Clay Deposits and Early Brick-making in Addison County, VT

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Overview

Many of the brick buildings in Addison County serve as historical landmarks or museums; some have been restored and converted to offices, banks, and other community buildings; and some have been left to face the tests of time and weathering. Regardless of their current state, most of the brick structures in Addison County would not be in existence were it not for the geological history of the region.

Figure 1. *In the towns of Addison, Middlebury, New Haven, and Weybridge, brick architecture is very prevalent. This is a picture of the John Strong House in Addison. It was one of the first brick buildings constructed in Addison County during the 1790's. Bricks for the house were made on site.*

Geological History of the Region

The main, abundant type of clay found in this region is *kaolinite clay*. Kaolinite, $Al_2Si_2O_5(OH)_4$, "exhibits both crystal faces and colloidal coatings", which results in the clay's *plasticity*. Also, the silica and alumina sheets of kaolinite are bonded tightly together by hydrogen bonds, which gives the clay a low shrink-swell capacity. Minerals with a *high shrink-swell capacity* allow water molecules to enter in between sheet layers, causing the clay to expand when wet and contract when dry; minerals with a *low shrink-swell capacity* prevent water from entering, so the clay does not change size under different conditions.

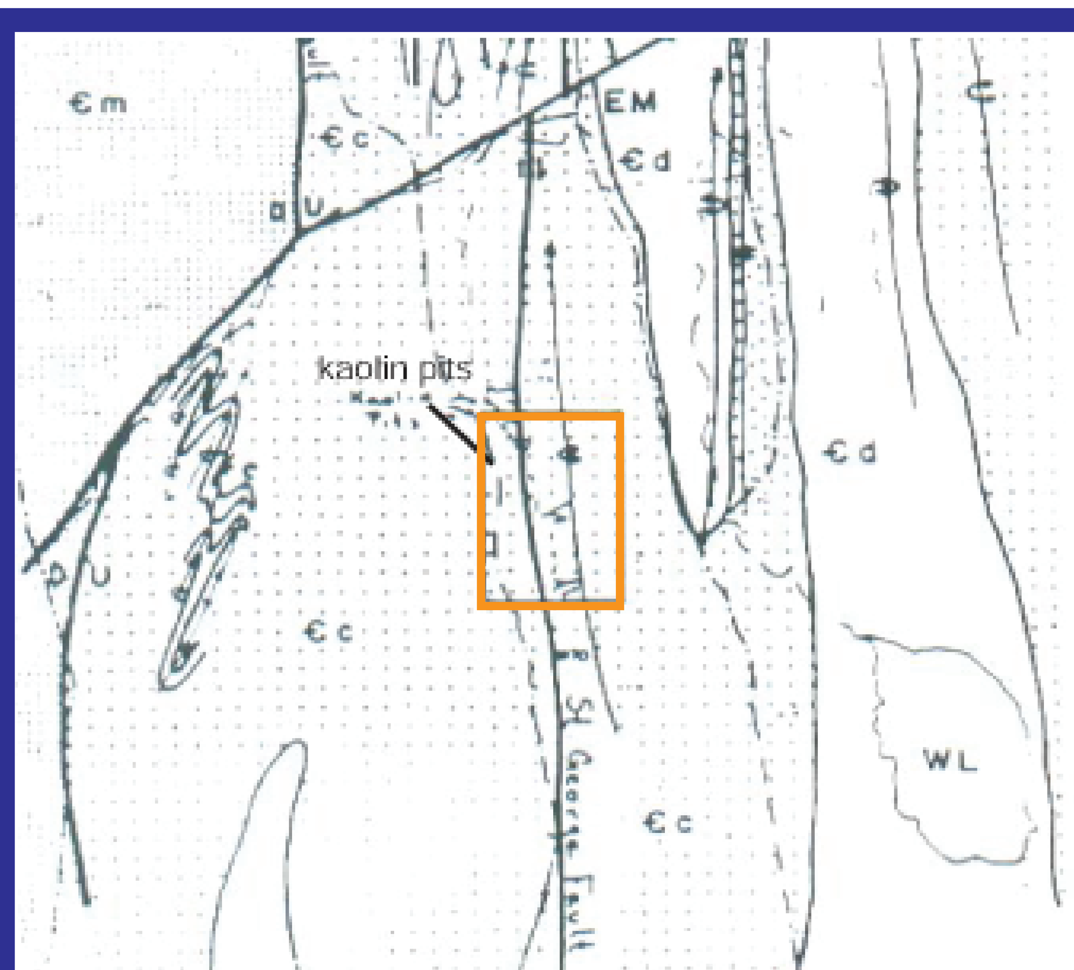

Figure 2. *An example of an exposed kaolin pit in East Monkton, VT and its association with the St. George Fault and other cross-faults. Cheshire Quartzite (Cc) borders the kaolin on boths sides.*

The present kaolin deposits are arranged along a zone of faulting and fracturing at the western border of the Green Mountains. Here there are kaolin and Cheshire Quartzite strata beneath a deposit of glacial till. The rocks that preceded the formation of these strata existed on the bed of the Atlantic Ocean before they were thrust up to where they exist today. During this thrusting processes is when the development of the kaolin occurred. The most widely accepted theory is that feldspar from the ocean floor underwent the process of *kaolinization* through *hydrothermal interaction*. These simultaneous thrusting and hydrothermal events occurred during the Triassic Period.

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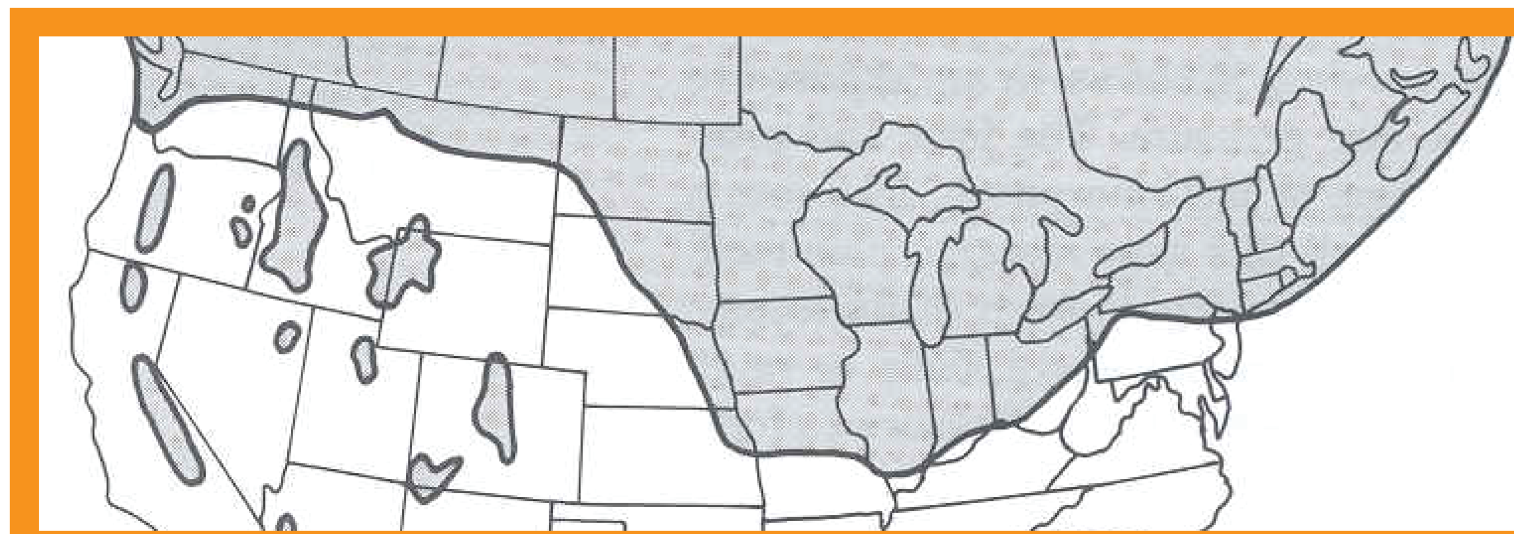

Figure 3. *The extent of the glacial ice cap during the last ice age. Note that the ice cap extends well beyond the area of study in the Champlain Valley.*

Now, the thrust is an eroded and highly fractured anticline. This erosion occurred during the Quaternary Period. When the glaciers extended, they eroded the top portion of the kaolin thrust, and deposited kaolinite clay during the retreat phase. As the glaciers retreated, they created Lake Vermont, and subsequently the Champlain Sea. In addition to water from the Atlantic, the Champlain Sea was being fed by melting glaciers, which deposited eroded material accumulated during their extension. Kaolinite clay particles were one of these deposits. Because of their fine grain size, glacial streams easily transported clay particles, which did not settle out until reaching the Champlain Sea. The sea was eventually cut off from the Atlantic Ocean because of *isostatic rebound*, and eventually shrunk to form Lake Champlain. Currently, clay from the bottom of Lake Vermont and the Champlain Sea is exposed above water level, and forms much of the base of the Champlain Valley.

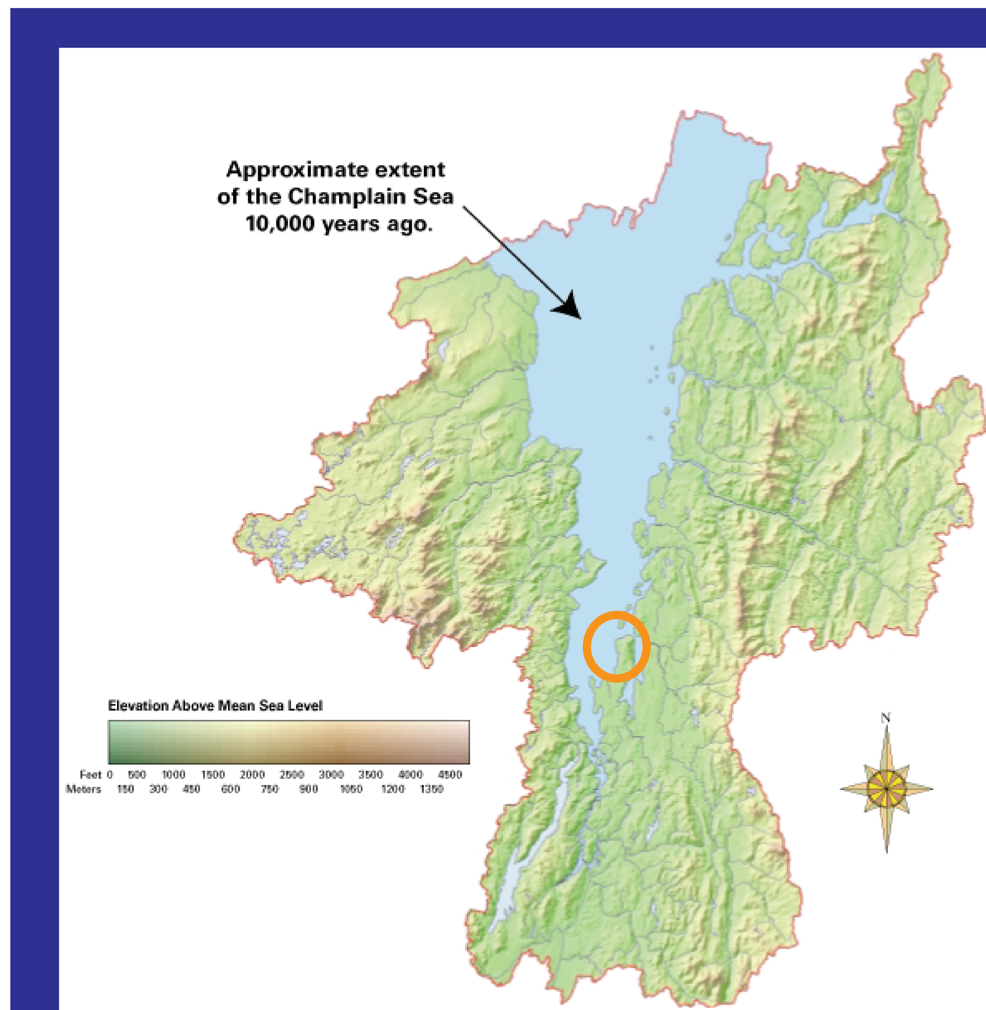

Figure 4. *The approximate extent of the Champlain Sea 10,000 years ago. The present day location of Addison County is marked by the orange oval, which, during this period, existed beneath the waters of the sea.*

The Local Clay Deposit and Its Properties

The clay in Addison County can be classified as *estuarian-transported clay*, for it was transported by glacial streams into the past arm of the Atlantic Ocean, and bares no relation to underlying rocks. Two subtypes of clay can be found in alternating layers of the soil. The first is *blue clay*, which existed at a deep portion of the Champlain Sea. The second is *brown clay*, which existed beneath a shallow portion of the sea. This layered clay, varve clay, is the result of annual variation in past stream flow.

The kaolinite clay of the region is very plastic, so it retains its shape after pressure is released. Because of its plasticity, the clay can be molded into any shape and retain it when dry. That clay shape can then be heated to create a hard, rock-like material, or a brick. The *blue clay* is very good for brick making due to its very fine texture, although some contains a considerable percentage of carbonate lime. *Brown clay* is not constant in character, also containing silt, sand, and gravel.

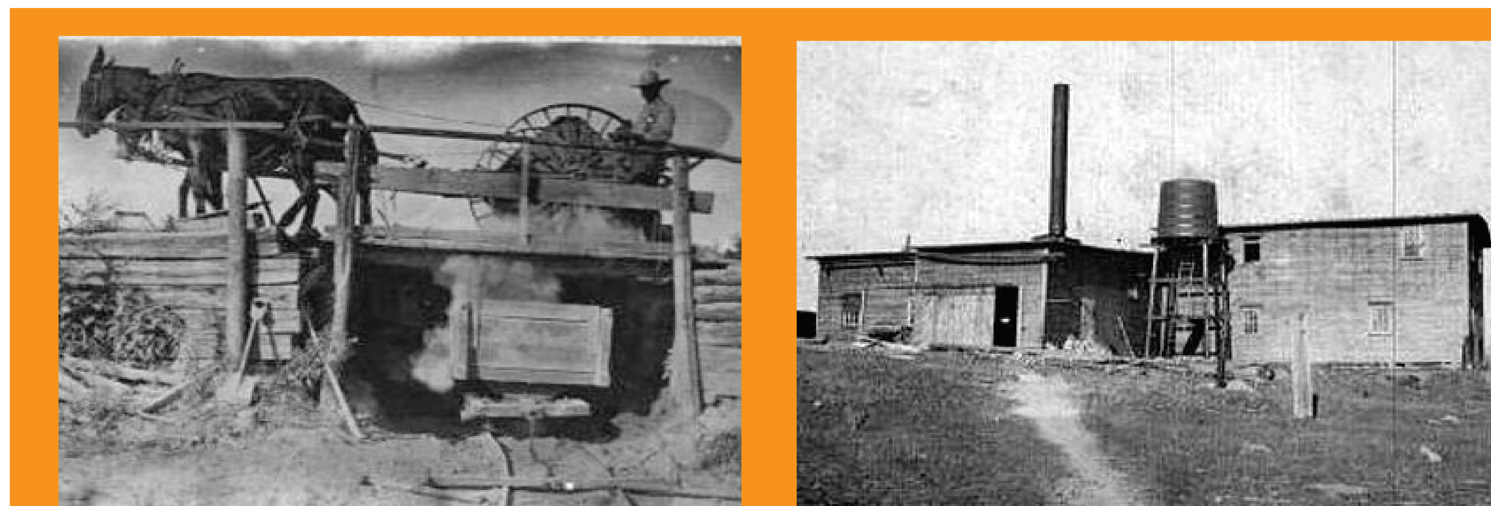

Figure 5. *An early clay mine (left), and an early "pug mill" (right).*

Brick-making in the 1800's

Bricks were first fired in Addison County around 1800. The main use of bricks prior to the period was for chimneys, but as a change to the Federal Style of architecture took place, along with a developed fear for major urban fires, brick buildings became more prevalent.

Many early brick buildings crumbled at a young age due to the rapid weathering that took place on bricks with a high percentage of carbonate lime. Early *brick failure* could also have been attributed to the use of impure clay. Clay that did not contain mainly kaolinite, but instead smectite, vermiculite, or a lot of sand and gravel, would have undergone shrinking and swelling in dry and wet conditions.

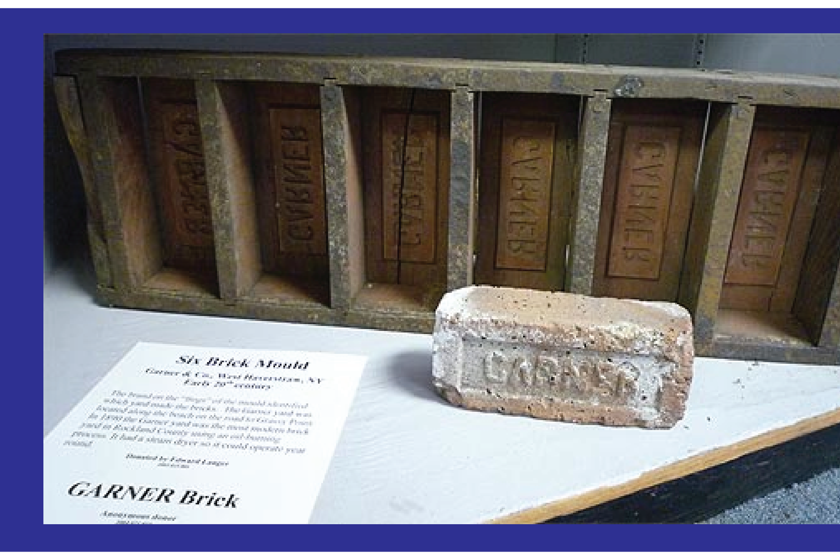

Figure 6. *An example of an early wooden 6 brick mold. Laws were created early on to regulate the size of bricks to 9 inches in length, 4 ¼ inches in depth, and 2 ½ inches in height. Such regulation made it easier for bricklayers to complete projects accurately.*

1.) The first step of the brick-making process was to mine a pure kaolinite, blue clay deposit, with a low content of carbonate lime. *Digging* occurred in the fall to allow clay to freeze and thaw during the winter. This clay tempering process, which took place in a horse-driven "pug mill", was a crucial and labor-intensive part of the brick making process. *Tempering* through weathering, wetting, kneading, and sand addition made the clay more plastic and workable.

2.) Lumps of tempered clay were pressed into a wooden or metal *mold* consisting of many rectangular slots. Molds were lubricated with water and sand early on, but later brick-makers used animal oil to achieve a sharp-edged product. Once shaped and removed from their molds, the bricks were labeled *green*.

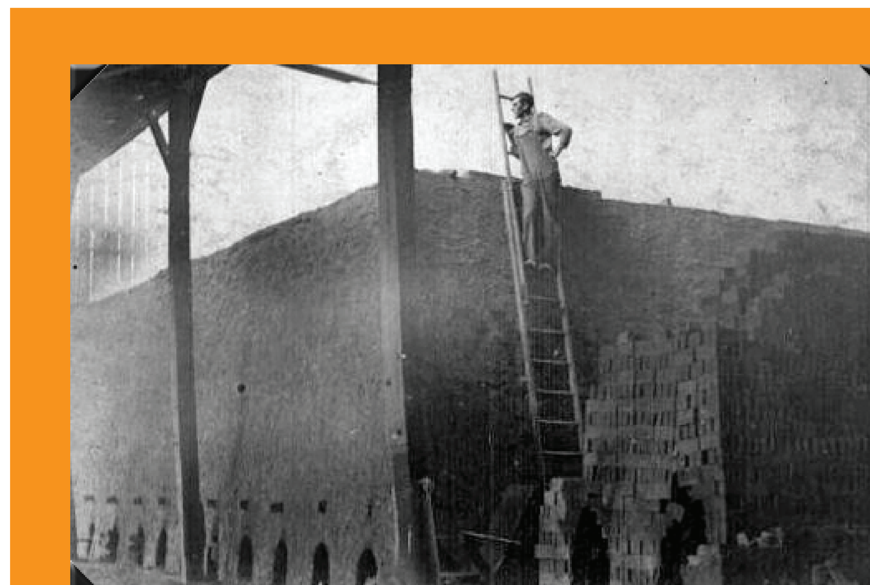

Figure 7. *An early example of a scove kiln. It sometimes took brick-makers several weeks to constrct such massive kilns. But with such volume they could fire all the bricks for one building at once. A brick-makers skill was ultimately determined by how evenly he could burn bricks in a kiln.*

3.) Green bricks were stacked in a clamp, or *scove kiln*, which could hold 15,000 to 30,000 bricks. To suffuse heat throughout the entire mass, a layer of previously hardened bricks was placed around the green bricks. To start, a gentle wood fire was set in the kiln to prevent a steam explosion. After, the temperature was raised to 1500 to 2000°F until the bricks hardened. Then the fire was stopped, and the bricks were allowed to cool for several days. Bricks close to the fire in the kiln were *overburned* and smaller; bricks on the top layers were *underburned* and larger; and bricks in the middle of the clamp would be perfectly burnt, shaped, and useable. Once the bricks were fired, they were exposed the elements to truly determine weather resistance. The final brick color depended on the amount iron in the clay, or the amount of oxygen allowed into the kiln during firing.

Figure 8. *The Community House in Middlebury is a perfect example of brick failure. The house has been painted since it was first built to prevent the brick exterior from crumbling off the frame.*