MINERAL RESOURCE POTENTIAL OF THE BRISTOL CLIFFS WILDERNESS,  
ADDISON COUNTY, VERMONT  

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MINERAL RESOURCE POTENTIAL  
SUMMARY STATEMENT  

The Bristol Cliffs Wilderness, Vt., has no identified mineral resources, except for certain non-metallic commodities. Geochemical sampling found slightly anomalous concentrations of copper, chromium, nickel, tin, and zinc in rocks, stream sediments, and panned concentrates, but not in sufficient quantity to indicate a potential resource. The results of the geochemical survey indicate that there is little evidence for the occurrence of metallic-mineral deposits within the study area. The only apparent resources are small deposits of peat and sand and gravel, and abundant rock suitable for construction materials. In the western part of the wilderness there is a low potential for silica-sand resources for glassmaking or chemical products. The area has an unknown potential for oil and natural gas at depth, but this cannot be evaluated by the present study.

INTRODUCTION  
The Bristol Cliffs Wilderness comprises 3,775 acres of land in the Green Mountain National Forest in Addison County, Vt. (fig. 1). The area is situated along the western front of the Green Mountains, approximately 1 mi southeast of Bristol and 8 mi northeast of Middlebury; Burlington and Rutland are 25 and 35 air miles to the north and south, respectively (fig. 1). The topography is gentle within the interior, but is precipitous along Bristol Cliffs, which are located along the western boundary of the study area and from which the wilderness obtains its name. Total relief in the study area is 1,805 ft, from lower altitudes of about 520 ft along the New Haven River near Bristol, to a high point of nearly 2,325 ft on the crest of South Mountain in the center of the wilderness. Two small ponds (north and Gilmore Ponds) are located near South Mountain. Several small unnamed streams drain radially away from the wilderness into the New Haven River, ultimately discharging into Lake Champlain to the west. Access is by U.S Route 7 at Middlebury, and by State Highway 17 and 116. Paved and gravel or dirt County and Forest Service roads are also present near the western, southern, and eastern boundaries of the area. A foot trail provides access to near Gilmore Pond from the southern border of the wilderness.

Previous Work  
Previous geologic studies in the vicinity of the Bristol Cliffs Wilderness have been limited to reconnaissance mapping by Keith (1923) and Cady (1959), the latter for compilation of the Centennial Geologic Map of Vermont (Doll and others, 1961). Areas adjacent to the wilderness have been examined in more detail, including mapping by Cady (1945) to the west of the study area, by Osberg (1952) to the south and southeast, and by Cady and others (1962) to the east. The most recent geologic work is by Tauvers (1982), who mapped the Lincoln area immediately north and east of the wilderness.
Figure 1.—Index map showing the location of the Bristol Cliffs Wilderness.
The present investigation began with field studies by P. C. Mory of the U.S. Bureau of Mines (USBM) in the fall of 1977, who collected 27 rock samples. These rock samples were analyzed by spectroscopic methods for 40 elements by the USBM Metallurgy Research Center, Reno, Nev.; selected samples also were analyzed by neutron-activation, atomic-absorption, fire-assay, and radiometric techniques. J. F. Slack, A. R. Dyke, R. L. Graves, J. T. Hanley, and J. C. Olson, all of the U.S. Geological Survey (USGS), spent one week of reconnaissance geologic mapping and sampling in June 1981. Rock samples collected at that time, together with stream sediments and panned concentrates obtained by A. E. Grosz, were submitted for geochemical analysis. A composite group of 34 rocks, 10 stream sediments, and nine panned concentrates was analyzed by semiquantitative spectrographic methods for 31 elements, and by quantitative atomic absorption for two elements (gold and zinc). Selected rock samples also were analyzed for major elements by X-ray fluorescence, and for uranium and thorium by neutron-activation methods.

SURFACE- AND MINERAL-RIGHTS OWNERSHIP

All surface and mineral rights in the Bristol Cliffs Wilderness were purchased by the Federal Government in the 1930's under the authority of the Week's Act of 1911. The only part of the area not under the jurisdiction and administration of the U.S. Forest Service is a small parcel of privately owned land about 12 acres in size in the northeastern corner of the wilderness (fig. 2).

GEOLOGY

The Bristol Cliffs Wilderness is underlain by metasedimentary rocks of Proterozoic and early Paleozoic age, mantled locally by glacial and alluvial deposits. Bedrock units consist of the Late Proterozoic and(or) Early Cambrian Pinnacle and Underhill Formations, both part of the Camels Hump Group, and the overlying Cheshire Quartzite of Early Cambrian age. These formations occur along the northwestern flank of the Green Mountain anticlinorium, stratigraphically above basement rocks of the Mount Holly Complex of Grenville (approximately 1 b.y. old) age (Doll and others, 1961). The metasedimentary units belong to a thick cover of north-trending anticlines and synclines common to the western front of the Green Mountain anticlinorium (Doll and others, 1961).

Geochemical analyses of rocks, stream sediments, and panned concentrates do not reveal any significant metal anomalies in the wilderness. Certain metals have slightly anomalous concentrations, but none are suggestive of important mineralizing processes in the study area. Histograms for metallic elements of particular interest (Slack and others, in press) show some enrichments, especially for panned concentrate samples. Anomalous values were discovered for copper, chromium, nickel, tin, and zinc. Slightly high values obtained for other metals (i.e., barium, boron, cobalt, lead) are interpreted as belonging to normal geochemical distributions and are not considered statistically significant.

It is quite likely that a large fraction of sampled material is derived from glacially transported debris, and that the geochemical data for stream sediments and panned concentrates may not be fully representative of the local bedrock. Certain metal concentrations can thus be judged to be inappropriate for the local geology, particularly chromium, nickel, and tin. Anomalously high concentrations of these elements, chiefly in panned concentrate samples, are interpreted as belonging to glacial materials derived from outside the study area. These glacial materials could be till or ground moraine derived from areas to the north during Pleistocene glaciation, or from outwash deposits formed by post-Pleistocene glacial retreat.

A logical source for the chromium and nickel is the mafic and ultramafic terrane of northern Vermont and southern Quebec. A source for the tin concentrations is more difficult to identify, but may be from cassiterite-bearing pegmatites to the north of the wilderness. A less likely possibility is that these metals were derived from detrital heavy minerals originally present as accessory grains in clastic rocks of the study area. In contrast, the anomalous copper and zinc values conceivably could be indigenous to the geology of the study area. The highest values recorded were in panned concentrate samples, 200 ppm for copper and 300 ppm for zinc. Because these samples were collected from entirely different drainage basins, they appear to have no collective significance.
Figure 2.—Surface- and mineral-rights ownership.
DESCRIPTION OF MAP UNITS

Cheshire Quartzite (Early Cambrian) - Massive to thin-bedded, fine- to coarse-grained quartzite, micaeous quartzite, and feldspathic quartzite. Parts of this unit have low potential for the production of high-silica sand.

Fairfield Pond Member (Dennis, 1964) of the Underhill Formation (Early Cambrian and (or) Late Proterozoic) - Thin-bedded quartzose schist and schistose quartzite, commonly with abundant muscovite and biotite. Base marked locally by thin unit of dolomitic quartzite.

Pinnacle Formation (Early Cambrian and (or) Late Proterozoic) - Thin-bedded mica-quartz-chlorite phyllite and schist, typically with abundant biotite and plagioclase.

Figure 3.—Geologic map of the Bristol Cliffs Wilderness.
MINERAL RESOURCE POTENTIAL

The Bristol Cliffs Wilderness has no identified mineral resources, except for certain non-metallic commodities. No mines or prospects are known within the wilderness and no prospecting permits have been issued by the U.S. Bureau of Land Management. The mining of kaolin, iron, and manganese elsewhere in Addison County is related to rock units that are not present in the wilderness. The study area is geologically favorable for containing strata-bound lead deposits, but no evidence of lead mineralization was observed. Locally anomalous concentrations of zinc and copper are not indicative of a potential for the occurrence of resources of these metals. With the exception of silica sand, the non-metallic resources are only of little interest.

Strata-Bound Lead Deposits

The geology of the Bristol Cliffs Wilderness is in many respects similar to areas containing major strata-bound lead deposits. These types of deposits characteristically occur in basalt quartzite sandstones above feldspar-rich basement rocks. Comparable geologic settings are found along much of the western front of the Green Mountains, where the Cheshire Quartzite overlies the Mount Holly Complex (Doll and others, 1961). Mineralization in strata-bound lead deposits typically consists of galena and local sphalerite forming the matrix (cement) for quartz-rich sandstones or orthoquartzites. Examples include the large (80 million ton) orebody at Laisvall, northern Sweden (Rickard and others, 1979), and other similar deposits elsewhere in the world (Bjoerlykke and Sangster, 1981). No evidence of lead mineralization was found during geochemical sampling of the wilderness, and concentrations of zinc and copper—which might be pathfinders to the lead—occur in separate drainage basins (Slack and others, in press). Moreover, contents of lead, zinc, and copper are extremely low in all rock samples analyzed. These data therefore are not indicative of a potential for strata-bound lead deposits in the study area.

Silica Sand

Parts of the Cheshire Quartzite in and near the wilderness are potential sources of high-silica (glass) sand. This same formation has been mined in the past for glass sand and refractory quartzite in western Massachusetts (Chute, 1943; Herz, 1958). In the study area, much of the rock making up the Cheshire contains abundant feldspar and muscovite, as well as accessory tourmaline, zircon, rutile, and pyrite (Slack and others, in press). Those parts of the Cheshire containing significant amounts of these minerals would therefore be too impure to be considered as a source of silica-sand for glass manufacture.

Industry specifications for glass sand (Murphy, 1975; Heinrich, 1980) are based on both physical and chemical factors. Physical limitations include grain size and shape, rock, friable, and nature and amount of accessory minerals. Chemical requirements are variable and depend upon the desired composition and color of the final glass product. For nearly all uses, silica contents must exceed 95 weight percent. Major contaminants, such as iron (as FeO), should be less than about 0.05 weight percent; lime, magnesia, and alkalis together (as oxides) should be less than about 0.5 weight percent, and titania less than 0.05 weight percent. Specifications for alumina are less restrictive, from 0.1 weight percent Al₂O₃ for optical glass, to as much as 4.0 weight percent for low-quality glass products. Analyses performed by the USGS (Mory, 1981) and the USGS (Slack and others, in press) indicate that most of the Cheshire Quartzite has excessive chemical impurities and as such has no potential for glass manufacturing. However, two samples analyzed from immediately outside the boundary of the wilderness (Slack and others, in press) are quite pure and qualify as material suitable for silica-sand products. One of these samples, from near the base of the Bristol Cliffs only 500 ft west of the wilderness boundary, has sufficient mineralogic and chemical purity to be considered for use as high-quality flint or sheet glass. Although such pure samples have not been discovered from within the wilderness itself, the geologic setting of the area suggests that some of these pure quartzite rocks should be found along the western portion of the wilderness. Based on these considerations, there is low potential in the western parts of the study area for a silica-sand resource. More detailed study would be required to fully evaluate this resource, however, particularly in terms of size, location, accessibility, and competition with other markets.

Crushed Stone

Much of the rock exposed in the Bristol Cliffs Wilderness would be suitable for road aggregate and general construction purposes. The Cheshire Quartzite could be used for crushed stone and possibly for dimension stone. However, the abundance of this formation and similar rock outside of the study area reduces the possibility of development of crushed stone from within the wilderness itself.

Sand and Gravel

A few small deposits of sand and gravel are located along the New Haven River on the northern boundary of the wilderness. However, numerous active sand and gravel pits outside of the study area (e.g., southwest of Bristol) contain large reserves of more accessible material.

Peat

Field reconnaissance by the USBM included the examination of a peat bog at the east end of North Pond. The bog is about 200 ft wide and 400 ft long and contains a large number of dead tree trunks. A test probe located in the center of the deposit revealed about 2 ft of water-saturated sphagnum moss. Because of its small size, inaccessibility, and large amount of contained debris, this peat deposit has low potential as a source of peat.

Oil and Gas

Although rocks exposed at the surface of the wilderness are devoid of hydrocarbons, a possibility does exist for oil and natural gas at depth. Recent seismic studies (Cook and others, 1979; Ando and others, 1982) suggest that the older metamorphosed rocks in the Blue Ridge of the southern Appalachians and the Green Mountains of Vermont overlie a thick sequence of young sedimentary rocks favorable for
hydrocarbon accumulations. The study area is within the so-called Eastern Overthrust Belt which is currently receiving attention to industry (McCaslin and Sumpter 1981; Bigelow, 1982); recently, large tracts of land in central and western Vermont—including parts of Addison County—have been leased in the anticipation of a search for oil and gas (Oil and Gas Journal, 1982). A hydrocarbon resource may exist in the deeper rocks of the wilderness, but it cannot be evaluated by the present investigation.

REFERENCES CITED


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