Geology of the Champlain Valley

The geologic history of the Champlain Valley National Heritage Partnership (CNHP) region is varied and dynamic. Over the last 500 million years, it has been covered with a warm shallow sea, a mile-high sheet of ice, a large glacial lake, and an arm of the Atlantic Ocean.

More than 500 million years ago the Iapetus Ocean, a warm, shallow sea, existed in what is now the Champlain and Upper Hudson basins. Over 400 million years ago, the Iapetus Ocean closed and the sedimentary rocks of the shoreline and continental shelf were folded and faulted to form the Green Mountains. During this process of mountain building, the older sedimentary rocks were altered by heat and pressure into metamorphic rocks such as marble and slate. In addition, portions of the earth's crust broke and moved as large fault blocks, causing younger rocks to be pushed up and over metamorphosed continental shelf rocks beneath. This is how the Taconic Mountains were formed.

Unlike the Green and Taconic Mountains, the Adirondacks are a unique dome formation, which started rising about 5 million years ago. As the dome rose, successively older rock layers were eroded away, exposing today's surface rocks that formed deep within the crust more than one billion years ago.

Approximately 3 million years ago the Great Ice Age began, with glaciers advancing and retreating across North America. The last advance, about 20,000 years ago, covered all of the Champlain and Upper Hudson basins and most of the surrounding mountains with a mile-high sheet of ice. The glacier altered the landscape as it moved, scouring out valleys, eroding mountains, and depositing glacial till.

The earth began to warm some 12,500 years ago and the ice retreated, forming Lake Vermont and Lake George from melted glacial water. Further retreat of the ice, and depression of the earth's surface due to its weight, allowed marine waters from the St. Lawrence estuary to flood a portion of the CVNHP region, creating an arm of the Atlantic Ocean called the Champlain Sea. Approximately 10,000 years ago, the earth's surface rebounded, cutting off the supply of salt water. As its salinity gradually became diluted, the Champlain Sea changed back to freshwater, creating present-day Lake Champlain. From marine fossils to rounded glacial valleys to beluga whale bones, the storied geologic past is on full display throughout the CVNHP region.

Lake Champlain Basin Program
Champlain Valley National Heritage Partnership

Under Pressure

ECHO

ECHO, Leahy Center for Lake Champlain, is located on the Burlington, VT waterfront. A mixture of science center, lake aquarium and museum, ECHO seeks to educate and delight visitors about the ecology, culture, history, and opportunities for stewardship of the Lake Champlain Basin. It is home to more than 70 species of live animals, as well as both permanent and traveling exhibitions. In the area of ECHO entitled, “Before the Basin”, guests can explore the dynamic geology of the region.

Over the course of 500 million years, this area has been covered by a warm shallow ocean, a mile-high sheet of ice, a large glacial lake, and an arm of the Atlantic Ocean. Visitors can learn about this varied geologic past by touching the cast of a gastropod fossil from the Iapetus Ocean, making mountains by colliding tectonic plates, eroding rocks from the Green and Adirondack Mountains, and peering into the Champlain Sea tidepool tank to see its inhabitants--sea stars, horseshoe crabs, urchins and more.

In addition, there is a geologic exhibit built into the outside eastern wall of the building. The brick design depicts the Champlain Thrust Fault, an unusual geologic formation that is visible along the Lake Champlain shoreline north of ECHO at Lone Rock Point. Approximately 450 million years ago, techtonic plates began to slowly slide toward one another; their eventual collision created the Appalachian Mountain chain, which includes the Green Mountains. During these mountainbuilding events, portions of the earth’s crust broke and moved as large fault blocks, causing younger rocks to be thrust up and over older ones. Visitors who are unable to go to Lone

Rock Point to view the older buff-colored dolomite sitting atop younger black shale have the option of seeing it at the Leahy Center instead.

Location:
ECHO, Leahy Center for Lake Champlain
One College Street
Burlington, VT
802 864.1848
info@echovt.org
http://www.echovermont.org/

Hours:
Year-round from 10 a.m. - 5 p.m.,
closed only on Thanksgiving, Christmas Eve and Christmas Day.

Admission:
Required

Under Pressure

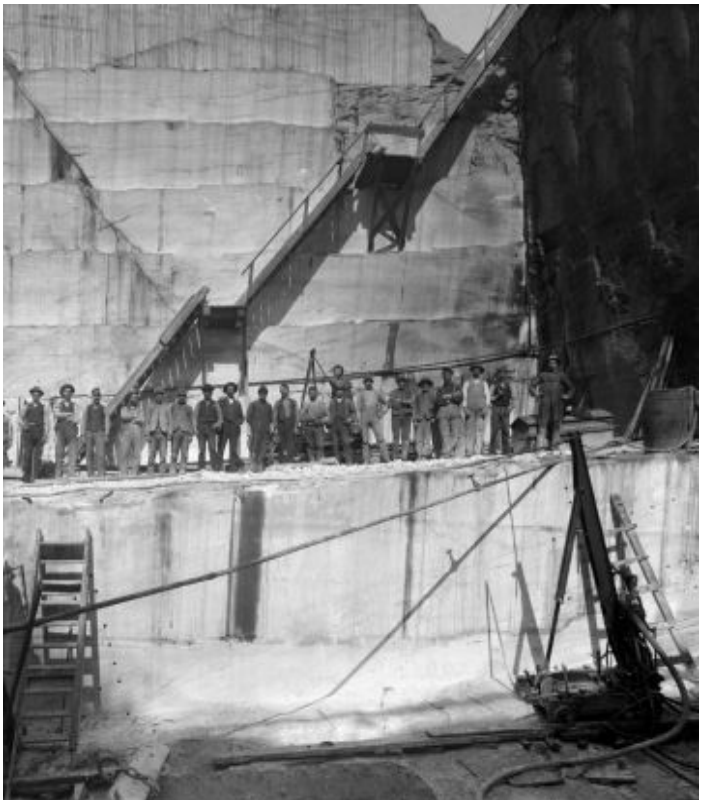
Marble Museum

More than 500 million years ago, a warm shallow ocean covered this region. Almost all life was in the oceans at this time, including organisms with shells. Over millions of years, the shells and skeletal remains of abundant sea life, including microorganisms, were deposited on the ocean floor along with sediments that washed in from the surrounding land. Over time these deposits, made of calcium carbonate, were compacted and cemented into the sedimentary rock limestone.

Limestone transforms into marble when exposed to heat and pressure. These conditions were present approximately 450 million years ago, when tectonic plates began to move toward one another, resulting in the formation of the Taconic Mountains. The compression of one plate against another generated the heat and pressure that caused the carbonate minerals in the limestone to recrystallize and form marble.

Founded in 1880, the Vermont Marble Company in Proctor, Vermont was an industry giant for over a century. The Supreme Court building and the columns in the National Gallery of Art were constructed by this company with Vermont marble. Immigrants came from many European countries to lend their skill and brawn to all manner of industry jobs.

Marble is extremely versatile. In addition to its uses as a building material, marble can be crushed for construction projects. Composed of calcium carbonate, it's useful for neutralizing acids in soils and streams, and also to treat acid indigestion. Powdered marble is a whitening agent and filler in products such as paint, plastic, cosmetics, and paper.



Location:
52 Main Street
Proctor, VT
800.427.1396
info@vermontmarblemuseum.org
https://vermontmarblemuseum.org/

Hours:
10:00 am – 5:00 pm, 7 days a week through the summer season (closing October 28). The last Museum tour of the day starts at 4pm.

Admission:
Tickets required

Under Pressure

Slate Valley Museum

Extending along the New York and Vermont border between Granville, NY and Rupert, VT and north to Fair Haven, VT is the 'Slate Valley', a belt of slate approximately 24 miles long and 6 miles wide. This area is unique in that the mineral composition of the slate produces a wide variety of colors including green, purple, and red.

The slate began as deposits of clay and fine sediments on the continental slope of the warm Iapetus Ocean, which covered this region over 500 million years ago. The sediments that washed in from the mountains and surrounding land were compacted by the weight of overlying deposits, and eventually solidified into the sedimentary rock shale.

The forces that turned shale into slate resulted from the collision of tectonic plates, which began approximately 450 million years ago and would eventually create the Green Mountains, part of the Appalachian Mountain chain. The compression of one plate against another generated heat and pressure, which caused mineralogical changes in the shale, transforming it into slate. About 20,000 years ago during the Great Ice Age, glaciers covered this area, eroding mountains and deepening valleys. This glacial scouring exposed the slate so it could be discovered in the fields of the Slate Valley.

As a result of the pressure that created it, slate splits easily into flat sheets. Coupling this with its durability results in an ideal roofing material. The slate industry began to grow in the 1850s, when the demand for slate shingles emerged.

Immigrants from Ireland, Wales and other European countries moved to the Slate Valley to work in the quarries. Over the years, the industry has experienced a boom and bust cycle. Currently, it's estimated that there are more than 20 working companies in the Slate Valley.

Location:
17 Water Street
Granville, NY
518.642.1417
http://www.slatevalleymuseum.org/

Hours:
Tuesday - Friday 1 - 5 PM
Saturday 10 AM - 4 PM
Closed Sunday & Monday

Admission:

Ancient Waters

Perkins Museum

The Perkins Museum of Geology is dedicated to presenting geologic concepts and processes to students, scholars, and the interested public. It is home to many exhibits, including an impressive collection of VT rocks, minerals and fossils, the only permanent large exhibit of the Bedrock Geologic Map of Vermont, and many marine invertebrate fossils from the Chazy Reef Formation.

The Museum is also home to the Vermont State Marine fossil: the Charlotte Whale, a 12-foot beluga whale skeleton discovered in 1849 in a farm field in Charlotte, VT. The whale was preserved in the sediments of the Champlain Sea, an arm of the Atlantic Ocean that occupied areas depressed below sea level by the weight of a mile-high glacier that covered this region during the Great Ice Age. The beluga whale died approximately 11,000 years ago, and was slowly buried by clay and silt sediments.

Approximately 10,000 years ago, the earth's surface rebounded, cutting off the supply of salt water. Gradually, the Champlain Sea became freshwater Lake Champlain. It was during the construction of the Burlington-Rutland railroad that workers discovered the bones of the Charlotte Whale, and presented geologists with the mystery of how it could be that whales once swam in a cow pasture in landlocked Vermont.

Location:
Delahanty Hall
University of Vermont - Trinity Campus
180 Colchester Avenue
Burlington, VT 05405-1758
802.656.8694
geology@uvm.edu
http://www.uvm.edu/perkins

Hours:
Monday - Friday 8:30 -4:30

Admission:
Free

Ancient Waters

Chazy Fossil Reef

Isle La Motte is home to the most complete fossil record of the Chazy Reef Formation, the world's oldest reef in which corals first appear. It was formed some 500 million years ago in the Iapetus Ocean, a shallow tropical sea straddling the equator. Over hundreds of millions of years, tectonic plate movement resulted in this fossilized reef arriving at its present location.

When the reef began to form, almost all life was in the oceans, with the exception of primitive plants on dry land. The first reef-builders were bryozoans, tiny soft-bodied animals living in colonies, followed by stromatoporoids, cabbage-like relatives of sea sponges. Other organisms came to inhabit the reef including the first known species of coral; gastropods; cephalopods, tentacled ancestors of squid; and trilobites, ancient lobster-like creatures. Over millions of years, the shells and skeletal remains of the sea life were deposited on the ocean floor and mixed with sediments that washed in from the surrounding land. These deposits were compressed, and hardened into the sedimentary rock limestone. In this Chazy limestone, fossils of the ancient ocean creatures are visible, formed when the imprints of their shells were preserved as the deposits cemented into rock.

During the 19th century on Isle La Motte, there were 5 large quarries, including Vermont's oldest, the Fisk Quarry, that produced a unique black and grey limestone, the fossil remnants of the ancient reef. The limestone was sold to Radio City Music Hall, the National Gallery of Art, and the VT State House, where visitors can view marine fossils in the floor. The quarried rough stone was used for piers in Montreal's Victoria

bridge and the Brooklyn Bridge.In 2009 several sites where the Chazy Fossil Reef is exposed, including New York's Valcour Island, and both the Fisk Quarry and Goodsell Ridge Preserves, were designated a National Natural Landmark.

Location:
Goodsell Ridge
239 Quarry Road
Isle La Motte, VT 05463
info@ilmpt.org
www.ilmpt.org/ilmpt/Preserves.html

Hours:
Memorial Day to Columbus Day:
Discovery Areas, Walk Through Time
Visitor Center: Wed - Friday 1 - 4 PM
Sat 10 AM - 4 PM Sun 12 - 3 PM
*Nature trails are open year round

Admission:
Free

Mining in the Mountains

Penfield Homestead

The Penfield Homestead Museum is located in the Ironville Historic District, the area associated with the once-thriving ironworks of the Crown Point Iron Company, started by Allen Penfield and Timothy Taft in the late 1820s. A walking tour along Putnam's Creek, once an important source of water power, highlights the steps of the extraction and transportation of iron. Mined in nearby Hammondville, the local iron ore was magnetite, named for its magnetic properties. It was sent to Ironville to be crushed and separated from impurities. In the 1830s, this company developed, with Joseph Henry, a magnetic iron ore separating machine, charged by an electromagnet with an attached voltaic battery. Thus, Ironville is known as the "birthplace of the electric age", the site of the first industrial application of electricity.

How did iron get in the ground under Hammondville? The ancestral Adirondack Mountains formed approximately 1 billion years ago when tectonic plates collided, causing pre-existing rocks, including those once deposited as sediments at the Earth's surface, to transform into metamorphic rocks. Great volumes of molten rock, or magma, rose up into the crust and pushed through overlying rocks. It cooled and crystallized, and formed igneous rocks, such as anorthosite, which today underlies the High Peaks region. Approximately 100 million years later, during the collapse and extension of these mountains, new magmas, rich in iron oxide rose into the crust and crystallized as iron ore.

Although little remains of the ironworks, there are several intact buildings on this 550-acre site, including the homestead, now a museum. Also

on site are artifacts from the Crown Point Spar Company, which mined and processed mica spar for use in ceramics, concrete, and as poultry grit from 1906 to 1935.

Location:
703 Creek Road
Crown Point, NY
518 597.3804
penfield@cptelco.net
http://www.penfieldmuseum.org/

Hours:
Saturday & Sunday 11 AM - 4 PM
June 11 - October 9

Admission:
Required

Mining in the Mountains

Iron Center Museum

The ancestral Adirondack mountains formed approximately 1 billion years ago when tectonic plates collided and formed an ancient supercontinent. During this collision, pre-existing rocks, including those once deposited as sediments at the Earth's surface, were modified by heat and pressure into metamorphic rocks. In addition, great volumes of molten rock, or magma, rose up into the crust and pushed through overlying rocks. This magma cooled and crystallized, and formed igneous rocks, such as anorthosite, which today underlies the Adirondack High Peaks region. Approximately 100 million years later, during the collapse and extension of these mountains, new magmas, rich in iron oxide rose into the crust and crystallized as iron ore.

Iron ore from this area of the Adirondacks is called magnetite because of its magnetic properties. Early surveyors in the area knew that iron was present when their compass needles pointed in the wrong direction. Large quantities of high grade iron ore were extracted from nearly 20 mines located near Mineville, Witherbee and Moriah, NY between circa 1820 and 1971. This iron assisted the United States in several war efforts, provided raw materials for tools, household items and railroads, and helped make steel for cars, skyscrapers, bridges and more. The Iron Center Museum tells the story of the local iron ore mining industry, including how the ore was extracted, processed and transported. Also examined are the lives of the miners, whose dangerous work took them into narrow tunnels deep under the ground.

Location:
34 Park Place
Port Henry, NY
518 546.3587

Hours:
Monday, Tuesday, Wednesday: noon - 2 PM; Friday and Saturday: noon - 3PM.
Closed Thursday and Sunday.

Admission:
by donation

Mining in the Mountains

Lyon Mountain

Lyon Mountain Mining and Railroad Museum is housed in the former Delaware and Hudson Railroad Station in Lyon Mountain, NY. This former company-town, belonging first to the Chateaugay Ore and Iron Company and later the Republic Steel Company, is known for its history of mining iron ore. The mining began in earnest in the 1870s, and produced some of the best iron in the industry, which found its way into famous structures such as the Brooklyn, George Washington and Golden Gate Bridges.

The Chateaugay mine was one of the deepest commercial iron mines in North and South America. Rocks were blasted from inside the mines and transported above ground. The raw ore then went through various steps to separate the impurities and prepare it for the blast furnace, out of which molten iron flowed. The operation closed in 1967, when mining the iron ore was deemed no longer profitable. This museum tells the story of iron ore and the people whose lives revolved around mining, processing and transporting it.

Here's how the iron got into the earth under Lyon Mountain. The ancestral Adirondack Mountains formed approximately 1 billion years ago when tectonic plates collided. During this collision, pre-existing rocks, including those once deposited as sediments at the Earth's surface, were modified by heat and pressure into metamorphic rocks. In addition, great volumes of molten rock, or magma, rose up into the crust and pushed through overlying rocks. This magma cooled and crystallized, and formed igneous rocks, such as a rock also found on the Moon called anorthosite, which today underlies the Adirondack High Peaks region. Approximately 100 million years later, during the collapse and extension of the mountains, new magmas, rich in iron oxide rose into the crust and crystallized as iron ore.

Location:
2914 Standish Road
Lyon Mountain, NY
518 735.4314
http://lyonmountainmuseum.blogspot.com/

Hours:
10:00 AM - 4 PM
Wednesdays and Saturdays
mid June - September 26

Admission:

Wind and Water

Alburgh Dunes

Approximately 20,000 years ago, during the Great Ice Age, this region was covered by a one-mile thick sheet of ice. As this glacier advanced, it scoured and abraded the surface over which it traveled. As the earth began to warm approximately 12,500 years ago, the ice sheet retreated, depositing large quantities of sand, gravel and silt as it moved northward. The melted glacial waters created Lake Vermont.

The earth's surface was depressed due to the weight of the glacier, which allowed marine waters from the St. Lawrence estuary to flood the region. This formed the Champlain Sea, an arm of the Atlantic Ocean, which was home to many marine animals, including beluga whales. Plants native to the Atlantic Coast migrated here, and remnant populations of beach pea, beach grass and tall wormwood are still found in the park. Approximately 10,000 years ago, the earth's surface rebounded and cut off the supply of salt water, changing the Champlain Sea into Lake Champlain.

The sand at Alburgh Dunes came from glacial till, the sediment that was deposited on the bluffs southeast of the beach when the last glacier melted. Over thousands of years, the bluffs eroded, and the sediment was carried away by water currents. Sand from that glacial till settled out in the area between two points of land, and created the beach. In the late summer and early fall, when lake levels are the lowest, the prevailing winds blow the sand back from shore and form the dunes. Plants are key to the dune structure, as their roots stabilize the shifting sand. Water, weather, plants, and animal activity are constantly changing these sand dunes.

Location:
151 Coon Point Road
Alburgh, VT 05440
802 796.4170
http://www.vtstateparks.com/htm/alburg.htm

Hours:
10:00 AM - Official Sunset
Memorial Day weekend - Labor Day weekend

Admission:

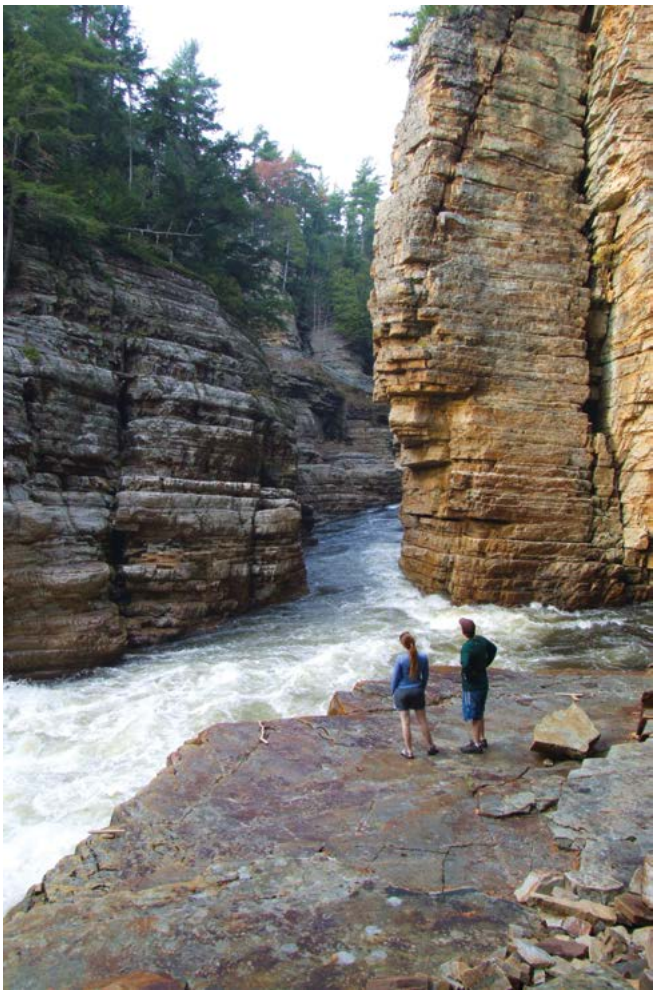
Wind and Water

Ausable Chasm

The warm and shallow Iapetus Ocean covered this region approximately 500 million years ago. Sand that eroded off ancient mountains onto the coastal plains of this ocean became compacted into sedimentary rock, the Potsdam Sandstone of which Ausable Chasm is made. Ripple marks are preserved in this sandstone, as are fossilized tracks of arthropods that inhabited the tidal flats of the Iapetus.

Approximately 20,000 years ago, during the Great Ice Age, Lake Champlain and the surrounding area was buried under a mile-high glacier. As the Earth began to warm some 12,500 years ago the glaciers retreated, leaving behind vast deposits of sediment. Also left behind was the enormous Lake Vermont, formed from melted glacial waters. As this lake drained, the Ausable River eroded downward through the glacial sediment. This is how the more gradual upper layers of the Chasm were formed. The River did not reoccupy its preglacial valley, but rather carved a new bedrock canyon through the Potsdam Sandstone, the Ausable Chasm that is visible today.

The Ausable River chose the path of least resistance when creating the 2-mile long, 150-foot deep gorge on its way to Lake Champlain. It followed vertical cracks in the rock called joints, the result of the bending and twisting caused by various mountain-building events. The joints intersect at an angle of 90 degrees, which explains why the river takes such a sharp turn to the east near the end of the Chasm.



Location:
2144 US 9
Ausable Chasm, NY 12911
518 834.7454
http://ausablechasm.com/

Hours:
Open year round 9:00-4:00
CLOSED: Thanksgiving, Christmas Eve/Christmas, New Year's Day

Admission:
Required.