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PAMPHLET

MINERAL RESOURCE POTENTIAL OF THE LYE BROOK WILDERNESS, BENNINGTON AND WINDHAM COUNTIES, VERMONT

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Studies Related To Wilderness

Under the provisions of the Wilderness Act (Public Law 88-577, September 3, 1964) and related acts , the U.S. Geological Survey and U.S. Bureau of Mines have been conducting mineral surveys of wilderness and primitive areas. Areas officially designated as "wilderness," "wild," or "canoe" when the act was passed were incorporated into the National Wilderness Preservation System, and some of them are presently being studied. The act provided that areas under consideration for wilderness designation should be studied for suitability for incorporation into the Wilderness System. The mineral surveys constitute one aspect of the suitability studies. The act directs that the results of such surveys are to be made available to the public and be submitted to the President and the Congress. This report discusses the results of a mineral survey of the Lye Brook Wilderness, Green Mountains National Forest, Bennington and Windham Counties, Vt. The area was established as a wilderness by Public Law 93-622, January 3, 1975.

MINERAL RESOURCE POTENTIAL SUMMARY STATEMENT

The Lye Brook Wilderness contains no significant mineral deposits. Although the Cheshire Quartzite is a potential source of low-grade silica sand and crops out in a large area within the wilderness, its degree of induration and relative inaccessibility make its use prohibitive. No major concentation of base metals exist within the Precambrian rocks, although they contain the highest metal concentrations within the wilderness. Uranium mineralization is not extensive in the Precambrian rocks, despite the occurrence of significant deposits nearby.

INTRODUCTION

Lye Brook Wilderness includes about 14,500 acres in the Green Mountain National Forest in southwestern Vermont. Parts of Bennington and Windham Counties southeast of Manchester Center and west of the Stratton Mountain Winter Sports Area are within the wilderness (fig. 1).

The study area is bounded on the west by U.S. Route 7, just east of the southerly flowing Batten Kill, and by Bromley Brook (fig. 1). Mill Brook constitutes part of the southwestern boundary, but the boundary is only approximate toward the southeast because it passes into a flat, marshy area just north of Branch Pond. The eastern boundary coincides for the most part with the Winhall River; traces of the Appalachian and Long Trails are the northern boundaries. The wilderness is about 2 mi east of the village of Manchester Depot.

The three most important trails giving access to the wilderness are the Lye Brook, Appalachian, and Long Trails. The Appalachian and Long Trails afford access to the northeastern part of the wilderness, while the Lye Brook Trail traverses the area from northwest to southeast. At least half of the wilderness is not easily accessible by trails, especialy the central and southeastern portion. The major rivers within the wilderness are for the most part difficult to navigate by small boat or canoe because of their steep gradients and numerous boulders.

Previous Studies

Reconnaissance geologic work by Billings and others (1952) and the detailed study of Hewitt (1961) include a portion of the wilderness area. Hewitt mapped the area to the west of the wilderness but also included a large portion of the western half of the wilderness in his geologic map. His report described the rock types, structure, stratigraphy, and metamorphism of the major lithologies. His analysis of the essentials of the geologic history of this area served as the basis for the geologic description that follows.

The presence of anomalously high radioactive areas within the wilderness were reported by Popenoe (1964). In addition, areas containing high-silica sand and construction materials, mineral pigments, and kaolin in the immediate surroundings of the Lye Brook Wilderness were included in a previous U.S. Bureau of Mines study (Harrison, 1981). This report also described an ocher deposit (nodular iron ore cut by

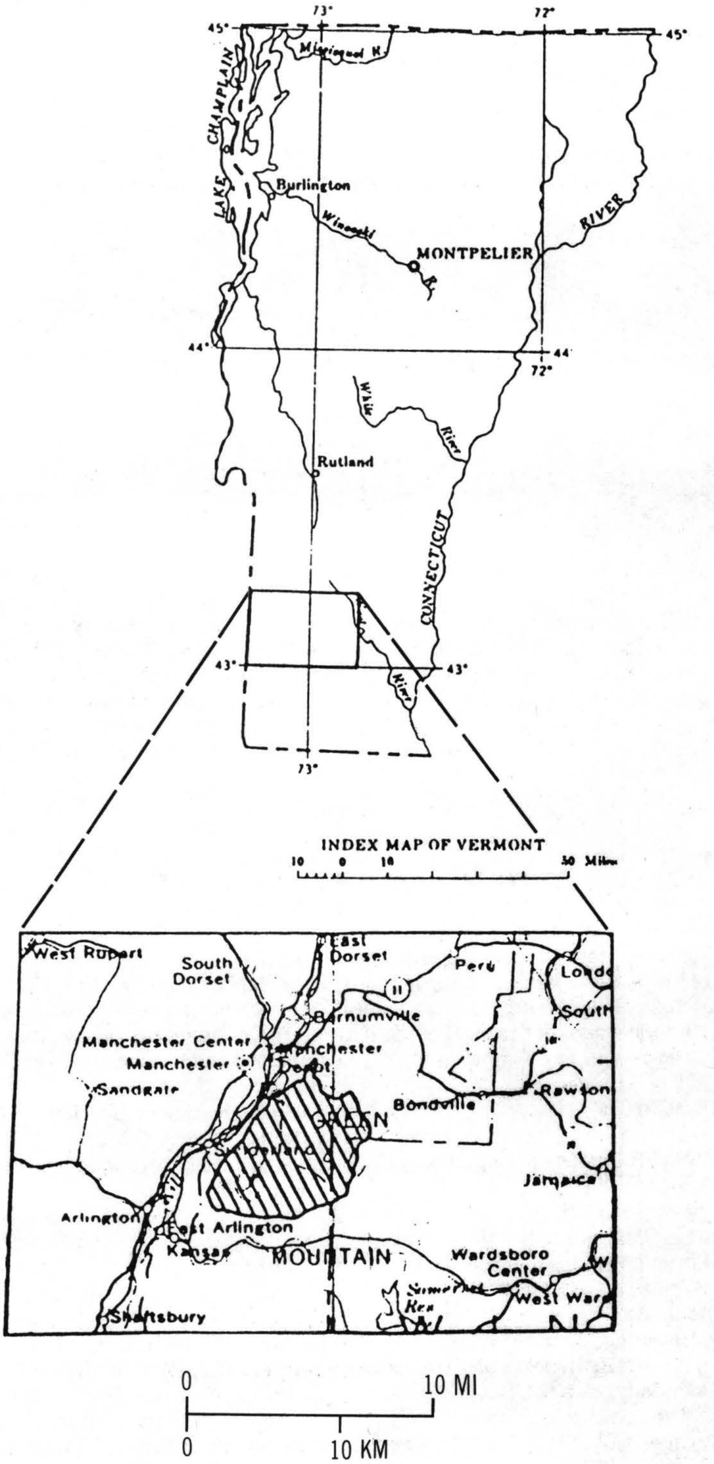


Figure 1.—Index map of Vermont showing location of the Lye Brook Wilderness.

manganese-bearing veins) characterized by Hewitt (1961) and Burt (1931).

Present Study

The U.S. Geological Survey (USGS) and the U.S. Bureau of Mines (USBM) completed field and laboratory studies in order to assess the mineral potential of the wilderness.

The geologic map of this report essentially represents the map published by Hewitt (1961) with modifications resulting from field work by the USGS (Ayuso and Robinson, in press). R. A. Ayuso, who was asssisted by G. R. Robinson, Jr., J. A. Goss, Allan Kolker, and W. B. Ward during the fall of 1981 and summer of 1982, collected geochemical samples from the Lye Brook Wilderness and vicinity (Ayuso and Day, in press) and did some geologic mapping, especially in the eastern portion of the area. A. E. Grosz collected heavy-mineral separates within and near the wilderness during the summer of 1981.

Seventy stream-sediment, 42 soil, and 120 rock samples were obtained for analysis. These were analyzed at the laboratories of the USGS by semiquantitative spectrographic methods for 31 elements. Eighteen representative samples were analyzed by delayed neutron-activation analysis for uranium and thorium and by atomic absorption for zinc. Results and discussion of the geochemical survey are given in Ayuso and Day (in press).

Field work in the fall of 1977 by the USBM and the past mining activity were summarized by Harrison (1981). Thirty-eight random chip or channel samples were taken from outcrops, float, grab samples of ocher concentrations, and one soil sample. The samples were analyzed spectrographically for 40 elements by the USBM Reno Metallurgy Research Center, Reno, Nev. Selected samples were tested by neutron-activation, atomic-absorption, and fire-assay analyses (Harrison, 1981).

SURFACE- AND MINERAL-RIGHTS OWNERSHIP

Approximately 90 percent of the surface and mineral rights are owned by the Federal government (fig. 2). Private ownership, which probably accounts for less than 10 percent of the area, is concentrated in the southeastern portion in Windham County and as smaller areas on the eastern boundary of the wilderness.

GEOLOGY AND GEOCHEMISTRY

Rocks of the Lye Brook Wilderness are of Late Precambrian through Early Cambrian age and rest unconformably on a basement consisting of gneisses, quartzites, schists, and amphibolites of Precambrian age known as the Mount Holly complex (Hewitt, 1961). The gneisses form irregularly banded rocks composed of quartz, microcline, and biotite, retrograded to greenschist facies metamorphism (Ayuso and Robinson, in press). Quartzites of variable thickness are massive, highly contorted, and cut by thin pegmatitic veins. Schists and amphibolites are also evident in the Precambrian basement near the eastern boundary of the wilderness.

The Early Cambrian sequence is represented by the Mendon Formation, which comprises conglomeratic quartz schist, gritty quartz-muscovite schist and graphitic quartz-muscovite phyllite among its major rock types (Hewitt, 1961). Dark quartzite lenses within the phyllite characterize the upper part of this formation, whereas the conglomerate unit occurs near the base. Blue quartz pebbles up to an inch in diameter occur in layers near the contact between the Early Cambrian and Precambrian rocks in Lye Brook Hollow (Ayuso and Robinson, in press).

The Cheshire Quartzite overlies the Mendon Formation and consists of massively bedded, gray to white, recrystallized sandstone. Hewitt (1961) observed that feldspar and ankerite are more abundant, and the bedding is less massive and becomes more phyllitic, toward the lower part of the Cheshire. The transition between the underlying Mendon Formation and the Cheshire Quartzite is gradational, as is the transition to the overlying Dunham Dolomite.

Two relatively small areas within the wilderness are underlain by the Dunham dolomite (Early Cambrian age), which consist of cream-colored, medium-bedded rocks. More extensive exposures of this rock type are evident near the northwest boundary of the wilderness along Lye Brook.

The Lye Brook Wilderness includes part of the west flank of the Green Mountains Anticlinorium, where it consists of an escarpment that faces west (Hewitt, 1961). Isoclinal and recumbent folding is characteristic of the rocks in this area, superimposed on the Green Mountains Anticlinorium. Minor folds overturned to the west are also characteristic of the Early Cambrian rocks. Slip cleavage and plastic deformation is a result of the intense shearing of the rocks overlying the Precambrian basement.

A reconnaissance geochemical survey of the Lye Brook Wilderness was made by the USGS to explore for unidentified and unexposed mineral deposits. Samples were collected and analyzed in order to describe the geochemical distribution and the possible existence of geochemical halos developed near mineral deposits. The results of this survey are discussed in Ayuso and Day (in press).

ASSESSMENT OF MINERAL RESOURCE POTENTIAL

Geochemical analyses of stream-sediment, soil, and rock samples suggest that unusually high metal contents are absent in the wilderness area. A large resource of silica, suitable for use as dimension or crushed stone, occurs within the wilderness in the Cheshire Quartzite. At least one third of the area is underlain by the Cheshire Quartzite, thus making silica resources potentially extensive. Extensive uranium mineralization is known in the nearby town of Jamaica, directly east of the wilderness boundary. Uranium concentrations within the Precambrian rock in the wilderness were typically less than 5 ppm. Restricted and spotty areas in the Precambrian Mt. Holly Complex rocks had values up to 51 ppm for thorium, giving unusually high thorium/uranium ratios. The random occurrence and distribution of anomalously high thorium-bearing rocks, together with the abundant glacial cover and inaccessibility of the wilderness, argue against more detailed exploration. Given the highly discontinous nature of the radioactive rocks and the thick glacial overburden, much effort would be needed to produce a reliable description of the occurrence of these rocks in the eastern part of the Lye Brook Wilderness.

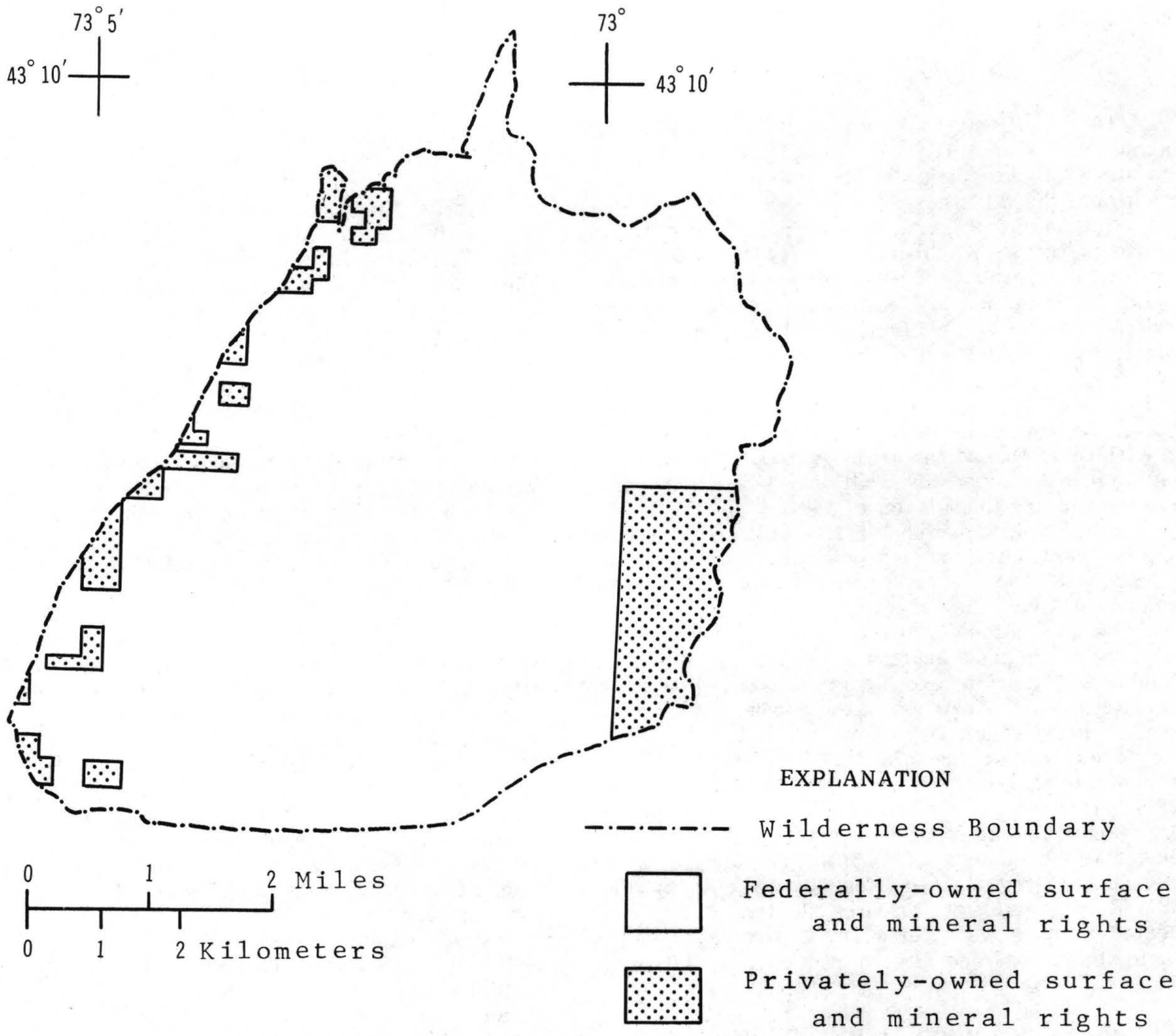
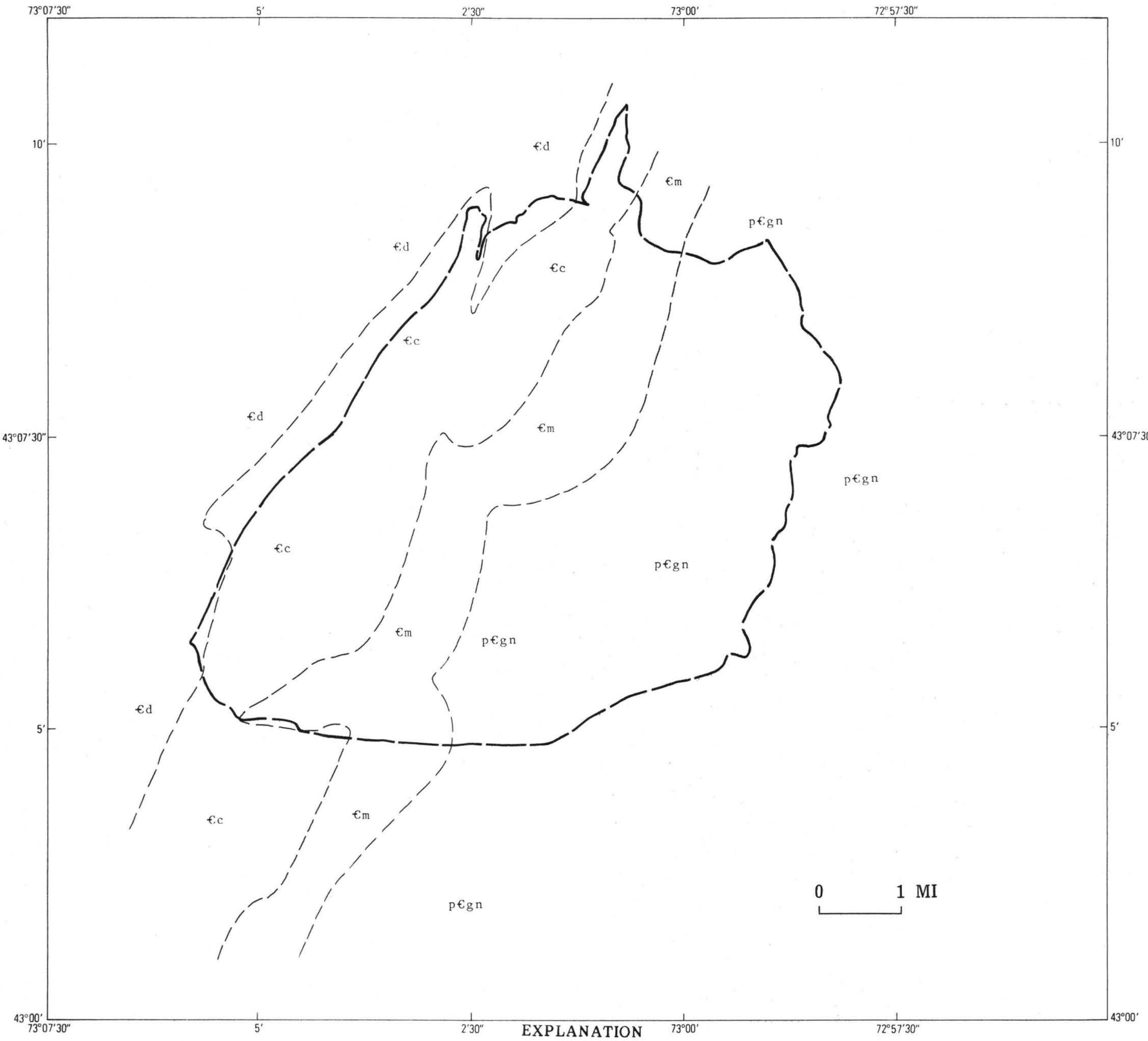


Figure 2.—Surface- and mineral-rights ownership.



EXPLANATION

€d	Dunham Dolomite (Clark, 1934) (Early Cambrian)—Cream-colored, medium-bedded dolomite
€c	Cheshire Quartzite (Early Cambrian)—Massively bedded, grey to white, recrystallized sandstone. Rock unit may be approximately as much as 800 ft thick. No quarries are known in the area. Chemical analyses show that the quartzite has too many impurities for use as high-grade silica sand. Potential uses are for dimension stone or crushed stone
€m	Mendon Formation (Early Cambrian)—Conglomeritic quartz schist, gritty quartz-muscovite schist, and graphitic quartz-muscovite phyllite
p€gn	Mount Holly Complex (Precambrian)—Gneisses, quartzites, schists, and amphibolites
(dashed line)	Contact—Long dashed where approximately located; short dashed where indefinite or inferred

Figure 3.--Geology and outcrop area of Cheshire Quartzite.

The Cheshire Quartzite represents a potential source for dimension or crushed stone and silica sand. However, its importance is minimized because it is a common rock type in Vermont and Massachusetts. Thus, it is easily available outside of the wilderness. Stone and Dennis (1964) reported that the Cheshire Quartzite is mined in Massachusetts for high-silica sand. Harrison (1981) obtained analyses of the Cheshire showing that most samples contain higher amounts of iron and aluminum than required for a potential resource of high-silica sand (table 1). The abundance of Cheshire Quartzite outside the wilderness, the massive style of bedding, and its highly recrystallized nature argue against its use as silica and glass sand.

Forty-eight samples of the Cheshire Quartzite analyzed at the USGS showed no significant metal anomalies (Ayuso and Day, in press). Twenty-six of these samples had iron contents of less than 1 weight percent, in general agreement with the results produced by Harrison (1981). The sum of magnesium, calcium, titanium, and manganese was characteristically less than 1 weight percent in the Cheshire. A few samples contained the highest values of boron (100 ppm), barium (1000 ppm), and zinc (1000 ppm) found within the wilderness.

The Precambrian rocks had the highest content of cobalt (30 ppm), copper (150 ppm), chromium (100 ppm), scandium (20 ppm), vanadium (200 ppm), strontium (700 ppm), lanthanum (150 ppm), and nickel (70 ppm). From a regional scale, the concentration of these metals was clearly higher in the Precambrian and progressively decreased toward the Mendon Formation and the Cheshire Quartzite from east to west. Although many of the metal abundances in the Precambrian rocks are higher than the average high-calcium granitic rock (Turekian and Wedepohl, 1961), their regional distribution is spotty and restricted to the northeast quadrant of the wilderness. Outcrop control toward the southwest is poor, and the areal extent of rocks containing the highest metal contents is not well-constrained.

Because of the intense exploration for uranium around the town of Jamaica, and the known area of anomalously high radioactivity within the wilderness (Popenoe, 1964), the USGS made an intense effort to examine and sample the Precambrian rocks near the eastern boundary. The expectation was that such rocks might be equivalent to the uranium-mineralized rocks a few miles to the east. At least two of the major rock types in the vicinity of Jamaica known to be mineralized are superficially similar to rocks within the wilderness. They consist of the "banded unit" (granitic gneiss,) biotite schist, amphibolite) and the pervasive pegmatite dikes. The "banded unit" is the primary site of uranium mineralization near the town of Jamaica, where it occurs randomly spread throughout and close to the pegmatite dikes occurring within factures and in joints.

Eighteen samples from the Precambrian rocks, selected because they occur within the known area of anomalously high radioactivity and judged to be similar to the mineralized rocks near Jamaica, were analyzed for uranium and thorium (table 2). The highest value for uranium in these rocks was 5 ppm and some samples had less than 0.1 ppm. A few anomalously high thorium contents (up to 51 ppm) were also found, but most samples typically contained less than 10 ppm (table 2). Such values are in great contrast to results from the mineralized zones around Jamaica that are commonly higher than 100 ppm for uranium. Thorium abundances around Jamaica are in a wide range, from 0 to about 0.5 weight percent.

As a result of the low contents of uranium and thorium in the Precambrian rocks, together with the spotty outcrop distribution within the wilderness, further prospecting is apparently not feasible. Despite the superficially similar lithologies in the wilderness to those to the east, the tectonic and geologic history of the two regions might be significantly different. This is suggested by the presence of a distinct stratigraphy in the Precambrian around Jamaica and because the two areas occur on opposite flanks of the Green Mountain Anticlinorium.

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Table 1.--Analyses of the Cheshire Quartzite from the Lye Brook Wilderness*

Sample Number	Atomic Absorption Analyses (percent)		Neutron Activation Analyses (percent)
	Fe_2O_3	Al_2O_3	SiO_2
VLB-3	0.94	0.25	96.7
VLB-4	0.90	0.49	98.4
VLB-9	0.97	10.9	77.8
VLB-12	0.87	1.5	81.9
VLB-14	1.3	13.1	67.1
VLB-15	0.83	1.6	97.1
VLB-16	1.4	1.2	97.2
VLB-21	0.43	0.10	95.9
VLB-22	0.71	0.25	100
VLB-23	0.41	0.25	99.4
VLB-26	1.6	1.1	99.4
VLB-28	1.0	5.0	80.9
VLB-32	0.81	0.15	92.5
VLB-33	0.96	1.3	99.3
VLB-34	1.80	12.6	74.7
VLB-35	1.1	7.3	86.1
VLB-38	0.29	0.49	97.3

*All data from Harrison (1981)

Table 2.--Delayed neutron activation analyses of the quartz-feldspathic gneisses and pegmatites from the Precambrian in the Lye Brook Wilderness*
Analyst--Robert B. Vaughn, USGS Laboratories, Denver, Colo.

Sample Number	Thorium (ppm)	Uranium (ppm)	Sample Description
LB-122	12.0	1.9	Interlayered rusty schists and quartz or feldspathic gneisses
LB-140	2.9	2.0	Coarse-grained granitic gneiss
LB-145A	51.2	4.3	Thin-banded micaceous gneiss
LB-146	5.1	5.0	Granitic pegmatite in micaceous gneiss
LB-149A	14.6	0.5	Coarse-grained feldspathic gneiss
LB-152	5.4	0.2	Feldspathic gneiss cut by numerous pegmatites
LB-154A	4.2	0.8	Interlayered biotite schists with feldspathic gneiss
LB-179	15.2	4.7	Interlayered biotite schists with feldspathic gneiss
LB-180	9.1	2.6	Coarse-grained quartz and feldspathic gneiss
LB-182	2.7	0.5	Thinly bedded quartz or feldspathic gneiss
LB-353	2.7	0.4	Biotite quartz or feldspathic gneiss cut by pegmatite
LB-353A	1.6	0.4	Pegmatitic dike in gneiss
LB-353B	6.2	1.2	Micaceous layer in gneiss
LB-359	6.2	2.8	Biotite quartz or feldspathic gneiss cut by pegmatite
LB-361D	1.4	0.2	Pegmatite dike in biotite-bearing amphibolite
LB-370B	1.3	0.2	Amphibolite layer in feldspathic gneiss
LB-372	2.6	0.1	Biotite quartzofeldspathic gneiss
LB-376	3.3	0.1	Biotite quartzofeldspathic gneiss

*All data from Ayuso and Day (in press)