followed by a carbonate sequence, the Shady Dolomite.

The oldest and lowermost unit of the Chilhowee Group is the Unicoi Formation (unit Zu) of Late Proterozoic age. It consists of a thick-bedded quartzite, in part arkosic and conglomeratic, interbedded with some thin-bedded arkose.

The Hampton Formation (unit €Zh), of Late Proterozoic or Early Cambrian age, overlying the Unicoi Formation, is generally thought of as a shaly interval between the more sandy or quartzitic Unicoi and Erwin Formations below and above, respectively. It is composed mainly of dark-gray to greenish-gray clay shale with interbedded layers of siltstone, arkosic sandstone in the lower part of the formation, and vitreous quartzite in the upper part.

The Erwin Formation (unit €e) of Early Cambrian age is the uppermost unit of the Chilhowee Group and includes four members, which, for the purposes of this report, have been grouped as one and included under the heading of Erwin Formation. Together, they consist of interbedded layers of white, vitreous quartzite; dark, ferruginous quartzite; siltstone; and shale. The white quartzite beds constitute a relatively small part of the formation but serve to distinguish it from the otherwise similar underlying Hampton Formation.

The Shady Dolomite (unit €s), also of Early Cambrian age, overlies the Chilhowee Group. It consists mostly of blue-gray and white dolomite but includes small amounts of limestone and a few beds of shale in the upper part. Dolomite of the Shady has been jointed, brecciated, and recrystallized. There are many places, not differentiated on the map, where the Shady Dolomite is covered by a waxy, brown-buff residual clay formed by weathering of the dolomite. In many places, the carbonate minerals have been removed entirely to leave a mass of light-brown or tan, sticky clay, which is locally sandy. Iron and manganese prospects and open-pit mines are scattered throughout the Shady Dolomite in and adjacent to the northwesternmost part of the study area. The manganese and iron oxides occur in residuum as concretionary lumps in the clay. These oxides have been concentrated during weathering of manganese and iron minerals in the bedrock.

The original host minerals of the manganese and iron oxides are thought to be primary sedimentary rather than hydrothermal in origin due to their widespread occurrence (King and Ferguson, 1960). The manganese oxide is probably derived from white dolomite of the Shady. The source of iron is questionable; it occurs either as disseminated pyrite in the upper quartzite layers of the Erwin Formation or as carbonate minerals in the lower part of the Shady Dolomite.

The Rome Formation (unit €r), of Early and Middle Cambrian age, overlies the Shady Dolomite and consists of mostly red, maroon, or brown shale interbedded with light-gray shaly dolomite.

Most of the geological information is from King and Ferguson (1960) except for that relating to the mineralized shear zone which is from Bitar and others (1985). Further details on the geology of the area can be obtained from those two reports.

GEOCHEMISTRY

Methods

A reconnaissance geochemical survey was undertaken to obtain information about the geochemical nature of the area. Panned concentrates were collected from 32 drainages, each drainage representing a 1-1.5 mi^2 area. At some sites, more than one sample was taken, and the highest value is shown on the map.

The heavy-mineral concentrates were used to evaluate the geochemistry of the study area. Heavy-mineral concentrates are a good sample medium because microscopic determinations of ore minerals and spectrographic determinations of elements of ore minerals are easier and in many cases possible only after the removal of common rock-forming minerals (mainly quartz and feldspar), which tend to dilute the sample.

Each heavy-mineral-concentrate sample was sieved through a 20-mesh screen. Light minerals (quartz and feldspar) still remaining after panning were removed by bromoform (specific gravity 2.85). Magnetite was removed with a hand magnet. A Frantz Isodynamic Separator[1] (15° side slope and 25° forward slope setting) was used to obtain 3 fractions: magnetic at 0.5 ampere (M.5), magnetic at 1 ampere (M1), and nonmagnetic at 1 ampere (NM). The NM fraction contains the most common ore-forming sulfide and oxide minerals as well as other nonmagnetic minerals, such as zircon, rutile, fluorite, and topaz.

Mineral proportions of each fraction were estimated with a binocular microscope and then analyzed semiquantitatively for 31 elements using a six-step direct-current arc optical-emission spectrographic method (Grimes and Marranzino, 1968). The semiquantitative spectrographic values are reported as one of six-steps per order of magnitude (1, 0.7, 0.5, 0.3, 0.2, 0.15, and multiples of these numbers), and the values are the approximate midpoints of the concentration ranges.

RESULTS

The values of tin, beryllium, niobium, tungsten, and molybdenum shown on figures 2-5 are from the fraction that showed the greatest variation in element concentration among the sample population. The abundance of these metals, provide clear evidence that the Precambrian rocks in the study area have been mineralized. Topaz and fluorite (fig. 2), found in the heavy-mineral concentrates, provide additional evidence of the general nature of the mineralization, which is geochemically similar to that which formed tin and tungsten ores in many parts of the world (Taylor, 1979). Samples that are rich in niobium and tungsten are most abundant in the southeastern part of the area and include the sites at which topaz and fluorite were found. This probably indicates that the mineralization was stronger in that general area. Columbite and wolframite, the most likely hosts of niobium and tungsten, do not survive transport over long distances, so they may not have survived reworking by the western and northern streams. More durable cassiterite, as well as phenakite, chrysoberyl, and some other beryllium minerals, could persist for much longer distances.

Beryllium

Beryllium concentrations ranging from 5 to 100 ppm are common in the NM fraction of samples draining the Precambrian granitic rocks in the southeast corner of the study area (fig. 2). These beryllium-rich concentrates are also rich in tin, niobium, molybdenum, and tungsten. Beryllium-rich concentrates were also obtained from Pond Branch, which drains the Unicoi Formation, and a stream in the northwest part of the study area that drains the Shady Dolomite and Erwin Formation. The beryllium in these two areas was probably eroded from the Precambrian granitic rocks and deposited in the Shady and the Erwin and later reworked into the modern drainage. Sedimentary rocks similar to the Shady and Erwin generally are not common primary host rocks for beryllium deposits.

No beryllium-bearing minerals were recognized in the heavy-mineral-concentrate samples. It is unlikely that the beryllium occurs in beryl since its specific gravity is less than that of bromoform and would therefore be removed with the light fraction during heavy-liquid separation. Heavier beryllium minerals could be present, such as chrysoberyl or phenakite.

Sample 80PM1 contains 1 percent fluorite and a trace of topaz, and sample 80PM30 contains 5 percent fluorite and 75 percent topaz. Samples 80PM35 and 80PM36 contain a trace of topaz. Fluorite is commonly associated with beryllium in beryllium deposits, because fluorine forms a stable complex with lithophile elements including beryllium, lithium, manganese, niobium, tin, and tungsten.

Tin

All samples from streams that drain the Precambrian crystalline rocks contain more than 1,000 ppm tin (fig. 3). Cassiterite was found in concentrate sample 80PM1 and probably occurs in the other tin-rich samples. There were no tin-bearing minerals observed in place in the rocks in the study area.

Most creeks that drain the Late Proterozoic and Cambrian sedimentary rocks also contain tin-rich alluvium. Only samples 80PM16 and 80PM17 contain as little as 50 ppm tin in the nonmagnetic fractions. The tin-bearing minerals in these streams were probably originally derived from the Precambrian granitic rocks and deposited in the sedimentary rocks and later redeposited in the modern drainage.

Niobium

The niobium contents are very high in many samples from the Precambrian rock area: Magnetic (M1) concentrates from 10 sample localities contain at least 1,000 ppm niobium (fig. 4). The niobium-rich samples are most common in the southeastern part of the study area, the same general area that has the most samples rich in tungsten. The occurrence of niobium in the magnetic M1 fraction indicates that it occurs in ferruginous minerals, such as columbite, ilmenite, or other multiple oxides.

Tungsten

High concentrations in 11 M.5 fractions (fig. 5) indicate that tungsten is probably present as wolframite. Wolframite was not recognized visually in the samples, but it is similar to other dark minerals and may have been overlooked. Scheelite was recognized in several NM samples from the eastern and southeastern parts of the study area, but the samples apparently contained too little tungsten to be detected spectrographically.

Molybdenum

Molybdenum was found only in the M.5 fraction of the concentrate, in concentrations ranging from 10 to 70 ppm (fig. 5). Molybdenum may be present in the iron-manganese oxides; these occur in the M.5 fraction and tend to carry many trace elements, including molybdenum.

Zinc

Though not plotted on the maps, nine M.5 fractions contained concentrations of zinc ranging from 500 to 1,000 ppm (see table 2). These samples have a close spatial correlation with those rich in beryllium, niobium, tin, tungsten, and molybdenum; all are from streams draining the Precambrian crystalline rocks in the southeast part of the study area.

The pervasive high concentrations of lithophile elements, including iron, beryllium, tin, niobium, tungsten, and molybdenum, in the southeasternmost part of the study area, indicate that widespread mineralization has occurred. It appears that the minerals are either dispersed in granitic and other plutonic rocks or are in quartz veins, pegmatites, or other dikes that cut the older metamorphic rocks.

REFERENCES

Bitar, R. F., Behum, P. T., Hammack, R. W., and Chatman, M. L., 1985, Minerals investigation of Pond Mountain and Pond Mountain Addition Rare II Furthur Planning Areas, Carter County, Tennessee: U.S. Bureau of Mines Open-File Report MLA 8-85, 54 p.

Griffitts, W. R., Bitar, R. F., and Chatman, M. L., in press, Mineral resource potential map of the Pond Mountain and Pond Mountain Addition Roadless Areas, Carter County, Tennessee: U.S. Geological Survey Miscellaneous Field Studies Map MF-1648-A, scale 1:24,000.

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.

King, P. B., and Ferguson, H. W., 1960, Geology of northeasternmost Tennessee: U.S. Geological Survey Professional Paper 311, 136 p.

Taylor, R. G., 1979, Geology of tin deposits: Amsterdam, The Netherlands, Elsevier Scientific Publishing Company, 543 p.

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[1] Any use of trade names is for descriptive purposes only and does not imply endorsement by the U.S. Geological Survey.

TABLE 2.--ANALYTICAL DATA FOR HEAVY-MINERAL CONCENTRATES FROM THE POND MOUNTAIN AREA, TENNESSEE

[pct., percent; ppm, parts per million; s, analyzed by emission spectrograghic methods; M5, fraction magnetic at 0.5 ampere; M1, fraction magnetic at 1.0 ampere; NM, fraction nonmagnetic at 1.0 ampere; N, not detected; <, detected but below limit of detection; >, above upper determination limit; A, B, or C letter designations indicate more than one sample collected from sample locality]

Sample	Latitude	Longitude	Fe-pct. s	Mg-pct. s	Ca-pct. s	Ti-pct. s	Mn-ppm s	Ag-ppm s	As-ppm s	Au-ppm s	B-ppm s	Ba-ppm s	Be-ppm s	Bi-ppm s	Cd-ppm s
80PM1ANM	36 16 46	82 3 50	.5	.05	.10	1.00	150	N	N	N	<20	50	100	N	N
80PM1BNM	36 16 46	82 3 50	.5	<.05	.10	.50	100	N	N	N	20	50	100	N	N
80PM1CNM	36 16 46	82 3 50	.5	<.05	<.10	.50	100	N	N	N	<20	50	100	N	N
80PM6NM	36 16 40	82 5 57	.5	.05	<.10	>1.00	100	N	N	N	500	70	<2	N	N
80PM16NM	36 18 23	82 4 22	.7	.10	<.10	>1.00	50	N	N	N	500	150	<2	N	N
80PM17NM	36 18 23	82 4 14	.7	.15	<.10	>1.00	50	N	N	N	500	150	<2	N	N
80PM18NM	36 17 59	82 4 17	.7	.15	<.10	>1.00	50	N	N	N	500	150	<2	N	N
80PM19NM	36 17 55	82 4 8	.7	.15	7.00	>1.00	300	N	N	N	300	70	7	N	N
80PM30NM	36 17 53	82 4 10	.5	<.05	<.10	>1.00	70	N	N	N	100	50	10	N	N
80PM31NM	36 17 42	82 3 59	.5	.05	<.10	>1.00	70	N	N	N	100	50	7	N	N
80PM32NM	36 17 44	82 4 10	.7	.10	<.10	>1.00	70	N	N	N	300	70	2	N	N
80PM33NM	39 17 24	82 4 3	.7	.10	<.10	>1.00	100	N	N	N	200	70	3	N	N
80PM34NM	36 17 19	82 4 3	.7	.10	<.10	>1.00	50	N	N	N	200	70	2	N	N
80PM35NM	36 16 46	82 4 17	.5	<.05	<.10	.50	70	N	N	N	<20	50	30	N	N
80PM36NM	36 16 53	82 4 20	.3	.05	<.10	.50	70	N	N	N	<20	50	10	N	N
80PM37NM	36 16 30	82 8 5	.7	.15	<.10	>1.00	100	N	N	N	1,500	1,500	<2	N	N
80PM38NM	36 16 47	82 8 13	.7	.20	<.10	>1.00	150	N	N	N	1,500	300	<2	N	N
80PM40NM	36 16 0	82 6 53	.5	.10	<.10	>1.00	150	N	N	N	500	50	5	N	N
80PM41NM	36 15 56	82 6 46	.7	.15	<.10	>1.00	150	N	N	N	200	150	2	N	N
80PM42NM	36 15 48	82 6 42	.7	.05	.50	>1.00	200	N	N	N	150	70	20	N	N
80PM43NM	36 16 5	82 5 59	.7	.07	<.10	>1.00	50	N	N	N	300	70	10	N	N
80PM44NM	36 16 11	82 5 44	.5	<.05	<.10	>1.00	70	N	N	N	100	50	2	N	N
80PM45NM	36 16 0	82 5 10	.5	<.05	<.10	.15	50	N	N	N	<20	<50	2	N	N
80PM46NM	36 18 6	82 7 2	1.0	.15	<.10	>1.00	100	N	N	N	500	200	<2	N	N
80PM47NM	36 18 27	82 6 28	1.0	.10	<.10	>1.00	100	N	N	N	500	200	<2	N	N
80PM48NM	36 18 35	82 5 52	1.0	.20	<.10	>1.00	70	N	N	N	500	200	N	N	N
80PM49NM	36 18 58	82 5 2	1.0	.10	<.10	>1.00	100	N	N	N	500	200	<2	N	N
80PM50NM	36 18 58	82 5 5	1.0	.10	<.10	>1.00	150	N	N	N	700	200	<2	N	N
80PM51NM	36 16 59	82 3 45	.7	<.05	<.10	>1.00	200	N	N	N	100	100	20	N	N
80PM52NM	36 16 8	82 4 47	.7	<.05	<.10	1.00	100	N	N	N	50	70	15	N	N
80PM53NM	36 15 57	82 4 49	.7	<.05	<.10	.50	100	N	N	N	20	50	5	N	N
80PM54NM	36 16 13	82 7 41	2.0	.30	.10	>1.00	500	N	N	N	1,000	100	100	N	N
80PM55NM	36 15 30	82 6 54	.7	<.05	<.10	1.00	100	N	N	N	20	300	5	N	N
80PM1AM1	36 16 46	82 3 50	2.0	.15	1.00	>1.00	1,000	N	N	N	50	100	20	N	N
80PM1BM1	36 16 46	82 3 50	2.0	.20	1.00	>1.00	1,000	N	N	N	50	100	20	N	N
80PM1CM1	36 16 46	82 3 50	2.0	.10	.70	>1.00	1,000	N	N	N	30	70	20	N	N
80PM6M1	36 16 40	82 5 57	2.0	.50	<.10	.50	700	N	N	N	>2,000	<50	<2	N	N
80PM16M1	36 18 23	82 4 22	10.0	.50	<.10	>1.00	1,000	N	N	N	>2,000	500	N	N	N
80PM17M1	36 18 23	82 4 14	10.0	.50	<.10	>1.00	700	N	N	N	>2,000	300	N	N	N
80PM18M1	36 17 59	82 4 17	10.0	.50	<.10	>1.00	200	N	N	N	>2,000	200	N	N	N
80PM19M1	36 17 55	82 4 8	10.0	.50	1.50	>1.00	500	N	N	N	>2,000	200	<2	N	N
80PM30M1	36 17 53	82 4 10	7.0	2.00	1.00	>1.00	500	N	N	N	>2,000	100	<2	N	N
80PM31M1	36 17 42	82 3 59	3.0	.30	<.10	>1.00	300	N	N	N	>2,000	100	N	N	N
80PM32M1	36 17 44	82 4 10	5.0	.50	.20	>1.00	300	N	N	N	>2,000	100	N	N	N
80PM33M1	36 17 24	82 4 3	1.0	.50	<.10	>1.00	300	N	N	N	>2,000	100	N	N	N
80PM34M1	36 17 19	82 4 3	5.0	.50	<.10	>1.00	150	N	N	N	2,000	100	<2	N	N
80PM35M1	36 16 46	82 4 17	5.0	3.00	1.50	>1.00	1,000	N	N	N	200	50	5	N	N
80PM36M1	36 16 53	82 4 20	.7	.20	<.10	>1.00	700	N	N	N	70	100	10	N	N
80PM37M1	36 16 30	82 8 5	20.0	1.00	.10	.70	1,000	N	N	N	>2,000	150	2	N	N
80PM38M1	36 16 47	82 8 13	20.0	.50	<.10	>1.00	1,000	N	N	N	2,000	200	3	N	N
80PM39M1	36 17 50	82 7 43	20.0	.15	<.10	.50	>5,000	N	N	N	1,000	5,000	10	N	N
80PM40M1	36 16 0	82 6 53	2.0	.50	.50	>1.00	500	N	N	N	2,000	100	<2	N	N
80PM41M1	36 15 56	82 6 46	5.0	.50	.50	>1.00	500	N	N	N	2,000	100	N	N	N
80PM42M1	36 15 48	82 6 42	20.0	.50	.15	>1.00	1,000	N	N	N	200	100	2	N	N
80PM43M1	36 16 5	82 5 59	2.0	.50	<.10	>1.00	300	N	N	N	>2,000	70	2	N	N
80PM44M1	36 16 11	82 5 44	10.0	.30	<.10	>1.00	500	N	N	N	1,500	50	10	N	N
80PM45M1	36 16 0	82 5 10	1.0	.10	<.10	1.00	300	N	N	N	50	50	10	N	N
80PM46M1	36 18 6	82 7 2	20.0	.50	<.10	>1.00	3,000	N	N	N	2,000	700	3	N	N
80PM47M1	36 18 27	82 6 28	20.0	.50	<.10	>1.00	3,000	N	N	N	2,000	700	3	N	N
80PM48M1	36 18 35	82 5 52	20.0	.70	<.10	>1.00	1,500	N	N	N	>2,000	500	<2	N	N
80PM49M1	36 18 58	82 5 2	20.0	.10	<.10	.50	>5,000	N	N	N	1,000	1,500	7	N	N
80PM50M1	36 18 58	82 5 5	20.0	.30	<.10	>1.00	5,000	N	N	N	2,000	700	5	N	N
80PM51M1	36 16 59	82 3 45	2.0	.20	<.10	>1.00	5,000	N	N	N	100	50	5	N	N
80PM52M1	36 16 8	82 4 47	1.5	.20	<.10	>1.00	1,500	N	N	N	100	50	5	N	N
80PM53M1	36 15 57	82 4 49	1.5	.20	<.10	>1.00	1,500	N	N	N	100	70	10	N	N
80PM54M1	36 16 13	82 7 41	1.5	.20	<.10	>1.00	100	N	N	N	1,000	150	<2	N	N
80PM55M1	36 15 30	82 6 54	2.0	.10	<.10	>1.00	700	N	N	N	70	50	<2	N	N
80PM1AM5	36 16 46	82 3 50	20.0	1.50	1.00	>2.00	10,000	N	N	N	20	100	20	N	N
80PM1BM5	36 16 46	82 3 50	30.0	1.50	1.00	>2.00	10,000	N	N	N	20	100	15	N	N
80PM1CM5	36 16 46	82 3 50	20.0	1.50	1.00	>2.00	10,000	N	N	N	<20	100	10	N	N
80PM6M5	36 16 40	82 5 57	30.0	.20	.10	1.00	>10,000	N	N	N	1,000	5,000	15	N	N
80PM16M5	36 18 23	82 4 22	30.0	.20	<.10	>2.00	7,000	N	N	N	1,000	3,000	7	N	N
80PM17M5	36 18 23	82 4 14	20.0	.30	.10	2.00	>10,000	N	N	N	1,500	7,000	10	N	N
80PM18M5	36 17 59	82 4 17	20.0	.15	<.10	>2.00	500	N	N	N	300	200	5	N	N
80PM19M5	36 17 55	82 4 8	20.0	.50	1.00	2.00	1,000	N	N	N	300	150	7	N	N
80PM30M5	36 17 53	82 4 10	20.0	1.50	.70	>2.00	5,000	N	N	N	500	200	20	N	N
80PM31M5	36 17 42	82 3 59	20.0	1.00	.20	2.00	7,000	N	N	N	300	100	5	N	N
80PM32M5	36 17 44	82 4 10	30.0	1.00	.50	2.00	7,000	N	N	N	500	200	7	N	N
80PM33M5	36 17 24	82 4 3	20.0	1.00	.20	2.00	10,000	N	N	N	150	<50	5	N	N
80PM34M5	36 17 19	82 4 3	30.0	.20	<.10	>2.00	1,000	N	N	N	500	200	7	N	N
80PM35M5	36 16 46	82 4 17	20.0	.70	.30	>2.00	7,000	N	N	N	20	50	10	N	N
80PM36M5	36 16 53	82 4 20	20.0	.10	<.10	>2.00	7,000	N	N	N	<20	100	20	N	N
80PM37M5	36 16 30	82 8 5	30.0	.50	.15	.70	>10,000	N	N	N	2,000	5,000	10	N	N
80PM38M5	36 16 47	82 8 13	30.0	.50	.20	.70	>10,000	N	N	N	1,000	700	15	N	N
80PM39M5	36 17 50	82 7 43	30.0	.15	.10	.70	>10,000	N	N	N	500	10,000	20	N	N
80PM40M5	36 16 0	82 6 53	30.0	.10	.10	>2.00	5,000	N	N	N	200	70	3	N	N
80PM41M5	36 15 56	82 6 46	30.0	.20	.15	>2.00	3,000	N	N	N	300	100	10	N	N
80PM42M5	36 15 48	82 6 42	20.0	.07	.10	>2.00	5,000	N	N	N	<20	50	<2	N	N
80PM43M5	36 16 5	82 5 59	20.0	.30	.10	>2.00	3,000	N	N	N	1,000	100	5	N	N
80PM45M5	36 16 0	82 5 10	15.0	.50	.10	>2.00	7,000	N	N	N	20	70	30	N	N
80PM46M5	36 18 6	82 7 2	20.0	.20	<.10	1.00	>10,000	N	N	N	1,000	10,000	20	N	N
80PM47M5	36 18 27	82 6 28	20.0	.20	<.10	2.00	>10,000	N	N	N	1,000	5,000	15	N	N
80PM48M5	36 18 35	82 5 52	30.0	.20	.10	2.00	10,000	N	N	N	1,000	3,000	15	N	N
80PM49M5	36 18 58	82 5 2	30.0	.15	<.10	.50	>10,000	N	N	N	700	>10,000	20	N	N
80PM50M5	36 18 58	82 5 5	30.0	.20	.10	1.50	10,000	N	N	N	700	2,000	20	N	N
80PM51M5	36 16 59	82 3 45	15.0	.10	.15	2.00	10,000	N	N	N	20	100	7	N	N
80PM52M5	36 16 8	82 4 47	15.0	.15	<.10	>2.00	7,000	N	N	N	20	50	50	N	N
80PM53M5	36 15 57	82 4 49	15.0	.20	.15	2.00	7,000	N	N	N	20	70	30	N	N
80PM54M5	36 16 13	82 7 41	20.0	.50	.10	>2.00	500	N	N	N	2,000	100	5	N	N
80PM55M5	36 15 30	82 6 54	20.0	.15	.15	>2.00	5,000	N	N	N	20	100	10	N	N

Sample	Co-ppm s	Cr-ppm s	Cu-ppm s	La-ppm s	Mo-ppm s	Nb-ppm s	Ni-ppm s	Pb-ppm s	Sb-ppm s	Sc-ppm s	Sn-ppm s	Sr-ppm s	V-ppm s	W-ppm s	Y-ppm s	Zn-ppm s	Zr-ppm s	Th-ppm s
80PM1ANM	N	<20	<10	300	N	70	N	50	N	N	>1,000	N	20	N	300	N	>1,000	<200
80PM1BNM	N	N	<10	N	N	50	N	20	N	N	>1,000	N	20	N	200	N	>1,000	200
80PM1CNM	N	N	<10	N	N	100	N	20	N	N	>1,000	N	20	N	200	N	>1,000	<200
80PM6NM	N	20	10	300	N	N	10	100	N	>100	200	N	100	N	1,000	N	>1,000	N
80PM16NM	N	150	50	100	N	N	N	30	N	30	50	N	100	N	500	N	>1,000	N
80PM17NM	N	200	50	100	N	N	<10	30	N	20	50	N	100	N	300	N	>1,000	N
80PM18NM	N	150	50	100	N	N	<10	30	N	30	300	N	100	N	1,000	N	>1,000	N
80PM19NM	N	50	20	150	N	70	<10	50	N	15	300	N	100	N	700	N	>1,000	N
80PM30NM	N	20	700	N	N	100	<10	150	N	N	>1,000	N	50	N	300	N	>1,000	N
80PM31NM	N	70	150	N	N	70	<10	20	N	15	>1,000	N	100	N	500	N	>1,000	N
80PM32NM	N	150	50	50	N	N	<10	50	N	30	>1,000	N	100	N	1,000	N	>1,000	N
80PM33NM	N	150	50	150	N	N	N	70	N	30	>1,000	N	150	N	500	N	>1,000	N
80PM34NM	N	150	50	150	N	N	N	20	N	20	>1,000	N	100	N	700	N	>1,000	N
80PM35NM	N	N	<10	N	N	70	N	20	N	N	>1,000	N	20	N	300	N	>1,000	500
80PM36NM	N	N	10	N	N	70	N	<20	N	N	>1,000	N	20	N	50	N	>1,000	N
80PM37NM	N	150	20	150	N	N	N	30	N	30	300	N	150	N	1,000	N	>1,000	N
80PM38NM	N	150	30	200	N	N	N	30	N	30	>1,000	N	100	N	1,000	N	>1,000	N
80PM40NM	N	100	20	150	N	N	<10	70	N	70	500	N	100	N	1,000	N	>1,000	N
80PM41NM	N	200	30	200	N	N	N	100	N	100	>1,000	N	200	N	1,000	N	>1,000	N
80PM42NM	N	50	20	50	N	N	<10	50	N	50	>1,000	N	100	N	500	N	>1,000	N
80PM43NM	N	150	30	150	N	N	N	30	N	50	>1,000	N	100	N	700	N	>1,000	N
80PM44NM	N	50	10	N	N	150	N	<20	N	N	>1,000	N	50	N	200	N	>1,000	<200
80PM45NM	N	N	<10	N	N	150	N	N	N	N	>2,000	N	<20	<100	70	N	>1,000	N
80PM46NM	N	150	50	150	N	N	<10	200	N	100	300	N	100	N	1,000	N	>1,000	N
80PM47NM	N	150	50	100	N	N	<10	500	N	100	500	N	100	N	1,000	N	>1,000	N
80PM48NM	N	200	50	100	N	N	<10	20	N	100	500	N	100	N	1,000	N	>1,000	N
80PM49NM	N	200	100	150	N	N	<10	70	N	150	300	N	100	N	1,500	N	>1,000	N
80PM50NM	N	150	30	200	N	N	<10	30	N	150	300	N	100	N	1,500	N	>1,000	N
80PM51NM	N	50	200	200	N	500	<10	100	N	70	>2,000	N	70	N	>2,000	N	>1,000	>2,000
80PM52NM	N	N	<10	150	N	50	<10	70	N	50	>2,000	N	<20	N	2,000	N	>1,000	1,000
80PM53NM	N	N	<10	100	N	150	<10	50	N	30	>2,000	N	30	N	1,500	N	>1,000	2,000
80PM54NM	N	100	<10	150	N	100	<10	70	N	20	>2,000	N	50	<100	200	N	>1,000	<200
80PM55NM	N	N	10	<50	N	100	<10	50	N	20	>2,000	N	20	N	500	N	>1,000	2,000
80PM1AM1	N	700	150	>1,000	N	1,500	10	700	N	10	2,000	N	100	200	>2,000	N	>1,000	>2,000
80PM1BM1	N	700	150	>1,000	N	1,000	20	700	N	10	2,000	N	100	500	>2,000	N	1,000	>2,000
80PM1CM1	N	700	150	>1,000	N	1,000	20	700	N	10	>2,000	N	100	300	>2,000	N	1,000	>2,000
80PM6M1	N	100	10	>1,000	N	500	N	30	N	10	150	N	70	<100	2,000	N	>1,000	500
80PM16M1	N	300	200	>1,000	N	100	20	150	N	10	50	N	70	N	500	N	>1,000	700
80PM17M1	N	500	200	>1,000	N	150	30	100	N	10	100	N	100	<100	500	N	>1,000	700
80PM18M1	N	500	200	>1,000	N	70	30	100	N	10	70	N	100	N	300	N	>1,000	300
80PM19M1	N	200	200	>1,000	N	150	20	200	N	10	200	N	100	N	700	N	>1,000	200
80PM30M1	N	1,000	200	>1,000	N	500	70	200	N	20	>2,000	N	100	N	1,000	N	>1,000	2,000
80PM31M1	N	200	200	>1,000	N	200	N	300	N	20	>2,000	N	70	<100	2,000	N	>1,000	>2,000
80PM32M1	N	300	200	>1,000	N	100	N	300	N	20	1,000	N	50	N	2,000	N	>1,000	>2,000
80PM33M1	N	300	200	>1,000	N	100	N	500	N	>100	>2,000	N	50	N	>2,000	N	1,000	>2,000
80PM34M1	50	500	150	>1,000	N	50	20	200	N	<10	>1,000	N	70	N	1,000	N	>1,000	2,000
80PM35M1	50	2,000	100	>1,000	<10	>2,000	100	300	N	20	>1,000	N	100	<100	1,500	N	1,000	>2,000
80PM36M1	20	1,000	100	>1,000	N	1,500	N	500	N	10	>1,000	N	20	N	>2,000	N	>1,000	>2,000
80PM37M1	50	700	100	1,000	N	50	100	100	N	20	300	N	100	N	700	N	>1,000	500
80PM38M1	30	300	150	1,000	N	50	70	100	N	20	100	N	100	N	500	N	>1,000	<200
80PM39M1	300	200	150	700	N	<50	200	100	N	15	50	N	70	N	200	<500	700	<200
80PM40M1	30	200	100	>1,000	N	100	<10	300	N	10	30	N	70	N	1,000	N	>1,000	>2,000
80PM41M1	20	1,500	100	>1,000	N	150	10	100	N	10	700	N	70	N	1,000	N	>1,000	2,000
80PM42M1	300	2,000	200	1,000	N	200	200	100	N	20	>1,000	1,000	100	300	700	N	1,000	500
80PM43M1	30	500	50	>1,000	N	1,000	N	300	N	10	700	N	50	<100	2,000	N	>1,000	>2,000
80PM44M1	30	2,000	50	>1,000	<10	2,000	N	200	N	10	>1,000	N	50	<100	2,000	N	>1,000	>2,000
80PM45M1	<10	2,000	50	>1,000	N	>2,000	N	300	N	<10	>1,000	N	<20	<100	>2,000	N	1,000	>2,000
80PM46M1	50	500	200	1,000	N	100	70	100	N	20	500	N	100	N	500	N	>1,000	300
80PM47M1	50	200	150	1,000	N	100	70	100	N	20	200	N	100	N	500	N	>1,000	500
80PM48M1	50	300	200	1,000	N	200	70	100	N	20	100	N	100	N	500	N	>1,000	500
80PM49M1	100	70	50	700	N	150	70	50	N	10	30	N	70	N	300	N	1,000	<200
80PM50M1	100	200	150	1,000	N	500	150	150	N	50	300	N	100	N	500	N	>1,000	<200
80PM51M1	<10	200	50	>1,000	N	>2,000	N	200	N	50	>1,000	N	100	N	>1,000	N	>1,000	>2,000
80PM52M1	<10	1,000	50	>1,000	N	>2,000	N	200	N	50	>1,000	N	<20	N	>1,000	N	>1,000	>2,000
80PM53M1	<10	1,500	50	>1,000	N	>2,000	N	300	N	50	>1,000	N	<20	<100	>1,000	N	>1,000	>2,000
80PM54M1	<10	300	50	300	N	<50	N	70	N	100	500	N	150	N	700	N	>1,000	N
80PM55M1	<10	100	10	>1,000	N	2,000	N	100	N	10	500	N	20	N	>1,000	N	1,000	>2,000
80PM1AM5	100	200	70	1,500	N	3,000	50	50	N	70	1,000	N	200	2,000	1,000	700	500	500
80PM1BM5	100	200	70	500	10	5,000	50	50	N	70	300	N	200	2,000	1,000	1,000	500	<200
80PM1CM5	100	200	70	700	10	1,000	50	50	N	150	2,000	N	200	20,000	1,000	500	300	200
80PM6M5	150	500	50	150	N	100	70	30	N	20	N	N	300	500	200	<500	2,000	N
80PM16M5	150	200	70	300	N	100	20	30	N	20	N	N	300	N	70	<500	500	N
80PM17M5	200	200	100	100	N	150	70	30	N	15	N	<200	200	<100	100	N	700	N
80PM18M5	20	200	15	200	N	150	20	30	N	15	N	N	300	N	70	N	1,000	N
80PM19M5	100	200	70	300	N	100	50	100	N	20	N	300	500	N	70	<500	500	N
80PM30M5	70	1,000	100	200	10	5,000	70	50	N	50	500	<200	200	500	500	500	700	N
80PM31M5	20	300	50	1,000	N	2,000	20	50	N	100	>2,000	N	200	1,000	1,000	N	700	300
80PM32M5	100	200	70	1,000	N	150	50	100	N	70	200	<200	200	<100	700	N	700	300
80PM33M5	30	300	15	1,000	N	100	15	30	N	150	1,500	N	70	N	1,500	N	1,500	500
80PM34M5	50	300	30	700	10	150	30	30	N	20	200	N	200	N	500	N	1,000	200
80PM35M5	50	1,000	50	200	20	3,000	50	30	N	50	500	N	200	300	1,000	700	500	N
80PM36M5	30	500	50	300	15	5,000	20	70	N	50	2,000	N	200	300	>5,000	1,000	700	300
80PM37M5	70	300	100	70	N	1,000	100	50	N	20	30	200	100	<100	500	N	2,000	N
80PM38M5	50	1,000	100	100	N	150	100	50	N	30	N	200	100	N	200	N	700	N
80PM39M5	500	300	150	100	10	50	300	100	N	20	N	<200	150	N	100	1,000	300	N
80PM40M5	100	150	15	N	N	150	20	20	N	20	N	N	300	N	70	1,000	500	N
80PM41M5	50	2,000	20	200	N	200	50	30	N	20	70	N	300	N	200	N	700	N
80PM42M5	100	150	20	N	N	300	50	<20	N	10	N	N	300	N	20	700	300	N
80PM43M5	30	300	30	150	<10	3,000	20	30	N	50	1,000	N	200	200	3,000	<500	700	N
80PM45M5	20	7,000	100	200	20	>5,000	50	70	N	200	>2,000	<200	100	1,000	>5,000	500	2,000	500
80PM46M5	500	300	300	50	30	300	150	500	N	20	150	<200	150	N	200	N	500	N
80PM47M5	200	300	100	200	N	200	70	700	N	20	20	N	200	N	100	N	2,000	N
80PM48M5	150	300	100	150	N	100	70	50	N	20	30	N	200	N	200	<500	1,500	N
80PM49M5	300	300	100	<50	15	70	150	70	N	20	N	N	150	N	100	N	700	N
80PM50M5	200	100	100	150	15	70	200	100	N	15	N	N	150	N	100	<500	700	N
80PM51M5	15	200	200	700	20	>5,000	20	100	N	50	2,000	<200	100	700	5,000	1,000	2,000	1,000
80PM52M5	15	5,000	200	100	70	>5,000	20	70	N	>200	2,000	N	70	1,000	3,000	N	2,000	200
80PM53M5	20	7,000	200	150	50	>5,000	50	100	N	>200	1,500	N	100	1,000	5,000	N	2,000	500
80PM54M5	30	500	15	200	10	1,000	20	20	N	20	N	N	200	N	700	N	2,000	N
80PM55M5	20	30	10	1,000	20	>5,000	15	70	N	50	200	N	50	N	2,000	N	1,000	500

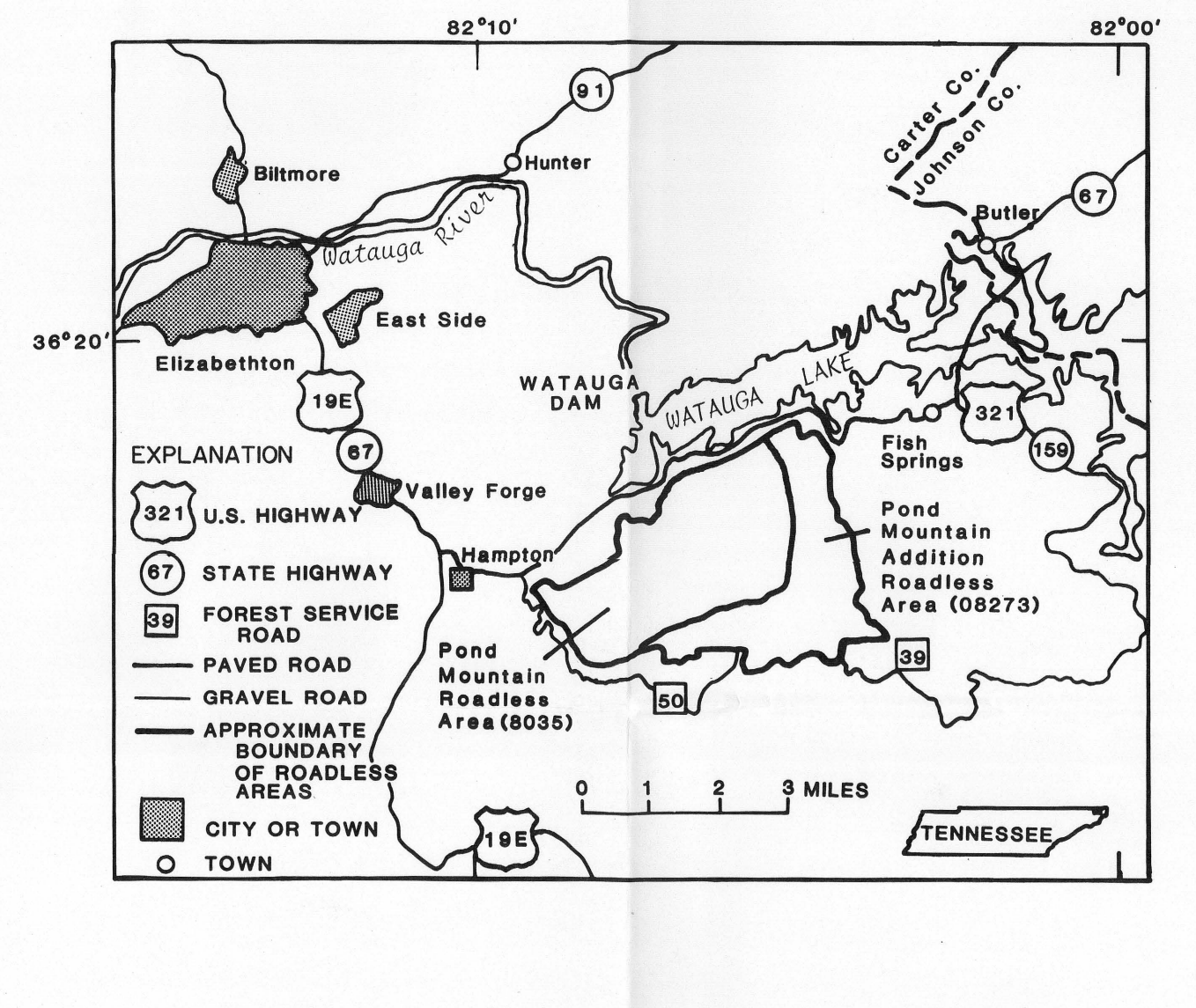
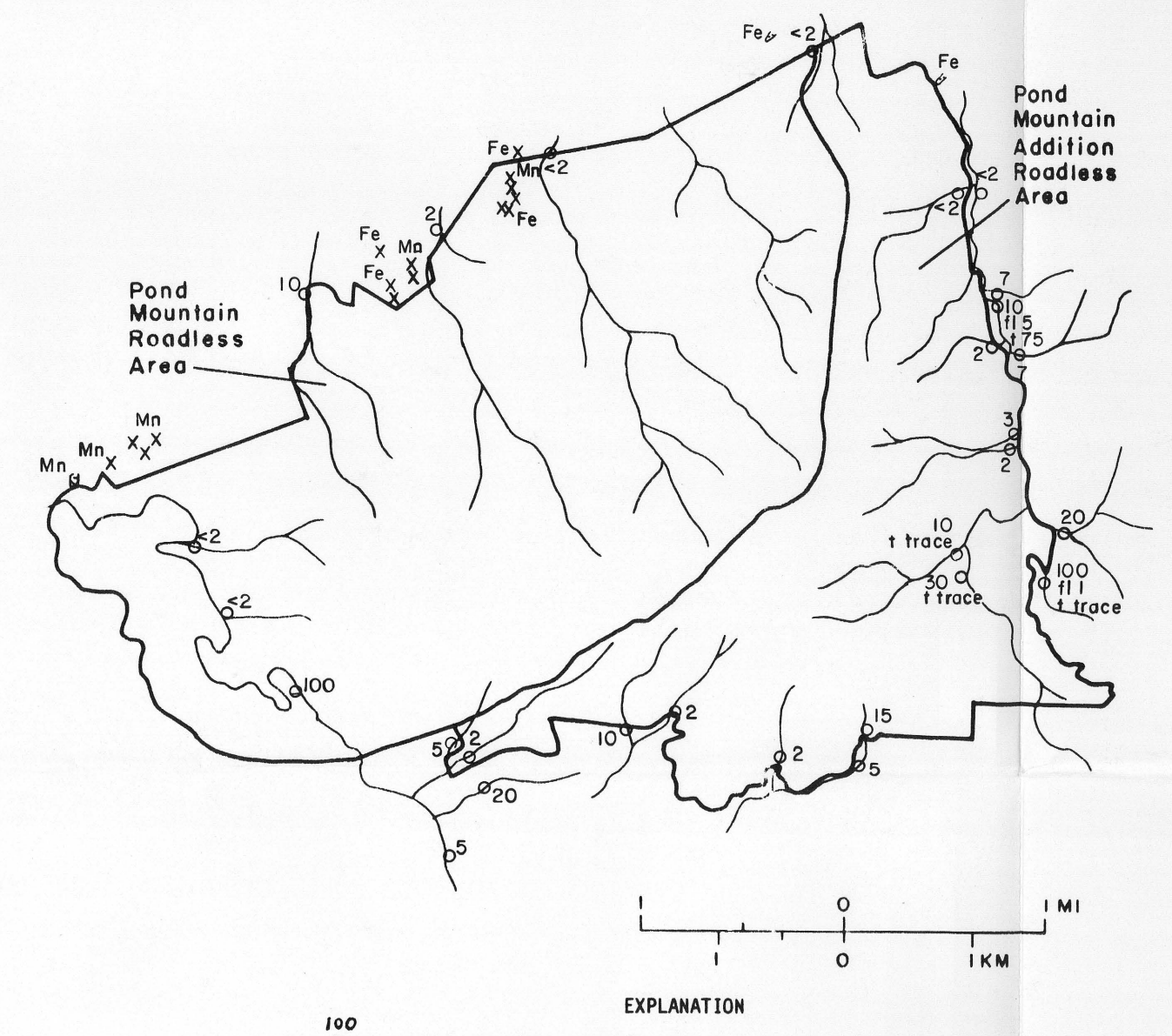


Figure 1.--Index map showing location of the Pond Mountain and Pond Mountain Addition Roadless Areas.

Table 1.--The limits of determination for the spectrographic analysis of rocks and stream sediments on the basis of a 10-mg sample

[Spectrographic limits of determination for heavy-mineral-concentrate samples are two reporting units higher than the limits given for rocks and stream sediments]

Elements	Lower determination limit	Upper determination limit
Percent		
Iron (Fe)	0.05	20
Magnesium (Mg)	.02	10
Calcium (Ca)	.05	20
Titanium (Ti)	.002	1
Parts per million		
Manganese (Mn)	10	5,000
Silver (Ag)	0.5	5,000
Arsenic (As)	200	10,000
Gold (Au)	10	500
Boron (B)	10	2,000
Barium (Ba)	20	5,000
Beryllium (Be)	1	1,000
Bismuth (Bi)	10	1,000
Cadmium (Cd)	20	500
Cobalt (Co)	5	2,000
Chromium (Cr)	10	5,000
Copper (Cu)	5	20,000
Lanthanum (La)	20	1,000
Molybdenum (Mo)	5	2,000
Niobium (Nb)	20	2,000
Nickel (Ni)	5	5,000
Lead (Pb)	10	20,000
Antimony (Sb)	100	10,000
Scandium (Sc)	5	100
Tin (Sn)	10	1,000
Strontium (Sr)	100	5,000
Vanadium (V)	10	10,000
Tungsten (W)	50	10,000
Yttrium (Y)	10	2,000
Zinc (Zn)	200	10,000
Zirconium (Zr)	10	1,000
Thorium (Th)	100	2,000



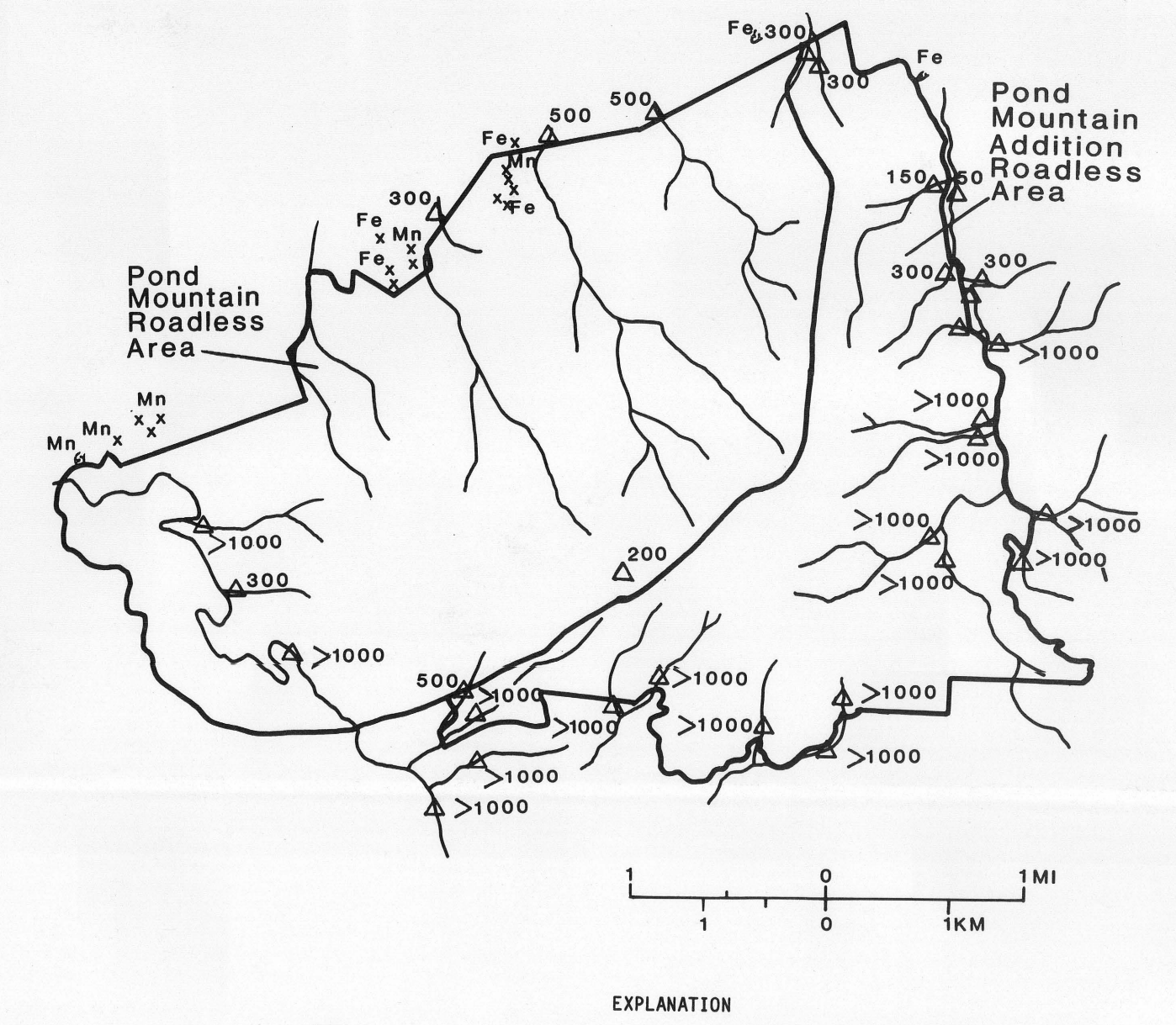
EXPLANATION

100 fl 5 t 75 SAMPLE LOCALITY--Number indicates Be (beryllium) content in ppm; fl 5, fluorite content in percent; t 75, topaz content in percent in nonmagnetic fraction of stream sediment

Fe MINE--Principal metal occurrence indicated by Fe, iron

x PROSPECT--Principal metal occurrence indicated by Fe, iron; Mn, manganese

Figure 2.--Map showing beryllium, fluorite, and topaz in the Pond Mountain and Pond Mountain Addition Roadless Areas.



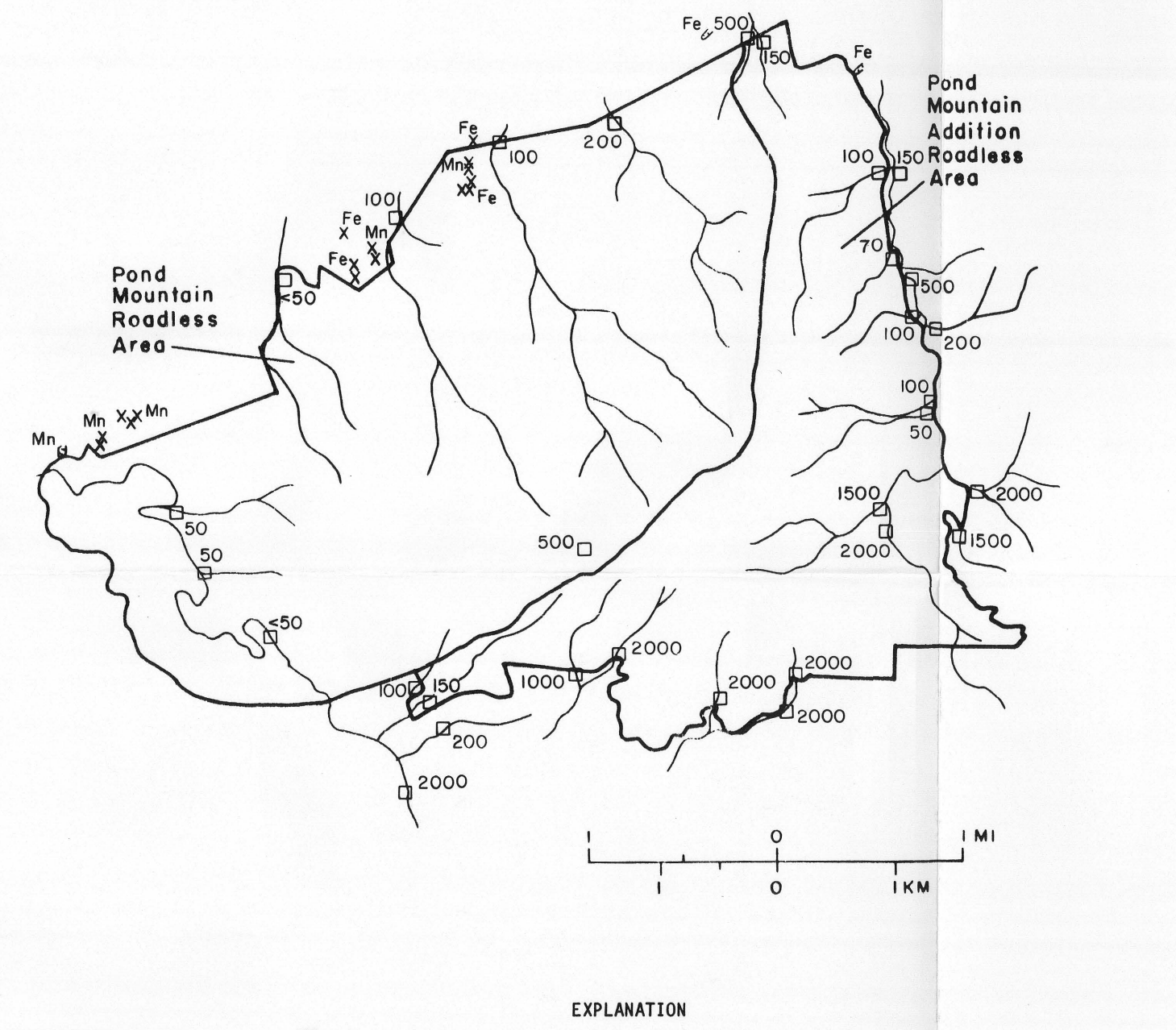
EXPLANATION

300 SAMPLE LOCALITY--Number indicates Sn (tin) content in ppm in nonmagnetic fraction of stream sediment

Fe MINE--Principal metal occurrence indicated by Fe, iron

x Mn PROSPECT--Principal metal occurrence indicated by Fe, iron; Mn, manganese

Figure 3.--Map showing tin in the Pond Mountain and Pond Mountain Addition Roadless Areas.



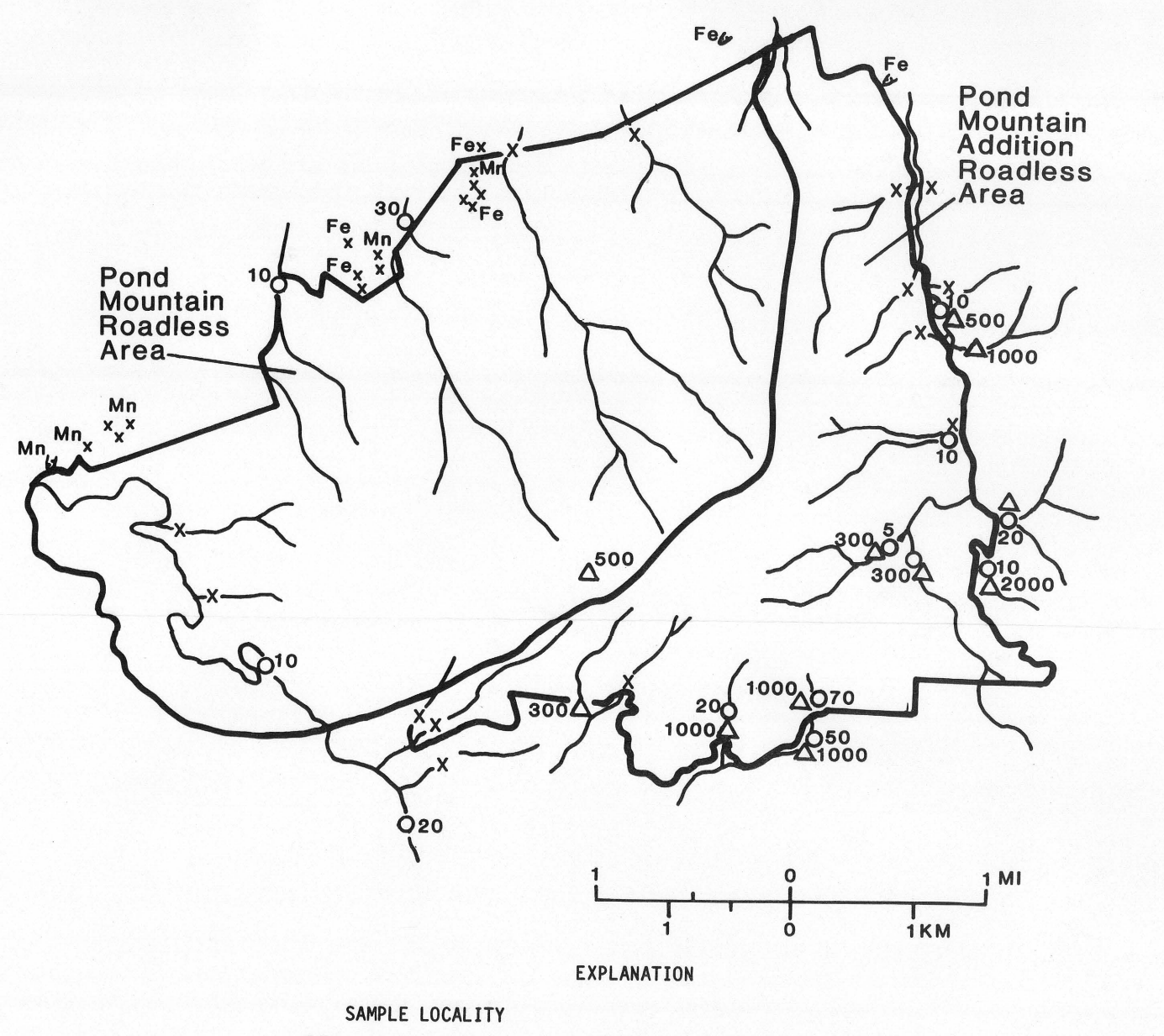
EXPLANATION

100 SAMPLE LOCALITY--Number indicates Nb (niobium) content in ppm in magnetic fraction (M1) of stream sediment

Fe MINE--Principal metal occurrence indicated by Fe, iron

x PROSPECT--Principal metal occurrence indicated by Fe, iron; Mn, manganese

Figure 4.--Map showing niobium in the Pond Mountain and Pond Mountain Addition Roadless Areas.



EXPLANATION

SAMPLE LOCALITY

300 Number indicates W (tungsten) content in ppm in magnetic fraction of stream sediment

10 Number indicates Mo (molybdenum) content in ppm in magnetic fraction (M.5) of stream sediment

X Indicates sample containing neither W (tungsten) or Mo (molybdenum)

Fe MINE--Principal metal occurrence indicated by Fe, iron

x PROSPECT--Principal metal occurrence indicated by Fe, iron; Mn, manganese

Figure 5.--Map showing tungsten and molybdenum in the Pond Mountain and Pond Mountain Addition Roadless Areas.

GEOCHEMICAL MAP OF THE POND MOUNTAIN AND POND MOUNTAIN ADDITION ROADLESS AREAS, CARTER COUNTY, TENNESSEE

By

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