



# **Part One**

## **The Physical Setting**



# The Physical Setting

As naturalists, land managers, and hikers, we constantly look for patterns in the landscape that help us make sense of the natural world. Of the things that create patterns of natural community distribution, four are especially important and far reaching. The nature of the bedrock that underlies Vermont has a major influence on the topography of the land, the chemistry of the soils, and the distribution of particular plants, especially when the bedrock is near the surface. The surficial deposits (the gravels, sands, silts, and clays that were laid down during and after the Pleistocene glaciation) can completely mask the effect of underlying bedrock where these deposits are thick. Climate affects natural community distribution, both indirectly by causing glaciation and directly by influencing the distribution of plants and animals. Finally, humans have their impacts on the land, clearing, planting, reaping, mining, dredging, filling, and also conserving natural lands.

**Table 1: Geologic Time Scale**

| <b>Era</b>  | <b>Periods</b>                     | <b>Time</b><br>(Millions of years before present) | <b>Significant Events in Vermont Geology</b>   |
|-------------|------------------------------------|---|--|
| Precambrian | Precambrian                        | Over 540  | Grenville Orogeny joins plates in Grenville supercontinent and uplifts Adirondacks.  |
| Paleozoic   | Cambrian<br>Ordovician             | 540 to 443  | Plates move apart. Green Mountains and Taconic rocks laid down in deep water of Iapetus Ocean. Champlain Valley and Vermont Valley rocks laid down in shallow sea. Taconic Orogeny adds Taconic island arc to proto-North America, raises Green Mountains and causes major thrusting. Iapetus Ocean begins to close. |
|             | Silurian<br>Devonian               | 443 to 354  | Vermont Piedmont rocks laid down in eastern Iapetus. Acadian Orogeny adds eastern New England to proto-North America and changes Green Mountains. Plutonic rocks intrude.  |
|             | Carboniferous<br>Permian           | 345 to 225  | Iapetus closes and supercontinent of Pangaea formed in Alleghenian Orogeny.  |
| Mesozoic    | Triassic<br>Jurassic<br>Cretaceous | 248 to 65   | Mount Ascutney pluton forms. Pangaea breaks up and the Atlantic Ocean forms.   |
| Cenozoic    | Tertiary                           | 65 to 2   |  |
|             | Quaternary                         | Less than 2                                       | Ice ages: Wisconsin glaciation covers Vermont with ice until about 13,500 years ago.   |

## The Rock Beneath Us

On a fall morning in low fog, the Champlain Valley can feel like a great sea. And it has been a sea, more than once. Five hundred million years ago, in Cambrian time, this salt sea was tropical, warm, and shallow, and present-day Burlington was not far from the equator. Trilobites and snails lived on the sea bottom; fishes had not yet evolved. During those times, calcium-rich sediments, the remnants of marine life, collected on the sea floor.

The history of Vermont's rocks is filled with tales of continental movement, the building and wearing away of mountains, and intense volcanic activity. We will tell this story only briefly and encourage the reader to look beyond this book to understand its fascinating details.

Most of Vermont's bedrock geology can be explained by its marine history and by plate tectonics, the movement of the world's continental plates atop a fluid mantle. Over the last billion or so years, the time for which geologists can piece together a history from subtle clues in the rocks, the continental plates have moved toward each other twice and away from each other twice, each time creating a huge supercontinent which later broke apart.

When continents meet, their collisions can wreak havoc at the edges. Like two rugs that are pushed together on a smooth floor, the continents are folded, wrinkled, and pushed under or over each other. Faulting and volcanic activity are dramatic results of this edge-pushing. When continents move apart, the wrinkles stay in place, and the sea floor stretches, creating rift zones and causing new deposition of sediments.

For much of its geological history, Vermont was at the continental edge. This has had two main effects. First, most of Vermont's bedrock originated as sea sediments. Second, Vermont has been especially vulnerable to the great forces of continental movement. So the state is made largely of sedimentary rocks, some of which have undergone intense metamorphism. We call these *metasedimentary* rocks. Volcanic activity has added other rocks to the landscape, especially in eastern Vermont. Metamorphism can affect those volcanic rocks as well.

The continental movements caused four major mountain building events, or *orogenies*, that shaped Vermont's mountains and valleys. During these tumultuous times, mountains were raised up, rocks were thrust over other rocks, and intense heat and pressure metamorphosed existing rocks and increased volcanic activity.

The first great mountain building event was the *Grenville Orogeny*, which took place more than a billion years ago in the Precambrian era. This created the Grenville supercontinent and a high mountain range on the eastern edge of proto-North America. Most of that range has now eroded away, but some of the rocks uplifted during that time are exposed in the Southern Green Mountains and the Adirondack Mountains of New York. These are the oldest rocks in the region.

Following this Precambrian collision, the plates began slowly spreading apart again, creating a rift zone much like the rift valley of present-day Kenya. Development of the rift was accompanied by outpourings of basalt and other volcanic rocks, which are visible today in parts of the Green Mountains. As the valley widened and as the great Grenville Mountains began to erode, sediments washed in and accumulated on the valley floor. Eventually the lowlands subsided and became inundated

with sea water, forming the ocean known as Iapetus — named for the mythological father of Atlantis. This ocean set the stage for the deposition of much of Vermont's rock. Its first evidence in today's landscape is the sandy beach sediments that are now the quartzites, or metamorphosed sandstones, of Bristol Cliffs and White Rocks in the Green Mountains. Later evidence is found in the many rocks that are broadly classified as mudstones — rocks that originated from silty or muddy sediments laid down in the deep water of the continental slope. These mudstones, more specifically shales, slates, phyllites, and schists, make up much of the Northern Green Mountains and the Taconics. Closer to land, on the continental shelf, the sediments of the present day Champlain Basin were laid down in a shallow, warm sea, a sea that was full of life.

In the middle Ordovician period, the character of the Iapetus Ocean changed dramatically. The continents began moving together again and as one plate was subducted under the next, the ocean became deeper. This change in the Iapetus Ocean was the beginning of the **Taconic Orogeny**. A huge volcanic island arc had formed in the Iapetus along the subduction zone and was moving toward the eastern edge of proto-North America. When it collided with the continent, deep crust and mantle rocks were squeezed up to the surface, leaving their mark as serpentine, talc, and other unusual minerals. At the same time, the seabed was pushed upward and transformed into the Green Mountains, closing the western part of the Iapetus Ocean in the process.

A dramatic result of these events was massive thrust faulting — the sliding of rocks on top of one another sometimes displaced them tens of miles from where they originally formed. Such was the case for the Taconic Mountains themselves. The rocks that make up the Taconic Mountains were thrust westward more than 60 miles over the top of what is now the Southern Green Mountains and the Berkshires in Massachusetts. Subsequent erosion has severed the connection between these rocks and their original source, creating the appearance that they were picked up and moved. The Cambrian Taconic rock, which would be the top of the Southern Green Mountains had it stayed in place, is now perched on top of younger, Ordovician rock. When faulting has left an isolated mass of older rock on top of younger rock, the formation is called a **klippe**. The Taconic klippe is world famous.

Other rocks were also moved during the Taconic Orogeny with similar, if less dramatic, results. The Champlain thrust fault, a long north-south line of rocks pushed on top of one another, is evident in the steep western slopes of the smaller mountains in the Champlain Valley, including Snake Mountain and Mount Philo. The Champlain thrust fault is plainly visible at Lone Rock Point in Burlington, which has made that location world famous as well.

Following the Taconic Orogeny, during the late Silurian and early Devonian periods, a long, north-south zone of subsidence appeared, running from the present-day Connecticut River valley north to the Gaspé Peninsula. This long valley, which was the remaining eastern part of the Iapetus Ocean, received sediments that gathered on the sea floor and mixed with the remains of marine animals that fell to the bottom. The rocks that ultimately resulted from these sediments, a mixture of limestone and mudstones, make up much of what is now eastern Vermont.

The plates continued to move together through the Silurian period, and as they did a large island known as Avalon, probably a part of the proto-African continent,

collided with proto-North America in the **Acadian Orogeny**. This collision added eastern New England to North America, and in Vermont changed existing mountains and reactivated faults. At the same time, subsurface rocks were heated and intruded upward, creating huge underground domes of molten magma, like volcanoes that never quite erupted. These domes, or **plutons**, hardened eventually, and as the rocks on top of them eroded away they were exposed as hills of granite. The Groton hills and the Barre granites were formed during this time, as were the large areas of granite that characterize the Northeastern Highlands.

Finally, proto-North America collided with proto-Europe and proto-Africa, closing the Iapetus Ocean and creating the supercontinent of Pangaea. This collision marked the **Alleghenian Orogeny**, which built the southern and central Appalachians but had only a small effect on Vermont. Mount Ascutney was formed as a result of the plutonic activity of this time.

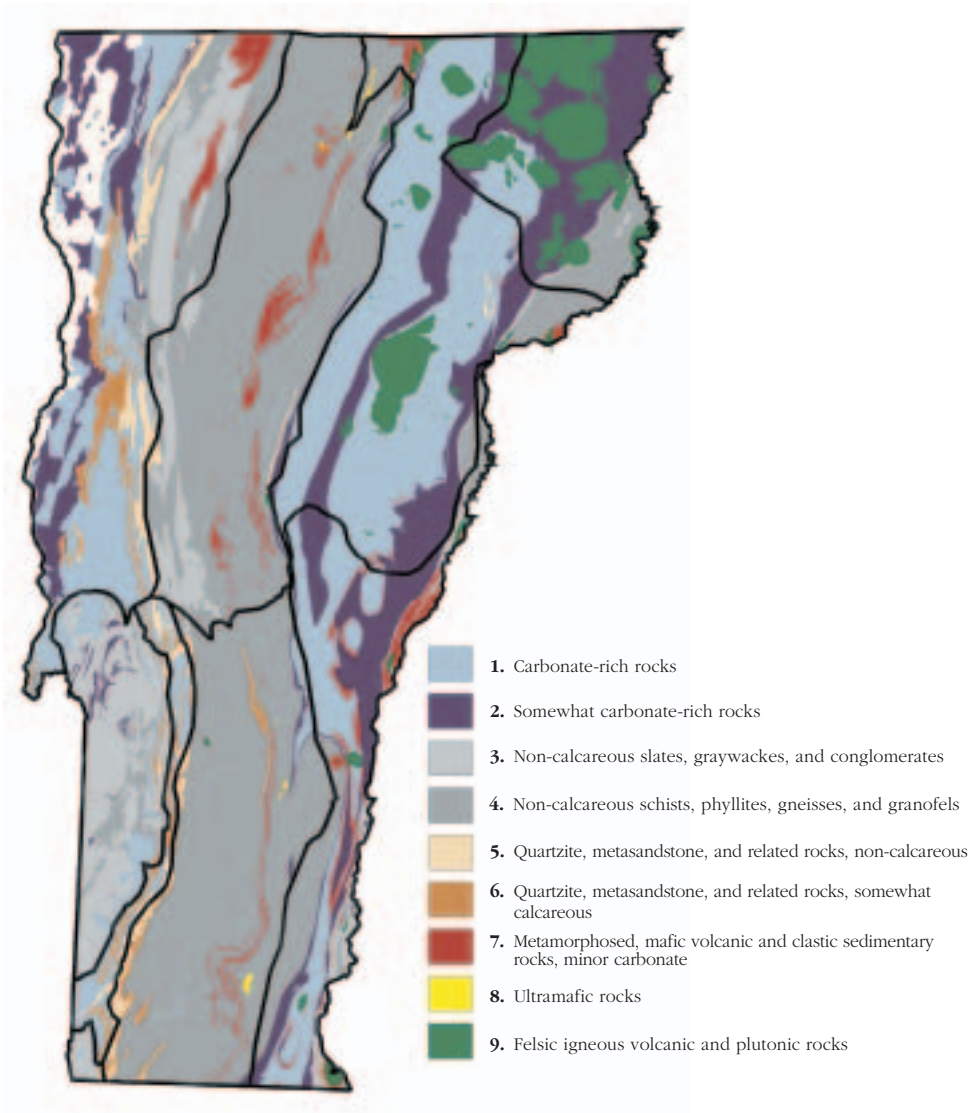
Thus the age of Vermont's rocks, in simplified terms, goes something like this. The southern portion of the Green Mountains, of Precambrian age, are the oldest rocks. The volcanic rocks of the Northern Green Mountains were formed in the rift zone that developed during the Cambrian period. The mudstones of the Green Mountains and Taconics, and the various limestones, dolomites, shales, and quartzites of the Champlain Valley and Vermont Valley were deposited in the late Cambrian and early Ordovician, in a sequence from shallow shelf to the deep sea of the continental slope. The youngest of the metamorphosed sedimentary rocks are the limestones and mudstones of eastern Vermont, laid down during the early Devonian. Finally, igneous rocks, originating as plutons, were intruded underneath all in the middle Devonian and later periods. These were exposed much later, as the overlying sedimentary rock eroded off the land.

Although this is all ancient geological history, it is extremely important for the natural communities that make up today's landscape. Ecologists recognize that certain rock types favor certain plants and therefore certain natural communities. Huckleberry and pitch pine grow very well on acidic rocks like granite, for instance. Basswood and maidenhair fern, on the other hand, seem to prefer "sweet" soils, those that are closer to neutral in reaction and have high concentrations of calcium and other plant nutrients. Figure 1 is a simplified map of Vermont's bedrock geology, emphasizing the ecological significance of the different rock types. Note that rocks of very different ages, like the Ordovician limestones of the Champlain Valley and the Early Devonian limestones of eastern Vermont, are combined here because to plants the differences in age and origin of rocks is inconsequential. And rocks that are similar in age, like those of the Taconics and northern Green Mountains, are separated here because their depositional environments and later metamorphism made them quite different.

This classification combines various rock types that have similar chemical compositions and weathering potentials since these are the things that have the greatest influence on plants and natural communities. In general, carbonate-rich rocks, made from calcium and magnesium carbonates, yield high-fertility soils by weathering easily and providing calcium, magnesium, and other elements necessary for plant growth. Because they are alkaline in reaction, they also buffer acidity and create favorable conditions for nutrient uptake. Non-carbonate rocks, such as granite and gneiss, generally do not provide important plant nutrients, do not break down easily, and

tend to produce acidic soils. But all these rocks are as variable as the original depositional environments in which they were created, and other factors such as overlying glacial deposits can mask the effect of bedrock. This map should be used only as a general guide.

**Figure 1: Ecological Classification of Vermont Bedrock.**



*Modified from Doll 1961 by Marjorie Gale and Laurence Becker, Vermont State Geologist's Office. Used by Permission.*

## Ecological Classification of Vermont Bedrock

- 1. Carbonate-rich rocks:** Dating from the Precambrian era through the Devonian period, these limestones, dolomites, marbles, and related metamorphic rocks are all similar ecologically. They have high concentrations of calcium carbonate and weather easily releasing calcium and other important plant nutrients. The famous marbles of Proctor and Danby are in this group, as are the crystalline limestones of the Waits River Formation in eastern Vermont.
- 2. Somewhat carbonate-rich rocks:** These Cambrian through Devonian age rocks are shales, slates, schists, and clastic metamorphosed rocks that are somewhat calcareous. The shale beaches of Lake Champlain are made of rocks in this group, as are the somewhat calcareous rocks of the Gile Mountain Formation in eastern Vermont.
- 3. Non-calcareous slates, graywackes, and conglomerates:** These metamorphic rocks are Cambrian through Devonian in age and are variable in composition but generally not calcareous nor high in other plant nutrients. They may be locally graphitic or sulphidic. Most of the rocks in the Taconic Mountains are in this class.
- 4. Non-calcareous schists, phyllites, gneisses, and granofels:** These rocks are Precambrian and Cambrian, and are generally non-calcareous or mildly calcareous locally. Most of the rocks in the Green Mountains fall into this general class.
- 5. Quartzite, metasandstone, and related rocks, non-calcareous:** These are mostly quartz-rich Cambrian rocks on the western edge of the Green Mountains. White Rocks, in Wallingford, is made from this rock.
- 6. Quartzite, metasandstone, and related rocks, somewhat calcareous:** These Cambrian rocks are mostly quartz-rich as well, but have calcareous beds. They contain more dolomite and calcite and are sometimes very rich plant habitats. Monkton quartzite (the “redstone” of western Vermont) is an example.
- 7. Metamorphosed, mafic volcanic and clastic sedimentary rocks, minor carbonate:** These are Cambrian through Mesozoic rocks found throughout Vermont. They locally contain minor dispersed carbonate. The “greenstone” of the Green Mountains is an example. They are rich in iron and magnesium.
- 8. Ultramafic rocks:** These unusual rocks have their origin beneath the oceanic crust in the upper portion of the earth’s mantle. Ultramafic rocks in Vermont include serpentinite and steatite. They are rich in iron and magnesium, contain heavy metals that are toxic to some plants, and contain little or no calcium. Some important commercial products that come from ultramafic rocks include soapstone, talc, verde antique (marketed as green marble) and asbestos.
- 9. Felsic igneous volcanic and plutonic rocks:** These intrusive and extrusive rocks rose as magma through the earth’s crust. They are generally resistant to weathering, rich in quartz and feldspar, and non-calcareous. Mount Ascutney and the Barre granites are examples of this type of rock.

## Sand and Silt, Clay and Cobble: The Work of Glaciers

In 1878, botanist Cyrus Guernsey Pringle made a curious discovery in Alburg, in Grand Isle County. He found beach grass, known then as *Ammophila arenaria*. This grass was well known from European beaches as well as along the Atlantic seacoast: from the dunes and beaches of Cape Cod, the shores of Long Island, and the shifting sands of the Outer Banks of North Carolina. But its discovery in Vermont was something of a surprise. What was it doing here, near fresh water?

Soon after, beach pea, another plant well known from the Atlantic coast, was found in Vermont, and so was beach heather.

In 1849, almost 30 years before these botanical discoveries were made, the skeleton of a whale had been unearthed while workers were excavating for a railroad bed in Charlotte. Clam and oyster shells were found along with the whale.

The story that explains these odd phenomena is the story of the Champlain Sea, that arm of the North Atlantic Ocean that invaded the Champlain Basin some 13,500 years ago, lasting for about 2,500 years until the connection to the ocean was severed and freshwater prevailed once more.

The presence of the sea in the Champlain Basin turns out to be just one piece of a much bigger story. For at least the past two million years (the Quaternary period), the earth has seen major climate shifts. Although we understand little about what causes these shifts, we do know something about their timing and their effects on the landscape. For example, we do know that for tens of thousands of years a great glacier covered northern North America, and remnants of this glacier still exist in Greenland and the Arctic. We know that this glacier reached its maximum extent about 20,000 years ago and was gone by about 13,500 years ago. The naturalists of the mid-19<sup>th</sup> century did not yet know about the great glaciation, but the story was beginning to emerge.

The impact of the glaciers was huge. The glacial ice was a mile thick in places, and its weight was tremendous. The glaciers moved slowly over the landscape from north to south. As they did they scraped everything in their path, removing all life, all organic soil, and rounding peaks as they passed over.

As the climate warmed and the glacier began to wane, huge volumes of water were released. The rushing waters carried with them a mix of boulders, gravel, sand, silt, and clay that had melted out of the ice. In places where the water slowed down, the heaviest fragments (boulders and cobbles) fell out first, then the less heavy (pebbles), then the finest (sand and silt). Many river valleys have glacial deposits along their sides and bottoms; these porous *kame terraces* tend to support pine, oak, and other species that occur on well-drained soils.

The ice and accompanying glacial debris blocked many stream outlets, and the meltwater filled the valleys. Glacial Lake Vermont covered most of the present day Champlain Valley, and its outlet was through the present day Hudson Valley. Glacial Lake Hitchcock filled the lowlands of the Connecticut River valley and its tributaries. These lakes drained when their outlets were opened, but they were in place long enough — thousands of years — to leave their mark. We have many evidences of these years of inundation, but two of the most significant are large areas of deltaic



*Glacier meeting water (College Fjord, Alaska).*

sand and large areas of lake-deposited clay. For example, where the present-day Winooski River flowed into Lake Vermont (in the Champlain Valley), the slowing of the water caused the sandy sediments that were carried by the river to drop out. The result was a sand delta at the mouth of the river, just east of present day Essex Junction. The very finest sediments, the silts and clays, remained in suspension, later to settle out on the lake bottom. Most of the clay soils of Chittenden and Addison Counties were laid down during this time.

A dramatic period in this sequence of events, and the one that explains the whale bones found in Charlotte, was when the glacier had retreated to just north of the present day Canadian border about 13,500 years ago. By this time, the tremendous weight of the ice had depressed the land underneath by several hundred feet. The result was that the lowest parts of Vermont were well below sea level. When the ice retreated far enough to uncover the Saint Lawrence valley, the sea made its way in from the north, filling the Champlain Valley with salt or brackish water for the next 2,500 years. We call this arm of the North Atlantic Ocean the Champlain Sea. Whales migrated along the Saint Lawrence to the Champlain Sea, as did, we presume, beach grass, beach pea, beach heather, and other marine plants that have since disappeared.

These 2,500 years saw more deposition of coarse and fine materials along the shore, at the river mouths, and at the sea bottom. West of Essex Junction, the sands were deposited during the marine invasion. And at the lowest elevations in the Champlain Valley, as in Panton, Addison, and Orwell, the clay is also of marine origin. As the ice melted, as the land rebounded, these deposits became exposed and the sea was replaced with fresh water.

These glacial deposits — the clay soils, kames, deltas, and eskers — are found throughout Vermont in river valleys and at lower elevations. Most of Vermont, however, is covered with glacial **till**, a thin smearing or jumble of unsorted rock fragments that was left behind as the glacier melted and retreated. Soil scientists distinguish between **basal till**, which was deposited at the base of the ice and is therefore very dense, and **ablation till**, which was carried higher in the ice column and simply left behind as the glacier melted. The distinction is important because basal till acts as an impeding layer in the soil, keeping water from moving downward. The till varies in thickness, too. It tends to be deepest in valleys and thinnest on hilltops where there is only bare bedrock. The source of the till may be very important in determining what vegetation will grow in a particular location, as till derived from granite is acidic whereas till derived from limestone is near neutral and rich in calcium. The till in a given place may have come from rock several miles to the north, and so may be very different in chemical composition from the bedrock that lies under it.

Collectively, all the different kinds of glacial deposits and landforms, including kame terraces, eskers, sand deltas, marine clays, till, and other glacial remnants — along with more recent deposits including **peat** (organic soils) and **alluvium** (floodplain soils) — constitute the **surficial deposits** of the region.

The surficial deposits, especially where they are deep and where they mask the effects of bedrock, have a significant influence on vegetation. The now rare Pine-Oak-Heath Sandplain Forest is found almost exclusively on sand deltas laid down during the marine invasion. Valley Clayplain Forest, a community that was once dominant in the Champlain Valley but is now reduced to fragments, is found on postglacial lake and marine clays. Large areas of kame gravel in the Northeastern Highlands support Lowland Spruce-Fir Forests; similar deposits support White Pine-Red Oak-Black Oak Forests in the Southern Vermont Piedmont. Till-derived soils are the most common in Vermont, and many of the variations in vegetation can be related to variations in till — in its thickness, its place of origin, and whether it was carried high in the ice column or at its base.

When combined with bedrock geology, the surficial geology of the state and region can tell us a great deal about which communities can be expected where.



*Flowing water transports sediment from the base of a glacier (Serpentine Glacier, Alaska).*

## Winter Snow and Summer Rain: Vermont's Climate

Climate is arguably the most important environmental factor determining the worldwide distribution of plants and natural communities. The Quaternary period — the last two million years — has brought major changes in both the climate of the world and the climate of Vermont, as expressed in the great ice ages. Pollen records allow us to piece together a general picture of the climate and vegetation of Vermont following the retreat of the last glaciers 13,500 years ago. For about 1,000 years, tundra dominated the landscape. By 11,000 years ago, trees had appeared and were becoming common. From about 6,000 years ago to 4,000 years ago, the climate steadily warmed and oak and pine became common. This period is known as the *hypsihermal interval*. Since then, the climate has gradually cooled, our present northern hardwood forests have spread, and cool climate species such as spruce and fir have expanded, perhaps indicating the beginning of the next ice age.

Today, Vermont's climate is classified as humid continental, meaning that the average temperature of the coldest month is less than 32°F and the average temperature of the warmest month is below 72°F. Summers are short, winters long and cold, and precipitation is abundant. The average length of the growing season ranges from 90 days in the Northeastern Highlands to over 150 days in the Champlain Valley. Annual precipitation ranges from about 30 inches in the Champlain Valley to more than 70 inches in the Southern Green Mountains. Average January temperatures range from 14°F in the Northeastern Highlands to 22°F in southwestern Vermont; average July temperatures range from about 64°F in the Northern Vermont Piedmont to about 70°F in the Champlain Valley.

The factors that cause variation within the state and the region are continental weather patterns, elevation, latitude, topography, microtopography, and the effects of large bodies of water, most notably Lake Champlain.

In general, the prevailing winds in Vermont come from the south and the west. On a continental scale, winds tend to move from west to east, but locally, north-south trending valleys can cause winds to move from south to north. Vermont is also close enough to the coast that it sees some oceanic weather on occasion, including hurricanes, which can have a dramatic effect on our forests.

Elevation has a dramatic influence on climate and vegetation. A hiker climbing Mount Equinox in the Taconic Mountains will experience a change in elevation of almost 3,000 feet, and if the day is still, the temperature will drop about 10.5°F from bottom to top. With no other weather patterns entering the picture, every rise of 1,000 feet yields a drop in temperature of 3.5°F. If the day is windy, the hiker will feel even colder at the top than the 10.5 degree drop would cause. And if the cool mountain air causes fog to settle on the mountaintop, then the hiker will feel colder still. Oaks and other hardwoods are common on the warmer floor of the valley, but a stunted Montane Spruce-Fir Forest caps the tops of the mountains here.

Latitude affects our climate, too, and there is a significant change in overall temperatures from north to south, simply because of the move away from the equator. On Mount Equinox, for example, the Spruce-Fir Forest that blankets the peak appears first at about 2,800 feet. In contrast, on Jay Peak near the Canadian Border, the Spruce-Fir Forest would begin much lower on the mountain, at about 2,500 feet. But the effect of latitude is not uniform. It seems to be important in the winter, but in summer, other factors override it, especially in the valleys.

Microtopography may be the most important factor in determining local climate patterns. Everyone who lives in the hills knows what a frost pocket is. Small, narrow valleys at moderate elevations tend to get the first frosts in fall and the latest ones in spring because warm air rises and cool air settles into the valleys on still nights. Hills and valleys create their own precipitation patterns, too, with west facing mountaintops often catching rains that come from the west while eastern slopes remain relatively dry.

Finally, large bodies of water can moderate the temperature locally. Fall temperatures are higher near Lake Champlain than away from it because this huge body of water holds the heat of the summer while the air cools. In spring, the lake holds the cold of the winter while the air heats up, keeping lake shore dwellers cool on early summer days. The regional effect of Lake Champlain is minimal, but locally it is important and quite noticeable.

## **People in Vermont**

Humans have been in Vermont for at least 8,000 years and have had their impact on Vermont's natural communities. Archeological evidence points to localized heavy use of some of the more fertile valleys, especially near lakes and waterways, by native Americans since they first arrived here. But their influences on the vegetation were probably minimal in comparison with those of European settlers.

In 1750, Europeans considered Vermont a wilderness and only a few hardy settlers had penetrated the state to trap furbearing animals. Most of the people here were Native Americans. The state was probably about 95 percent forested, with mountaintops, shores, occasional Indian settlements, and wetlands the only open places. European settlers came in earnest in the late 18th century, following the end of the French and Indian Wars in 1763. The early 19th century saw the clearing of Vermont's forest, with the timber used in lime kilns, converted to charcoal for use in iron and copper production, burned to produce potash, and exported to the south for lumber and a variety of other uses. By the 1850s Vermont was far from the wilderness it had been only 100 years earlier; nearly three quarters of the state was cleared, the streams were full of silt from the eroding land, and sheep grazed almost every hillside. In fact, Vermont was for a time the world's largest exporter of wool. When the fertile lands of the Midwest opened up, however, farmers left Vermont's infertile hills for the tallgrass prairies and their deep fertile soils. By 1980, dairy farming had replaced sheep, but even dairy farming had become a marginal endeavor in many areas of Vermont. Only 21 percent of the land remained open. The changes over these short 250 years were dramatic.

Vermont's vegetation has evolved and changed in response to all these events: the underlying bedrock laid down millions of years ago, surficial deposits left by glaciers and their meltwaters, changing climate, and human activity. Today's vegetation is a reflection of all these things working together and varying from place to place. The natural communities that occupy the modern Vermont landscape reflect the peculiar combinations of bedrock, soils, weather patterns, natural disturbance regimes, plant dispersal, animal movements, and history working together over a long period of time. Natural communities are always changing. Three hundred years from now, the climate will surely be different, the forests will have recovered from the abuses of the 19<sup>th</sup> century, and humans will have had new impacts on the land that we cannot even begin to predict. Just as surely, the combinations of plants and animals that occupy a given place on the landscape will be different from those that occur there today.



*River valleys have been used by humans for millennia (Connecticut River; Canaan).*