MINERAL COLLECTING

IN VERMONT

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SPECIAL PUBLICATION NO. 2 1968

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INTRODUCTION

Mineral collecting is a hobby which is becoming more and more popular every year. As more people collect minerals, the old localities become depleted and new ones are hard to find. For some reason, Vermont has attracted very few mineral collectors. Many collectors living in Vermont spend a lot of time collecting in other states and have overlooked some good local mineral localities. Vermont holds great potential, especially for the mineral collector who is willing to search out new localities.

This publication has two purposes. First, to briefly outline the geology of Vermont and the types of mineral occurrences which occur in Vermont, to aid the amateur collector in his search for new mineral localities. Second, to describe some known localities as examples of what to look for, and to give the beginning collector an idea of places where he can start his collecting. The localities described here were chosen to illustrate as many different geological types of localities as possible, including localities widely distributed throughout the state, and with as many different minerals as possible. Some of these localities are well known, others have not been described before. Some are very accessible and others are very difficult to reach. The localities are arranged alphabetically. Figure 1 is an index map of all the localities described herein, each of which is numbered in the order in which it appears in the publication.

For each locality a portion of the topographic map showing the surrounding territory has been reproduced. The quadrangle name is printed on each map and the entire quadrangle may be purchased from the Distribution Section, United States Geological Survey, 1200 Eads Street, Arlington, Virginia, 22202. The maps reproduced here are all of the 15-minute series. (Each covers 15 minutes of latitude and longitude.) The scale on these maps is one inch equals approximately one mile. Each of the maps in the text is reproduced at this same scale, and has true north straight up and down. Figure 2 has a list of the common topographic map symbols and further information on topographic maps can be obtained from the Map Information Office, United States Geological Survey, Washington, D.C. 20242. In some cases, these maps are very old, and so do not show many of the man-made features that have changed (roads, railroads, houses, etc.). For each locality a brief description of how to reach it is also given. The map and the description together should enable these localities to be found without too much trouble.

This next paragraph should not be necessary, but unfortunately there are collectors who spoil things for everyone else. Carelessness and disrespect for property will only lead to the closing of Vermont localities to collectors, as has happened in some other places. Please obtain permission from land, quarry, and mine owners before collecting. Be careful of old abandoned mine shafts, tunnels, and quarries with steep or overhanging walls. Do not destroy any property. And finally, take only as many specimens as you can use so that the localities are not cleaned out. It is pointed out here that this book is designed for the amateur collector and, in this connection, it should be remembered that a good mineral collector conforms to the standards of good mineral collecting by practicing conservation.

The following references will be useful for information on other Vermont localities you may want to track down.

Catalogue of Minerals found in the State of Vermont and in the Adjacent States, 1824, by Fredrick Hall, printed by P. B. Goodsell, Hartford, 44 pages. This is one of the earliest accounts of Vermont mineral localities. In general it gives only vague references to the various localities, and the mineral names and identifications are out of date. But it lists many potential localities for the persistent explorer.

"Minerals of Vermont" in the *Seventeenth Annual Report of the State Geologist of Vermont*, 1929-1930, by George H. Perkins, Burlington, Vt., pages 151-178. This reference contains a review of the reported mineral occurrences in Vermont previous to 1929. Many of the localities are given only by township, but these descriptions at least indicate what might be found and a general area in which to start looking. There are many other references in the various publications of the Vermont Geological Survey from 1832 to the present. These can not all be listed here. Many of them are included with the specific localities to which they refer. The State Library in Montpelier has a list of the publications currently available and it and most other libraries in the state have collections of the reports of the Vermont State Geologist. Also, *The 25th Report of the State Geologist*, 1945-1946, contains an index to reports 1-24 of the State Geologist.

Vermont Mines and Mineral Localities, 1964, by Philip Morrill and Robert Chaffee, Hanover, New Hampshire, 54 pages. This publication has information on many Vermont mineral localities, although in many cases they are not for the roadside collector but for the explorer and more hardy types.

Mineral Collecting in Vermont is only a beginning of the study of Vermont minerals and will be revised in the future. A second volume summarizing all of the known data on minerals found in Vermont is in preparation. Many localities will very likely be overlooked and additional information on the known localities will be found as more collectors start hunting in Vermont. This is one area in which the amateur collector can be of great benefit to the science of mineralogy. Anyone with information on new or overlooked localities, or with new minerals found at the listed localities is urged to send this information to the Vermont State Geologist, University of Vermont, Burlington, Vermont, 05401.

LOCALITIES SHOWN IN FIGURE I

1. Vermont Kaolin Company Quarry and Monkton Iron Ore Beds, Monkton.
2. Huntley Quarry, Leicester Junction.
3. Roadcut on Route 9, Woodford.
4. Parrot Jasper Mine and Dolomite Quarry, Colchester.
5. Mineral area, East Richford.
6. Manganese Prospect, west of Richford.
7. Berkshire Copper Mine, Berkshire.
8. Mineral area, Fletcher and Bakersfield.
9. Swanton Red Marble Quarry, Swanton.
10. Roadcut south of Bloomfield and mineral area, southwest of Island Pond.
11. Road fill and quarry between North and South Hero and quarry west of Sand Bar Bridge.
12. Ruberoid Asbestos Mine, Lowell.
13. Johnson Talc Mine, Johnson.
14. Wolcott Copper Mine and Morrisville Lead-Zinc prospect.
15. Arsenic Mine, East Braintree.
16. Pike Hill Mines, Corinth.
17. Ely Mine, Vershire.
18. Elizabeth Mine, South Strafford.
19. Roadcuts on the east side of Lake Willoughby.
20. Craftsbury Granite locality.
21. Oram Lead-Zinc Mine; Stucco Pink Quarry; and Kaolinite Pits, Brandon.
22. Slate Quarries, Poultney and Fair Haven.
23. Mineral area, Round Hill, Shrewsbury.
24. Molybdenite Mine and Copperas Hill Mines, Cuttingsville.
25. Marble Quarry, South of Danby.
26. Devil's Den, Mt. Tabor.
27. Roadcuts on Route 155, Mt. Holly.
28. Sherburne Mica Mine, Sherburne.
29. Waterbury Talc Mine, Moretown.
30. Mad River Talc Mine and Serpentine Quarry, Duxbury.
31. Clay concretion locality, Barre.
32. Mineral area, South of Whitingham.
33. Adams Brook nickel prospect and Dover ultramafic.
34. Mineral area along Connecticut River at Bellows Falls.
35. Pine Hill Quarry, East of Perkinsville.
36. Carleton Talc Mine, Chester.
37. Roadcut on Route 103, Gassetts.
38. Roadcut on Route 103, Ludlow and Kingman Brook mineral area east of Tyson.
39. Plymouth Five Corners area.
40. Bridgewater Gold Mines.
41. Vermont Marble Verd Antique Quarry, Rochester.
42. Mineral area, Hartford.

Fig. 1. Index Map of Vermont Mineral Localities.

Fig. 2.

TOPOGRAPHIC MAP SYMBOLS

VARIATIONS WILL BE FOUND ON OLDER MAPS

Hard surface, heavy duty road, four or more lanes

Hard surface, heavy duty road, two or three lanes

Hard surface, medium duty road, four or more lanes

Hard surface, medium duty road, two or three lanes

Improved light duty road

Unimproved dirt road and trail

Boundary, national

State

County, parish, municipio

Civil township, precinct, town, barrio

Incorporated city, village, town, hamlet

Reservation, national or state

Small park, cemetery, airport, etc.

Railroad, single track and multiple track

Railroads in juxtaposition

Narrow gage, single track and multiple track

Railroad in street and carline

Bridge, road and railroad

Drawbridge, road and railroad

Footbridge

Tunnel, road and railroad

Overpass and underpass

Important small masonry or earth dam

Dam with lock

Dam with road

Canal with lock

Index contour

Supplementary contour

Fill

Levee

Mine dump

Tailings

Intermediate contour

Depression contours

Cut

Levee with road

Wash

Tailings pond

Perennial streams

Elevated aqueduct

Water well and spring

Small rapids

Large rapids

Intermittent streams

Aqueduct tunnel

Disappearing stream

Small falls

Large falls

Marsh (swamp)

Urban area

Buildings (dwelling, place of employment, etc.)

School, church, and cemetery — Cem

Buildings (barn, warehouse, etc.)

Power transmission line

Telephone line, pipeline, etc. (labeled as to type)

Wells other than water (labeled as to type) — Oil — Gas

Tanks; oil, water, etc. (labeled as to type) — Water

Located or landmark object; windmill

Open pit, mine, or quarry; prospect

Shaft and tunnel entrance

ACKNOWLEDGMENTS

The following persons were very helpful to this project by supplying information on Vermont mineral localities. Many of the localities included here are due to the assistance of these people.

Dr. Charles Doll, State Geologist, started this project and was the source of a great deal of information on Vermont minerals and also accompanied the writer to several localities. Mr. Elmer Senn of Richmond, Vermont, supplied a great deal of information and went on many of the trips to visit localities. Mr. Earl Melendy of South Londonderry, Vermont, has a small mineral museum behind his house and permitted examination of his Vermont minerals; he also supplied information about several localities. Mr. Fred Tupper of Canton, Maine, has explored a large part of Vermont and found many very interesting localities which he has generously shared with the writer. Mr. and Mrs. Lewis Speed of Bethel, Vermont; Mr. Ruben Martin of Richford, Vermont; Mrs. Charles Cookson of Groton, Vermont; Mr. Chris Hepburn of Brattleboro, Vermont; and Mr. Aubrey Stratton of West Townshend, Vermont, have all been very generous in providing information on Vermont mineral localities. The many members of the Burlington Gem and Mineral Club of Burlington, Vermont, have also supplied useful information to this project.

Knowledge about the geological environment of a mineral locality can be invaluable to the amateur collector. It is helpful in the identification of minerals, because only certain minerals are found in each type of occurrence. Therefore, if the geology is known many minerals can be eliminated from consideration because they do not occur in that particular geologic environment. Also, when looking for new or lost localities, it is easier to find certain geologic environments and then look more closely for specific minerals. The following section will discuss the various types of geological environments and the minerals found in each, as an aid to collectors.

There are three main geologic environments: namely, sedimentary, igneous, and metamorphic. Sedimentary *rocks* are those formed from the products of either mechanical or chemical breakdown of pre-existing rocks. The sedimentary rocks are subdivided into different types on the basis of their mineralogy and particle size. The following is a list with a simplified definition for the most common types of sedimentary rocks:

Sandstone: composed of sand-size grains (about 1/16 of an inch) of quartz, but there can be a variety of minerals, such as feldspar and mica. Silica, iron oxides, or calcite are commonly present as cementing material and will usually determine the color of the rock.

Conglomerate: composed of rounded pebbles (3/4 of an inch or larger) surrounded by finer grained material.

Breccia: very similar to conglomerate except that the rock fragments are angular instead of rounded.

Shale: composed of consolidated clay-sized particles (less than 0.0025 of an inch). It shows thin bedding and usually splits apart very easily.

Mudstone and Claystone: very similar to shale except that they do not split into layers.

Limestone: a rock composed of calcium carbonate, usually the mineral calcite. It can be recognized readily because it effervesces in cold dilute hydrochloric acid.

Dolostone: a rock composed of calcium magnesium carbonate or dolomite. Dolomite will not effervesce in dilute hydrochloric acid unless it is powdered first.

Igneous rocks are those which crystallize from a magma, which is a hot solution of silicates and oxides. Igneous rocks can be divided into two main types. These two types are related to the grain size of the minerals in the rock and the conditions under which the rock formed. Igneous rocks which form deep in the earth's crust and consequently cool slowly, have a coarse-grained texture, while igneous rocks which form on or near the earth's surface crystallize rapidly and therefore have a fine texture. The individual minerals cannot usually be recognized in the fine-grained types. These two groups of igneous rocks are further subdivided on the basis of the minerals which they contain. The following are some of the more common types of igneous rocks:

Granite: a coarse-grained igneous rock which contains quartz, orthoclase feldspar, and minor amounts of plagioclase feldspar, biotite and muscovite. The fine-grained equivalent is called rhyolite.

Syenite: very similar to granite, but it contains little or no quartz. Its fine-grained equivalent is trachyte.

Granodiorite: a coarse-grained rock with some quartz and equal amounts of orthoclase and plagioclase. It can also contain augite, biotite, and hornblende. The fine-grained rock of this type is called quartz latite.

Monzonite: the same as granodiorite except that it contains no quartz. Latite is the fine-grained equivalent. Rhyolite, trachyte, quartz latite, and latite can not be told apart in hand specimens generally because of their fine grain size, hence these rocks are usually referred to as felsite.

Diorite: a rock composed mainly of plagioclase feldspar and hornblende.

Gabbro: composed mainly of plagioclase feldspar and augite. Olivine may also be present. The fine-grained equivalents of these two rock types are called basalt.

Peridotite: a rock composed mainly of olivine and pyroxene. If it is mainly olivine, the rock is referred to as a dunite, and if it is mainly pyroxene, the rock is called a pyroxenite. Fine-grained equivalents of peridotite are very rare.

Metamorphic rocks are rocks which have changed form. Initially they may have been any of the above igneous or sedimentary rocks and due to an increase in temperature or pressure or both, have been changed texturally and/or mineralogically. A major division made in metamorphic rocks is into foliated and non-foliated groups. Foliation is the result of parallel orientation of the mineral grains. The important foliated metamorphic rocks are:

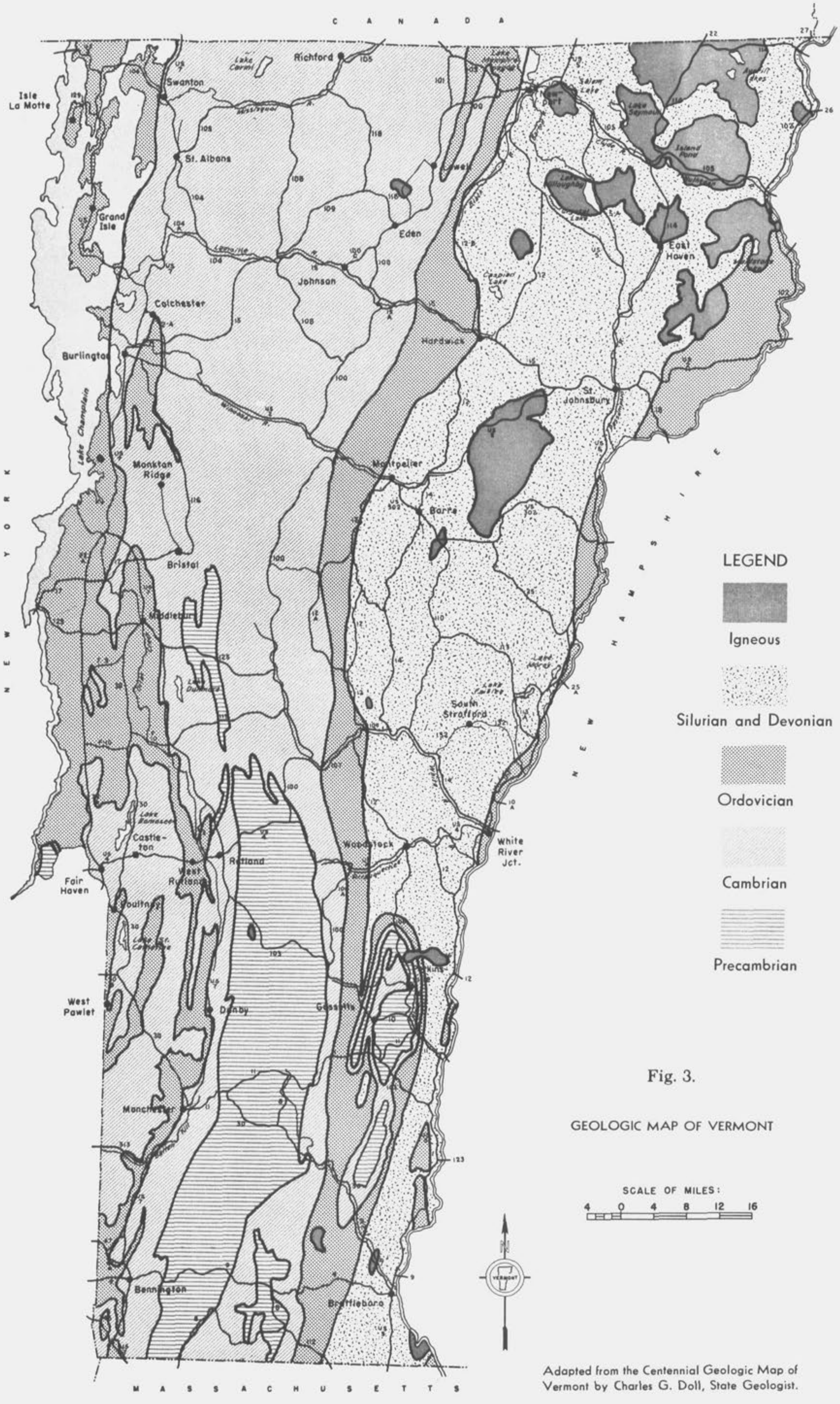


Fig. 3.

GEOLOGIC MAP OF VERMONT

Adapted from the Centennial Geologic Map of Vermont by Charles G. Doll, State Geologist.

Slate: a very fine-grained (individual grains cannot be seen with the naked eye) rock. Because of the foliation present it splits readily into thin layers.

Phyllite: similar to slate but the grains are coarse enough to be just barely visible.

Schist: similar to the above but coarse grained. Slate, phyllite, and schist all contain micas, chlorite, quartz, and can also contain hornblende, feldspar, and serpentine. Other minerals such as garnet, staurolite, kyanite, andalusite, and sillimanite may be present.

Gneiss: a banded metamorphic rock but in this case the bands are usually mineral separations rather than the orientation of the mineral grains. The most common gneisses are composed of quartz and feldspar, and look like a granite, except for the banding.

The most important nonfoliated metamorphic rocks are:

Metaquartzite: this rock is the metamorphic equivalent of a quartz-rich sandstone and has the appearance of a sandstone, except that the quartz grains are more tightly held together.

Marble: a rock composed of calcite or dolomite which has recrystallized due to metamorphism. Marble usually has a much coarser grain size than the original rock.

Hornfels: a very fine-grained metamorphic rock in which the individual minerals can not be recognized. This type of rock forms at the contact with near-surface igneous intrusions.

Calc-silicate: a metamorphic rock formed from limestones and dolostones which had a large amount of other minerals, especially quartz, present or to which material was added during metamorphism. The resulting rock is high in magnesium and calcium silicates.

Figure 3 shows the distribution of rocks in Vermont according to their geologic age. The Ordovician and Cambrian rocks adjacent to Lake Champlain are sedimentary and all other rocks in the state are metamorphic, except those shown on the map as igneous.

Each of these three major types of geologic environments can be subdivided into more restricted environments. Table I briefly summarizes the more important ones found in Vermont and lists

TABLE I MINERAL LOCALITIES IN VERMONT ARRANGED ACCORDING TO GEOLOGICAL OCCURRENCE

TYPE OF OCCURRENCE	POSSIBLE MINERALS	LOCALITY EXAMPLES IN VERMONT
A. Sedimentary		
1. Primary sedimentary	calcite, dolomite, pyrite, quartz, "clay minerals"	Swanton marble localities; clay concretion localities, quarry west of Sand Bar Bridge
2. Secondary vein and cavity fillings in sedimentary rocks	calcite, dolomite, quartz	Bridge between North and South Hero
3. Placer deposits	gold, magnetite, garnet	Plymouth Five Corners
B. Metamorphic		
1. Low- to medium-grade metamorphic regional	chlorite, biotite, calcite, chloritoid, pyrite, garnet	Pine Hill Quarry, Perkinsville; Huntley Quarry, Leicester Jct.; Road cut Route 9, Woodford; Mineral area, Fletcher; Slate quarries, Poultney; Marble quarry, Danby; Roadcut Route 105, Mt. Holly; Mineral area south of Whitingham; Kingman Brook area, Tyson

Table I (cont.)

TYPE OF OCCURENCE	POSSIBLE MINERALS	LOCALITY EXAMPLES IN VERMONT
a. Low-grade metamorphism of basic igneous rocks	talc, antigorite, chrysotile, calcite, magnesite, dolomite, actinolite, tremolite, chlorite, magnetite	Ruberoid Asbestos Mine; Johnson Talc Mine; Waterbury Talc Mine; Mad River Talc Mine; Adams Brook Nickel Deposit; Carleton Talc Mine; Verd Antique Quarry, Rochester; Mineral area, East Richford
2. High-grade regional metamorphic	andalusite, kyanite, sillimanite, staurolite, garnet	South of Bloomfield; Conn. River, Bellows Falls; Road cut, Gassetts
C. Igneous		
1. Primary igneous		
a. Silica-rich granite	biotite, quartz, microcline, plagioclase	Craftsbury Granite, Craftsbury
b. Magnesium-iron-rich dunite	olivine, magnetite, chromite	Ruberoid Asbestos Mine
2. Granite pegmatites	quartz, microcline, muscovite, tourmaline, plagioclase, garnet, beryl	Road cut at Lake Willoughby; Sherburne Mica Mine; Conn. River, Bellows Falls
3. Hydrothermal		
a. Arranged by major elements present. Copper-lead-zinc-iron	chalcopyrite, bornite, pyrrhotite, galena, sphalerite, hematite	Berkshire Copper Mine; Pike Hill Mines; Ely Mine; Elizabeth Mine; Parrot Jasper Mine; Oram Lead-Zinc Mine; Wolcott Copper Mine; Morrisville lead-zinc prospect; Mineral area, Hartford
Arsenic	arsenopyrite	Arsenic Mine, East Braintree
Molybdenum	molybdenite, pyrite	Cuttingsville Molybdenite prospect
Gold	native gold, pyrite	Bridgewater Gold Mines
Chromium	muscovite (var. fuchsite)	Round Hill, Shrewsbury
b. In basic igneous rocks	prehnite, stilbite, other zeolite minerals	Ruberoid Asbestos Mine; Conn. River at Bellows Falls

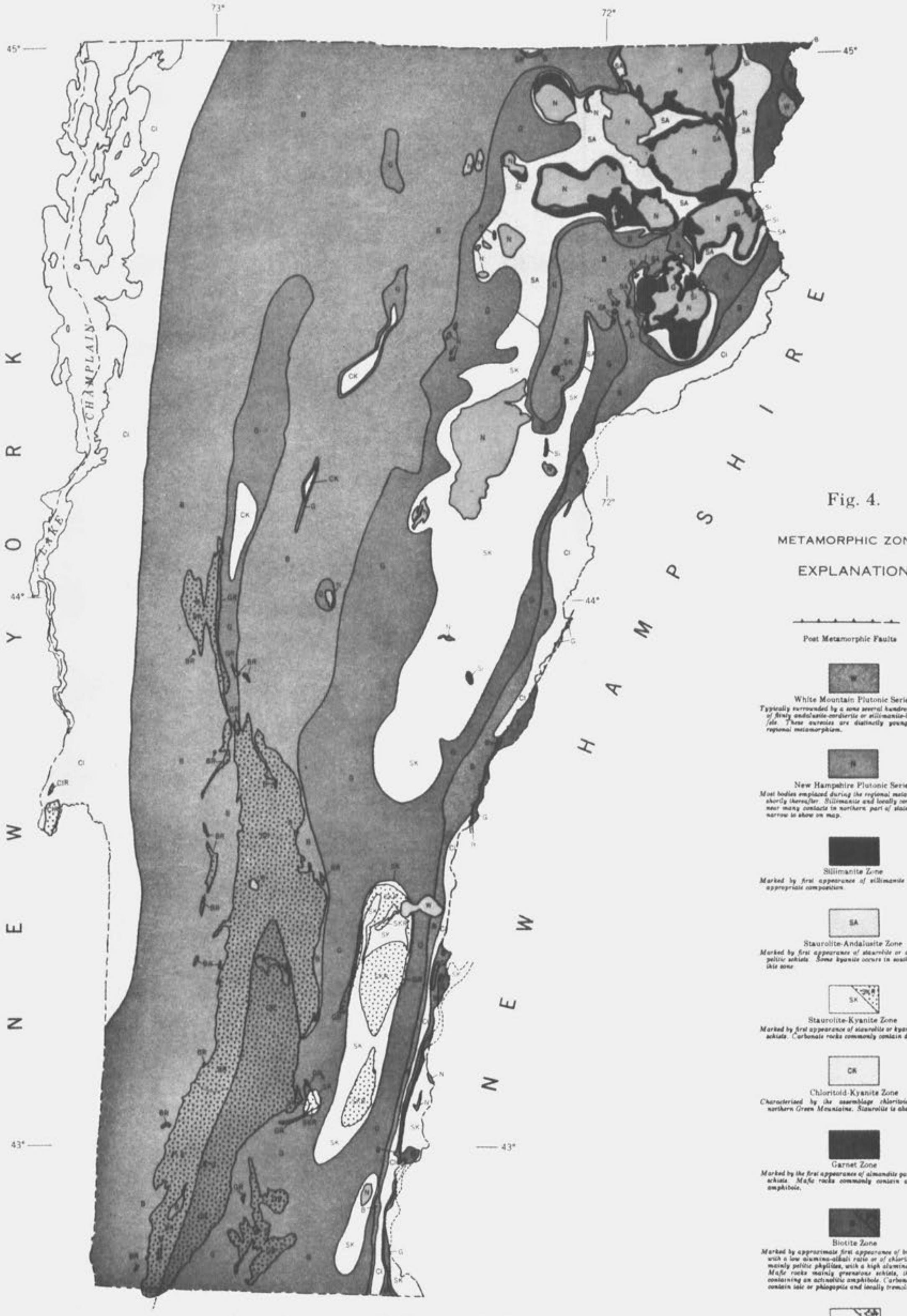


Fig. 4.

METAMORPHIC ZONES

EXPLANATION

Post Metamorphic Faults

White Mountain Plutonic Series
Typically surrounded by a zone several hundred yards wide of finely andalusite-cordierite or sillimanite-bearing hornfels. These aureoles are distinctly younger than the regional metamorphism.

New Hampshire Plutonic Series
Most bodies emplaced during the regional metamorphism or shortly thereafter. Sillimanite and locally cordierite occur near many contacts in northern part of state in zones too narrow to show on map.

Sillimanite Zone
Marked by first appearance of sillimanite in rocks of appropriate composition.

SA
Staurolite-Andalusite Zone
Marked by first appearance of staurolite or andalusite in pelitic schists. Some kyanite occurs in southwest part of this zone.

SK
Staurolite-Kyanite Zone
Marked by first appearance of staurolite or kyanite in pelitic schists. Carbonate rocks commonly contain diopside.

CK
Chloritoid-Kyanite Zone
Characterized by the assemblage chloritoid-kyanite in northern Green Mountains. Staurolite is absent.

Garnet Zone
Marked by the first appearance of almandite garnet in pelitic schists. Mafic rocks commonly contain a dark green amphibole.

Biotite Zone
Marked by approximate first appearance of biotite in rocks with a low alumina-alkali ratio or of chloritoid in rocks, mainly pelitic phyllites, with a high alumina-alkali ratio. Mafic rocks mainly greenstone schists, though locally containing an actinolitic amphibole. Carbonate rocks may contain talc or phlogopite and locally tremolite or scolite.

Cl
Chlorite Zone
Rocks showing evidence of considerable recrystallization but containing few minerals not found in sedimentary rocks. Stilpnomelane is reported locally in schistose greywackes.

Polymetamorphic areas
Mainly rocks metamorphosed before the Cambrian to probable sillimanite zone or higher, then later subjected to a lower-grade Paleozoic metamorphism. Grade of Paleozoic metamorphism indicated by color beneath stipple, and by letters preceding "R" in letter symbol.

MASSACHUSETTS

METAMORPHIC MAP of VERMONT

0 10 20 30
Scale of miles

From Centennial Geologic Map of Vermont
Compiled by James B. Thompson, Jr.

some examples of typical minerals found in each type of environment and some examples of Vermont localities. (The specific minerals found at each locality are included with the locality description.) A locality may fit into more than one classification. For example, a locality with an igneous intrusion cutting metamorphic rocks will have minerals characteristic of both igneous and metamorphic environments. (These localities are listed under more than one heading in Table I.)

There are two special sedimentary occurrences, aside from the primary sedimentary environments, which are of interest to mineral collectors in Vermont. One is the occurrence of secondary vein and cavity fillings in sedimentary rocks. Some of these may be hydrothermal in origin but most represent solution and redeposition of material within a confined area. The other is the environment of recent sediments, especially stream sediments, where, due to high specific gravity and resistance to weathering, certain minerals are concentrated. These are referred to as placer deposits and minerals commonly concentrated include native gold, garnet, magnetite, rutile, ilmenite, and zircon.

Metamorphic rocks can be divided into special environments depending on the temperatures and pressures to which the rocks were subjected. Different minerals will form at different temperature-pressure conditions and these minerals can be used as guides to the degree of metamorphism in an area. Certain common easily identified minerals have been chosen by geologists to indicate the degree (grade) of metamorphism in an area. These minerals are chlorite, biotite, garnet, staurolite, andalusite, kyanite, and sillimanite. Chlorite is formed at the lowest metamorphic grade, lowest temperatures and pressures, and sillimanite at the highest grade, highest temperatures and pressures, and the other minerals represent intermediate grades.

Figure 4 is the metamorphic map of Vermont. It is divided into zones such as the chlorite zone, biotite zone, etc. The chlorite zone represents rocks which have been only slightly metamorphosed. Chlorite has formed but no other metamorphic zone-indicating minerals. The rocks of the Champlain Valley are in this zone and the metamorphism is so slight that in most cases it can not be seen, so that these rocks can be considered sedimentary. The biotite zone represents rocks which have undergone a little more metamorphism, so that biotite is formed. Chlorite will still be present in the biotite zone. The garnet zone rocks have been metamorphosed even more, so that garnet is formed. Chlorite and biotite may both be present in the garnet zone rocks. Staurolite usually forms next in increasing metamorphism, but is not shown as a separate zone in Vermont. Either the staurolite-andalusite zone or the staurolite-kyanite zone represent the rocks of still higher grade metamorphism, and finally the sillimanite zone shows the location of rocks which have been metamorphosed the most in Vermont. This metamorphic map is of great value to mineral collectors because it limits the area where certain minerals can be found. Any of the above minerals can be found in its zone or any higher grade zone but *never* in a lower grade zone. For example, garnets may be found in Vermont wherever the garnet zone, staurolite-kyanite or andalusite, and sillimanite zone are shown on the map. Garnets can never be found in the areas shown on the map (Figure 4) as the chlorite or biotite zones (unless transported there by people or glaciers).

This does not mean that all of the areas shown as garnet zone or higher will yield garnets. The first criterion, that of high enough temperatures and pressures, is met in those areas but a second criterion, that of rocks of the right composition to form garnet, must also be met. A fairly pure sandstone can be metamorphosed to any grade up to sillimanite and the only mineral ever to be found will be quartz.

The staurolite-andalusite and staurolite-kyanite zones are areas where, in the first case, either staurolite or andalusite or both will be found in rocks of the right chemical composition to form these minerals. In the second case either staurolite or kyanite or both will be found. The staurolite-andalusite and staurolite-kyanite zones form at similar temperatures but the andalusite forms at lower pressure while in the same rocks kyanite will form at higher pressures. Andalusite is found only in northeastern Vermont and kyanite is found only in central and southern Vermont. The minerals in the zones shown on the metamorphic map and described above form during the metamorphism of a rock which was originally a shale. In rocks of other compositions a different sequence of minerals will be found. Table II lists the minerals formed in rocks of various compositions in the different metamorphic zones.

A special type of metamorphism found in Vermont is the metamorphism of ultramafic igneous rocks (dunite, peridotite). These rocks originally formed at higher temperature than that of the regional metamorphism, so that their metamorphism is really to lower grades (retrograde metamorphism). Two somewhat independent reactions take place in this retrograde metamorphism of the ultramafic igneous rocks. The first is water moving into the rock and changing the olivine to serpentine. The second is CO_2 moving into the rocks and reacting with the serpentine to form talc plus carbonate (usually magnesite). These two reactions have taken place in the ultramafic igneous rocks throughout most of Vermont, but to varying degrees. Some of the larger ultramafic bodies still have cores of

TABLE II. MINERALS FOUND IN ROCKS OF DIFFERENT COMPOSITIONS IN DIFFERENT METAMORPHIC ZONES

Metamorphic zone	Metamorphosed shales (aluminum-rich rock)	Metamorphosed limestones or dolostones	Metamorphosed basic igneous rocks
chlorite	quartz muscovite chlorite	calcite dolomite tremolite	albite chlorite epidote calcite
biotite	quartz muscovite chlorite chloritoid biotite	calcite dolomite epidote tremolite diopside	albite chlorite epidote calcite actinolite
garnet	quartz muscovite chlorite biotite chloritoid garnet	calcite diopside garnet	andesine epidote hornblende garnet
staurolite-andalusite, staurolite-kyanite	quartz muscovite chlorite biotite garnet staurolite andalusite or kyanite	calcite diopside garnet zoisite	andesine epidote hornblende garnet
sillimanite	quartz muscovite biotite garnet sillimanite	calcite diopside anorthite wollastonite	andesine diopside (or other pyroxene) hornblende garnet

unaltered olivine, such as the Dover ultramafic, see figure 54. In others, the whole igneous body has been changed to serpentine and the outer rim to talc-carbonate, such as the ultramafic at the Rochester verd antique quarry, see figure 66. Others have been changed completely to talc-carbonate which is the end product in this retrograde process. There are over 100 ultramafic and altered ultramafic bodies shown on the state geologic map and the various quadrangle maps. These are all potential collecting localities, but the minerals present in each case are restricted according to which of the above zones are present.

There are many areas of igneous rocks in Vermont and these are of great economic importance, especially the Barre granite. But, generally, these areas are barren of minerals of interest to collectors. One locality of interest is the Craftsbury granite where orbicules of biotite can be found. There are other special types of igneous environments which are of great interest to collectors. These are granite pegmatites and hydrothermal deposits.

Granite Pegmatites are well known to mineral collectors for their rare minerals and their gem stones. There are a number of different elements which are characteristically concentrated in pegmatite-forming solutions and these give rise to a list of possible minerals in pegmatites. Many minerals, such as beryl, topaz, columbite, spodumene, and lepidolite, are found only (except in very unusual cases) in pegmatites. So, if the collecting area is not a pegmatite these minerals will not be found; they occur only in a pegmatite locality.

Unfortunately, most pegmatites do not contain beryllium, lithium and the other unusual elements, but are only a water-rich granite magma. In these pegmatites, quartz, albite, orthoclase, and muscovite are usually the only minerals found. New Hampshire and Maine are noted for their pegmatite collecting localities, but for some reason the Connecticut River seems to be the westward boundary of pegmatites containing these unusual elements. All of the pegmatites investigated in Vermont are of the ordinary type. Several of the localities described in this publication have pegmatites present, in which tourmaline and garnet may be found, but none of the more glamorous minerals have been found in Vermont (A very little beryl has been found in an area near Lake Willoughby).

Hydrothermal deposits, usually vein type deposits, can be quite variable in mineralogy, depending upon the temperatures of formation and the elements which the fluid contains. Table I lists some of the localities in Vermont which are the result of hydrothermal action. The mineralogy of these localities is quite variable depending upon the elements originally present.

A special type of hydrothermal environment is found in basic igneous rocks (basalts and gabbros), in which the zeolite minerals have formed. There are many famous localities in the eastern United States for stilbite, heulandite, chabazite, natrolite, prehnite, datolite, and other zeolites. This group of minerals is typically found as vein and cavity fillings in basalts and gabbros. Like the other special occurrences, these minerals are almost always found in this type of environment and nowhere else. There are two mineral occurrences cited in this publication which are of this type. One is the prehnite occurrence at Bellows Falls and the other the occurrence of stilbite and prehnite at the Ruberoid Mine. There are no typical zeolite localities in Vermont like those in Massachusetts and New Jersey.

With the above information a mineral collector should be able to predict what minerals he will find in a given area, if he knows the geology. An ultrabasic intrusion in a metamorphic area will yield certain minerals from the ultrabasic depending upon the degree of retrograde metamorphism, and the country rock will yield other minerals depending upon the composition of the rock and the grade of metamorphism. Also, a collector can decide what areas to visit for certain minerals. If he is interested in talc he should investigate one of the altered ultramafics, and if he is interested in finding kyanite he should look somewhere in the staurolite-kyanite zone; to look elsewhere would be a waste of time.

This geological approach to mineral occurrences is also useful in finding interesting localities cited in the old reports. There is a report of red tourmaline from the Whitingham area. Red tourmaline contains lithium and is found only in pegmatites. A check of the geological map of that area showed the rock yielding the red tourmaline to be marble. An investigation of the locality revealed the red elongated crystals (Figure 52), not to be tourmaline but rutile, which is more likely in this type of geological environment. The conflicting information of red tourmaline occurring in a marble made this locality stand out as one worth investigating by the writer.

For each locality, a brief description of the regional geology is given. The names of rock formations are also given for most localities. These are not usually of great importance to mineral collectors, except that collectors searching for new localities might look for similar types of mineral occurrences at other places in the same formation, and could use the state geologic map to see the regional distribution of a given formation. An explanation is given for the formation of any unusual minerals found at each locality, but no mineral descriptions are given. For information about mineral identification see one of the standard reference works such as:

Mineralogy for Amateurs, by John Sinkankas, D. Van Nostrand Co., Inc., Princeton, N.J., 1964; $12.50.

Field Guide to Rocks and Minerals, by Frederick H. Pough; Houghton Mifflin Co., N.Y., 1955; $3.95.

How to Know the Minerals and Rocks, by Richard M. Pearl; McGraw Hill Book Co.; 1955; $3.50.

MINERAL LOCALITIES

ADDISON COUNTY

VERMONT KAOLIN COMPANY QUARRY AND MONKTON ORE BEDS

To reach the Vermont Kaolin Company deposits go from Bristol or Hinesburg to East Monkton. At East Monkton turn west for 3/4 of a mile and then go south 1 1/4 miles to the kaolin pits which are next to the road, Figure 5, Locality No. 1. The Monkton and Bristol iron ore beds cover a wide area. Two specific localities are shown on Figure 5, Locality No. 2. To reach the one, continue south past the kaolin pits for 3/4 of a mile to a private Vermont Kaolin Company road trending northwest. Park and follow an old trail due west from here to a

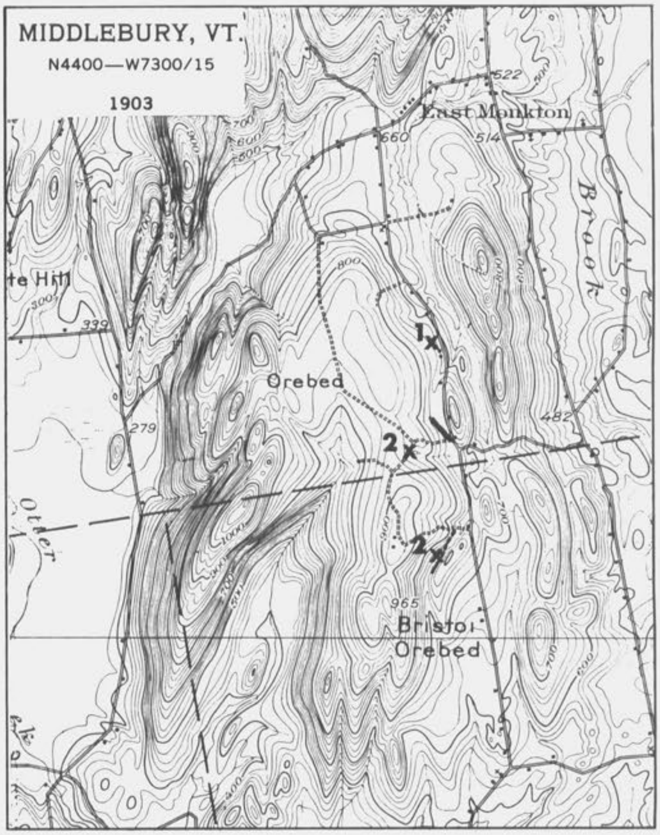


Fig. 5. Map showing the location of the Vermont Kaolin Company Quarry (1) and Monkton Iron Ore Beds (2).

small pond. Around the edge of this pond hematite and goethite can be found. To reach the other ore bed continue south another 3/4 of a mile to a road which goes west; park, and follow an old trail south (see map). In the quartzites along this trail are good specimens of goethite cementing a quartzite breccia.

The minerals found in this area are kaolinite, goethite, hematite, and an unidentified manganese oxide. These minerals may have formed in two possible ways: 1. as a residual weathering product of a feldspar-rich rock to form the kaolinite and of an iron-rich rock to form the iron oxides, or 2. by hydrothermal activity of solutions rich in potassium and aluminum to form the kaolinite and rich in iron to form the iron oxides.

REFERENCE

Cady, W.M., 1945, Stratigraphy and Structure of West-Central Vermont, Geological Society of America Bull., Vol. 56, p. 515-587.

Huntley Quarry, Leicester Junction

Turn west off U.S. Route 7 at Leicester and follow the road to Leicester Junction. After crossing Otter Creek and the railroad tracks, the quarry entrance and old lime kilns can be seen to the south of the road, Figure 6.

Calcite and tremolite (variety mountain leather) are the only two minerals found here, but the calcite crystals are large, up to 2 inches in some cases, Figure 7. The best crystals are found at the north end of the quarry in a pile of loose material. The marble in the quarry is pink, gray, and white with some very nice banded material for cutting.

This quarry is located in the Beldens Member of the Chipman Formation. The Beldens Member is interbedded buff dolomite and white to blue-gray marble and limestone. The mountain leather and calcite are both late minerals which formed in veins and cavities in the marble.

REFERENCE

Osberg, P.H., 1952, The Green Mountain Anticlinorium in the Vicinity of Rochester and East Middlebury, Vermont, Vermont Geological Survey, Bull. 5.

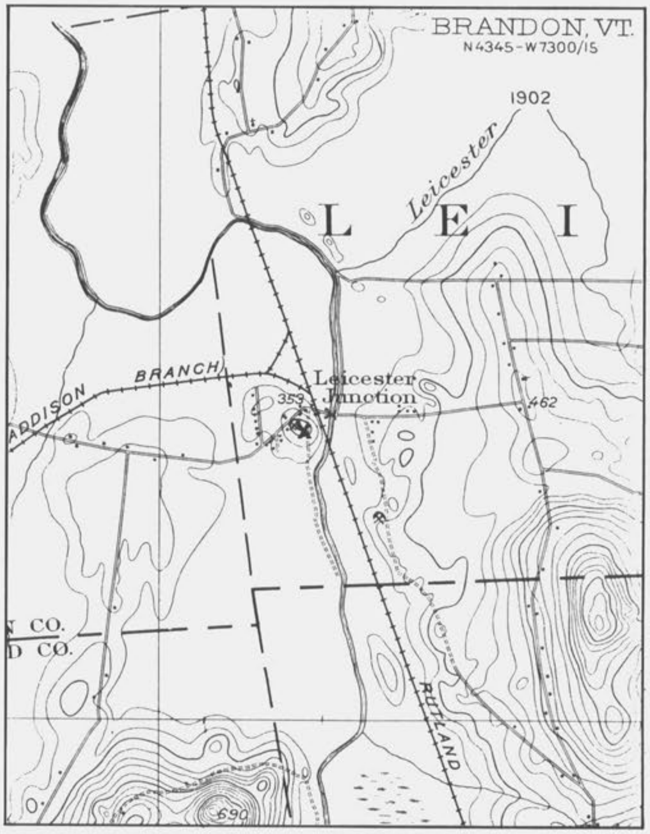


Fig. 6. Map showing the location of the Huntley Quarry, Leicester Junction.

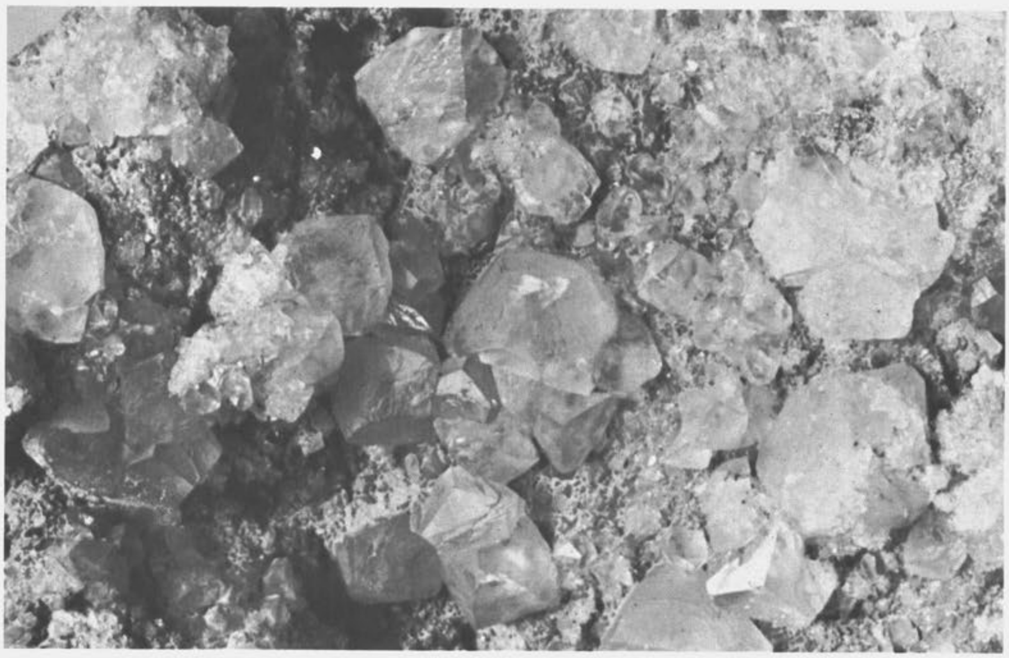


Fig. 7. Calcite crystals from the Huntley Quarry, Leicester Junction (times 1.6).

BENNINGTON COUNTY

ROAD CUT ROUTE 9, WOODFORD

On Route 9, about six miles east of Bennington, there is a large road cut on the north side of the road, Figure 8. Blue quartz, garnet, orthoclase feldspar, plagioclase feldspar, biotite, and hornblende are found in this area. The most interesting mineral found here is the blue quartz which can be cut into cabachons.

The rocks here are Precambrian in age and are metamorphosed igneous and sedimentary rocks of the Mount Holly Complex. Blue quartz is found in several localities in Vermont and is always associated with medium- to high-grade metamorphic rocks. Several theories for the origin of the blue color have been proposed. Some investigators say that the blue color is due to the presence of many small inclusions of rutile. Others say that the color was the result of strain developed during metamorphism. Recent studies have shown that the cause of the blue color is different for blue quartz from different localities and the exact causes are still not fully understood.

REFERENCES

MacFadyen, J.A., 1956, The Geology of the Bennington Area, Vermont, Vermont Geological Survey, Bull. 7.

Skehan, J.W., 1961, The Green Mountain Anticlinorium in the Vicinity of Wilmington and Woodford, Vermont, Vermont Geological Survey, Bull. 17.

CHITTENDEN COUNTY

PARROT JASPER MINE

The Parrot Jasper Mine is located in the Town of Colchester about .4 of a mile west of U.S. Route 2, just south of the bridge over the Lamoille River. Take the first road west, south of the Lamoille River, to the next intersection about .2 miles to a "T" intersection. Park and follow a narrow dirt

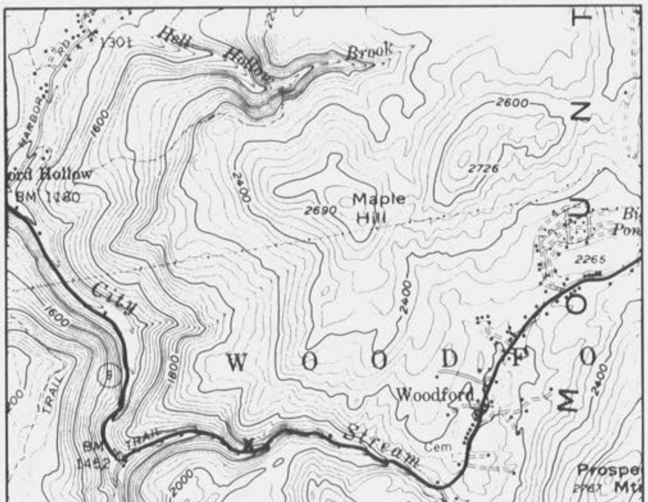


Fig. 8. Map showing the location of the roadcut on Route 9, near Woodford.

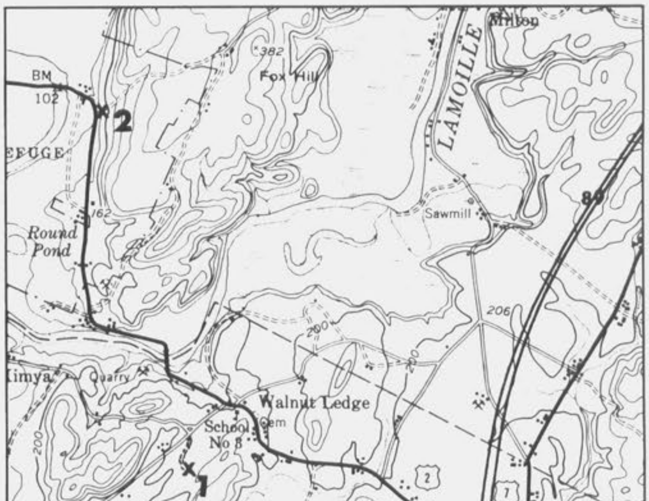


Fig. 9. Map showing the location of the Parrot Jasper Mine (1) and Dolomite Quarry (2), Colchester.

road directly opposite the "T" intersection for .2 of a mile to the Jasper Mine, Figure 9, Locality No. 1.

The minerals found here include jasper (much of it is good lapidary grade), hematite (specular), and small amounts of chalcopyrite, bornite, malachite, and chrysocolla.

This locality is in the Dunham Dolomite, of which some is of cutting grade; here it doesn't have as many color variations as it has at some other localities. The presence of the copper sulfides and hematite suggest that mineralization here is due to hydrothermal solutions, rich in iron and copper, replacing the dolomite with the minerals mentioned above.

Locality No. 2 on Figure 9 is another quarry in the Dunham Dolomite which has some good cutting material.

REFERENCE
Stone, S.W. and J.G. Dennis, 1964, The Geology of the Milton Quadrangle, Vermont, Vermont Geological Survey, Bull. 26.

FRANKLIN COUNTY

Mineral Area, East Richford

Follow Route 105 east of Richford to the junction of 105 and 105A. Stay on Route 105 for 2.7 miles where a power line crosses the road. Park and follow the power line northwest for .2 of a mile to Lucas Brook. The power line is overgrown with brush and walking is rough. Follow Lucas Brook downstream for .1 to .2 of a mile, Figure 10.

In the stream bed and along the sides are numerous boulders of actinolite with talc, fuchsite, and magnetite. As you progress downstream the going gets very rough and there are some actinolite boulders 10 to 15 feet across.

The actinolite and other minerals occur in pods or lenses and represent the alteration of small ultramafic bodies. The fuchsite is probably formed from the break-down of chromite in the ultra basic rocks. The surrounding rock is a schist of the Hazen's Notch Formation.

REFERENCE
Cady, W.M., et al, 1963, Bedrock Geology and Asbestos Deposits of the Upper Missisquoi Valley and Vicinity, Vermont, U.S.G.S., Bull. 1122-B.

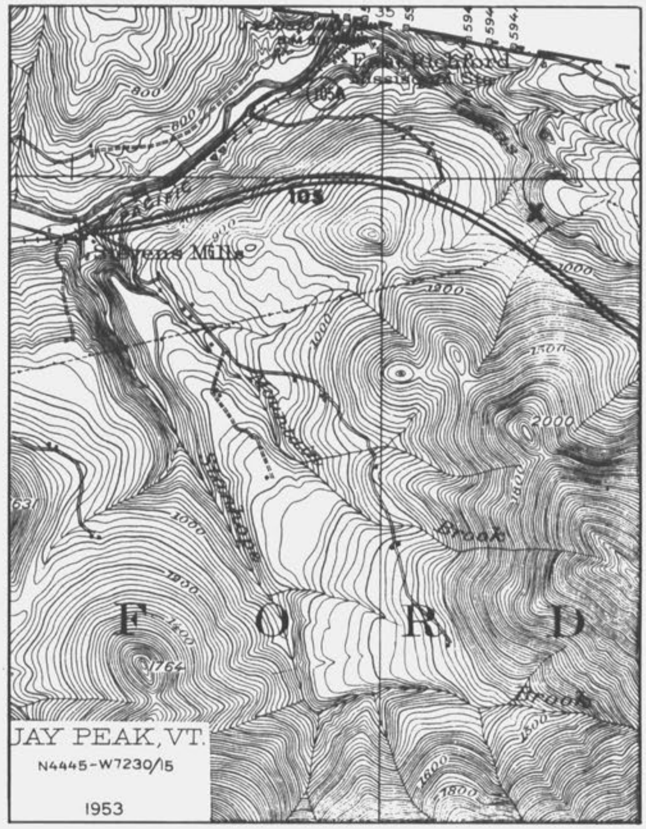


Fig. 10. Map showing the location of the mineral area near East Richford.

Manganese Prospect

This small manganese prospect is located between Richford and Berkshire. Follow the gravel road north for one mile from the road intersection three miles east of Berkshire or 2 1/2 miles west of Richford. Just to the east of the road is a small pit and dump, Figure 11. The pit has been filled in with tree stumps.

The minerals found here include hematite (specular) rhodonite, pyrolusite, and calcite.

The surrounding country rock is the Tibbit Hill volcanics and greenstone. This rock is composed mainly of chlorite, albite, and epidote and is a metamorphosed basic volcanic rock. The rhodonite may have originated in a sedimentary or volcanic rock originally rich in manganese and iron which has been metamorphosed to form the rhodonite and hematite. The pyrolusite is the result of recent weathering.

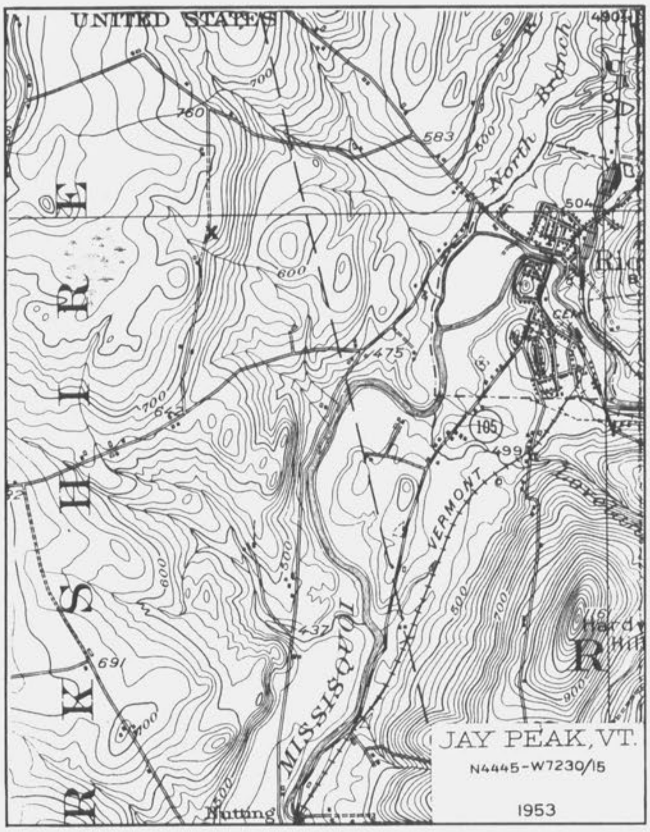


Fig. 11. Map showing the location of the Manganese Prospect west of Richford.

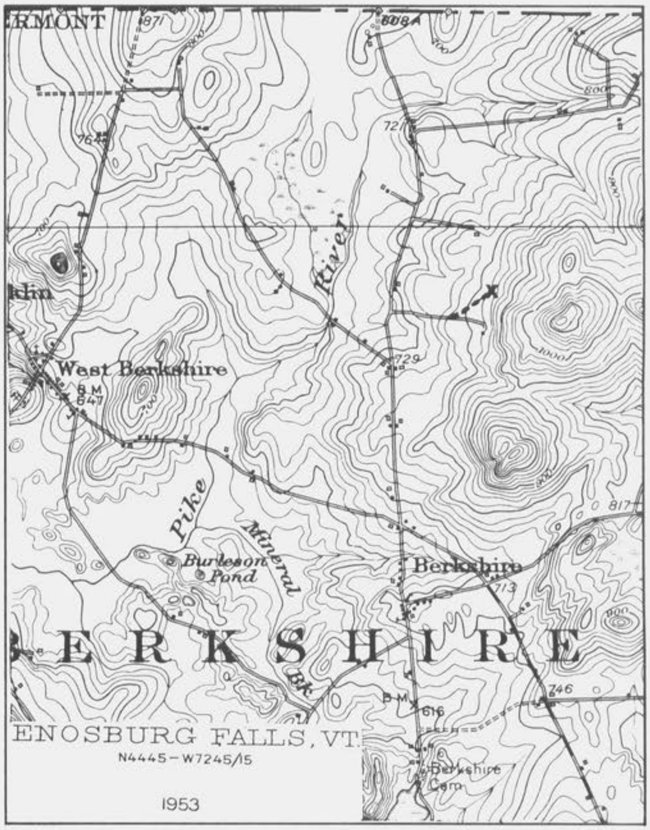


Fig. 12. Map showing the location of the Berkshire Copper Mine.

REFERENCE

Dennis, J.G., 1964, The Geology of the Enosburg Area, Vermont, Vermont Geological Survey, Bull. 23.

Berkshire Copper Mine

The Berkshire Copper Mine was operated by the Vermont and Boston Mining Company sometime ago. It is reached by going north 1 1/2 miles from Berkshire and taking a sharp right turn on a narrow dirt road. Proceed .3 miles on this road to a turn to the left where cars can be parked. Follow the turn-off road northwest (it is very faint or has disappeared) across the field to the tree-covered dumps, Figure 12.

Very rich specimens of bornite and chalcopyrite can be found on the dumps, also secondary copper minerals including malachite and azurite are present as thin coatings.

This mine is in the Tibbit Hill volcanics, which are a fine-grained, chlorite-albite-epidote rock formed from the metamorphism of an original basic volcanic rock. The bornite and chalcopyrite are hydrothermal in origin and the malachite and azurite are thin films on the rock resulting from the weathering of the bornite and chalcopyrite. It is interesting to note that pyrite and pyrrhotite which are found in most of the other copper mines in Vermont are absent here.

REFERENCE

Dennis, J.G., 1964, The Geology of the Enosburg Area, Vermont, Vermont Geological Survey, Bull. 23.

Bakersfield Pyrite Location

Pyrite is found for several miles along Route 108 between East Fletcher and Bakersfield. The best locality is just north of the town line between Fletcher and Bakersfield. About .2 of a mile north of the town line a small stream crosses the road and just east of the road along the stream are some large outcrops which contain pyrite, Figure 13. The

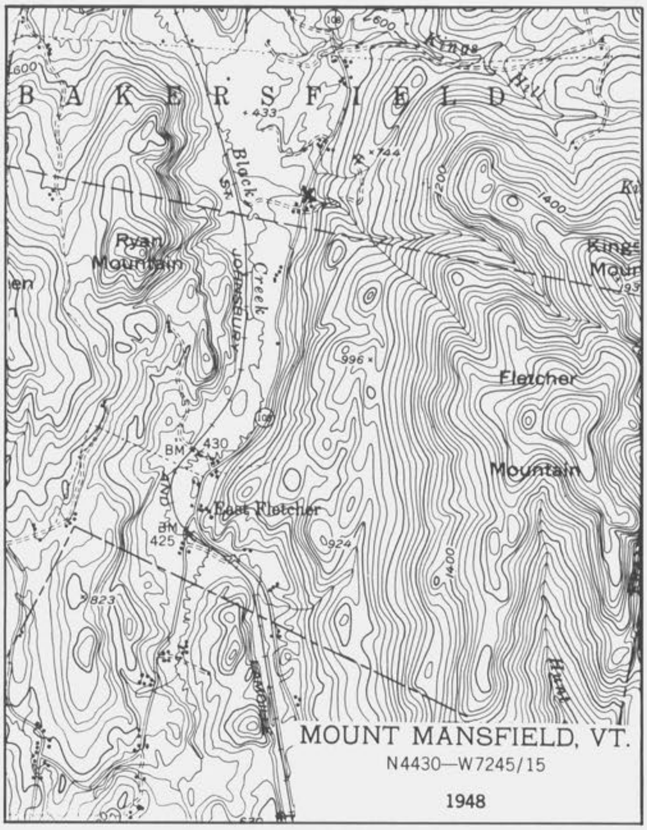


Fig. 13. Map showing the location of the mineral area between Fletcher and Bakersfield.

Fig. 14. Polished sample of "Swanton Red Marble" from Swanton, Vermont (times 1.6).

surface of the rock is weathered and some cavities where one-inch and larger pyrite cubes had been, can be found. Upstream pyrites are also found along with magnetite octahedrons at a small waterfall.

The rock in this area is fine-grained, carbonaceous quartz-sericite-albite-chlorite schist and phyllite of the Underhill Formation. The pyrite is the result of a high iron and sulfur content of the original sediments, and formed during the low-grade metamorphism.

REFERENCE

Christman, R.A., 1959, Geology of the Mount Mansfield Quadrangle, Vermont, Vermont Geological Survey, Bull. 12.

Swanton Red Marble Localities

The Dunham Formation includes a series of dolomites which are red, brown, orange, gray, purple, and white, usually showing a mottled effect, Figure 14. These dolomites have been used for building and ornamental stone under the name Swanton Marble or Swanton Red Marble.

This locality has little interest to mineral collectors, but does have excellent lapidary material. Bookends, table tops, and even cabachons of the fine-grained material have been made from the Dunham dolomites.

There are numerous localities in Vermont from the Canadian Border to Malletts Bay. The locality listed below is in Franklin County and another locality is shown in Figure 9, Locality No. 2.

The locality in Figure 15 is off U.S. Route 7 about .4 of a mile south of the bridge across the Missisquoi River. To reach it turn east on a narrow road which passes under the Interstate and go about .3 of a mile to a small quarry and dump owned by the Vermont Marble Company.

REFERENCE

Stone, S.W. and Dennis, J.G., 1964, The Geology of the Milton Quadrangle, Vermont, Vermont Geological Survey, Bull. 26.

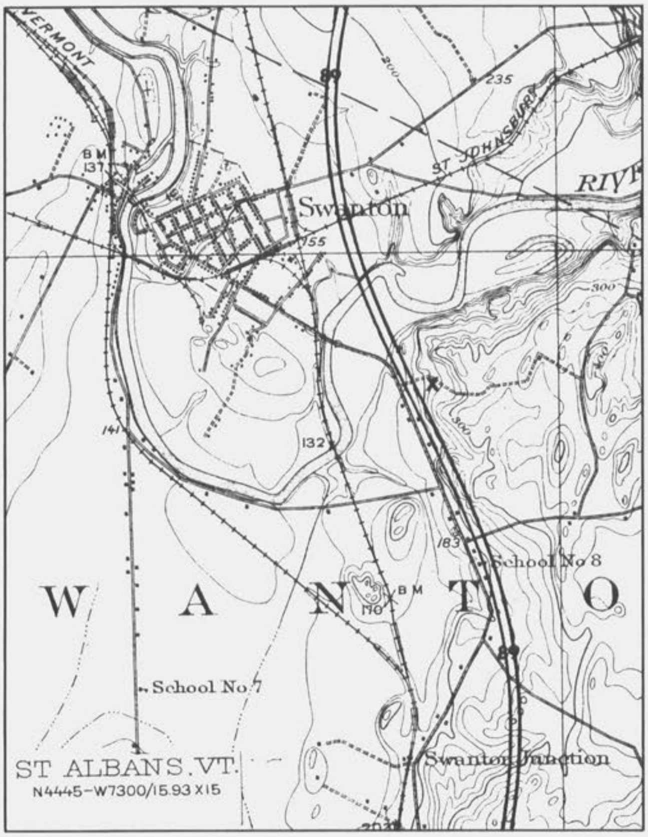


Fig. 15. Map showing the location of the Swanton Red Marble Quarry, Swanton.

ESSEX COUNTY

Essex County Andalusite Localities

Northeastern Vermont has many andalusite occurrences. Two of these are located on the maps in Figures 16 and 17. The locality in Figure 16 is a road cut on Route 102 about .6 of a mile south of Bloomfield, opposite a small cemetery. The other locality, Figure 17, is about 3 miles southeast of the village of Island Pond and can be reached by following the road along the west side of Island Pond for 2.3 miles south of the intersection with Route 105 and turning right on a secondary road for about a mile to a small bridge. The best andalusite occurs at various places along this stream, but andalusite is present in the rocks for several miles north and south on this same slope.

The andalusite from these localities occurs as fresh pink crystals, dark crystals containing many inclusions (some of these crystals have oriented inclusions giving the appearance of a cross or flower of the chiastolite variety of andalusite), and white crystals partially altered to muscovite, Figure 18. Associated minerals include garnet, sillimanite, quartz, muscovite, and biotite. These are all fine grained and generally not visible to the naked eye, although small garnet crystals were seen in some specimens.

These minerals are found in the Gile Mountain Formation which is a light to dark gray phyllite or schist. This rock was originally a sedimentary rock similar to a shale and has been subsequently metamorphosed. Much of this metamorphism was caused by the invasion of granitic magma into these sedimentary rocks (see Figure 3 for the location of these igneous bodies).

REFERENCES

Goodwin, B.K. 1963, Geology of the Island Pond Area, Vermont, Vermont Geological Survey, Bull. 20.

Johansson, W.I., 1963, Geology of the Lunenburg-Brunswick-Guildhall Area, Vermont, Vermont Geological Survey, Bull. 22.

Myers, P.B. Jr., 1964, Geology of the Vermont Portion of the Averill Quadrangle, Vermont, Vermont Geological Survey, Bull. 27.

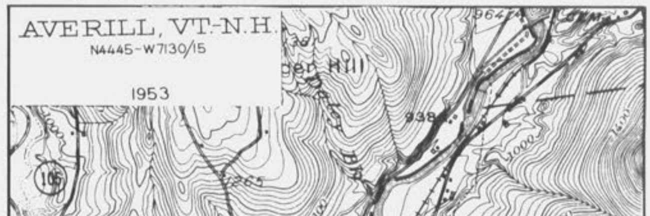


Fig. 16. Map showing the location of the Road Cut south of Bloomfield.

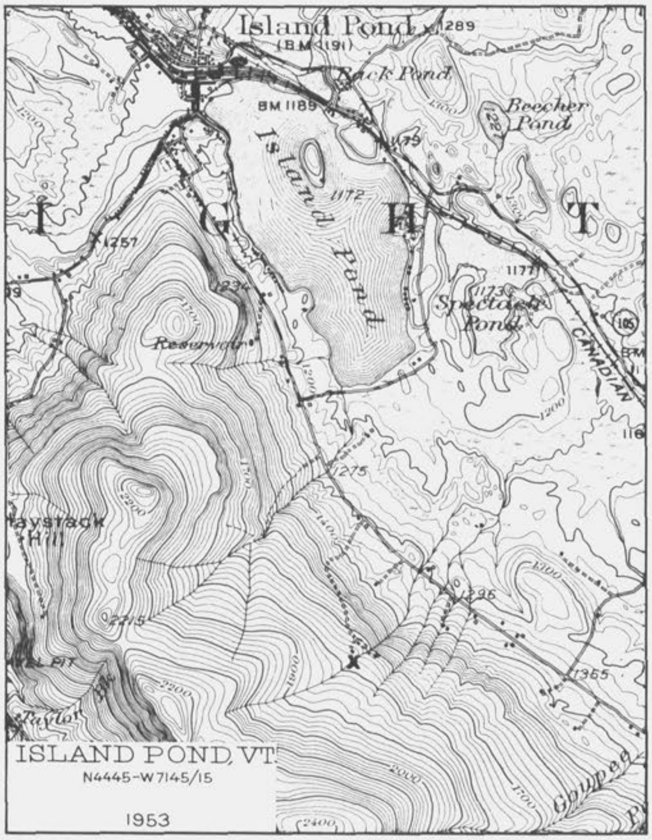


Fig. 17. Map showing the location of the mineral area southwest of Island Pond.

Fig. 18. Cut sample of andalusite in schist from Route 102 south of Bloomfield (times 1.6).

GRAND ISLE COUNTY

South Hero Island Localities

Two similar localities are found at the opposite ends of South Hero Island (Grand Isle), Figures 19 and 20. The one locality is situated on U.S. Route 2 where it crosses from South Hero Island to North Hero. The road is built up from the lake and the fill on the side of the road contains quartz crystals, calcite crystals, and pyrite concretions or suns. The other locality is found on U.S. Route 2 at the west end of the Sand Bar Bridge. On the south side of U.S. Route 2 is a small quarry where quartz, calcite, and pyrite can also be found, although they are not the same quality or in as great quantity as the same species found at the north end of the island.

Both of these localities are in the Stony Point Formation, which is a calcareous black shale. The pyrite formed from iron and sulfur under reducing conditions when the original rock formed. The

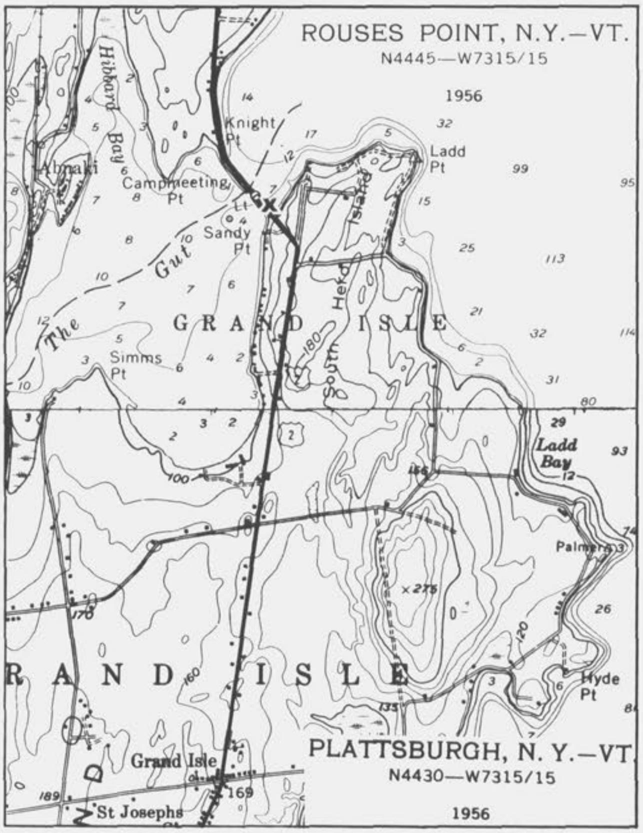


Fig. 19. Map showing the location of the road fill and quarry between North and South Hero.

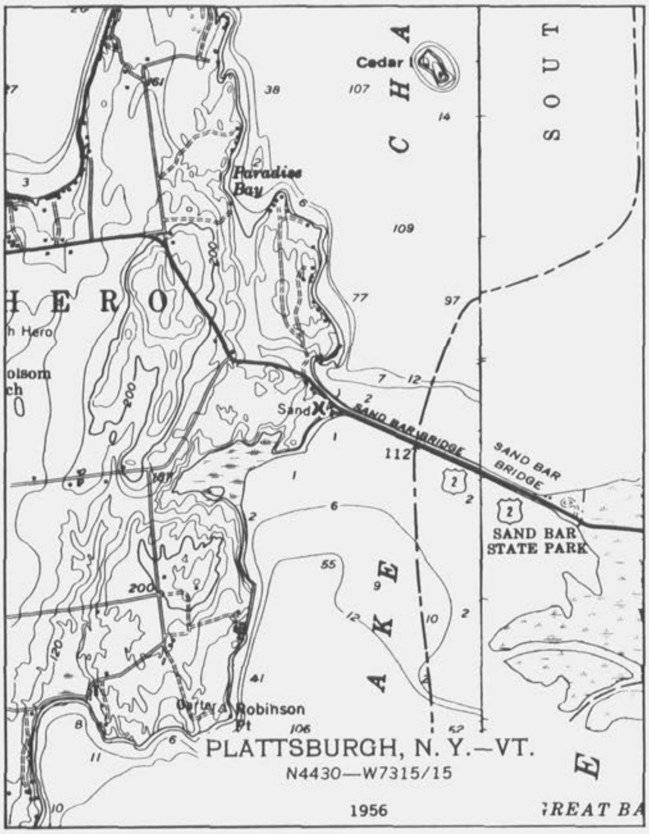


Fig. 20. Map showing the location of the quarry west of Sand Bar Bridge.

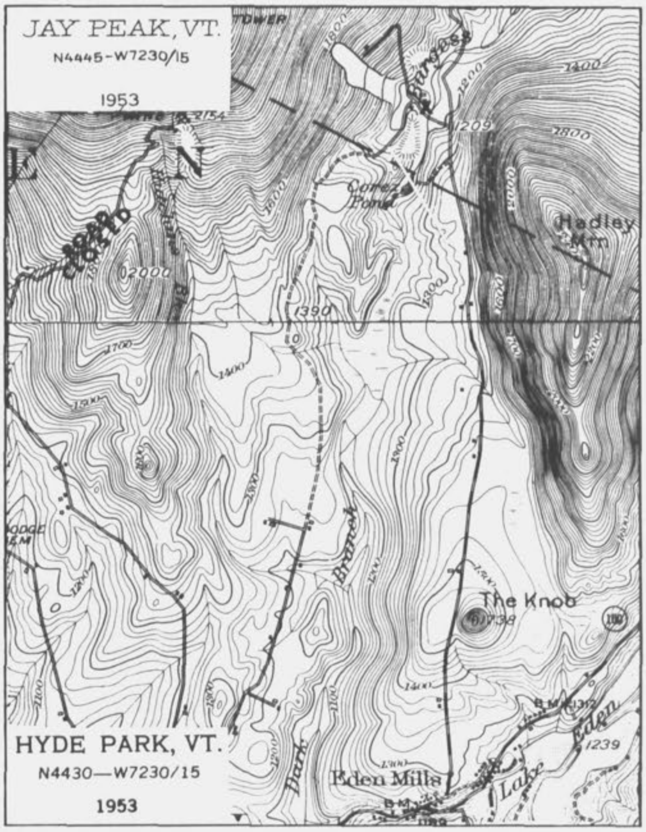


Fig. 21. Map showing the location of the Ruberoid Asbestos Mine, Lowell. Old mine in Eden.

calcite and quartz are vein fillings deposited from solutions traveling through cracks in the rock.

REFERENCE

Erwin, R.B., 1957, The Geology of the Limestone of Isle La Motte and South Hero Island, Vermont, Vermont Geological Survey, Bull. 9.

LAMOILLE COUNTY

Ruberoid Asbestos Mine

The Ruberoid Asbestos Mine (Ruberoid is now a subsidiary of the General Aniline and Film Company) is the most interesting mineral locality in Vermont. This locality has been referred to by a variety of names. Part of the mine is located in the town of Eden, Lamoille County and part in the town of Lowell, Orleans County; the nearest village is Eden Mills; the mine is located on the northeast side of Belvidere Mountain. All of the preceeding names have been used for this locality. The mine can be reached by taking Route 100 to Eden Mills and from there take the north road which leads to the mine, Figure 21.

The Ruberoid Company will conduct individuals and groups on tours of the mill and mine if prior arrangements are made, Figure 22. In the past, material has been dumped outside the gate at the entrance to the property and collecting is allowed here at any time.

Thirty-two minerals are known to occur at the Ruberoid Mine. They are:

antigorite	diopside	apatite
magnetite	clinozoisite	uvarovite
brucite	grossular (Figure 23)	bornite
chlorite	idocrase (Figure 24)	chalcopyrite
chrysotile (cover)	sphene	pyrite
talc	zoisite	chalcocite
olivine	biotite	dolomite
chromite	albite	prehnite (cover)
calcite (Figure 23)	artinite	stilbite
magnesite	pyroaurite	siderite
heazlewoodite	graphite	

There are three separate quarries on Belvidere Mountain; the Eden quarry which is abandoned, the Lowell and "C" area quarries which are being mined at present. These quarries are all in ultrabasic rock, dunite and peridotite, which has been completely or partially altered to serpentine. The surrounding rocks are metamorphosed sediments and volcanics of the Camels Hump Group. These include schist, gneiss, quartzite, and amphibolite. The serpentine (antigorite) formed by the alteration of the ultrabasic rock. Some talc and carbonate also formed this way. For some reason, conditions at Belvidere Mountain were such that while serpentization was going on there was also fracturing of the rock. The chrysotile (asbestos) formed along these fractures as the adjacent ultramafic rock was undergoing alteration. Without the fracturing, the chrysotile could not have formed.

Magnetite, chromite, and olivine are primary minerals found in the ultrabasic rock. Talc, antigorite, brucite, chlorite, chrysotile, siderite, biotite, calcite, magnesite, pyroaurite, and dolomite are due to the alteration of the ultrabasic by CO_2 and H_2O. Diopside, clinozoisite, grossular, idocrase, sphene, zoisite, graphite, apatite, and uvarovite were formed by the metamorphism of blocks of limestone and/or dolostone caught up in the hot magma. Heazlewoodite, bornite, chalcopyrite, pyrite, and chalcocite are the result of late copper-bearing hydrothermal solutions which penetrated these rocks. Finally, artinite, albite, prehnite, stilbite and some of the calcite, clinozoisite, and zoisite are very late cavity filling minerals and formed from late hydrothermal solutions, similar to the formation of zeolites in basalts.

Fig. 22. Ruberoid Mine, Lowell. Courtesy Ruberoid Company

REFERENCE

Cady, W.M., Albee, A.L., and Chidester, A.H., 1963, Bedrock Geology and Asbestos Deposits of the Upper Missisquoi Valley and Vicinity, Vermont, U.S.G.S., Bull. 1122-B.

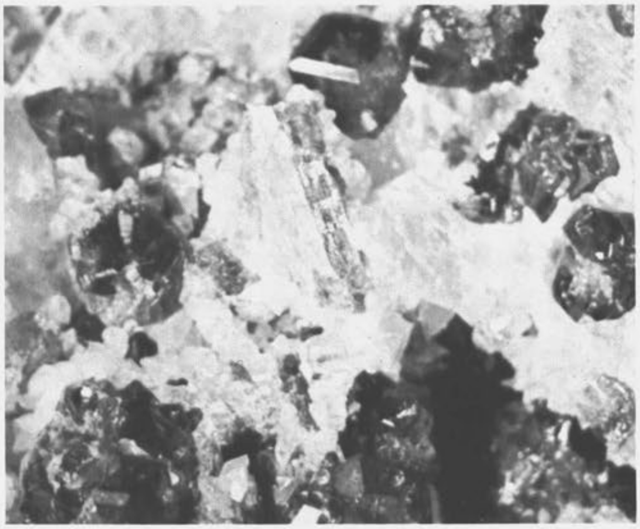


Fig. 23. Garnet in calcite, Ruberoid Asbestos Mine (times 1.6).

Fig. 24. Idocrase crystals, Ruberoid Asbestos Mine.

Johnson Talc Mine

To reach this locality take Route 100C north from Johnson for about 3 miles to a crossroad with a sign to the talc mine. Turn west and go about 1 mile to the mine, Figure 25.

Mining has been going on in this area since 1900 and is continuing at the present time. There are numerous old dumps and mine holes in the area. Due to the slippery nature of the talc rock great care should be taken near any openings.

The following minerals are abundant on the dumps: talc, pyrite, serpentine, magnetite, dolomite, and magnesite. Less common are pyrrhotite, bornite, chalcopyrite, graphite, and ilmenite. Gersdorffite (NiAsS) is reported and was recovered at the mill for a short time as a nickel ore, but was not seen by the writer on the dumps.

The ultramafic body being mined is about 3,500 feet long and 200 feet wide. It is completely altered to talc-carbonate rock with some small areas of serpentine remaining. The surrounding country rock is the Camels Hump Formation which is a graphitic schist, chlorite-albite schist, and a quartzite schist.

REFERENCE

Albee, A.L., 1957, Bedrock Geology of the Hyde Park Quadrangle, Vermont, U.S.G.S. Geologic Quadrangle Maps of the U.S. Map GQ 102.

Morrisville Lead-Zinc Prospect

This locality is due north of the intersection of Routes 15 and 15A east of Morrisville. The best way to reach the locality is to go east from the intersection on Route 15 for .2 of a mile to the first road north. After turning north on this road there is a power line trending northwest. Follow this power line to the summit of the hill (to pole number 77) and go due north along the summit to several small pits in a dense spruce thicket (500 to 1000 feet), Figure 26, Locality No. 1.

The minerals found here include: pyrite, galena, sphalerite, calcite, and barite. The barite is

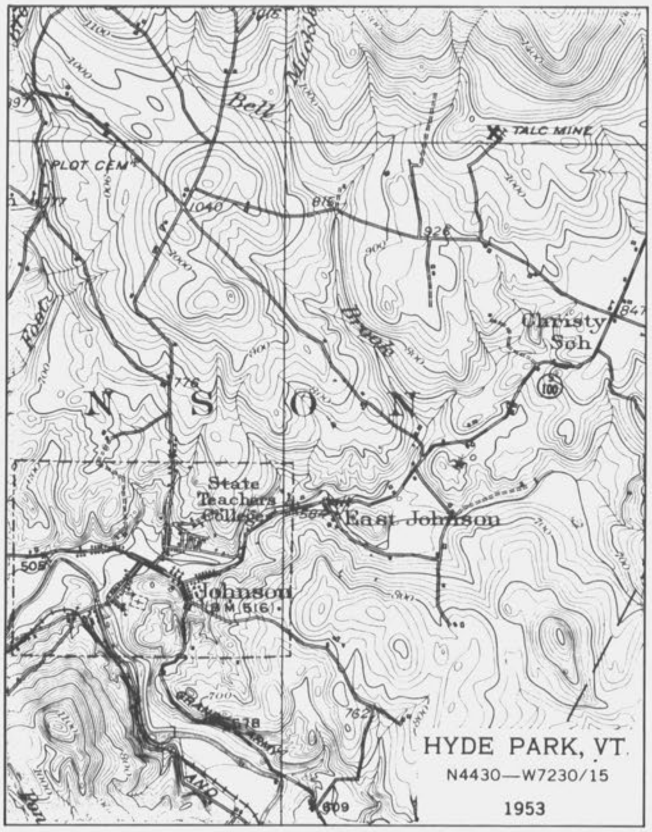


Fig. 25. Map showing the location of the Johnson Talc Mine, Johnson.

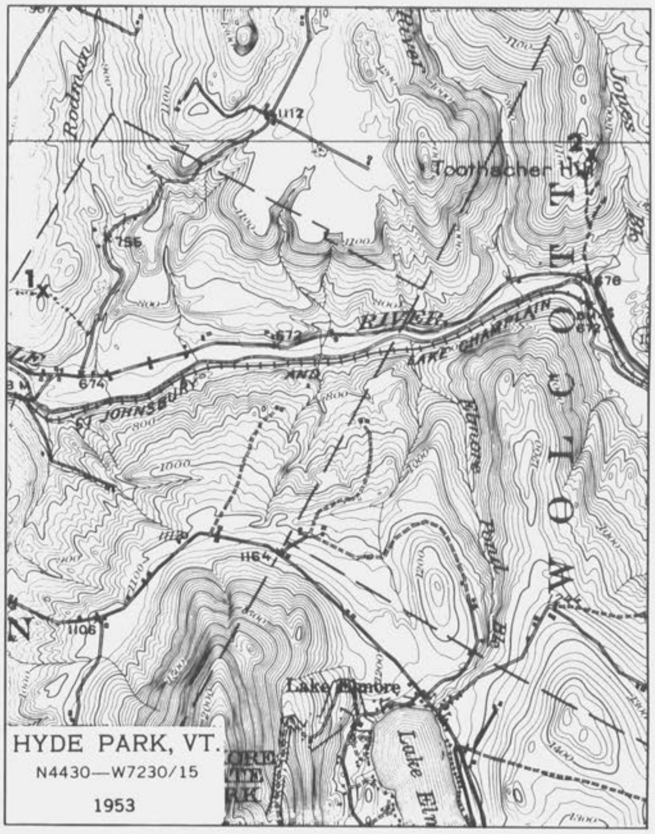


Fig. 26. Map showing the location of the Wolcott Copper Mine (2) and Morrisville Lead-Zinc Prospect (1).

white and quite abundant, both in the dumps and on the side of the larger pit. It can be recognized by its high specific gravity.

The country rock is a fine-grained, muscovite-chlorite-albite schist with the above minerals occurring in cross-cutting veins. The sulfides and the barite are of hydrothermal origin. The deposit is unusual in that the hydrothermal solutions contained barium which formed the mineral barite, which is not a common mineral in Vermont.

REFERENCE

Albee, A.L., 1957, Bedrock Geology of the Hyde Park Quadrangle, Vermont, U.S.G.S. Survey Map, GQ 102.

WOLCOTT COPPER MINES

The Wolcott Copper Mines are located on Toothacher Hill in Wolcott. Park along Route 15 by Jones Brook. Follow an old dirt road across the brook and up the hill (this road is not drivable), Figure 26, Locality No. 2. There are many lumber roads on Toothacher Hill which can be very confusing. One of the mines can be reached by going left at the first two forks in the road and right at the third fork. The total distance from the main highway to the mine is about three-fourths of a mile. Other mines are reported in this area but were not seen by the author.

Pyrite, magnetite, pyrrhotite, and minor chalcopyrite, sphalerite, and galena have been found in this area. The country rock is greenstone (chlorite-albite-muscovite-quartz schist) and quartzite of the Stowe Formation. This deposit is very similar mineralogically to the Orange County copper deposits and is of a similar hydrothermal origin.

REFERENCE

Albee, A.L., 1957, Bedrock Geology of the Hyde Park Quadrangle, Vermont, U.S.G.S., Map GQ 102.

ORANGE COUNTY

EAST BRAINTREE ARSENIC MINE

Follow Route 12 south from East Braintree. There is one bridge in the center of town and 1/2 mile south of the town is another bridge. South of the second bridge take a turn east on a gravel road. Continue on this road about 1/3 of a mile to a fork in the road. Stay to the right, and just past the fork is a place to pull off to the left of the road. Park here and walk along the road to a small stream (it is intermittent in the summer). Just past the stream on the right is a trail. Follow this trail which goes along the stream for a short distance (about 1/4 mile) and then makes a sharp left turn. Continue on after the left turn to an old chimney, pits, and dumps of the arsenic mine, Figure 27.

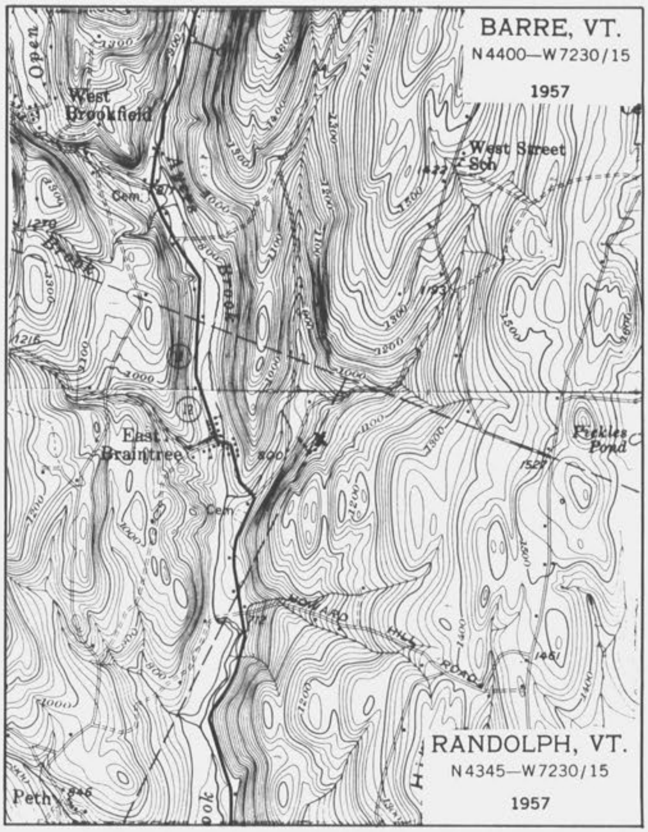


Fig. 27. Map showing the location of the Arsenic Mine, East Braintree.

Arsenopyrite is very abundant here in large masses and occasionally in good crystals. Pyrite and quartz are also found here. The arsenopyrite is in a vein about 1000 feet long and 3 to 4 inches wide surrounded by a fine-grained, black phyllite of the Waits River Formation. The arsenopyrite is of hydrothermal origin, but the fact that only iron, sulfur, and arsenic are present is unusual.

REFERENCE

Ern, E.H. Jr., 1963, Bedrock Geology of the Randolph Quadrangle, Vermont, Vermont Geological Survey, Bull. 21.

Pike Hill Mines

From Route 25 in the center of Waits River go southwest on the gravel road 1/2 mile and make a left turn. Then go 1 1/2 miles and make a right turn for .2 of a mile to a road on the left. The road from Waits River to this point is not in very good condition but is passable. Park and walk west about 1/2 mile to the mine and dumps, Figure 28. There are extensive dumps and several old mine tunnels in this area. Mining started in this area in the 1860's and continued until 1919.

Pyrrhotite, pyrite, chalcopyrite, garnet, calcite, kyanite, and tourmaline can be found on the dumps.

The country rock is the Waits River Formation and includes quartz-calcite-mica schists, garnet-mica schists, and minor quartzites and marbles. The ore at Pike Hill formed in a manner similar to that at the Elizabeth Mine and involved a combination of hydrothermal activity and regional metamorphism.

Reference

Murthy, V.R., 1957, Bedrock Geology of the East Barre Area, Vermont, Vermont Geological Survey, Bull. 10.

Ely Mine

Take Route 113A to West Fairlee and go west 1 1/2 miles toward South Vershire. The old smelter and foundations which once were the village of Copperfield can be seen on both sides of the road. Park and follow the dirt road north 3/4 of a mile to the mine dumps, Figure 29. This mine was first started in 1821 and continued intermittently with many owners until 1900 when it closed for the last time.

Actinolite, calcite, garnet, hornblende, malachite, pyrite, pyrrhotite, tourmaline, and sphalerite have been found here. Some of the other minerals found at the Elizabeth Mine are probably also present.

The country rock is the Gile Mountain Formation and is a quartz-muscovite schist. The copper

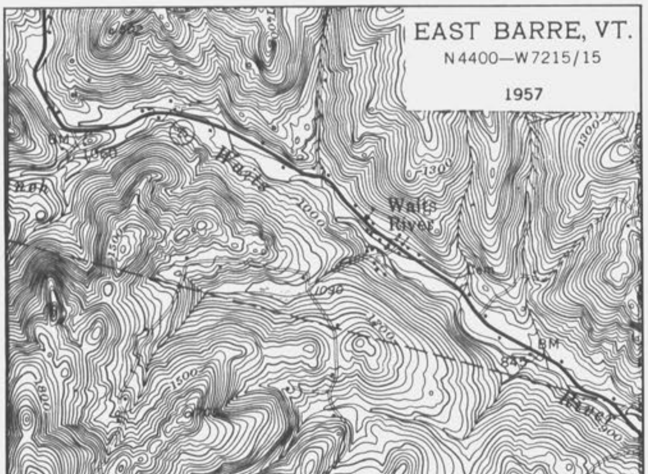


Fig. 28. Map showing the location of the Pike Hill Mines, Corinth.

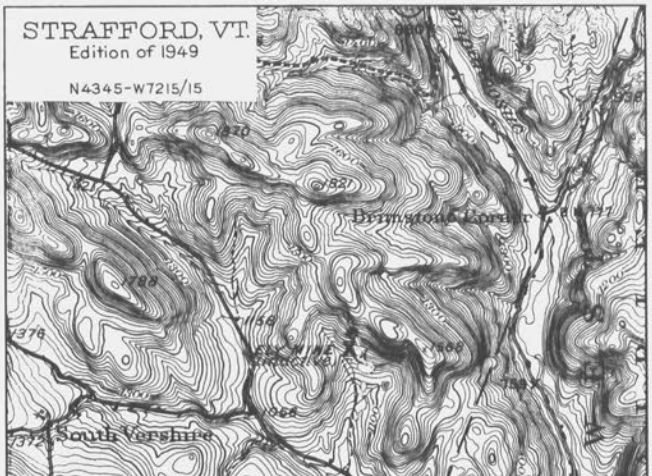


Fig. 29. Map showing the location of the Ely Mine, Vershire.

mineralization at the Ely Mine is similar to that at the Elizabeth Mine and Pike Hill Mine, and all of these were probably formed at the same time by related copper-bearing hydrothermal solutions.

REFERENCES

Jacobs, E.C., 1916, Copper Mining in Vermont, 10th Annual Report of the Vermont State Geologist, 1915-1916, p. 192-199.

Doll, C.G., 1944, A Preliminary Report on the Geology of the Strafford Quadrangle, Vermont, Twenty-fourth Annual Report of the State Geologist of Vermont 1943-1944, p. 14-28.

Elizabeth Mine

The Elizabeth Mine, formerly owned by Vermont Copper Co., was active until 1958 when it was closed due to the high cost of recovering the ore, Figure 30. The mine is located about 2 miles from South Strafford. It can be reached by following Route 132 east from the center of South Strafford about 1/4 mile. Continue straight where Route 132 turns left and at the next fork in the road go left and continue on to the mine, Figure 31.

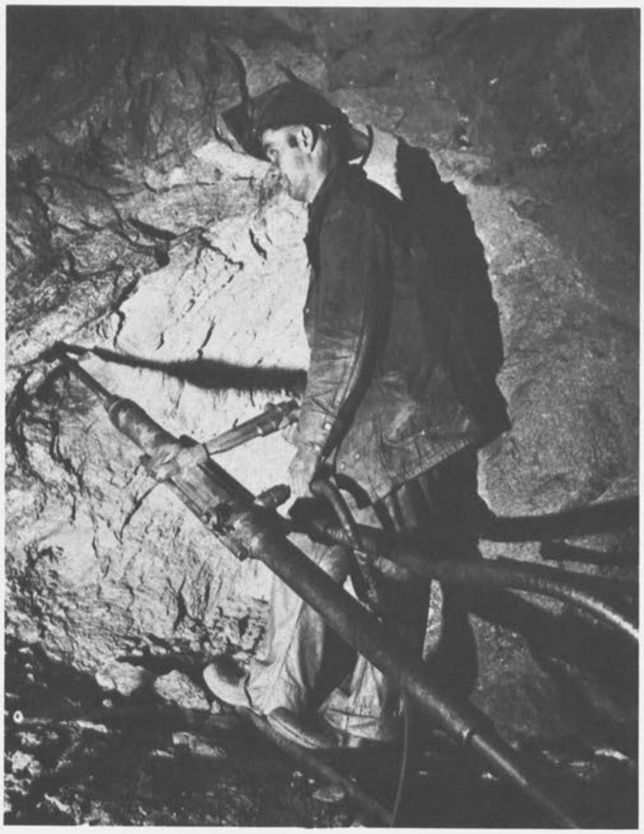


Fig. 30. Elizabeth Copper Mine, South Strafford. Courtesy Vermont Copper Company

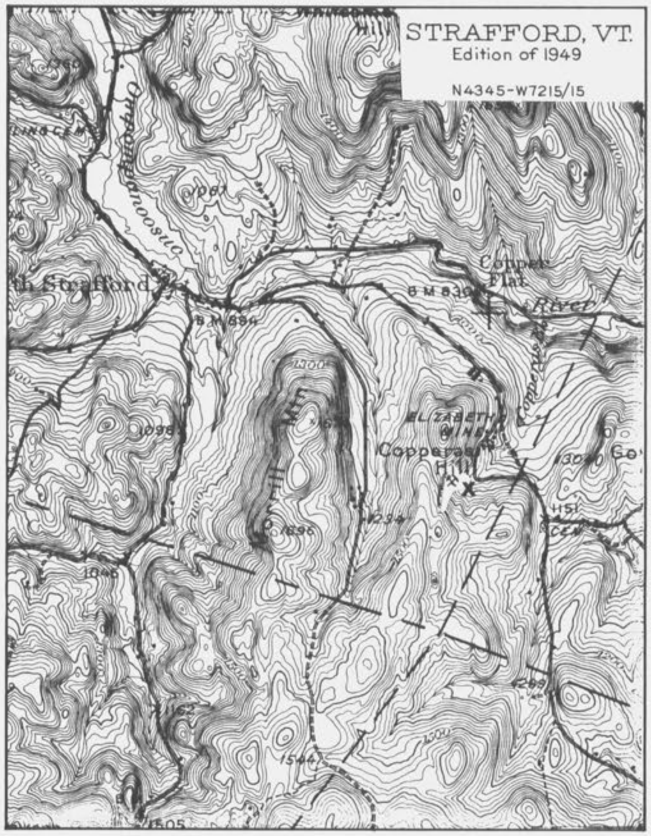


Fig. 31. Map showing the location of the Elizabeth Mine, South Strafford.

The principal mineral in the copper orebodies of the Elizabeth Mine is pyrrhotite. The other minerals are chalcopyrite, sphalerite, cubanite, pyrite, and very rare valleriite, galena, tetrahedrite, tennantite, and molybdenite. Minerals found in the country rock associated with the ore are: quartz, plagioclase, calcite, biotite, actinolite, muscovite, idocrase, sphene, apatite, tourmaline, rutile, garnet, staurolite, hornblende, and kyanite. Many of these are found only in small amounts.

The sulfides are present both disseminated and in massive bands. The surrounding rocks are amphibolites, quartz-mica schists, and quartzites of the Gile Mountain Formation. The geologic history of these deposits is quite complex as both regional metamorphism and hydrothermal activity are responsible for the minerals found here. Regional metamorphism reached the kyanite grade and was followed by hydrothermal activity which formed the sulfides and a series of alteration zones around the sulfides in which kyanite was replaced by muscovite, feldspar was replaced by muscovite, and hornblende and garnet were replaced by biotite and chlorite. Metamorphism to a lesser degree continued during the formation of the sulfides and also after the hydrothermal activity had ceased.

REFERENCES

Howard, P.F., 1959, Structure and Rock Alteration at the Elizabeth Mine, Vermont, Pt. II Rock Alteration, Economic Geology, v. 54, p. 1414-1443.

McKinstry, H.E. and Mikkola, A.K., 1954, The Elizabeth Copper Mine, Vermont, Economic Geology, v. 49, p. 1-30.

ORLEANS COUNTY

Road Cuts on the East Side of Lake Willoughby

Along Route 5A on the east side of Lake Willoughby there are extensive road cuts, Figure 32. The scenery is quite spectacular here. The Lake Willoughby trough in which these outcrops are located can be seen for many miles. This narrow cut, with very steep mountains on both sides of the lake,

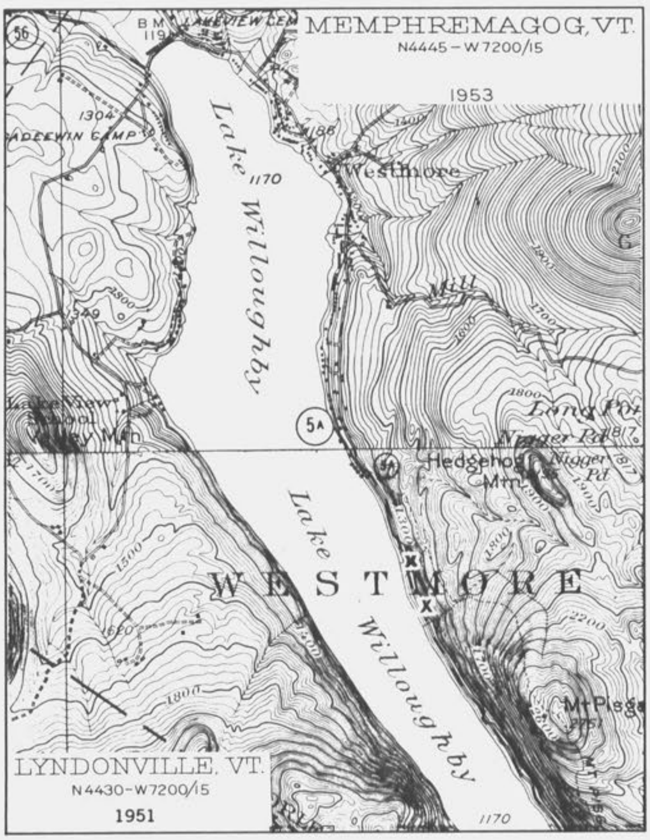


Fig. 32. Map showing the location of the roadcuts on the east side of Lake Willoughby.

was caused by glacial erosion along a zone of weakness. The best place to park is at a turn-off on the east side of Route 5A where a pipe carries spring water from the side of the cliff down to the road. From here the best outcrops are north along 5A. Be careful of falling rock from the steep road cuts and also be careful of the fast traffic. More adventurous persons might want to climb the large talus slopes above the road.

A number of rock types are found in these road cuts, including granite, granite-pegmatites, schists, and calc-silicate rocks. These rocks belong to the Waits River and Gile Mountain formations and were once sedimentary rocks which have been altered when intruded by granitic magma.

The granite and granite-pegmatites contain quartz, microcline feldspar, plagioclase feldspar, garnet, biotite, muscovite (some unusual "plumose" muscovite has been found in this area) and pyrite. Beryl has also been reported from this area, although none was seen by this writer in the road cuts. The metamorphic schists and calc-silicates contain quartz, muscovite, biotite, garnet, hornblende, diopside, sphene, and idocrase. These are usually fine grained, but nice garnet and idocrase specimens have been found.

REFERENCES

Dennis, J., 1956, The Geology of the Lyndonville Area, Vermont, Vermont Geological Survey, Bull. 8.

Doll, C.G., 1951, Geology of the Memphremagog Quadrangle and the Southeastern Portion of the Irasburg Quadrangle, Vermont, Vermont Geological Survey, Bull. 3.

Craftsbury Granite

In the town of Craftsbury there is an occurrence of a very unusual type of granite. Locally it is called the "prune" or "bullseye" granite. More precisely it is an orbicular granodiorite. It is a rock composed of quartz, plagioclase feldspar, biotite, and muscovite and looks like a granite. The unusual feature is that scattered throughout the rock are segregations or orbicules composed mainly of biotite, Figure 33. The orbicules can be separated quite easily from the rock and have the appearance of "prunes"; also, the biotite flakes are arranged in concentric layers, so that on a weathered surface they look like "bullseyes".

The Craftsbury granodiorite outcrops in an area only 3/4 of a mile long and 1/8 of a mile wide,

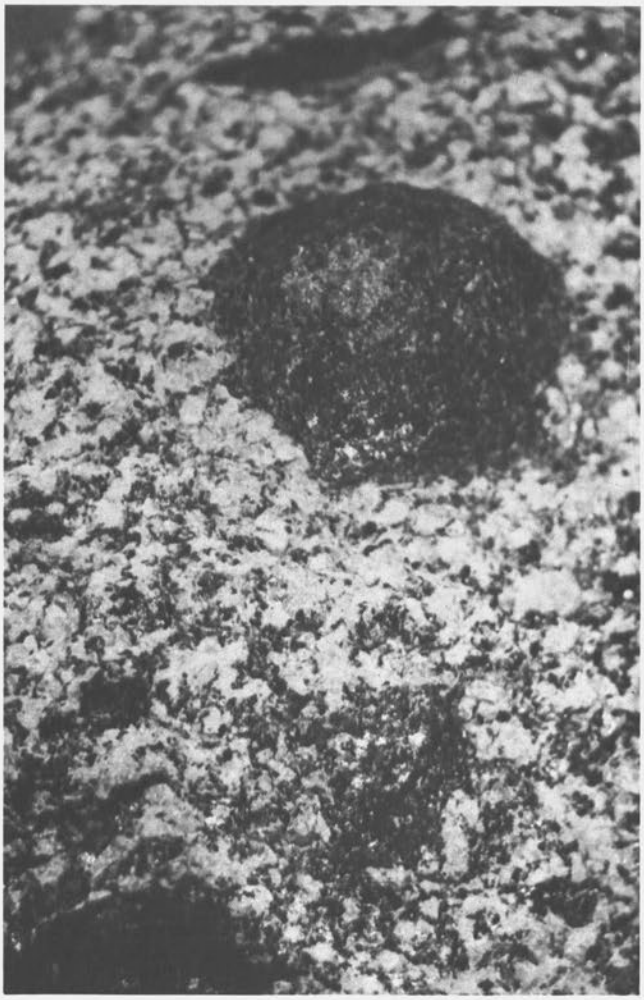


Fig. 33. Biotite orbicule in Craftsbury Granite, Craftsbury (times 1.6).

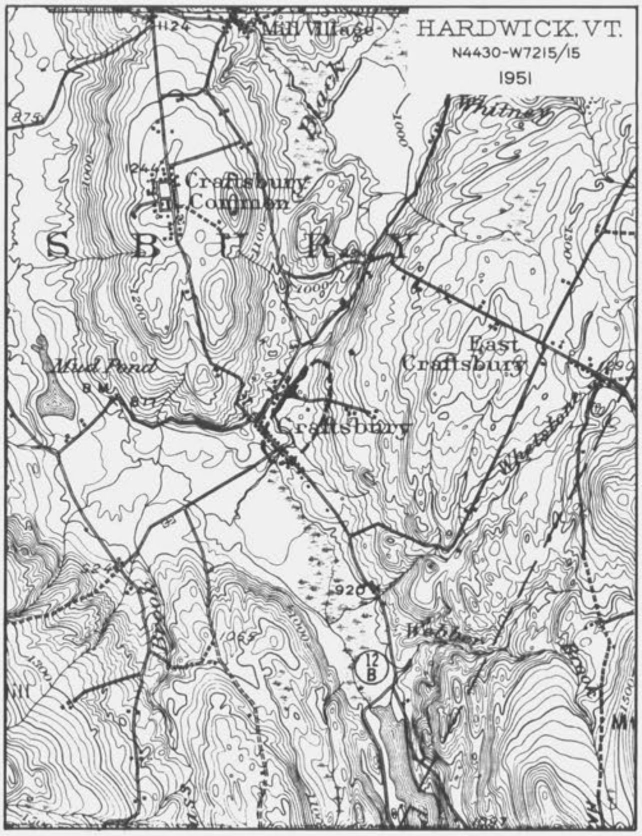


Fig. 34. Map showing the location of the Craftsbury Granite (boundary of area marked by dashed line).

Figure 34. The best area to collect specimens is along the Black River at the northwestern edge of the village of Craftsbury.

At the Rock of Ages Quarry in the Bethel White Granite, about three miles north of Bethel, some biotite orbicules are found. They are not as abundant here and are usually smaller.

The origin of the biotite orbicules is not fully understood. They are probably due to a combination of crystallization around pre-existing cores in the magma and then movement accompanying crystallization.

REFERENCE

Konig, R.H. and Dennis, J.G., 1964, The Geology of the Hardwick Area, Vermont, Vermont Geological Survey, Bull. 24.

RUTLAND COUNTY

Oram Lead-Zinc Mine

To reach the Oram Lead-Zinc Mine, take the first right turn off U.S. Route 7 north of Brandon. This is a gravel road for about 2 miles from the center of town. Continue straight on this gravel road to its end and then turn left. Go for 1/2 mile to the next intersection and make a right turn. Proceed another 1/2 mile to a faint dirt road to the left. Park and follow this road to the mine and dumps, Figure 35, Locality No. 1. There is a small tunnel and dump on the left not far along the road, which are barren.

Galena, sphalerite, and pyrite are very abundant on the dumps. The galena and sphalerite occur in the Winooski Dolomite which is Cambrian in age. These sulfides are hydrothermal in origin. The pyrite occurs in a black shaly material and is the result of the original high iron and sulfur content of the shale.

REFERENCE

Cady, W.M., 1945, Stratigraphy and Structure of West-Central Vermont, Geological Society of America Bull., Vol. 56, p. 515-587.

Stucco Pink Quarry

Take Route 73 east from Brandon for 1 1/2 miles from the intersection with U.S. Route 7. Just before a fork in the road make a sharp right turn onto a gravel road. Go 1/4 mile and park. The quarry is in the woods to the west, Figure 35, Locality No. 2.

This area was quarried for pink dolostone or marble. There is also some verd antique and Swanton Red Marble dumped here from other localities.

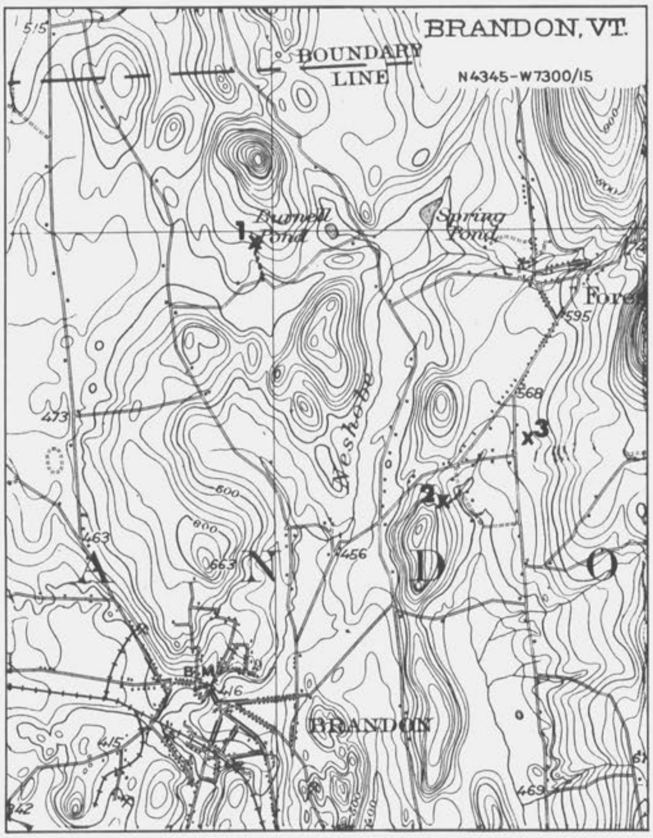


Fig. 35. Map showing the location of the Oram Lead-Zinc Mine (1), Stucco Pink Quarry (2), and Kaolinite Pits (3), Brandon.

The rock in the quarries is the Dunham Dolomite, but it does not look very much like the Dunham Dolomite at the Parrot Jasper Mine and other localities in northern Vermont.

REFERENCE

Cady, W.M., 1945, Stratigraphy and Structure of West-Central Vermont, Geological Society of America Bull., Vol. 56, p. 515-587.

Brandon Kaolinite

About 1 1/2 miles west on Route 73 from U.S. Route 7 in Brandon is a fork in the road. Route 73 goes left, but to reach this locality continue straight (the right fork). Proceed on this road to where it ends at an intersection (about 1/2 mile). Park here and cross the road. Kaolinite can be found in the woods north and south of this intersection. To the northeast of the intersection is a depression in which kaolinite, lignite, fossil nuts, and other plant remains can be found, Figure 35, Locality No. 3. Also north along the road there is a pile of rock which contains galena and sphalerite. This material was dumped here from some other locality.

The lignite and the kaolin formed from material carried westward from the Green Mountains and was deposited in a swamp. The kaolin covered the plant remains and preserved them. A study of the nuts, fruits, leaves, and branches found here has shown that about 20 to 30 million years ago Vermont had a warm temperate climate similar to that of southeastern United States today.

REFERENCE

Cady, W.M., 1945, Stratigraphy and Structure of West-Central Vermont, Geological Society of America Bull., Vol. 56, p. 515-587.

Welby, C.W., 1962, Paleontology of the Champlain Basin in Vermont; Vermont Geological Survey, Special Publication No. 1. See references in.

Fair Haven Slate Quarries

There are over one hundred slate quarries in the Fair Haven, Castleton, Poultney, and Pawlet Areas. Most of these are abandoned. About a dozen are operating at present. Figure 36 shows the location of one quarry north of Fair Haven. There are several others along this road. Figure 37 shows the location of numerous quarries south of Fair Haven

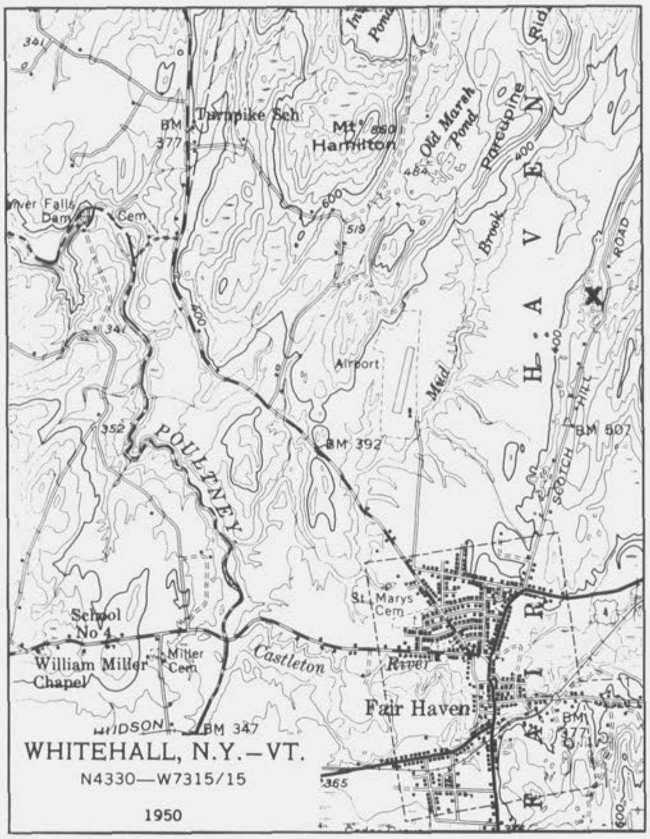


Fig. 36. Map showing the location of the Slate Quarries north of Fair Haven.

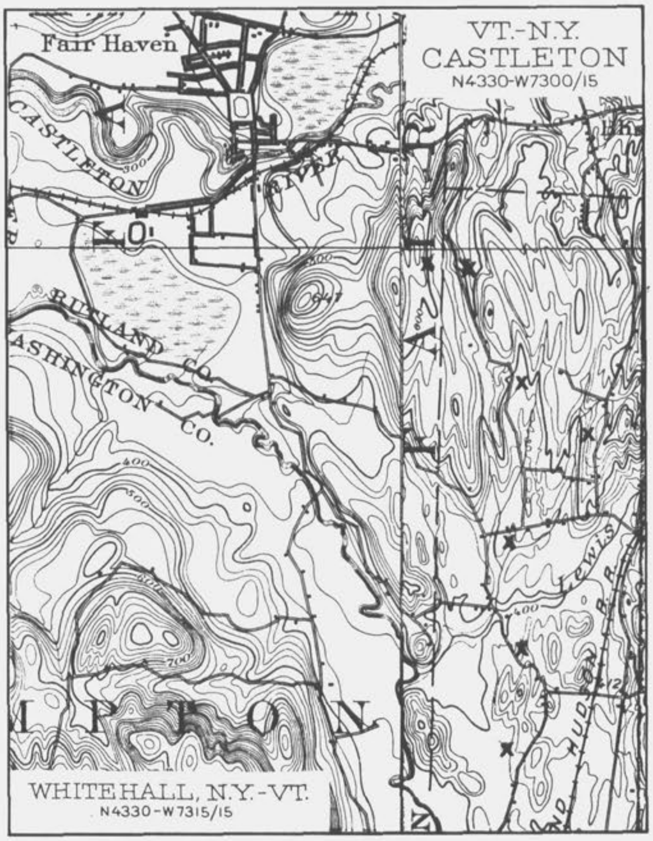


Fig. 37. Map showing the location of the Slate Quarries south of Fair Haven.

in Poultney. Again, there are many others not shown.

The minerals found in these quarries include pyrite (abundant and in good crystals), bornite, chalcopyrite, calcite (crystals), and quartz (crystals).

Almost all of these quarries are in the Cambrian Mettawee Slate. The Mettawee Slate is green and purple in color and is used for roofing, ornamental paving, and in the manufacture of asphalt shingles. Figure 38 is a photograph showing one of the slate quarries in this area.

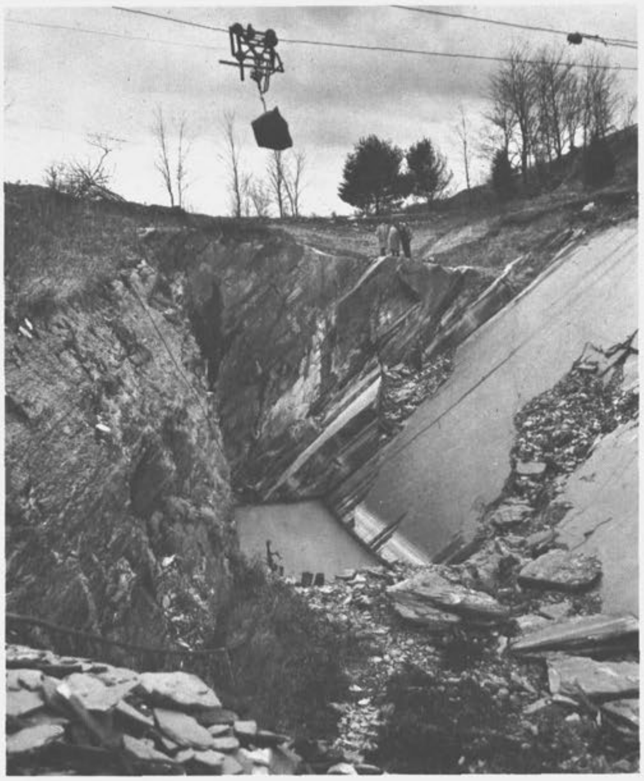
REFERENCES

Fowler, P., 1950, Stratigraphy and Structure of the Castleton Area, Vermont, Vermont Geological Survey, Bull. 2.

Shumaker, R.C. and Thompson, J.B., Jr., 1967, Bedrock Geology of the Pawlet Quadrangle, Vermont, Vermont Geological Survey, Bull. 30.

Zen, E-an, 1964, Stratigraphy and Structure of a portion of the Castleton Quadrangle, Vermont, Vermont Geological Survey, Bull. 25.

Fig. 38. Slate Quarry, Poultney.



Courtesy Rising and Nelson Slate Company

Round Hill Fuchsite Locality

To reach this locality go east from North Clarendon and follow the road along the Cold River. This area is relatively flat and Round Hill can be seen for some distance ahead. The road makes a sharp turn around the north end of Round Hill and one should park before going around the turn. This locality covers a very small area on the mountain and as there are no roads or trails it may be difficult to find. Upon leaving the road, stay on the west side of the sharp ridge running north-south. Walk about 1/2 mile south from the road, keeping the ridge just to the left. Continue to climb toward a saddle in the ridge, to the locality on the west side of the ridge, just under the saddle, Figure 39.

The minerals fuchsite, tourmaline, pyrite, quartz, and magnetite are found here. The fuchsite makes very interesting cutting material.

The fuchsite occurrence, which is up to 100 feet wide, is enclosed by Precambrian schist and gneiss. The associated tourmaline and pyrite suggest that the minerals here are hydrothermal in origin. Chromium-rich solutions probably formed the fuchsite from an ordinary muscovite schist.

REFERENCES

Brace, W.F., 1953, The Geology of the Rutland Area, Vermont, Vermont Geological Survey, Bull. 6, 120 p.

Dale, N.T., 1914, The Commercial Marbles of Western Vermont, Report of the State Geologist 1913-1914, p. 42-43.

Cuttingsville Molybdenite Prospect and Copperas Hill Mines

The molybdenite prospect is located on the top of Granite Hill, west of Cuttingsville. The best way to reach it is to take the dirt road which runs parallel to Route 103, but on the west side of Granite Hill. This road can be reached by taking Route 140 in East Wallingford and going east about two miles and turning north. Go about 1 mile, just past the power line, and park. Walk due east to the top of the ridge (a fairly steep climb). The pit is right on the top of the mountain, so by walking along the

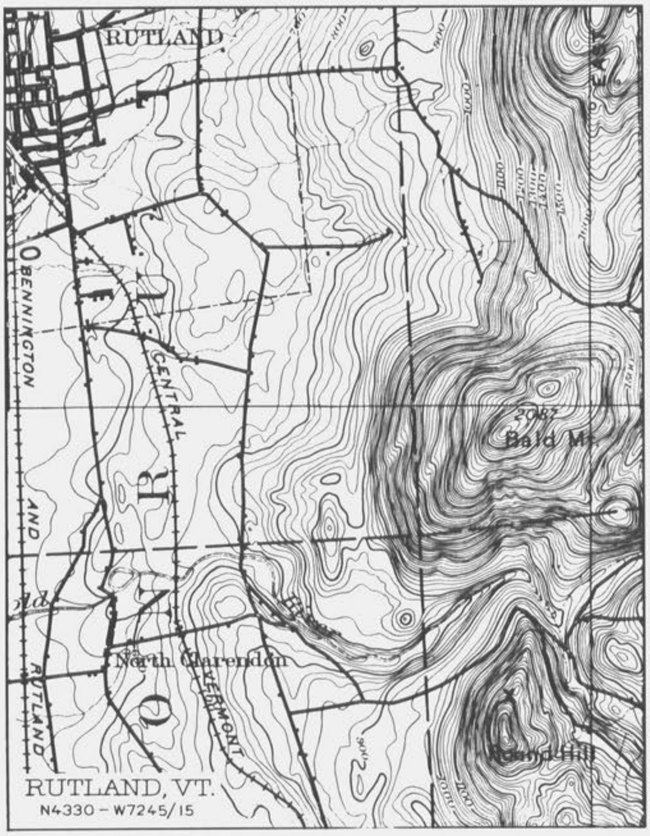


Fig. 39. Map showing the location of the mineral area, Round Hill, Shrewsbury.

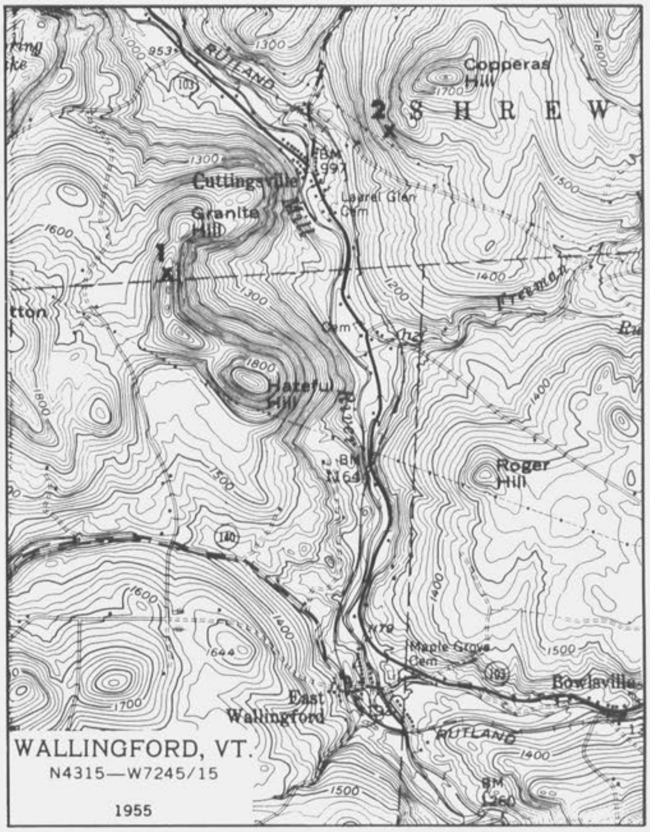


Fig. 40. Map showing the location of the Molybdenite Prospect (1) and Copperas Hill Mines (2), Cuttingsville.

very top of the ridge it can't be missed, Figure 40, Locality No. 1.

The minerals found here include: pyrite, molybdenite, and ferrimolybdite (bright yellow alteration material).

Granite Hill is really made up of syenite and other quartz free rocks which have intruded the surrounding gneisses. Nepheline and sodalite have been found in this area, but to a limited extent. The molybdenite and pyrite are formed by hydrothermal solutions which may be late residual solutions left after the crystallization of the syenites. The ferrimolybdite is an alteration of the molybdenite.

Copperas Hill is closely northeast of Cuttingsville. The old dumps can be seen from Route 103 in Cuttingsville. Drive to the side of Copperas Hill and then walk up the slope to several small pits and dumps, Figure 40, Locality No. 2. Much of the material on the dumps has been roasted, but massive pyrrhotite is abundant in the pits. No other sulfides were seen. The pyrrhotite is hydrothermal in origin and may be related to the syenite or its location may be a coincidence.

REFERENCE

Eggleston, J.W., 1918, Eruptive Rocks at Cuttingsville, Vermont, in Eleventh Annual Report of the State Geologist of Vermont, 1917-1918, p. 167-193, and in the American Journal of Science, v. 45, p. 377-410, 1918.

Dorset Mountain Quarry

There are many marble quarries in the area of Danby. This locality is an abandoned quarry which can be reached by going 1.1 miles south along U.S. Route 7 from Danby Village. On the west side of the road is a gravel pit. Park in the gravel pit and climb over the top of the gravel bank to the quarry, Figure 41. Good calcite crystals and tremolite (mountain leather) can be found here. There are also several small caves in the quarry.

This quarry is in the Shelburne Marble which is the result of the low-grade metamorphism of a limestone. The tremolite and calcite are the result of later solutions passing through fractures in the marble and depositing these minerals.

REFERENCES

Shumaker, R.C. and Thompson, J.B., Jr., 1967, Bedrock Geology of the Pawlet Quadrangle, Vermont, Vermont Geological Survey, Bull. 30.

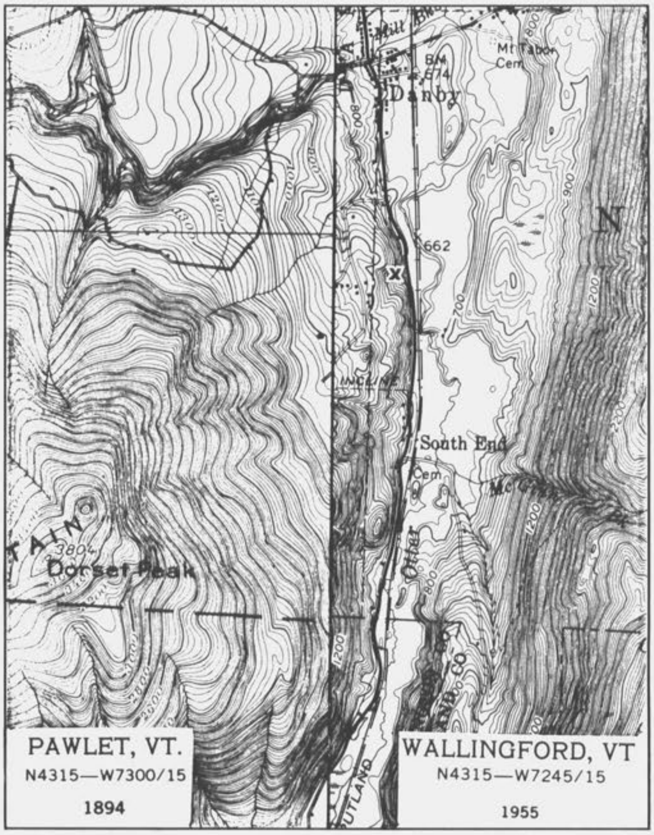


Fig. 41. Map showing the location ot tne Marble Quarry, Dorset Mt., south of Danby.

Devil's Den, Mount Tabor

To reach the Devil's Den area take the Mount Tabor Road from Danby. This is a gravel road most of the way and in fairly good condition. Park at the Devil's Den picnic area and walk back (north) along the road to the outcrops on the east side of the road, Figure 42. There is a small cave here which is apparently the origin of the name Devil's Den. In the outcrops along the road excellent smoky quartz crystals have been found, Figure 43. Also, ilmenite, pyrite, and clear quartz crystals are found in this area. The best crystals came from one pocket, but there are many fragments and parts of crystals in the area and some exploring and digging might uncover another pocket.

These crystals are found in cavities in the Precambrian Mount Holly Complex, which is a muscovite-chlorite schist in this area.

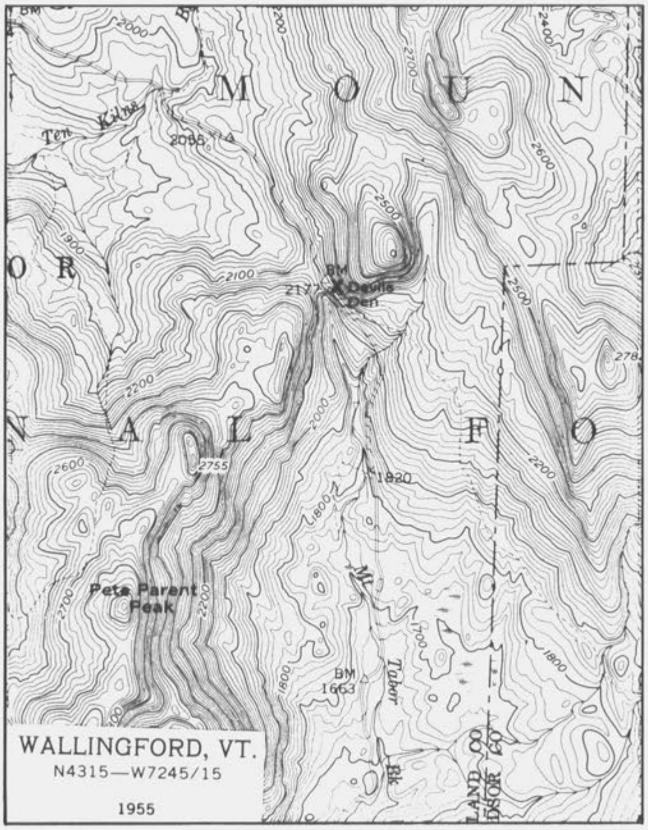


Fig. 42. Map showing the location of the Devil's Den, Mt. Tabor.

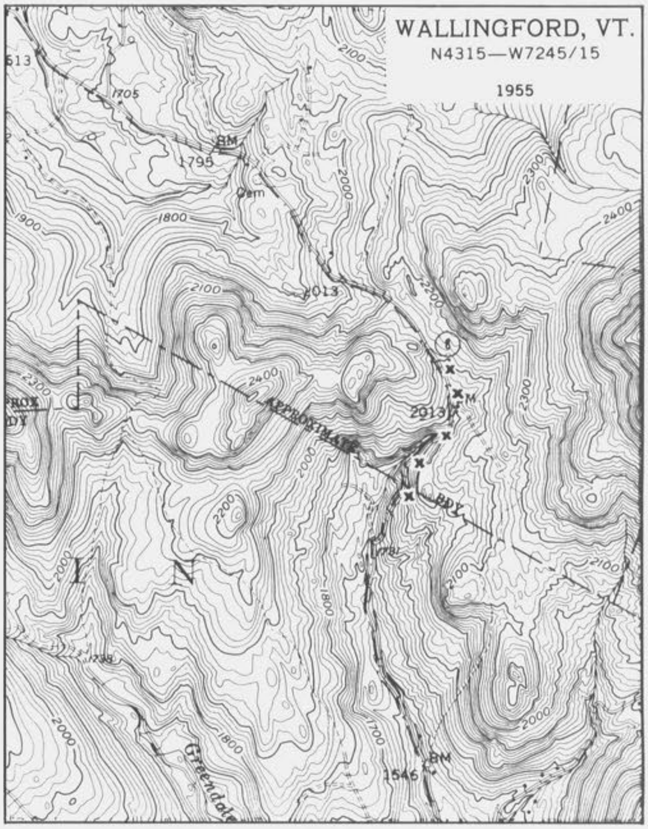


Fig. 44. Map showing the location of the Road Cuts on Route 155, Mt. Holly.

Fig. 43. Smoky Quartz crystal from Devil's Den, Mt. Tabor.

Road Cuts, Route 155

Along Route 155, six to eight miles south of East Wallingford, Figure 44, are a series of outcrops which contain tourmaline, actinolite, calcite (some pink), epidote, phlogopite, pyrite, albite, sphene, and diopside. Many of these minerals occur as large crystals or crystal aggregates.

These minerals formed from the metamorphism of a sedimentary carbonate rock. The rock is part of the Precambrian Mount Holly Complex.

Allen Mica Mine, Sherburne

Park on Route 100 in North Sherburne at Coffee House Road. Walk east from this intersection about .2 of a mile to a pit 30 feet by 10 feet with a small dump, Figure 45. There are no roads or trails to the mine, so a little searching in the woods may be necessary.

Albite, orthoclase, tourmaline, and muscovite (some sheets several inches across) are found here. This is not an outstanding mineral locality and does not compare with pegmatites in other parts of New England, but it was included here because it is one of the few pegmatites in the state which has been worked with a possibility of its being economic. The surrounding rock is a Precambrian biotite-microcline gneiss.

REFERENCE

Brace, W.F., 1953, The Geology of the Rutland Area, Vermont, Vermont Geological Survey, Bull. 6.

WASHINGTON COUNTY

Waterbury Talc Mine

The Waterbury Talc Mine is just off U.S. Route 2, about 2 miles east of Waterbury. The dumps, which are just south of U.S. Route 2, can easily be seen from the road. There is a gravel road up to the dumps, Figure 46.

This mine has been abandoned since 1955. In the past there had been extensive underground mining with four levels and 8000 feet of workings.

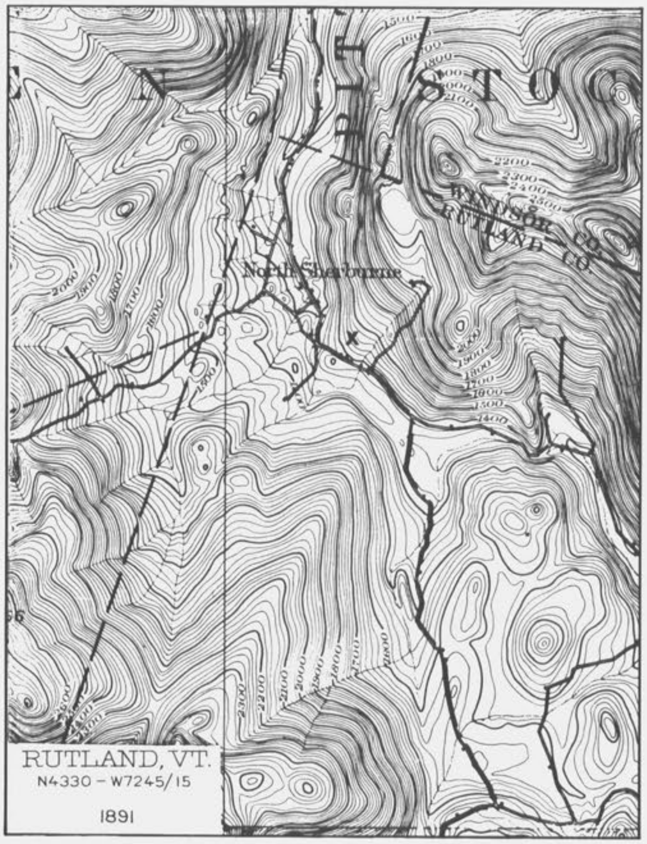


Fig. 45. Map showing the location of the Sherburne Mica Mine, Sherburne.

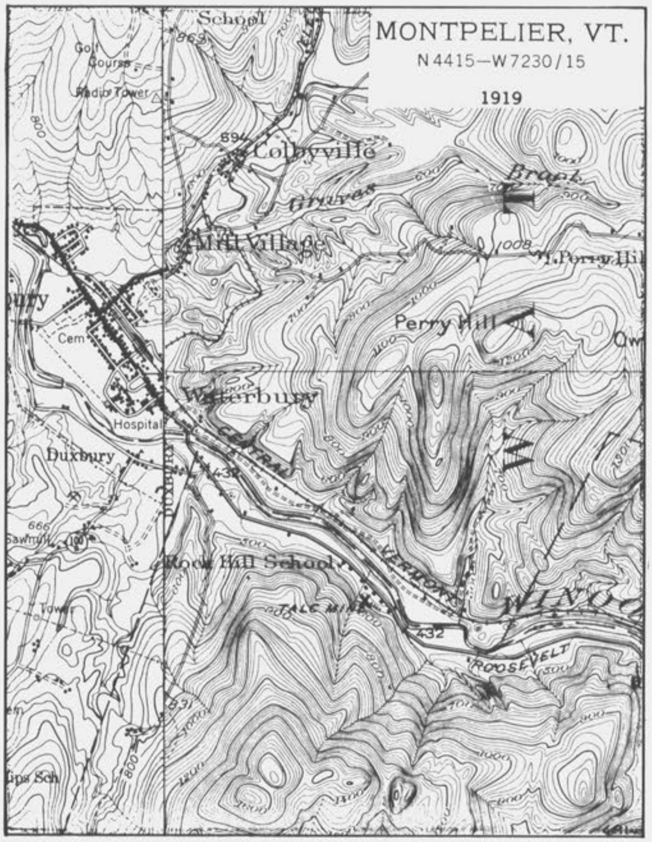


Fig. 46. Map showing the location of the Waterbury Talc Mine, Moretown.

Talc, actinolite, pyrite, magnesite, dolomite, and calcite are common on the dumps, and pyrrhotite and magnetite are found occasionally.

The Waterbury Talc Mine is a typical altered ultramafic body. It has a core of serpentine and a rim of talc-carbonate rock. The surrounding country rock is a quartz-sericite-chlorite schist.

REFERENCE

Chidester, A., 1962, Petrology and Geochemistry of Selected Talc-bearing Ultramafic rocks and Adjacent Country Rocks in North-Central Vermont, U.S.G.S. Prof. Paper 345, 207 p.

Mad River Talc Mine and Duxbury Serpentine Quarry

From Route 100B in South Duxbury, take the gravel road which goes northwest just south of the bridge. Take the second left fork to the serpentine quarry, Figure 47, Locality No. 1. This was once a verd antique quarry but was later developed for crushed rock. The Mad River Talc Mine is about a mile south of this quarry and can be reached best by going on Route 100B to the intersection with Route 100 and proceeding south on Route 100, 3/4 of a mile to the first right turn. This is a dirt road which goes through a farmer's fields and pasture, so please close all gates. At some times of the year this road is not passable the entire distance by car, Figure 47, Locality No. 2.

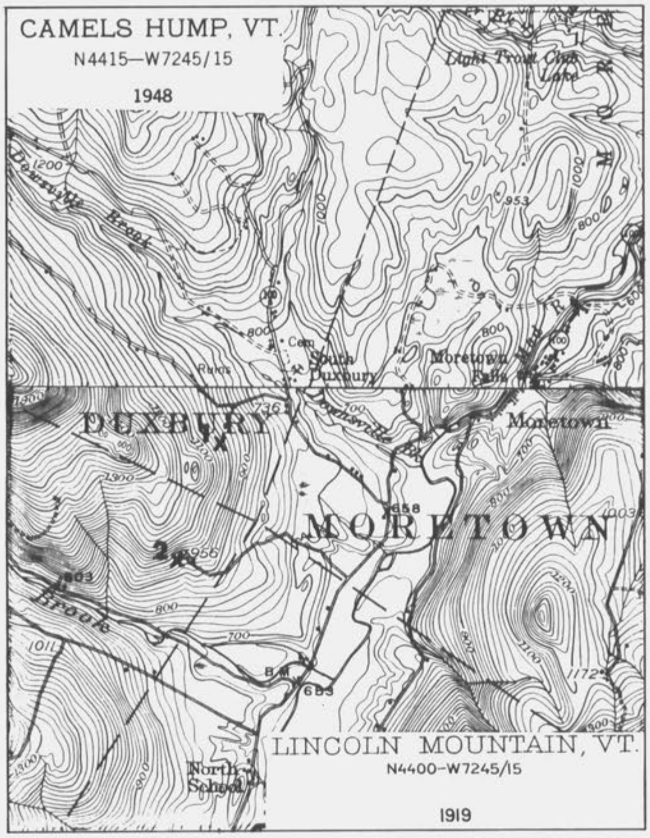


Fig. 47. Map showing the location of the Mad River Talc Mine (2) and Serpentine Quarry (1), Duxbury.

Minerals found at these two localities include: talc, actinolite, serpentine-antigorite, tremolite (white fibrous material), chromite (rare disseminated grains), magnetite (octahedrons up to 1/2 in. across), magnesite, dolomite (some good crystals), pyrite, calcite (some is fluorescent pink).

Both of these localities are in the same ultramafic body. It has been altered to talc carbonate rock at the north and south ends. The Mad River Talc Mine is at the south end, and a small pit has been dug in the talc at the north end and can be seen just after making the left turn to the quarry. The serpentine quarry is in the serpentine core.

REFERENCE

Chidester, A.H., 1962, Petrology and Geochemistry of Selected Talc-bearing Ultramafic Rocks and Adjacent Country Rocks in North-Central Vermont, United States Geological Survey, Prof. paper 345.

Clay Concretions, Barre

The clay concretions are found in a clay bank about 1000 feet north of where U.S. Route 302 crosses Stevens Brook, Figure 48. They are composed of a mixture of calcite and clay minerals and occur in many unusual forms, Figure 49. They are formed by calcite crystallizing around a nucleus (a sand grain, shell fragment, or twig) and cementing the clay into the concretions. These are more resistant than the surrounding uncemented clay and are washed free.

Clay concretions are found at many places in Vermont, such as, behind the shopping center in Manchester Center, along Lake Champlain, as at Button Bay State Park, along the Connecticut River at Westminster, and other places. At all of these localities the concretions are found in clay beds. These clays are relatively recent geologically, up to 10,000 or 12,000 years old, and represent clays deposited in lakes or rivers which have since cut down to lower levels.

REFERENCE

Dodge, H.W., 1962, The Geology of Button Bay State Park, Vermont Geological Survey.

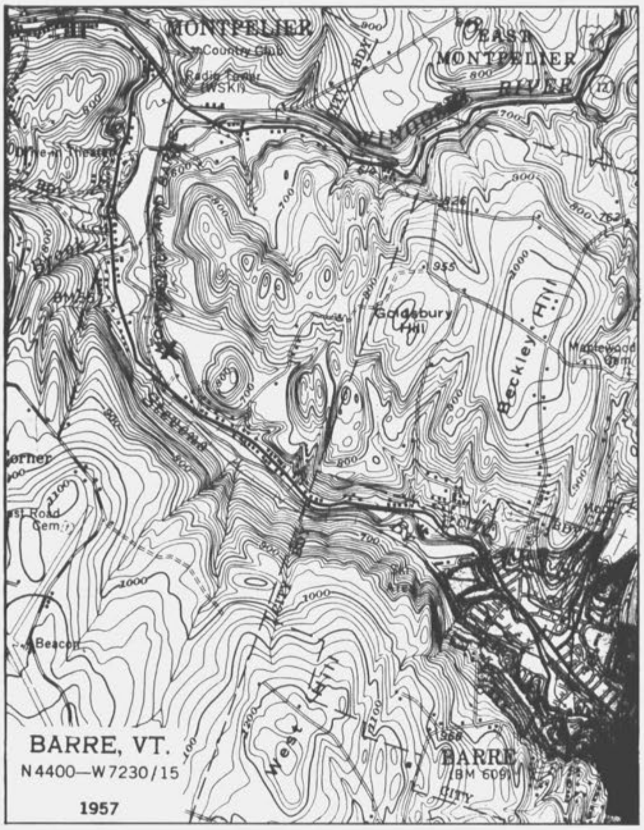


Fig. 48. Map showing the location of the Clay concretion locality, Barre.

WINDHAM COUNTY

Mineral Area South of Whitingham

There are several localities in the area around Whitingham. One is reached by going southeast from Whitingham on Routes 100 and 8, about 2 miles to where Routes 100 and 8 make a sharp right turn. Continue straight ahead on a gravel road for about a mile to where it ends at an intersection. Turn left and park along the road. The mineral area is west of the road in the meadows and woods, Figure 50, Locality No. 1. Muscovite, rutile (Figure 51), quartz, pyrite, tourmaline, graphite, and calcite are found in outcrops, stone fences, and loose material in the area.

The other locality is reached by parking at the New England Power Company Plant in Readsboro and walking south about a mile along the railroad tracks to an old lime quarry, Figure 50, Locality No. 2. Phlogopite, calcite, graphite, diopside, and hematite (perhaps from some other area) are found here. There is also a large rock dump from the water tunnel east of the plant which has some pyrite and garnet.

These two mineral localities are associated with the Sherman Marble member of the Readsboro Formation. The outcrop pattern of this forma-

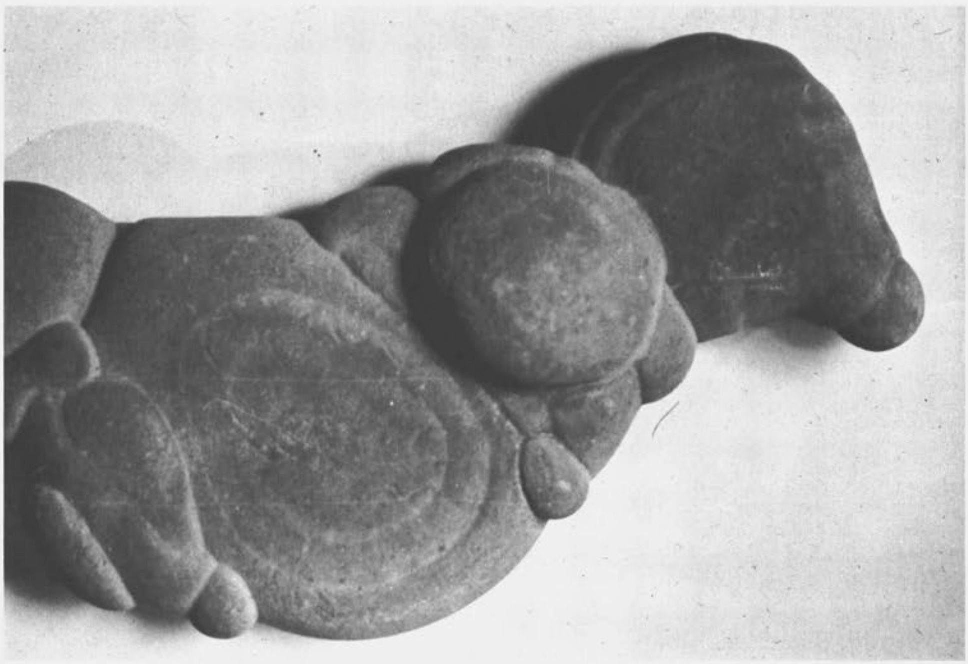


Fig. 49. Clay concretion, Barre (times 1.6).

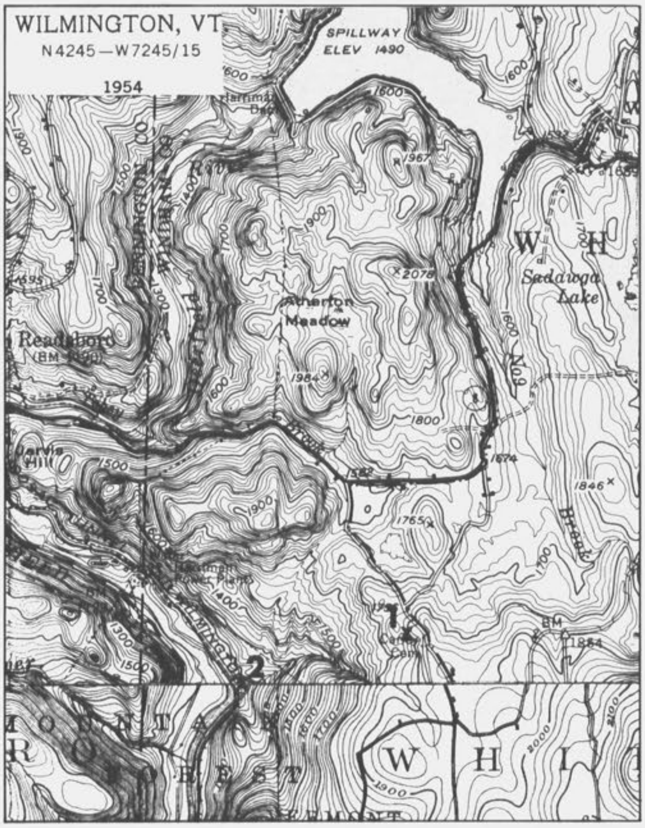


Fig. 50. Map showing the location of the mineral areas south of Whitingham.

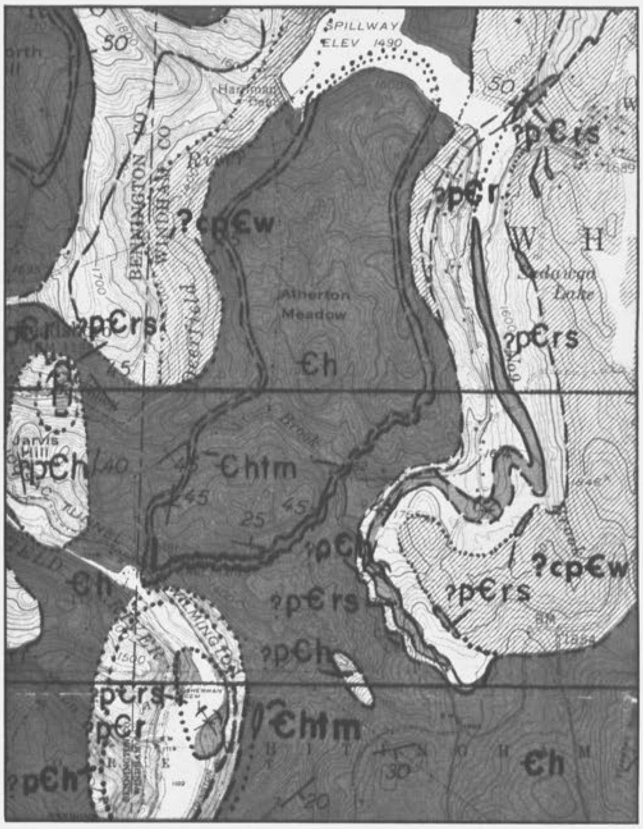


Fig. 52. Geologic Map of the mineral areas, south of Whitingham (Skehan, 1961).

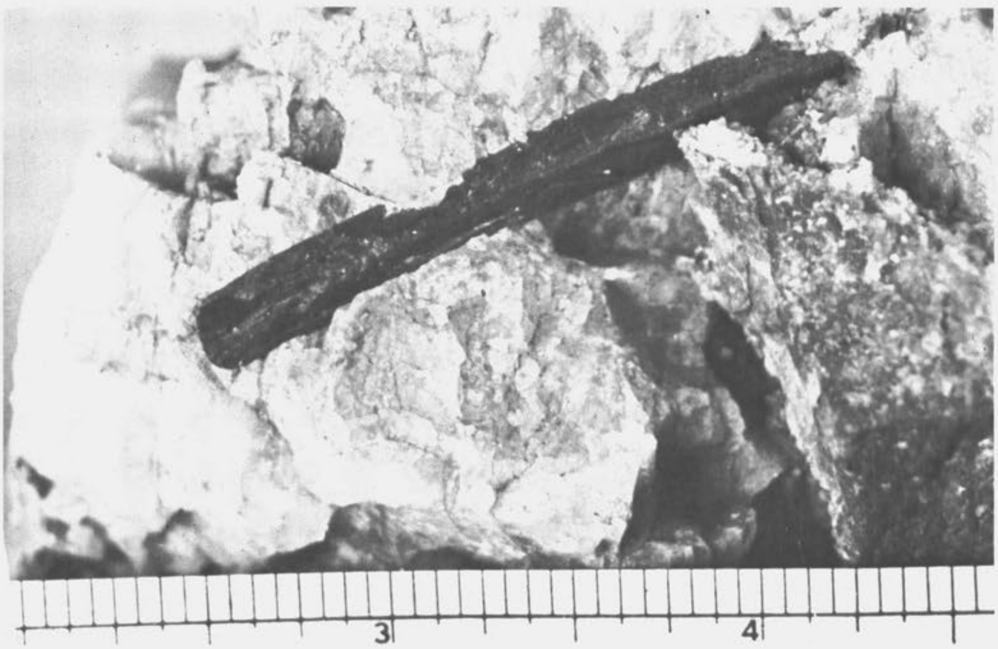
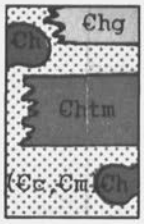


Fig. 51. Rutile crystal in quartz, mineral area south of Whitingham.



Hoosac formation (€h): medium to coarse-grained, rusty weathering muscovite-chlorite-biotite-garnet-quartz schists; thin graphite-albite and non-albitic muscovite schist; thin interbedded amygdaloidal amphibolites (€htm); muscovite-chlorite green schist mapped separately (€hg).

Cheshire quartzite (€c): grades laterally into rocks of Hoosac lithology on east flank of Green Mountains in Stamford; massive, glassy white and buff quartzite.

Mendon formation, (€m): black, fine-grained, banded, sericite-biotite-chloritoid phyllite with thin interbeds of gray quartzite representing the Moosalamoo member.

Turkey Mountain member (€htm): dense, dark green amphibolites spotted gray to green or dark brown by "amygdules" of fine-grained quartz and albite filled with epidote, hornblende and garnet.

Heartwellville schist (?p€h): coaly black to dark gray graphite-muscovite-(chlorite)-garnet-quartz lensed schist; light to dark green chlorite-muscovite-(garnet)-quartz lensed schist. In western Dover marbles lithologically identical with those of Sherman member are mapped as ?p€hs.

Sherman marble member of Readsboro formation (?p€rs): coarse-grained, white or pink, siliceous calcite marble, and fine-grained, siliceous dolomite marble; actinolite-diopside-phlogopite lime-silicate granulites.

Readsboro schist (?p€r): rusty to gray garnet-chlorite-biotite-quartz-albite augen schist and gneiss; graphitic near base.

Searsburg conglomerate (?p€rsc): thin, white to buff glassy quartzite; blue and white quartz conglomerate; albite and microcline conglomerate; micaceous white quartzites; coarse feldspathic, arkosic conglomerates, and coarse albite schists.

Wilmington gneiss (?ep€w): coarse gray, buff and pink microcline-augen and porphyritic-
Stamford granite gneiss (ep€sgg): microcline in quartz-albite-microcline-biotite-epidote groundmass.

tion is shown in Figure 52. It is very limited in extent and has been quarried in several places; these quarries and other outcrops in the area are potential collecting sites. The diopside, graphite, calcite, and phlogopite are the result of the metamorphism of a limestone. The rutile and tourmaline are hydrothermal in origin.

REFERENCE

Skehan, J.W., 1961, The Green Mountain Anticlinorium in the Vicinity of Wilmington and Woodford, Vermont, Vermont Geological Survey, Bull. No. 17.

Adams Brook Nickel Prospect

From Route 30 near West Dummerston, take the road which goes to Williamsville, South Newfane, and Dover. About 8 miles from Route 30, a small stream is crossed and there is a long outcrop on the north side of the road. There is good collecting in the road cut and north along the small stream (Adams Brook), Figure 53. The nickel prospect can be reached by going 1/2 mile north along the road which parallels Adams Brook. Turn left and go about another 1/2 mile to a gravel pit. Park and climb down the steep bank to Adams Brook where part of the ledge has been worked and there is a small dump.

The minerals found here include serpentine (antigorite and chrysotile), quartz (crystals and agate), and some green coatings tentatively identified as garnierite. These minerals occur in the Dover ultramafic body which has undergone various metamorphic changes as indicated in Figure 54. The quartz is very unusual, as it is associated with ultramafic rocks. It is hydrothermal and occurs as vein fillings.

REFERENCE

Skehan, J.W., 1961, The Green Mountain Anticlinorium in the Vicinity of Wilmington and Woodford, Vermont, Vermont Geological Survey, Bull. 17.

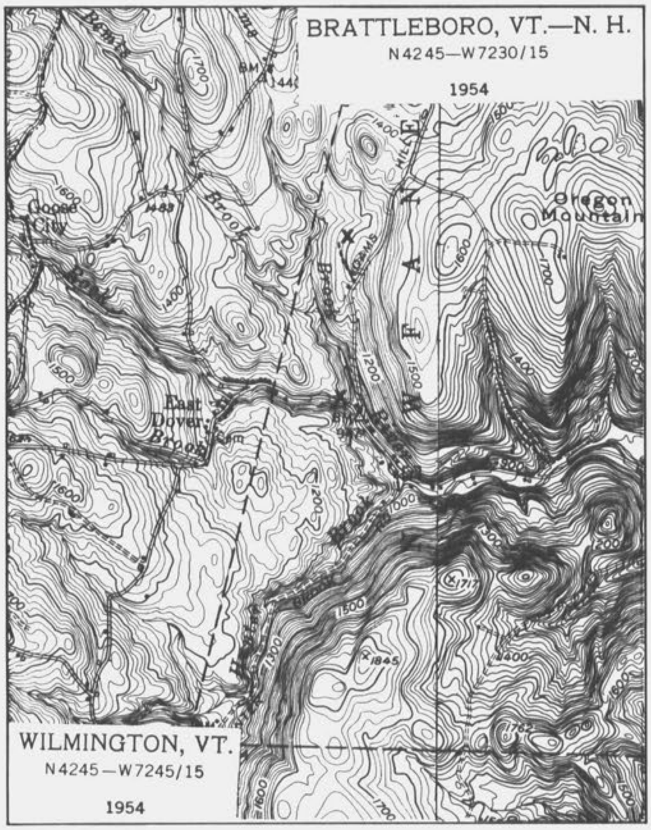


Fig. 53. Map showing the location of the Adams Brook nickel prospect and Dover ultramafic.

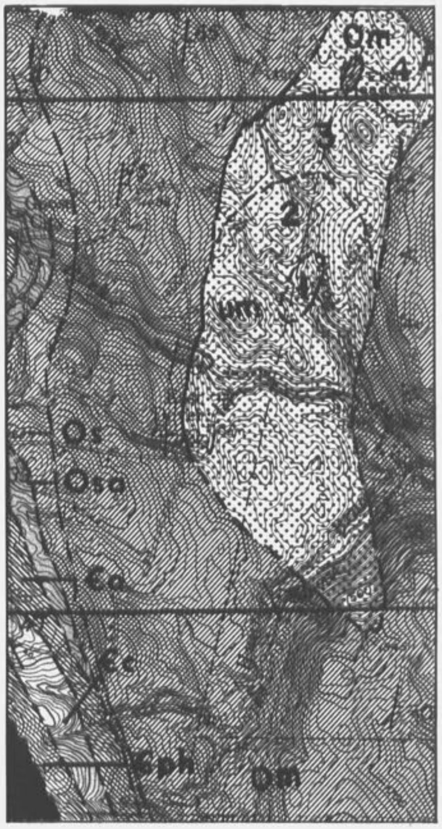
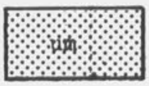
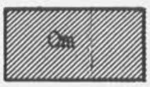


Fig. 54. Geologic Map of Adams Brook nickel prospect and Dover ultramafic (Skehan, 1961).

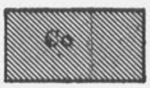


Ultramafic rocks (um): talc-carbonate bodies of small size; zoned talc-carbonate-serpentines of larger size; zoned talc-carbonate-serpentine-dunite body of very large size: Zone 1 is 90% or more olivine; Zone 2 is 60-90%; and Zone 3 is 30-60% olivine; Zone 4 is 0-70% talc-carbonate and 30-100% serpentine.

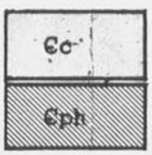


Moretown formation (Om): thin beds of banded epidote amphibolites; thin coarse-grained garnet amphibolites; dark gray to black biotite-muscovite-quartz schists; gray to light green, well-banded biotite-muscovite-quartz schists.

Stowe formation (Os): pale green, chlorite-muscovite-magnetite schist with thin, banded, epidote amphibolites and greenstone beds. A prominent greenstone member (Osa) at the base of the formation is mapped in the Cooper Hill locality where the formation is unusually broad.



Ottauquechee formation (€o): rusty weathering, dark gray to black muscovite-chlorite schist; thin beds of gray to black quartzite; thin beds of well-foliated chlorite-muscovite-magnetite schist; well-banded, fine-grained, feldspathic-chlorite schist.



Chester amphibolite (€c): banded, well-foliated, epidote-chlorite amphibolite; thin beds of dark gray to black schist and chlorite-garnet-muscovite schist.

Pinney Hollow formation (€ph): pale green, well-foliated chlorite-muscovite-magnetite schists; thin beds of well-banded epidote-chlorite amphibolite.

Connecticut River at Bellows Falls

This locality is along the Connecticut River below the bridge which crosses from Vermont to New Hampshire. There is parking space at the bridge, but be careful when climbing down to the river. Interesting minerals are found north and south of the bridge, Figure 55.

The rock here is the Bethlehem gneiss which is composed of plagioclase and orthoclase feldspar, biotite, and muscovite. Associated with the gneiss are some schists, pegmatites, and hydrothermal veins. The schists contain biotite, muscovite, garnet, and sillimanite (some of the sillimanite crystals are several inches long). The pegmatites contain garnet, tourmaline, muscovite, and orthoclase, and the hydrothermal veins have calcite, fluorite and prehnite present. The best prehnite is found south along the river behind the power house.

Also, just south of the bridge are some indian petroglyphs. Many are reported to have been covered by loose rock, but several are still visible.

REFERENCES

Kruger, F.C., 1946, Structure and Metamorphism in the Bellows Falls Quadrangle of New Hampshire and Vermont, Geological Society of America, Bull., vol. 57, p. 161-206.

__________, 1946, The Geology of the Bellows Falls Quadrangle, New Hampshire and Vermont, published by the New Hampshire Planning and Development Commission.

WINDSOR COUNTY

Pine Hill Quarry

From Route 106 in Perkinsville, take the road to the Springfield dam recreation area, Figure 56. There are two areas to collect from here, on the dam and in the quarry just east of the dam.

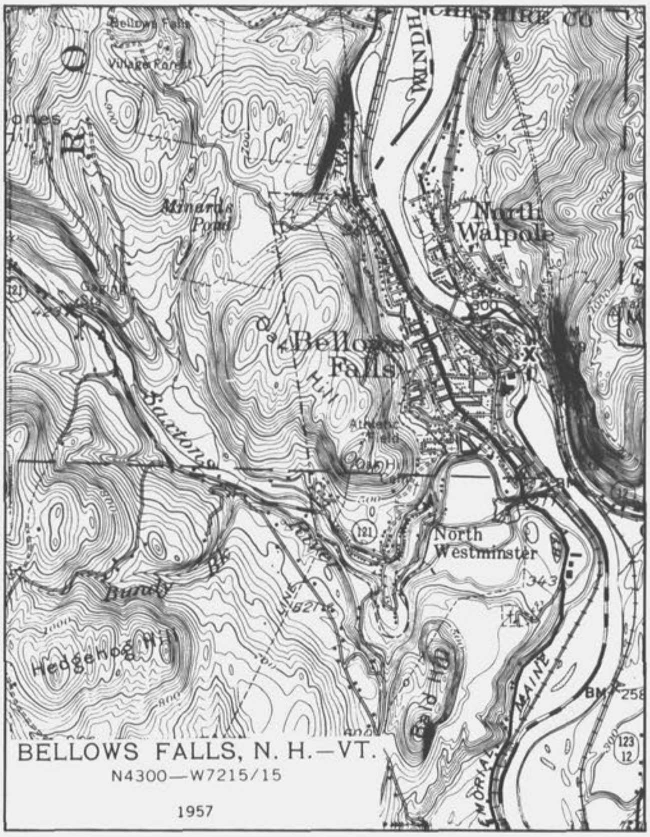


Fig. 55. Map showing the location of the mineral area along the Connecticut River at Bellows Falls.

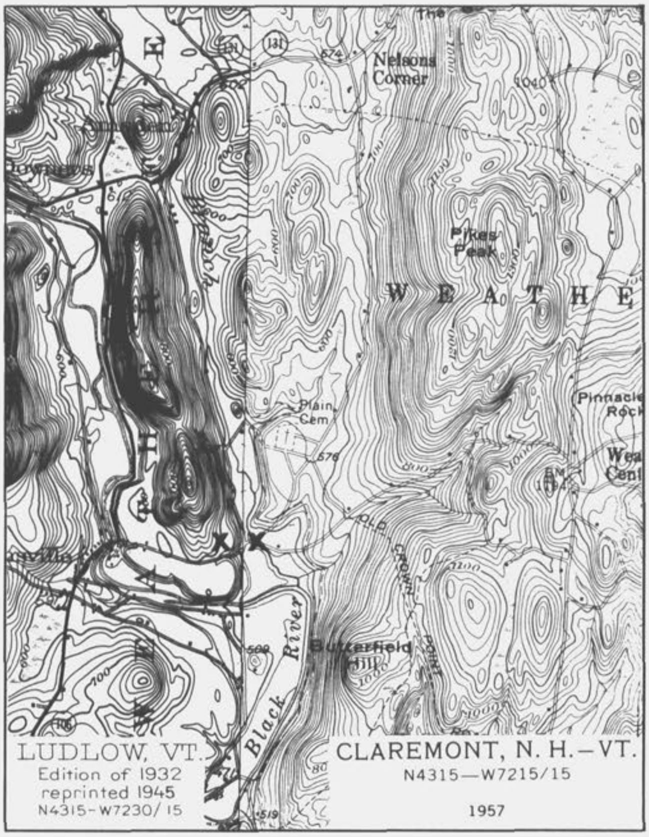


Fig. 56. Map showing the location of the Pine Hill Quarry, East of Perkinsville.

The minerals found here include: pyrite, pyrrhotite, chlorite, ilmenite, smoky quartz, calcite, actinolite, and biotite.

The rocks in this area are marbles, gneisses, and some mica schists. Most of the minerals found here are metamorphic in origin, but the sulfides and ilmenite may be hydrothermal.

Carleton Talc Mine

The Carleton Talc Mine can be reached by taking Route 11 west from its intersection with Route 103 in Chester for 1.6 miles to a gravel road going north. Follow the gravel road for .2 mile to a gate on the left, Figure 57. There is a charge of $1.00 per person to collect here and a sign on the gate tells where to pay the fee and get permission to enter the property.

The rock in this area is a quartz-muscovite-garnet schist with some albite and chlorite and minor amounts of pyrite, ilmenite, magnetite,

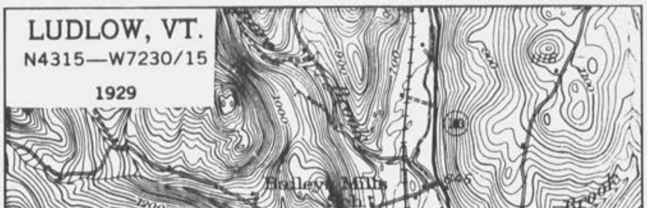


Fig. 57. Map showing the location of the Carleton Talc Mine, Chester.

Fig. 58. Actinolite in talc, Carleton Talc Mine, Chester (times 1.6).

sphene, clinozoisite, rutile, and tourmaline. Between this schist and the talc deposit are several interesting mineral zones. Next to the schist is a biotite rock which consists of coarse books of biotite with minor epidote, apatite, and zircon. This zone is usually about one foot thick. A thin chlorite zone, several inches thick, is next, which is followed by an eight-inch thick actinolite rock. Next to the actinolite is a zone of almost pure talc with some actinolite protruding from the talc. The core consists of a talc-dolomite-magnesite rock. Magnetite and chromite are also found in the core. All of the above rock types can be found on the dumps around the mine. The best specimens found are actinolite, talc (Figure 58), chlorite, magnetite (octahedrons

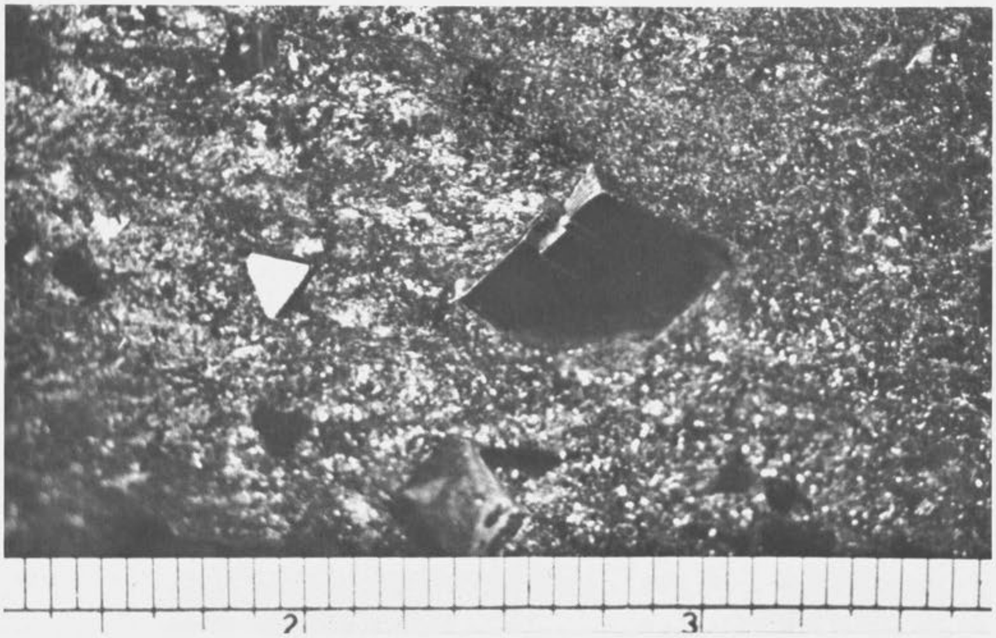


Fig. 59. Pyrite and magnetite in chlorite, Carleton Talc Mine, Chester.

up to 1/2 inch across), pyrite (cubes up to 1 inch; the pyrite and magnetite are found mainly in fine-grained chlorite (Figure 59) and are not very common on the dump), and tourmaline.

This locality is a classic example of the metamorphism of an ultramafic igneous body and the reaction of the ultramafic and the surrounding rocks.

REFERENCE

Hess, H., 1936, Metamorphic differentiation at contacts between serpentinite and siliceous country rocks, Am. Min., v. 21, p. 339-363.

Gassetts Road Cut

There are several outcrops just north of the village of Gassetts where Route 103 crosses the Williams River, Figure 60. The large outcrop south of the river contains garnet, staurolite, kyanite (gem quality has been reported), muscovite, paragonite (can not be distinguished from muscovite in hand specimen), quartz, and chlorite. A small outcrop northwest of the bridge across the river contains actinolite, diopside, calcite, sphene, and pyrite.

These two outcrops represent the high-grade metamorphism of a shale and an impure limestone, respectively. Garnet was once mined in this area for use as an abrasive, but has been abandoned.

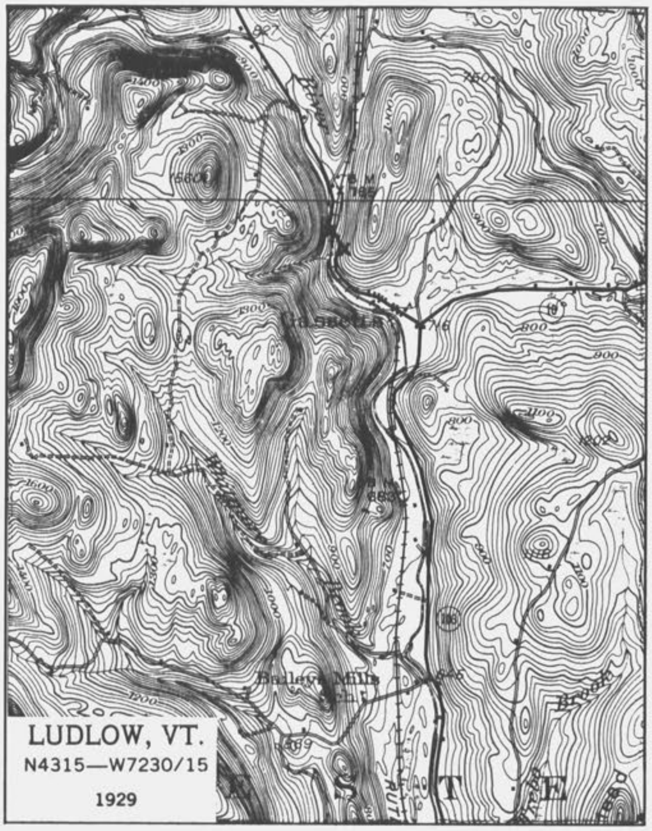


Fig. 60. Map showing the location of the Road Cut on Route 103, Gassetts.

The mill south of the bridge is processing talc from the Johnson and Johnson Company mine in Hammondsville.

Kingman Brook Tyson

Take Route 100 to Tyson and from Tyson follow the road east toward South Reading. The mineral collecting area is along both sides of the road and in the small stream bed about a mile from Tyson, Figure 61, Locality No. 1.

The rock in this area is a quartz-muscovite-albite-biotite-chlorite schist of the Pinney Hollow Formation, and contains crystals of garnet, magnetite and chloritoid. Chloritoid is widespread in the low- to medium-grade metamorphic rocks of Vermont, but is usually microscopic in size and rarely recognized by the average collector. This is one easy-to-reach locality where chloritoid crystals up to 1/2 inch long can be found, Figure 62. Although this mineral is not glamorous it should be in every collection of Vermont minerals.

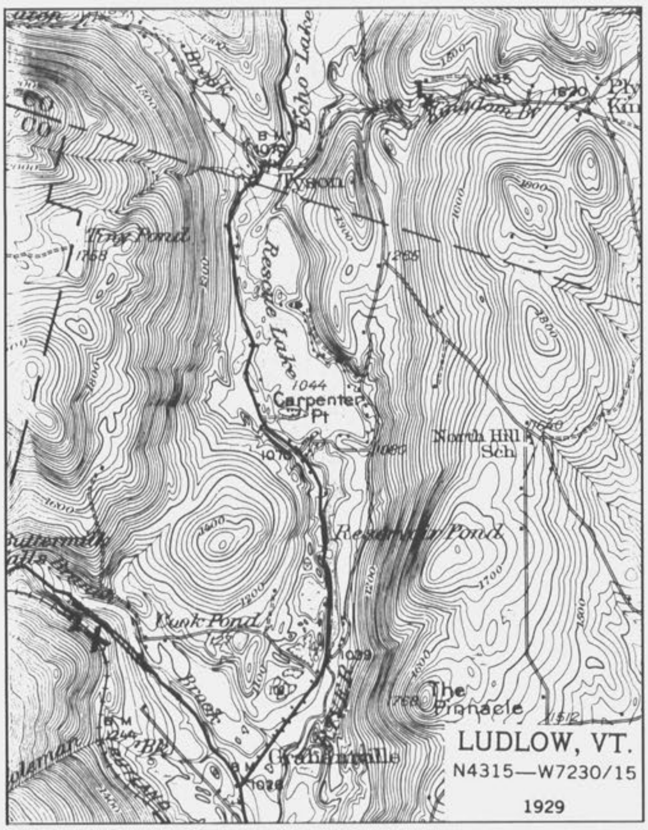


Fig. 61. Map showing the location of the Road Cut on Route 103, Ludlow (2), and the Kingman Brook mineral area east of Tyson (1).

Fig. 62. Chloritoid (dark crystals) in muscovite schist, Kingman Brook, Tyson.

Routes 103-100 Area

This locality is the long road cut along Route 103, one mile west of the intersection of Routes 103 and 100. There is a large parking area on the north side of Route 103, Figure 61, Locality No. 2.

There are a number of different types of rocks found in this outcrop which includes marble, calc-silicates, pegmatites, mica schist, quartzite, and several gneisses. These are all part of the Precambrian Mount Holly Complex.

Good specimens of talc, calcite, diopside, pyrite, and tourmaline are found here. A rock which contains black tourmaline and pyrite cubes is especially attractive. These minerals formed during the regional metamorphism of the area, excepting the pyrite and tourmaline which may be hydrothermal in origin.

Plymouth Five Corners

There are many areas in Vermont where gold can be recovered by panning and sluicing in stream beds. The area around Plymouth Five Corners is one such region where considerable gold has been recovered, and the stream sediment will still yield gold although not in large quantities. From Route 100A, 1.4 miles south of the intersection with Route 100, take the dirt road south along Hale Hollow. This road is passable to Plymouth Five Corners which was once a small village, but is now abandoned and only foundations are left, Figure 63.

Any place along Broad Brook has the potential of yielding gold. Magnetite and garnet are also recovered from the heavy mineral fraction of the stream sediment.

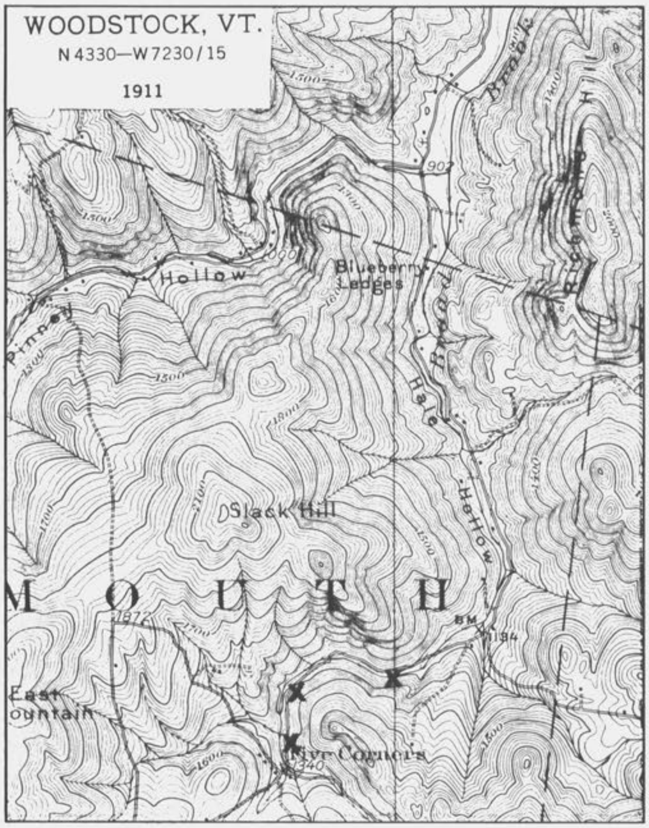


Fig. 63. Map showing the location of the Plymouth Five Corners area.

The gold found in the stream sediment is referred to as placer gold. It is concentrated in the stream because of its high specific gravity and its ability to withstand weathering and alteration. The gold was originally distributed in very small amounts in the surrounding rocks and was concentrated by erosion and stream action.

Two methods can be used to recover the gold: panning and sluicing. Panning is the simplest method. Any shallow pan can be used. Just shovel a small amount of stream sediment into the pan and swirl it around so that the light material is washed out and the heavy minerals concentrated. Only a small amount of sediment can be processed by this method and only a very little gold is usually recovered.

Sluicing is done with a sluice box which is a long narrow box open at both ends and at the top, and has a carpet, towel, or other thick material on the bottom. The sluice box is placed in the stream in such a way that water flows through it. Sediment is then shoveled into the upper end. By adjusting the rate of water flow the light material will be carried away and the heavy material, including the gold, will settle on the carpet or towel. When the carpet is sufficiently laden with heavy minerals it is carefully removed and the concentrates transferred to the pan for panning. Panning is best learned by doing with the help of an experienced person. This accomplished, the carpet or towel may be immersed in a bucket of water for recovery of additional concentrates. The sluice box allows more material to be processed and, thus, increases the chances of recovering gold.

Some of the other streams in Vermont from which placer gold is reported are:

Rock River in Newfane and Dover
West River in Townshend and Jamaica
Williams River in Ludlow
Ottauquechee River in Bridgewater
White River in Stockbridge and Rochester
Third Branch of the White River in Braintree
Mad River in Warren, Waitsfield, and Moretown
Little River in Stowe and Waterbury
Gold Brook in Stowe
Lamoille River in Johnson
Gihon River in Eden
Missisquoi River in Lowell and Troy

Many other rivers, and small tributaries of the above rivers, yield gold. The general references listed in the *Introduction* contain more information about possible gold panning areas.

Bridgewater Gold Mines

In the area around Bridgewater there are many gold mines, Figure 64. The amount of gold recovered is not known, but samples of native gold in quartz from Bridgewater do exist in museum collections. Undoubtedly only a few of the mines produced any gold and others were dug in vain. Also reported from these mines is galena, sphalerite, pyrite, pyrrhotite, and chalcopyrite. The writer visited some of these mines and found traces of sulfide specimens only, but these localities may have potential if the right area is investigated. The collector who wishes to search out old mines can spend a great deal of time in this region.

Reference

Chang, P.H., Ern, E.H. and Thompson, J.B., 1965, Bedrock Geology of the Woodstock Quadrangle, Vermont, Vermont Geological Survey, Bull. 29.

Verd Antique Quarry Rochester

Take Route 100 for two miles north from the center of Rochester, then turn east for 1 1/2 miles (stay on the black-top road) to the Vermont Marble Company verd antique quarries and dumps, Figure 65.

The minerals found here are serpentine, calcite, dolomite, magnetite, pyrite, talc, and rarely actinolite and pyrrhotite.

This verd antique body is typical of the altered ultramafic intrusive rocks of Vermont. It has a core of serpentine and a rim of talc-carbonate rock, Figure 66. It is surrounded by an albite-epidote-carbonate-chlorite schist which may also be a reaction zone. The country rock is a graphitic quartz-muscovite schist.

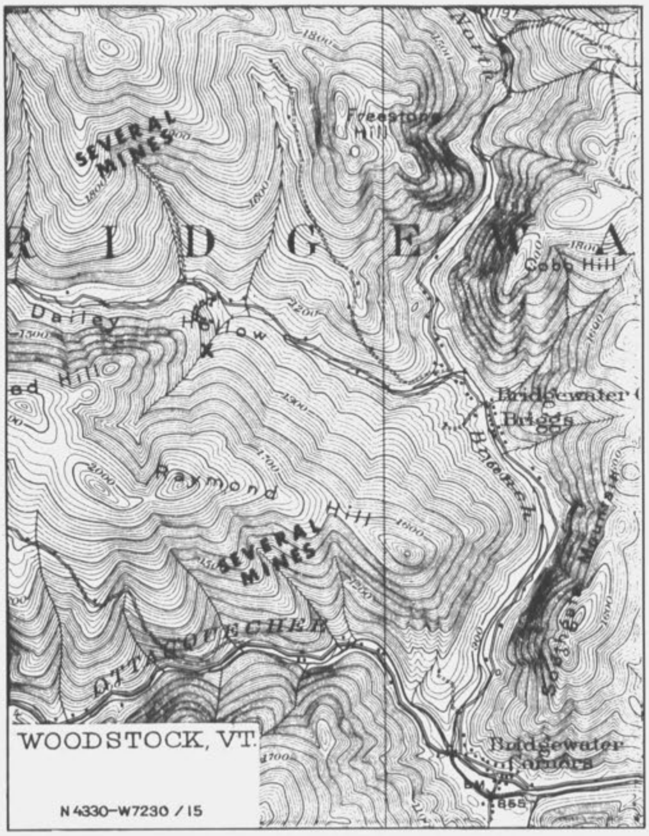


Fig. 64. Map showing the location of the Bridgewater Gold Mines.

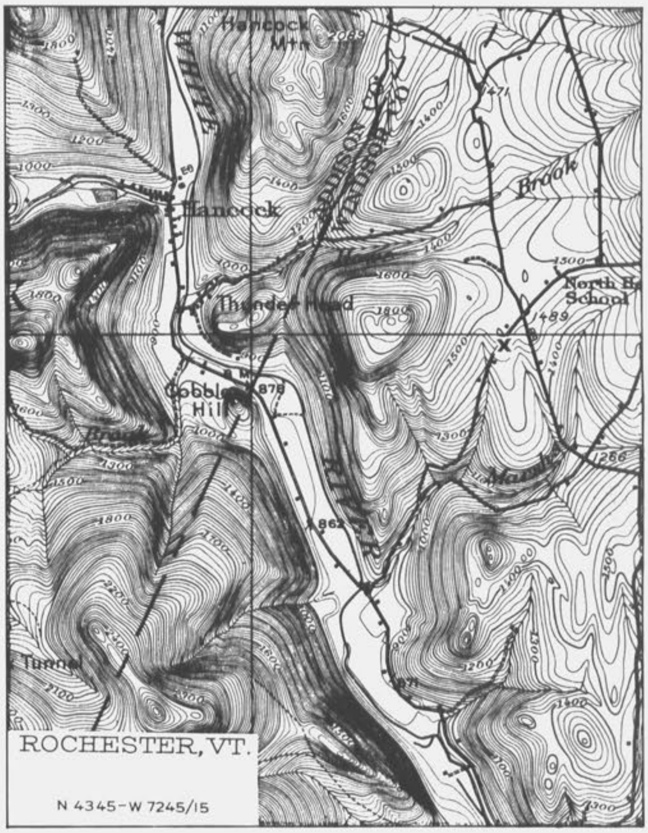


Fig. 65. Map showing the location of the Vermont Marble Company Verd Antique Quarry, Rochester.

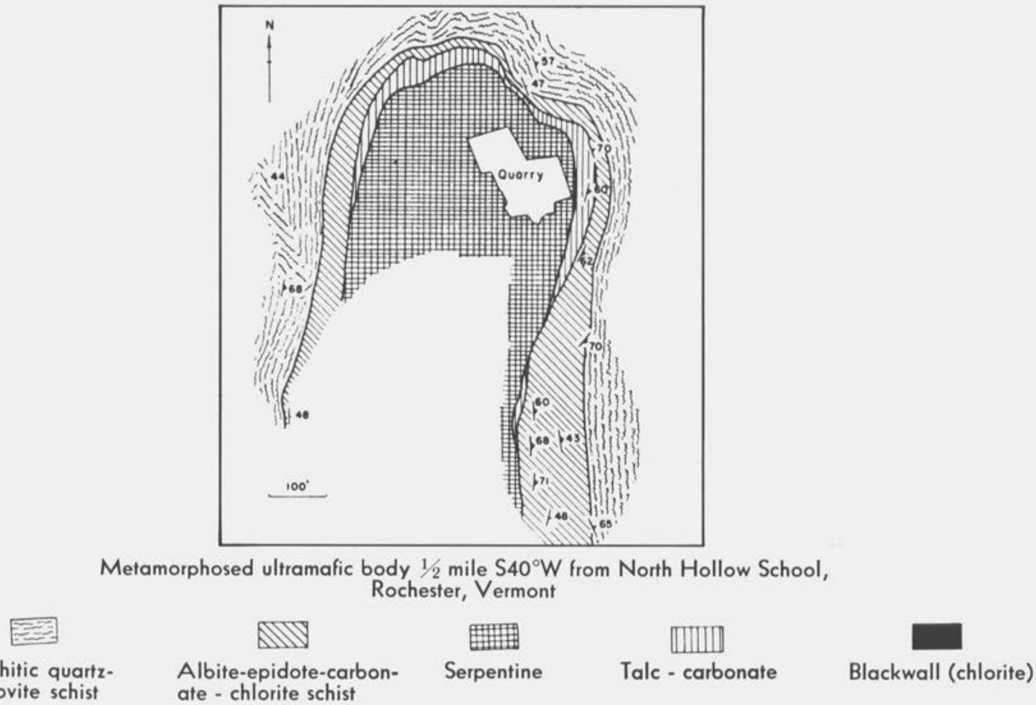


Fig. 66. Geologic map of the Vermont Marble Company Verd Antique Quarry, Rochester (Osberg, 1952).

REFERENCE

Osberg, P.H., 1952, The Green Mountain Anticlinorium in the Vicinity of Rochester and East Middlebury, Vermont, Vermont Geological Survey, Bull. No. 5.

Mineral Area Near Hartford

Proceed north two miles from Quechee on the road between Quechee and West Hartford. Park and walk 1/4 to 1/2 mile east, Figure 67. The following minerals are found in both outcrop and loose material on the hillside; namely, garnet, pyrrhotite, pyrite, (the last two in large pieces of milky quartz), hornblende, and coticule (thin pink bands in amphibolite composed of spessartine garnet and magnetite).

The rock in this area is the Standing Pond Member of the Waits River Formation and is a garnet-hornblende amphibolite.

REFERENCE

Lyons, J.B., 1955, Geology of the Hanover Quadrangle, New Hampshire and Vermont, Geological Society of America, Bull., v. 66, p. 106-146.

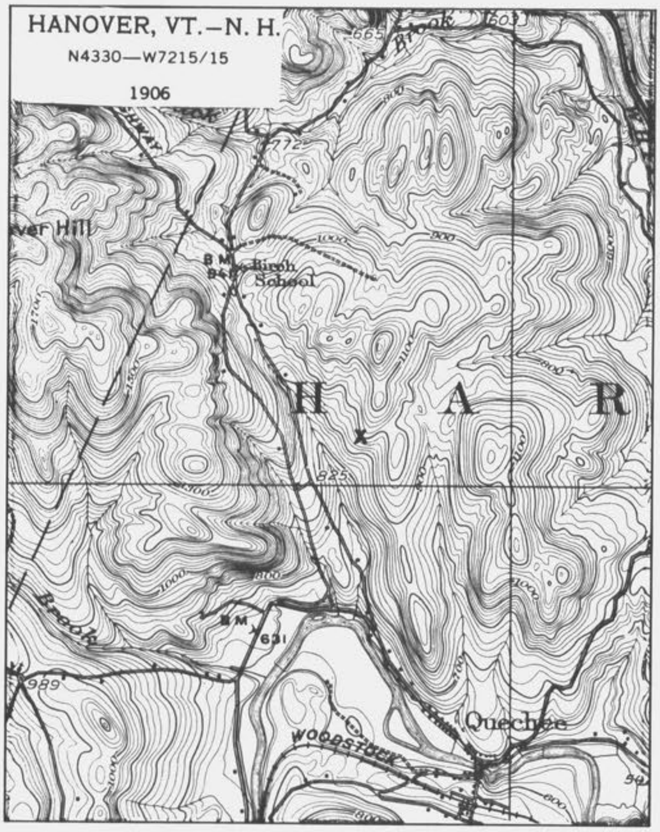


Fig. 67. Map showing the location of the mineral area near Hartford.

MUSEUM AND SPECIAL EXHIBITS
OF INTEREST TO MINERAL COLLECTORS

GEOLOGY MUSEUM, University of Vermont, Burlington, located in the Perkins Geology Hall.

The museum has a small general collection and special exhibits of Vermont minerals, rocks, and fossils. It is open to the public, weekdays 9 to 5 and Saturdays 9 to 12.

STATE MINERAL CABINET, located in the Vermont State Library, Montpelier.

A small collection of general interest and Vermont specimens. Open to the public from 9 to 5, Monday through Friday.

FAIRBANKS MUSEUM, St. Johnsbury.

This museum has many natural history exhibits including some minerals and fossils. It is open to the public June through August, Monday to Thursday, 9 to 5 and 7:30 p.m. to 9:30 p.m.; Friday and Saturday, 9 to 5; Sunday 2:30 to 4:30; September through May; Monday to Saturday 10 to 4:30; Sunday 2:30 to 4:30.

VERMONT MARBLE COMPANY MARBLE EXHIBIT, Proctor, Vermont. (Figure 69)

"World's largest marble exhibit," open late May to mid-October, 8:30 to 5:30, July and August 8:30 to 8:00.

TO ROCK OF AGES QUARRY AND EXHIBITS take Route 14 south from Barre and follow signs. (Figure 68)

Quarry Tours every day 8:30 to 5:00 from May 1 through October 31; longer hours in midsummer. Craftsman Center every day 8:30 to 4:00 year round, guide service June 15 to September 15.

JONES BROTHERS COMPANY, Route 302 in Barre, and **WELLS-LAMSON QUARRY**, go south of Barre on Route 14 and then follow signs.

Plant and quarry tours every day, 8:30 to 5:00 between May 27 and October 28.

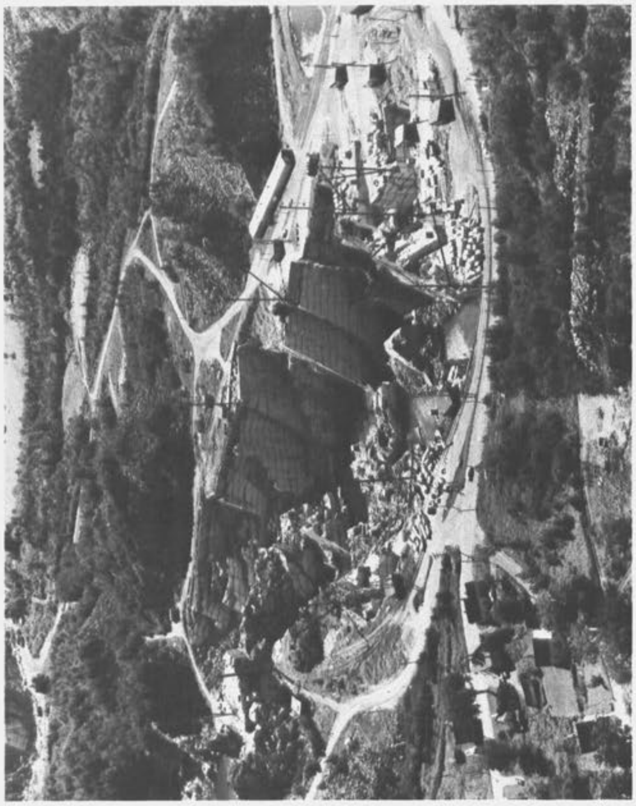


Fig. 68. Rock of Ages Granite Quarry, Barre.
Courtesy Rock of Ages Corporation

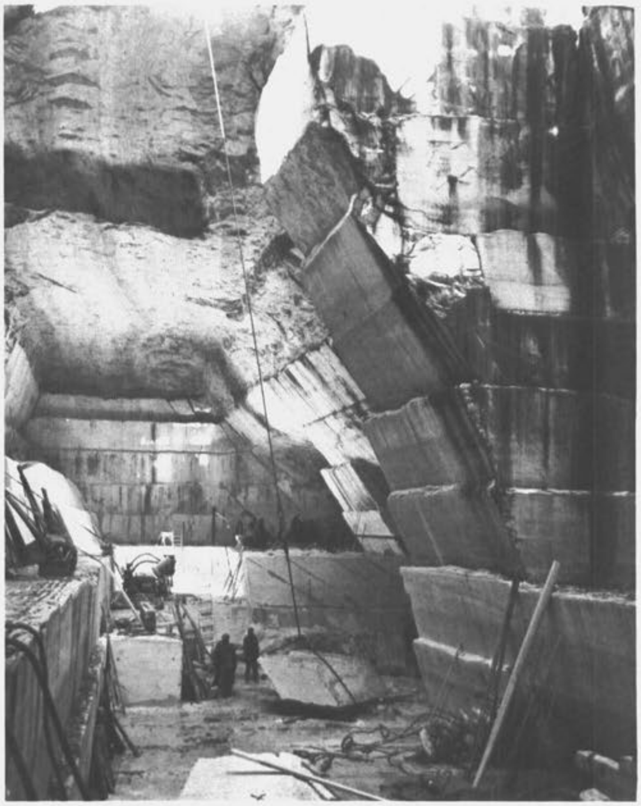


Fig. 69. Vermont Marble Company Quarry.
Courtesy Vermont Marble Company

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