Vermont Geological Survey

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GEOLOGY OF VERMONT LANDS

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Geologists study the earth, the processes which shape the landscape, and the rocks which record several billion years of time in order to understand how the earth has changed and how it may change in the future. Some change is rapid and catastrophic. Earthquakes, floods, tsunamis, and volcanoes all result in rapid changes that we can clearly observe. Much geologic change happens slowly and in small increments which are difficult for us to perceive in our human time frame. The earth is 4.5 billion years old, the oldest known rocks in Vermont are 1.3 billion years old, and humankind is thought to be only around 40 thousand years old. A single lifetime is a blink-of-an-eye in a geologic framework.

Vermont's landscape represents more than one billion years off geologic history. Vermont rocks formed in a variety of environments, originating as sediment deposited in ocean basins, beaches, and tidal flats, as lava which flowed and explosively erupted from volcanoes, and as metamorphic rocks, folded and broken as continents collided along ancient plate boundaries. Glacial ice and meltwater sculpted, eroded, and deposited sands and gravels on the underlying hard rock. Water, wind and human actions continue to alter the Vermont landscape. Many of Vermont's State Parks offer excellent opportunities to observe and explore the changes in Vermont's landscape through time.

Mt. Philo, Charlotte, Vermont

The views of the Champlain Valley from the top of Mt Philo (elev. 968 ft) are exceptional. Much of the landscape has developed due to both erosion and deposition by glacial ice and meltwater. Vermont was heavily glaciated and once buried beneath ice. The glaciers carved away rock and ground it into finer grained sands and gravels, scoured valleys, and left behind rounded bedrock with grooves and striations. As the glaciers melted and retreated 12,000 years ago, ice dams and melting water formed lakes. Running water and melting ice deposited eroded material as deltas and moraines. The materials deposited at the surface help explain the history and evolution of the landscape. As the glaciers retreated from Vermont, Mt. Philo was an island in an inland sea as evidenced by the marine sand deposits at its base. The State Fossil, the Charlotte Whale, is believed to have died in a shallow marsh of the Champlain Sea and been covered by fine clay sediment, providing more evidence for changes in climate and history of the Lake Champlain area. Yet all this activity is recent when compared with the 550 million year old bedrock of the Champlain Valley.

The Cambrian (550 million years old) sedimentary rocks of the Champlain Valley formed from sediment (sand, silt, carbonates and shells) deposited in shallow water along the continental margin in the Iapetus Ocean, a precursor to the Atlantic Ocean. The rock at the summit of Mt. Philo is a medium grained, reddish- purple rock called Monkton Quartzite. Most of the rounded grains, visible if you look closely, are quartz and feldspar. The nearly horizontal layers, marked by different colors, minerals and grain sizes, are bedding. Ripple marks, like those at the beach resulting from currents moving sand grains back and forth, are visible in the quartzite. Mud cracks are also present and give

more evidence for ancient tidal deposits.

The oldest rocks are usually at the bottom of a deposit, but at Mt. Philo, the rocks at the summit are older than the rocks in the valley. The rocks moved up through the geologic section along faults and are on the upper plate of the Champlain Thrust Fault. The Champlain Thrust runs north-south for nearly 75 miles along the west side of Vermont and places Cambrian rocks on top of younger Ordovician rocks. The resistant quartzites cap the small mountains along the east side of the Champlain Valley. Monkton Quartzite was used to construct the Redstone Campus and other buildings in Burlington.

Smugglers Notch, Cambridge, Vermont

From an ancient ocean floor to burial beneath a huge glacial ice sheet to present -day stream erosion, Smugglers Notch has experienced it all! Smugglers Notch, a gap between Mt. Mansfield and Sterling Mountain, is a steep V-shaped valley. The Notch is a drainage divide, with Brewster River carrying water to the north and West Branch River draining south. In addition to the slow, headward erosion by streams, large blocks of rock occasionally break off along fractures and tumble down from the valley walls resulting in a rapid change to the landscape. In 1983, a large rockfall occurred when an 11,500 ton block of schist broke loose, smashed into the valley wall, and broke into smaller boulders, some of which "bounced" across Route 108 leaving holes in the pavement.

Smugglers Notch, just north of Vermont's highest peak, also lies along the crest of the Green Mountain Anticlinorium. The Anticlinorium is a large upward fold in the rocks, much like an arch. The rocks exposed in the Notch are green and gray schists- metamorphic rocks which formed from deposits of sediment and volcanic rocks on an ocean floor 500 million years ago. The rocks, folded, metamorphosed and transported during mountain building events known as the Taconic and Acadian Orogenies, contribute to the overall shape of the land.

Owls Head Mountain, Groton State Forest, Vermont

The summit of Owls Head Mountain (elev. 1958 ft) in Groton State Forest is accessible via a short hike and provides views of Peacham Bog, Kettle Pond and Lake Groton. The rock at Owls Head is granite-one of the official State Rocks of Vermont. The rounded knoll has weathered rather evenly due to the uniform texture of the gray, medium grained granite. The granite may reach several miles in depth, as is estimated for the Barre granite plutons. The rock exposed at Groton was formed about 380 million years ago and cooled many kilometers down in the earth's crust. The surrounding Gile Mountain and Waits River formations are mainly gray mica-rich metamorphic rocks called schist. The granite cuts across layers in the schist and this relationship allows geologists to determine the relative ages of rocks. By looking carefully at the rock and what it intrudes, a relative time scale is pieced together.

The rock has been sculpted by glacial ice as well, and erratics or boulders of granite are found in the valleys surrounding the mountain. Thousands of feet of rock have been removed by erosion during the past 250 million years, and rock is continuing to be eroded today. The granite is sheeted, as is visible on the south slopes, and the effect of ice and water working along joints and fractures in the rock continues to peel off granite fragments today. Less visible is a slow weathering of the granite bedrock and the glacial materials to form sandy , acidic soils in the area. Granite similar to that at Groton has been successfully quarried for years in the Barre-Montpelier area and is an important economic mineral resource for Vermont.

Mt. Ascutney, Ascutney State Park, Vermont

The rocks at Mt. Ascutney (elev. 3144 ft) and it's neighbor to the west, Little Ascutney, were formed from hot magma. These igneous intrusions are called plutons. The eastern pluton is composed of light-colored syenite and granite, and the western pluton is composed of darker granodiorite and gabbro. The two plutons form the core of an ancient, extinct volcano that is approximately 120 to 125 million years old. The rocks here are some of the youngest in Vermont's state parks. However, the plutons intrude highly deformed metamorphic gneiss and schist that range from 1,400 to 425 million years old. The 1,400 million year old rocks are some of the oldest rocks in Vermont.

The high temperature associated with the intusion of magma into the surrounding rock produced a "baked" zone, known to geologists as a contact metamorphic aureole. When hot magma comes in contact with cool rock, the minerals that make up the cool rock may partially melt and get rearranged. The aureole usually shows this change by variations in texture and composition across a "baked" zone. The eastern pluton, under Mt. Ascutney, has a contact metamorphic aureole that is up to 1 km wide.

During the last ice age, glacial ice advanced towards the south and carried broken blocks of granite and syenite from Mt. Ascutney to the southeast. The rocks are strewn along the land to form a linear "boulder train" which can be traced all the way to Massachusetts. The valleys of the Connecticut River and its tributaries were also the site of glacial Lake Hitchcock which stretched from West Burke, Vermont to Rocky Hill , Connecticut. Dammed by a moraine at the southern end, the receding ice melted and water collected in Lake Hitchcock. When the dam broke about 13,000 years ago, the water drained rapidly and the present courses of the rivers were established. Post-glacial erosion resulted in a number of terraces carved into the valley-fill sediments and glacial lake clays.

From ancient beaches to volcanoes to ice-covered mountains and stream-carved valleys, the Vermont State Parks are hosts to our geologic record of Vermont's changing landscape.