A BRIEF FOSSIL HISTORY OF VERMONT

Due to extensive metamorphism, erosion and glaciation, the fossil record in Vermont is limited and generally confined to the western third of the state. Although widely separated in geologic time, the fossil deposits found in Vermont tell vivid stories of three distinct periods in Vermont's geologic past.

VERMONT BACKGROUND GEOLOGY

Much of the bedrock in Vermont was originally deposited 500 million years ago as **ocean bottom sediments** in an ocean that no longer exists. We call this ancient ocean the **Iapetus** ("father of the Atlantic") **Ocean** and know it primarily by the fossils and sediments that it left behind. **Plate tectonic forces** slowly closed the Iapetus over many millions of years until it disappeared completely about 350 million years ago, leaving a high mountainous **suture zone** at the juncture of North America with northern Europe and Africa. The eroded roots of this suture zone exist today as the Appalachian Mountain chain of eastern North America.

Vermont is located directly in the middle of a northern portion of the Appalachians that runs up through Quebec and Newfoundland, and as a result of the intense heat and pressure caused by **subduction and compression**, most of the rocks here have been **metamorphosed** to some extent. This has had the unfortunate result (from a paleontological point of view) of recrystallizing most of the original materials and rendering the fossils unrecognizable.

For most of the 350 million years since this ocean closing event took place, Vermont has stood as a high mountainous alpine region, undergoing constant erosion. Mountainous regions seldom contain environments favorable for the preservation of fossils (why do we find so many fish fossils, but so few mountain goats and eagles?). For that reason we have **no record whatsoever of Mesozoic fossils in Vermont**. This is not to say that creatures such as dinosaurs didn't live and die in what is now Vermont for all those years, it only means that the fossils were not preserved or were subsequently removed by erosion. With the passing of the final glacial stage about 12,000 years ago, Vermont was reduced essentially to low rounded mountains, hills and valleys and through these fertile areas a number of **ice age mammals** such as wooly mammoths, caribou, and beaver followed the retreat of the glaciers. We have a modest fossil record of some of those animals.

From the above scenario, you can begin to see how the fossil record in Vermont consists primarily of ocean bottom sediments (from the Iapetus Ocean) protected from severe metamorphism along the Champlain Valley on the far western side of Vermont, and ice age plants and animals preserved in surface bogs and clay layers throughout the state. Let's briefly outline these fossils and see how they can be used to date the rocks and interpret our geologic history:

THE PALEOZOIC IAPETUS OCEAN

The animals that inhabited the **warm, shallow waters** of the **Iapetus Ocean** lived at a time when no plants or animals yet lived on land. **Trilobites** (such as *Olenellus* and *Isotellus*), **cephalopods and gastropods** (*Maclurites*), **bryozoans** (*Prasopora*) and **graptolites** are frequently found in the black shales and limestones along the islands of Lake Champlain that represent the ancient ocean muds. The island of **Isle la Motte** in Lake Champlain is known worldwide for its beautifully preserved fossilized reef structures. These reefs contain cephalopods, bryozoans and some of the earliest known corals and have been recognized as important scientifically because they represent an intermediate stage in the evolution of reefs. The black "marbles" of Isle la Motte have been quarried for over a hundred years and are prized for the intricate patterns that the fossils make when polished. Mineralized fluids have filled some of these fossils with beautiful crystals of calcite and quartz.

In areas that were at that time beaches, near-shore estuaries or river deltas, **trace fossils of worm borrows and mysterious animal tracks and ripple marks** are often found in the sandstones and clays. Some areas of limestone were subjected to metamorphism and have been transformed into beautiful marbles, some still retaining faint ghost-images of fossils. Because a succession of index fossils exists that allows us to identify the various ages and stages of this old ocean, we are also able to correlate one area to another in portions of the state which have been heavily folded or fractured. This is extremely useful because as any Vermont geologist knows: the rock is heavily folded and fractured just about everywhere in Vermont!

A TINY WINDOW ON VERMONT ABOUT 25 MILLION YEARS AGO

A small and unusual deposit of lignite (crude coal) is found embedded in kaolinite near Forestdale,Vermont. Known as the "**Brandon lignite**", this isolated deposit contains the **seeds, twigs and leaves of subtropical trees and plants** and provides a rare glimpse at a time when the climate of Vermont was much different than it is now. The Brandon lignite is the only known "window" on the fossil record in Vermont during that hugh span from 350 million to 12,000 years ago that is otherwise unaccounted for, and is the finest deposit of Oligocene plant megafossils found in the northeastern United States. The fossil collection of the Perkins Museum at the University of Vermont has a large collection of Brandon lignite fossils.

THE POST-GLACIAL FOSSILS OF VERMONT

Like many regions of the northern United States, Vermont was heavily glaciated during the ice age and at one point sat beneath almost a mile of ice. The effect of the weight of all of this ice was to compress the land and depress it below sea level. When the ice melted and retreated, waters from the North Atlantic flooded the St. Lawrence and Champlain Valleys and created an inland sea known as the "**Champlain Sea**" which

persisted for 2500 years. Into this sea came a variety of sea animals including **salmon, seals and the ancestors of beluga whales**. (One of the most prized fossils in our museum is the complete skeleton of a beluga whale found in Vermont...more on that story in just a bit) **Caribou, weasels, rabbits, elk and mammoth** moved through the opening lands, followed closely behind by the **first Native Americans**. Occasionally some of these animals became mired down and trapped in the many bogs and half-frozen swamps that covered the land. Their fossils are still unearthed by farmers, hikers and road crews.

THE CHARLOTTE WHALE

In 1849, while digging the first railroad in Vermont, workmen unearthed the strange bones of an animal which they had never before seen. Thinking it to be a strange horse, they continued to dig and damaged much of the skull before a scientist from the University could be contacted and brought to the scene. The scientist, Zadock Thompson, immediately knew that the workmen had found something unusual and proceeded to carefully collect all the bone fragments and take them back to his lab. Upon reconstructing the skeleton and showing it to other paleontologists in New York and Paris, Thompson realized that it was the fossil of a small white or **"beluga" whale** (*Delphinapterus leucas*).

The question immediately became: "how do you get the skeleton of a whale buried in 10 feet of sand and clay in Vermont, hundreds of miles from the nearest Ocean?" This very interesting early use of **index fossils** allowed the early geologists to realize that areas of Vermont were once covered with marine waters and began their search for a reason for those waters. The whale was found along with fossils of **specific types of small bivalve clams** (Mya, Macoma) found only in marine waters, and as geologist began to find these same clams in other regions of the state they could begin to trace the outline of the Champlain Sea.

MODERN RESEARCH

Much of the paleontological research that takes place in Vermont today utilizes ***micro*fossils** from the muds and clays of the Champlain Basin. Researchers first obtain core samples of the sediments they plan to study. They then dry and sift these sediments to remove the unwanted portions. Powerful microscopes are then utilized to sort and identify the tiny shells of one-celled protozoans known as **foraminiferans** ("forams"). Since these tiny animals were wide-spread and numerous, evolved quickly in time and are easily identified, they serve as valuable indicators of the delicate changes that took place in the climate during the 2500 year life of the Champlain Sea. These forams are valuable tools in allowing us to "fine-tune" our knowledge of the recent history of our area.

Jeff Howe
Perkins Museum of Geology
March, 1993