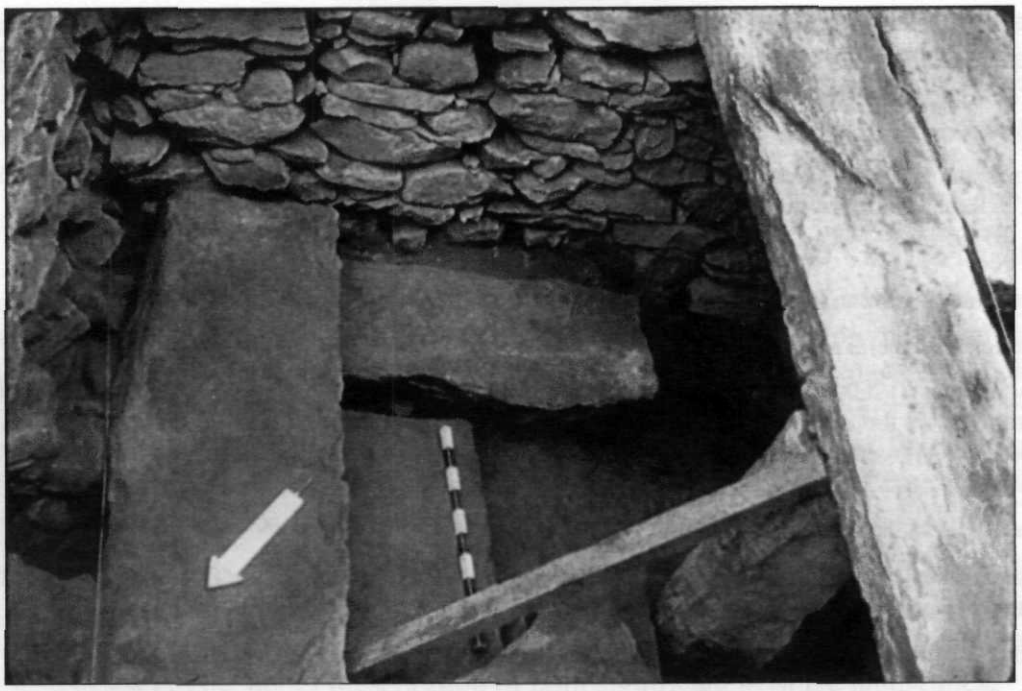

Figure 1. This circa 1823 root cellar was covered with a roof constructed of 14.5 foot long quarried stone slabs (now partially collapsed). Phoenixville, Eastford, CT (Photo used with permission of Old Sturbridge Village (P.83 VIIA Slide #27 Sept. '83).

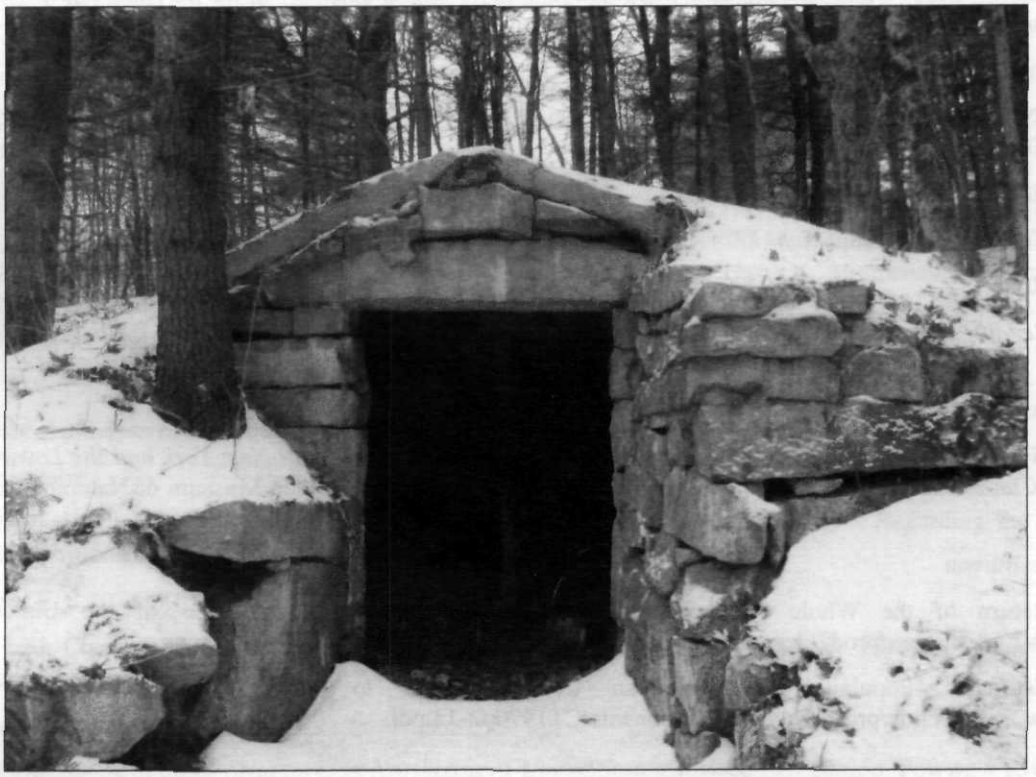

Figure 2. The wide walk-in height doorway of a 19th century hillside root cellar in Westford, MA (Photo courtesy of David Brody).

Stone Chambers: Root Cellars, Ice Houses, or Native American Ceremonial Structures?

Mary Gage and James Gage

Abstract

This article addresses the question of the cultural affiliation and purpose of the nearly 700 stone chambers found in northeastern United States by evaluating their architecture and construction methods.

Introduction

The Northeastern United States has at least 697 stone chambers (Dr. Curtiss Hoffman, personal communication, 2015). Stone chambers are free standing, dry masonry stone structures with stone slab or corbelled roofs. Their walls can be vertical, vertical with the upper section corbelled, or fully corbelled. They come in a wide range of designs, shapes, and sizes. They may have additional architectural features like niches, shafts, boulders integrated into the construction, and passageways. Occasionally, stone chambers are found integrated into house and barn foundations. A few examples have mortar, which may be part of the original construction or added at a later date.

The age, cultural affiliation and purpose of these chambers is the subject of much debate. Two major hypotheses have been put forth: (1) The stone chambers are historic root cellars and/or ice houses; (2) They are prehistoric Native American ceremonial structures. These hypotheses reflect the two major cultures that inhabited the Northeastern United States: Euro-Americans and Native Americans. Proponents of each hypothesis have traditionally considered their interpretation as the sole or exclusive explanation and have rejected the opposing argument. Are these two hypotheses mutually exclusive, or could both of them in fact be correct? In other words, could some be historic agricultural structures and could some be pre-contact Native American ceremonial structures? How do we test these hypotheses? And, if both hypotheses are in part correct, how do we distinguish between the two?

A review of the available archaeological evidence supports the idea that both hypotheses are in part correct. A stone "chamber" in Deerfield, New Hampshire was built using quarried stone slabs with 19th century tool marks (J. Gage 2015). Several stone chambers in Vermont were found integrated into house and barn foundations, indicating an historic date for them (Neudorfer 1980: 14, 29, 99). Optically stimulated luminescence (OSL) dating and radiocarbon (C-14) dates of several chambers have produced pre-European contact dates (Mahan *et al.* 2015; Whittall 1991: 63-65). These dates support the idea that some of these structures are part of what the United Southern and Eastern Tribes (USET) have designated Ceremonial Stone Landscapes (CSL), built by their ancestors for spiritual purposes. This paper explores the idea of using architectural design, basic building principles and construction methods as a means of testing these hypotheses and as a potential means of distinguishing between the two cultures.

Historic American Stone Roofed Structures

One of the most prominent features of stone chambers is their use of stone roofs. In the Northeastern United States, structures have been documented with corbelled roofs, flat horizontal stone slab roofs, corbelled wall to slab roof, gabled slab roof, and stone arched roofs (aka barrel vaults). This section evaluates the evidence for the use of these different roofing techniques in American architecture.

The following five examples were chosen to convey the range of stone roofs being used by Euro-Americans and the diversity of structures in which they were used. This is a sampling and not a comprehensive list. It does not include chambers with corbelling. The subject of corbelling will follow under a separate heading.

(1) Slab Roof - Culverts

Public roads, farm roads, and railroad lines all had to cross over small streams and seasonal runoff channels. The water was directed under the road through a culvert. The most commonly used building material for culverts until the introduction of form-poured concrete in the late 1800s was stone. Stone was strong, durable, and low maintenance -- unlike wood, which required periodic replacement (Martin 1887: 185-188). The top of the culverts were covered with stone slabs laid flat in a horizontal position. Stone slabs were pried from layered surface bedrock or found naturally occurring. In the 19th century, new stone splitting techniques were introduced and some culverts utilized quarried stone slabs and stone bars (Gage & Gage 2005).

(2) Long Slab Roof - Sprague Root Cellar, Phoenixville, Eastford, Connecticut

The Old Sturbridge Village field school excavated a below ground level root cellar attached to the outside of a house cellar (Figure 1). The root cellar was originally accessed from the house cellar. It was 12 x 12 feet square and five feet high. The roof was made of four or five long quarried stone slabs that were 14.5 feet long. The slabs were split with the plug and feather method. All but one of the stone slabs broke and collapsed into the cellar. The roof was waterproofed using a "lime cement caulking." The house and root cellar were built circa 1823 for George Sprague, a blacksmith.

In the same year, the Phoenix Mill was built nearby. This two-story stone factory building was constructed of stones quarried from local glacial boulders. Sprague likely provided blacksmithing services during the mill's construction (i.e. sharpening quarry tools, amongst other things). The quarried stone roof for the root cellar may have been partial payment for his services (Worrell *et al.* 1980: 37-38, 44-45, 81; OSV Records; Simmons 1982, 1984; Lyon & Sachiw 1988).

(3) Gable Roof - Root Cellar, Westford, Massachusetts

This root cellar was built into a hillside. It was constructed of quarried stones from the Westford quarries located less than a quarter mile away. A short passage way formed by retaining walls on either side leads to a wide doorway (Figure 2). The interior is a rectangular room. A long stone bar was used as a ridge beam to support a series of stone slabs made into a gable roof (Figure 3). A stone post was used to provide additional structural support for the ridge beam stone. The angled sides of the gable would have helped to drain water off the roof away from the inside of the root cellar. This is the only known example of a stone slab gable roof. The stones were quarried with the flat wedge method, which dates it to after 1800 (Gage & Gage 2005: 41-42; Gage & Gage, 2013). (Description based upon photographs by David Brody.)

Figure 3. Interior view of the Westford root cellar. The rectangular interior room is covered with a gable roof made from quarried stones supported by a stone ridge beam. (Photo courtesy of David Brody).

(4) Quarried Bars Laid Flat - Burial Crypt, Deerfield, New Hampshire

This abandoned or unused burial crypt has a low square doorway (approx. 3x3 feet) in the center of the front wall. Above the doorway is a single long quarried stone bar that serves both as one of the roof stones for the structure and as a lintel for the doorway. Above the roof slab are two stone slabs set up on their edges side by side to form a façade for the structure. The two slabs appear to be a single slab split in half, possibly to make them easier to move and position. Although the façade stones serve to retain some of the earth in the mound on top of the structure, their purpose is aesthetic rather than utilitarian.

Entering through the doorway, there is a step down into the interior. On the left side there is a line of quarried stone posts that support the roof stones and partition the structure into two rooms. An opening in the partition wall near the back provides access to the second room. On the right, there are a series of four steps formed by quarried granite bars. On the top "step" are two short stone posts providing additional support for the roof slabs. The second room, based upon a single photograph, appears to be rectangular in shape and lacks the "step" feature of the first room. The roof is constructed of a series of side by side long stone bars which span from one side of the structure to the other.

All of the stone was quarried with the commercial version of the plug and feather method. The long length of the stone bars indicates the stone was either quarried from a surface ledge quarry or large glacial erratic(s). It was probably quarried locally. The construction of this structure required the knowledge and equipment to transport and hoist large multi-ton stone slabs. This knowledge and equipment was not widely known or available until after 1825 (J. Gage 2015; description based on photographs by Pamela Gaudreau).

(5) Stone Arch (Vaulted) Roof - Root Cellars

Stone and brick arch root cellars are found throughout the United States and are mentioned in the 19th century agricultural literature (Figure 4). In some geographical areas like the Flint Hills of Kansas and German farm regions in Pennsylvania, arch root cellars were popular (Parish 2012; Long 1972: 156-167). In New England, the authors have found six stone arch, one concrete arch and three brick arch root cellars, and more examples will likely be found. Stone and brick arch roof construction was also used in the construction of some 19th century cemetery burial crypts. There are a number of surviving stone arch bridges in New England.

It should be noted that farmers in New England preferred to partition off a space within their house and barn cellars for root crop storage (J. Gage 2012). This in part accounts for the low number of free-standing root cellars.

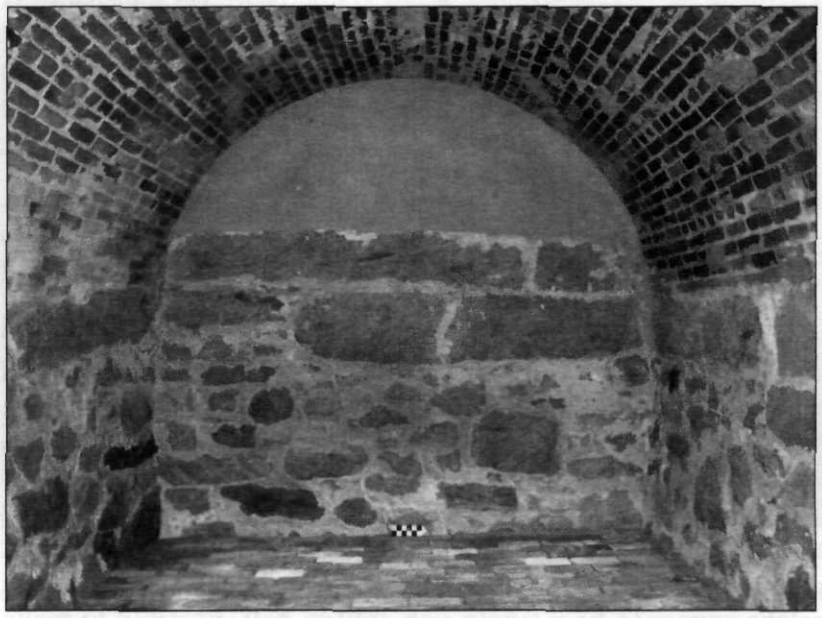

Figure 4. Circa 1843 brick arch root cellar, Shaw-Perkins Mansion, New London, CT.

Corbelling

Corbelling, a specialized construction method, was used in some chambers. The shape of the chamber determined the amount of corbelling. Rectangular rooms had corbelling integrated into a few layers at the top of the walls. Circular domed-topped rooms had fully corbelled roofs. These are rare. The method has long been associated with the Native American hypothesis. The question is, was it used in Euro-American architecture?

What is Corbelling?

Corbelling is a dry masonry technique in which flat stones are placed in a horizontal position with the stone projecting partially over the edge of the stone below it. Each subsequent layer of stone projects over the edge of the layer below it (Adcock 2010). Figure 5 illustrates the basic principal of corbelling.

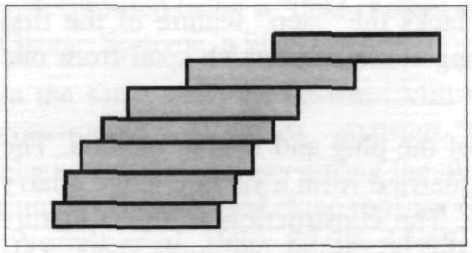

Figure 5. This illustration shows the basic principle of the corbelling technique where each layer of stone projects over the edge of the layer below it (Based upon an illustration by Sean Adcock).

Corbelling & Stone Chambers

In the Northeastern United States, the builders of stone chambers used corbelling in two ways: a *fully corbelled* chamber, sometimes referred to as "beehive" construction after the shape of colonial beehives, and *corbel to slab roof* construction. Fully corbelled chambers are dome-shaped. The corbelling begins at the floor level and curves inward to form the dome. At the top of the dome, the remaining opening at the top is covered with a capstone. The size of the capstone can vary (Figure 6).

Corbel to slab roof construction is found in chambers with rectangular or tunnel-like rooms. These chambers have two long, parallel side walls. The lower portion of each wall is vertical and the upper portion is corbelled. The amount of corbelling can range from two to three layers near the top to the upper one-third being corbelled. The corbelling of the two parallel walls narrows

the width between them. This narrow width is spanned by a series of flat stone slabs (Figure 7). The purpose of the corbelling is to reduce the length (and weight) of the stone slab needed to span the distance between the walls.

Figure 6. Fully corbelled chamber (dome roof), Rocky Brook Stone Chamber, Thompson, CT.

Figure 7. Corbel to stone slab roof construction, stone chamber, Webster, MA.

Did the Americans have knowledge of corbelling?

We conducted an extensive search for physical examples of American architecture that incorporate corbelling, and for references to the use of corbelling in the American literature. The search criteria for American stone structures/buildings with corbelling had a single requirement: the structure had to have good provenance that it was built during the historic period. Corbelling is found in a number of stone chambers in the Northeast. However, these structures lacked historical documentation or other evidence to establish a historical construction date. A few of these structures had pre-contact C-14 and OSL dates (Whittall 1991: 63-65; Mahan *et al.* 2015).

These findings justified our precaution of requiring historical provenance. The authors located only two stone buildings in New England with corbelling that had good provenance (see below). The literature search found examples of the use of corbelling in building cornices, various aspects of brick chimney construction, fireplace supports, and floor joists supports.

The evidence indicates that some American masons, bricklayers, and architects knew about the corbelling technique and used it. Farmers may have been familiar with it from examples they saw on chimneys and brick building facades. The evidence also indicates that the use of corbelling was limited and primarily occurred in specialized contexts, like chimney construction and brick cornices. The Park House and Spicer Hill root cellars demonstrate corbelling occurred in other architectural contexts. More examples will likely be found with historical provenance.

Architectural Record

(1) Park House (1791)

John Park, son of William and Anna Park, was born on March 15, 1731 in Scotland. His father William was a stone-cutter and gravestone carver. John likely learned these trades from his father. John also learned the stone masonry trade while in Scotland and became a master stone mason. He worked on the Duke of Argyle's castle in Scotland for seven years. In 1756 his father William immigrated to Groton, Massachusetts. John, his mother and two brothers followed in 1767. John was 36 years old at the time. He purchased 300 or 400 acres of land in Groton. He likely farmed this land in addition to practicing his gravestone and stone masonry trade. John Park is best known for constructing three stone gaols (jails) in Worcester, Massachusetts in 1788; in Concord, Massachusetts in 1789; and in Amherst, New Hampshire in 1793. Tragically, he died in a construction accident while working on the Amherst gaol (Park 1893).

John Park's stone house in Ayer (formerly part of Groton) is the only surviving example of his stone masonry work. It was completed in 1791. The house is a two-story gable roof house with exterior walls made of thin slabs of stone (schist) laid horizontally in mortar. The authors had the opportunity to document the cellar of the house. The first floor's four end wall fireplaces are each supported on separate chimney bases in the cellar (two on each end wall). The two chimney bases on each end wall form three recessed storage spaces (total of six recessed spaces in the cellar). Four of the six recessed spaces are covered by wood floor joists. Two have a stone slab roof (one on each end wall). The stone slab used for the recess on the south side cellar wall came up short by several inches. To properly support the roof slab, two courses of stonework were corbelled (Figure 8). Although this is a limited example, it demonstrates that John Park knew how to use the corbelling technique. This stone roofed recessed storage area was like what Amos Long Jr., a Pennsylvania folklife researcher, referred to as "cooling closets." These were storage places where root crops, dairy products and other food stuffs could be placed to be kept cool and extend their shelf life (Long 1972: 15, 111).

Figure 8. On the right side, two layers of corbelled stones were used to support the stone slab which was not quite long enough to span the whole distance. 1791 John Park House, Ayer, MA.

(2) Spicer Hill Root Cellar, Ledyard, Connecticut

This root cellar was built using a combination of thin stone slabs and rectangular blocks of stone laid in what appears to be a lime mortar (Figure 9). The mortar indicates this is an historic

structure. It is accessed through a rectangular walk-in height doorway with a single step down to a flagstone floor. The interior is divided into four rooms by two short thick dividing walls that serve as pillars to support a stone slab roof. Both dividing walls have three to four courses of corbelled stones at their ends. (Description based upon published & unpublished photographs by Ted Hendrickson.)

Figure 9. This root cellar is divided into four rooms by two thick stone masonry walls which double as columns to support the stone roof. Three layers of corbelling are evident at the top of the walls. Spicer Hill Root Cellar, Ledyard, CT.

Historical Literature Record

(1) Building Cornices

A cornice is a decorative projection on the exterior wall of a building. The cornice is usually at the top of the exterior wall, although it can sometimes occur on the lower section of the wall of a multi-story building. It was used on both flat roof buildings as well as under the eaves of gable roofs. Cornices are generally associated with brick and finished stone masonry buildings but occasionally occurred with wood buildings.

A popular means for creating the cornice was to use the technique of corbelling to project the bricks outward. The cornice could be a simple series of three to four rows of corbelled bricks or corbelled bricks arranged in an elaborate design (Colliery Engineering Co. 1889: 141-145). Examples of this use of corbelling can be found in many of New England's 19th century multi-story brick buildings.

(2) Chimneys

Corbelling was used in three aspects of brick chimney construction:

(a) Embellished Chimney Caps – The section of the chimney that extends above the roof is sometimes embellished with decorative brickwork. The decoration can range from a simple widened section near the top to elaborate patterns. These embellishments, which many times projected out from the chimney stack, sometimes employed the corbelling technique (Figure 10). Abbott Lowell Cummings, the noted architectural historian, found the tradition of decorative chimney stacks came from England. The earliest surviving examples of decorative stacks in Massachusetts date from the early 1700s (Cummings 1979: 123-4; Fidler 1892: 83).

(b) Widening and Angled Construction – Chimneys sometimes needed to be widened partway up to support additional flues and for other reasons. The widened section was supported by corbelled brickwork (Fidler 1892: 79-80). Some chimneys had to be shifted to one side a foot or more to avoid load-bearing beams and other structural features. To

shift the chimney, it was built at an angle using corbelled construction. Once the proper shift distance was reached, the chimney transitioned back to the vertical position.

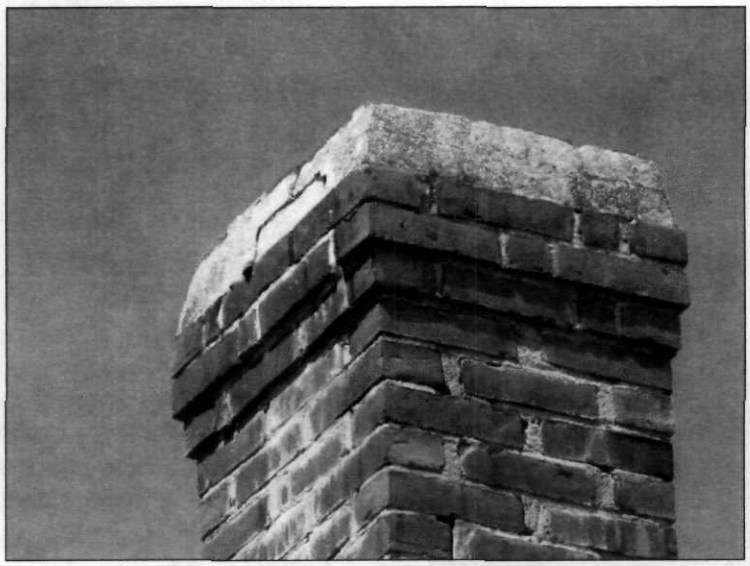

Figure 10. A typical widened section near the top of a house chimney created with corbelled brickwork.

(c) Ash Pit – Ash pits were used to collect ash from the fireplaces in a building. The ash was dumped through an ash chute into the pit. Several basic designs were used for ash pit construction. One design features a corbelled brick transition between the narrow ash chute and the much wider collection pit (Figure 11) (Ramsey & Sleeper 1951: 18; Betts 1938: 14).

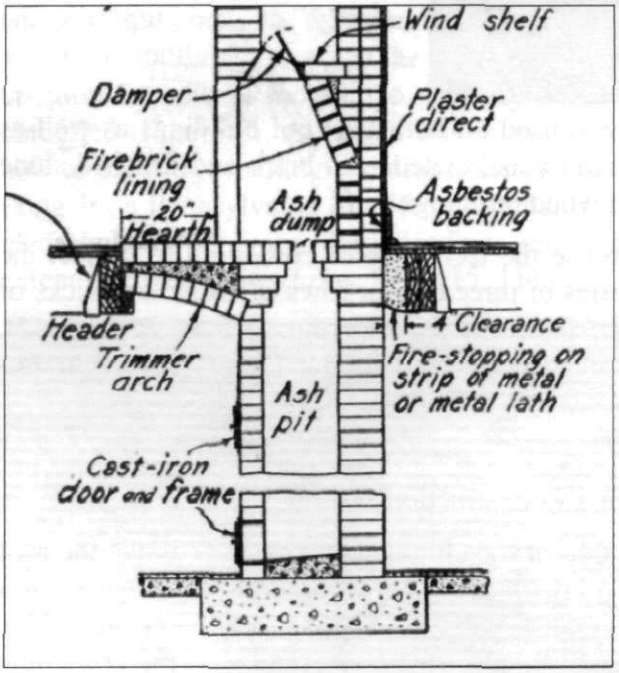

Figure 11. Excerpt from a 1938 fire-protection pamphlet showing the use of corbelling in the design of a brick fireplace ash pit chute.

(3) Corbelled Fireplace Supports

Some fireplaces in historic buildings were built outward from the main chimney stack rather than being integrated into it. The weight of the projecting fireplace sometimes required an additional separate structural support. A farm house (ca. 1712) in Birmingham Township, Pennsylvania and the Frye House (1812) in Lower Liberty, West Virginia are reported to have corbelled fireplace supports in their basements. An online search located a photograph of one these supports from the DeTurk House, Berks County, Pennsylvania. These supports were a separate structure from the main chimney block that supported the chimney stack (Chester County Preservation Office 2011: B-7; Morgan 1994: 121-122; Aeyrie 2012).

(4) Floor joist or horizontal floor support

In brick and stone buildings floor joists, beams, and lintels were sometimes supported by corbelled masonry ledges projecting from the wall (Nickey 1979: 117-118; Ramsey and Sleeper 1951: 217).

Basic Historic American Architectural Traits

The basic core concepts underlying American (and British-European) architectural design are deeply imbedded in American culture. Most people take them for granted and give them little thought. When investigating the cultural affiliation of an unknown structure, these basic core concepts can offer vital clues. The following discussion is *per se* self-evident but it is important to draw attention to these details. They will play a significant role in the subsequent analysis later in this article.

The authors, in their over 20 years of field experience, have had the opportunity to explore numerous house and barn foundations, root cellars, and other examples of brick and stone masonry work used in historic structures in New England. Stone masonry follows the same basic principles as wood frame architecture. Euro-American domestic and industrial architecture is overwhelmingly based upon square, rectangular, box-like geometry. Houses, barns, factories are box-like constructions. Rooms are generally laid out with square or rectangular floor plans. Windows and doors are in rectangular frames. This rigid adherence to box-like construction is universal with the exception of Victorian architecture (i.e., round and octagonal towers) for a short period in the late 19th century. Stone and brick masonry uses the same box-like principles. Box-like construction exhibits straight, linear, flat surfaced walls with square corners.

Another part of our research looked at the type of stone used to construct foundations. In 1757 Joshua Hempstead traded pieces of blasted stone to J. Trueman for blasting it out. It was used for building his cellar (Hempstead 1901: May 24, 1757 entry). Field documentation of blasted stone pieces shows they have flat faces and straight sides which make them suitable for building stones. In Essex County, Massachusetts Charles Mann stated farm fields yielded two types of stones: "round cobbles.....have no face, bed,.....and are worthless,....." and "the square-faced, solid, good, shaped stones, ..." (Mann 1887: 133-4). The latter were building stones. In the 1790s and 1800s stone dealer advertisements list cellar stone, well stone, hammered stone, ballast stone, etc. For example, the *Massachusetts Centinel* (May 1, 1790) ran the following advertisement:

> *"The subscriber begs leave to inform the Publick and his Customers in particular, That he has for sale, all kinds of STONE, SLATE, CLAY and GRAVEL, at the lowest rate; cellar and well Stones, from 3s.6d. [$0.94] to 9 shillings [$2.25] per Perch.*
>
> *Paving Stones, from 9d to 1s.6 per yard.*
>
> *Slate from 6s. to 9s. per load*
>
> *Sand from 2s.6 to 4s per ditto*
>
> *Clay from 2s. to 4s per ditto*
>
> *Gravel from 1s.6 to 4s. per ditto*
>
> *Ballast from 1s. to 1s.6 per ton*
>
> *Dreath Slate from 2d. to 3d. per foot*
>
> *Hammered Stone from 1s. to 1s.6 per foot*

All which will be delivered upon the spot, at the shortest notice, by calling at his House in Elliot-Street; and the smallest favour gratefully acknowledged, by SAMUEL ADAMS, Truckman.

Also, to be sold, by said Adams,

'Four good draught HORSES, and two pair of one-horse TRUCKS. April 28, 1790."

The advertisement shows there were different uses for different types of stone. This fits with the other historical literature. Field documentation of house and barn foundations, and stone-lined wells showed there are differences in the type of stone used in each type of structure (M. Gage 2015). House and barn foundations primarily used flat-faced stones. The flat face was set in the wall so that it was exposed on the open interior side of the foundation. In addition, the flat-faced stones allowed the builders to create flat surfaces that were incorporated in straight linear walls. The flat-faced stone construction has widespread usage, indicating it was more than superficial or just for looks as in a finished look. It likely had a structural component that made the walls stronger and more stable. The research produced basic traits that can be used to identify Euro-American root cellars: straight, linear walls with square corners, flat stones and flat surfaces. Some have straight vertical walls top to bottom, and some have vertical walls with several corbelled top layers.

Key Traits of Historic Euro-American Architecture

Shape – Rectangular, square, and L shapes that create box-like interior rooms.

Vertical walls – From top to bottom, masonry walls are either vertical or vertical with a corbelled upper section (i.e., bottom is vertical with several top layers corbelled). They do not lean inward or outward (except due to structural failure), bulge out, or have other odd non-vertical configurations.

Straight Linear walls – From one end of the room to the other end, the wall follows a straight line. It does not undulate, bulge out, or follow an irregular line.

Square corners – Where two walls meet, the corner forms a right angle (90 degrees).

Flat-faced – Masonry wall surfaces are flat or semi-flat. The quality of the flat face of the wall varies with the type of stone used, skill of the builder, and effects of freeze-thaw cycle on the wall. Overall, the wall exhibits an intentional attempt to create a neat flat-faced surface.

Historic buildings, root cellars, and house and barn cellars in New England from the 1600s through the late 1800s have these basic characteristics. Exceptions occasionally occur but make up less than 1% of historic structures. For example, ice houses were sometimes built with circular stone-lined shafts or deep, sunken, rectangular shafts with rounded corners.

Historic Examples

The following five examples demonstrate these basic traits, and also how they can be used to test structures whose purpose and cultural affiliation are in question. The house foundation, barn foundation, and arched roofed root cellar are easily identified as historic structures. Ledyard stone chamber #1 and Montville stone chamber #4 both lack provenance to identify them as historic, and their purpose is open to debate. A careful review of their basic traits, however, suggests they are historic root cellars rather than Native American structures. These basic traits are found in the three confirmed historic examples.

House Foundation

Georgetown – Rowley State Forest Site #4, Georgetown, Massachusetts.

The house foundation has an L-shaped layout. It was built with flat faced stones integrated to create a flat wall surface. It has square corners and straight walls (Figures 12 & 13).

Figure 12. House foundation with flat faced walls, square corners, and box-like shape. Georgetown, MA.

Figure 13. Another wall of the same house foundation showing the common type of flat faced stones used.

Figure 14. Barn foundation has the same characteristics as the house foundation in figs. 12 & 13. The only difference is the flat faced stones are larger. Georgetown, MA.

Figure 15. Some of the stones used in the barn foundation were blasted field stone. This foundation stone has a single long blast hole.

Barn Foundation

Georgetown – Rowley State Forest Site #3, Georgetown, Massachusetts.

The barn foundation has a rectangular shape built with extra large stones with the same flat faces, flat wall surface, square corners and straight walls as the house foundation above (Figure 14). In addition, the barn contained blasted stone, as evidenced by the blast hole (Figure 15).

Root Cellar with Vertical Walls

Ledyard Stone Chamber #1, Ledyard, Connecticut.

This structure has a rectangular or square-shaped room (Figure 16). The interior exhibits vertical walls bottom to top. There is no corbelling. It has flat-faced stones with a flat wall surface, square corners and straight walls. A stone column is visible in the middle photograph, which is a trait found in some American barns. Ted Hendrickson, a professional photographer, arranged a triple set of photographs to highlight the left and right sides framing, the middle and entrance. It gives an overall view of the interior.

Figure 16. This root cellar has a rectangular room, straight vertical flat faced walls, and square corners. The stone support column is unusual but has been used in some American barns. Ledyard, CT (Photo courtesy of Ted Hendrickson).

Root Cellar with Vertical/Corbelled Walls

Montville Stone Chamber #4, Montville, Connecticut.

This root cellar has long parallel vertical walls that transition to corbelled near the top (Figure 17). The left and middle photographs show the corbelling. The interior shape is tunnel-like, while maintaining a basic rectangular shape. Note the root cellar was constructed with semi-flat stones but still has a flat wall surface and straight walls. The Montville #4 stone structure, like the Park House, indicates farmers also used the corbelling method. Farmers found it useful for narrowing the top width of the cellar to accommodate the length of the stone slabs they had.

Figure 17. This root cellar has a rectangular tunnel like room with long parallel vertical walls that transition to corbelled near the top. Montville, CT (Photo courtesy of Ted Hendrickson).

Root Cellar with Arched Roof

East Thompson Road Farm Site, Thompson, Connecticut.

Thin stone slabs with narrow, rectangular, flat ends were used to construct the flat surfaced walls and arch (Figure 18). Arches require a wooden framework to create the stone arch. Knowledge

of building arches came over from Europe. They are European in origin and an historic marker. This particular root cellar has a façade of large rectangular granite blocks with flat wedge marks, indicating it was built post-1800 (Gage & Gage 2005: 41-42; Gage & Gage, 2013) (Figure 19). Facades showed up in several other root cellars in Connecticut.

Figure 18. Interior view of the root cellar's stone arch roof made from flat stones. Thompson, CT.

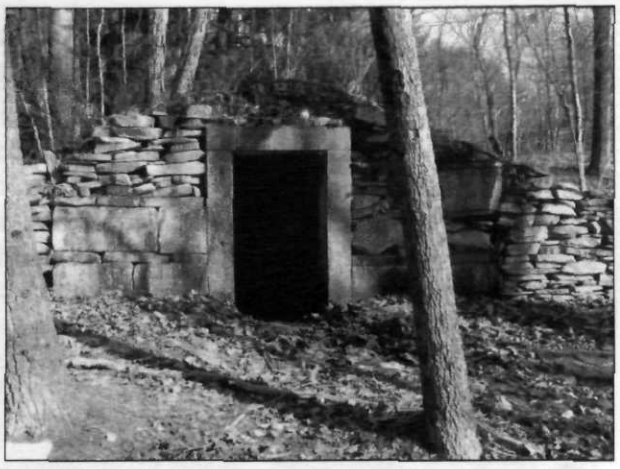

Figure 19. Exterior façade of the root cellar.

Ice Houses

Unlike American root cellars, which are well documented in published works (J. Gage 2012), very little work has been done on American ice houses, especially those that had masonry walls. Chamber #2 at the Gungywamp Site in Groton, Connecticut and the Upton Chamber in Upton, Massachusetts (and likely other chambers as well) have been interpreted at some point as ice houses (Gungywamp Society, n.d.; Dudek 2012: 37-38). A brief discussion of the subject is warranted.

Ice houses were built using a wide range of different designs. These designs can be divided into three broad basic categories: above ground, below ground, and partially above and partially below ground. Stone, brick, wood, or a combination of these materials was utilized in their construction. A brief review of American and Canadian ice houses on historic properties and in several 19th century American sources demonstrated that all had examples with wooden roofs and wooden doors. One source recommended a thatched roof (Divine 1997; Allen 1883: 689-693; Hiles 1893: 44, 69-78; Woolverton 1898: 104-105). Tim Buxham (2014) in his book on British ice houses illustrates a number of examples with brick and stone vaulted (i.e., dome) roofs. To what extent stone or brick was used to roof American ice houses is not currently known.

Ice houses required three key features to be successful: (1) insulation, (2) vent, (3) drain. Below ground ice houses made use of the cooler temperature of the earth. The majority of ice houses, whether below ground or not, packed the ice in a thick layer of sawdust. Vents were usually located in the roof to help to vent condensation, which could accelerate the rate of melting. Drains were placed in the bottom of the ice house to channel melt water away from the ice. Standing water would increase the rate of melting. In order for a stone chamber to be interpreted as an ice house it needs to have clear evidence of a ventilation system as well as a floor drain.

Gungywamp Chamber #2 is a 2.6m long x 2.2m wide x 1.5 m high chamber accessed via a short passageway. One side of the chamber is a long boulder and the other side has a vertical/corbelled wall. The roof is composed of stone slabs. The entrance was closed by a "slab of mica quartz" that weights "250-300 pounds" (Barron 1994: 11-12) Realistically, who would want to move a several hundred pound stone on a daily or weekly basis to access the ice? A hinged wooden door would have been far more practical. The chamber also lacks any type of drain and does not have a vent, both of which were critical to the success of an ice house.

Other Traits Specific to Historic Masonry Structures

Arch – The arch is a distinctively European-American architectural feature. There is no evidence of its use by any Native American culture in North or South America.

Quarry Tool Marks – Half round drill marks spaced 6-8 inches apart (plug and feather method – see Figure 20), trapezoid shaped flat wedge marks spaced 3-4 inches apart (flat wedge method – see Figure 21), 6-20 inch deep single half round drill marks (blast holes – see Figure 15) are all indicators that a stone was quarried. Blasting was introduced into New England in the early 1740s but not common until after 1800. An early version of the plug and feather method was developed in the 1790s but examples are rare. A commercial version of the method was introduced after 1803 and prior to 1823. The flat wedge method was invented in the late 1790s. These tool marks all indicate a post-1740 and in most cases a post-1800 date for the split stone (Gage & Gage 2005, 2013, n.d.).

Figure 20. Quarried stone bar with 3 inch deep half round drill marks spaced 6-7 inches part created by the plug & feather method of splitting stone.

Figure 21. Trapezoid shaped tool marks from the flat wedge method of splitting stone.

One or two pieces of quarried stone in a structure may represent a later repair to it and this possibility should be evaluated. Walls and/or a roof made from quarried stone would strongly suggest an historic date for the structure. These stone splitting methods were primarily used by Americans. However, some Native Americans in southern New England did learn the stone masonry trade. The authors have found a

few examples of holes drilled with steel tools and quarried stone in contexts suggestive of ceremonial usage (Gage & Gage 2015, 258-260). These examples are for the most part rare.

Native American Chambers

The existence of pre-contact stone chambers constructed by Native Americans has been demonstrated archaeologically. Two examples of stone chambers with good pre-contact dating are described below. Other chambers like the Hunts Brook Chamber in Montville with its 37-foot long crawl-in height tunnel passageway can be identified as Native American by its shear impracticality to serve or function as a root cellar, ice house or other farm structure. These chambers were used as a starting point for developing a set of Native American architectural traits.

Dated Chambers

Pottie Chamber (Newton, New Hampshire)

In clearing the entrance to the chamber a stone scraper was found. A two foot by two foot test pit was excavated behind the chamber and produced soft clay potsherds in association with charcoal 18 inches below grade. A second two foot by two foot test pit was excavated on top of the chamber's roof. A piece of charcoal was recovered in level C (yellow soil) 15 inches below ground level and two and one half inches above the capstone. The charcoal was submitted to Geochron Laboratories for C-14 dating. It produced a date of 850 BP +/- 140 years (uncorrected) (Whittall 1969: 10-11).

Upton Chamber (Upton, Massachusetts)

In 2011, during restoration and stabilization work to the passageway's entrance, ten soil samples were obtained for optically stimulated luminescence (OSL) dating. These samples were submitted to the United States Geological Survey (USGS) laboratory in Denver, Colorado, which conducted an analysis on four of the samples. Three of the samples tested were taken "from soil behind the lowest stones in the wall of the entrance passageway", and the fourth was "taken below the bottom of the artifact layers in an archaeological test pit in from the chamber entrance." After a rigorous testing and analytical process, Shannon Mahan (Mahan *et al.* 2015) of the USGS concluded:

> *"The three samples that were collected in the entranceway to Upton Chamber (Upton #2, Upton #4, and Upton #5) returned ages of 535, 580, and 455 years with an average age of 523 years. When the errors are attached to the samples ages from the chamber entranceway, the return ages are between 385 and 660 years ago (or 1350 A.D. to 1625 A.D.; using the year 2011 as the end year). Upton #10, taken below the bottom of the artifact layers in the archaeological test pit located in front of the entrance to the chamber, did not return the same ages as those in the chamber. The age of this unit is between 650 and 880 years ago [1130 A.D. to 1360 A.D.] and most probably dates the surface the chamber was built on. These results put the origin of the entranceway to Upton before documented English settlement of the area."*

Mahan noted that the difference between the passageway entrance dates and the dates for the potential construction surface for the chamber may reflect one or two subsequent repair episodes possibly due to one or more flooding episodes.

The northern half of the town of Upton in which the chamber is located was owned by the Nipmuc Indians up to ca.1684-1704 according to a map created by Rebecca Wetzell and Mike Gorman and published in *Upton and Mendon Town Crier* (reproduced as supplemental figure S8 in Mahan *et al.* 2015). This is consistent with the historical findings in the archaeological report on the chamber by archaeologist Martin Dudek, who noted, "No notable colonial settlement took place during this period [1620-1675]" (Dudek 2012: 20).

The complete report on the OSL dating of the Upton Chamber will be published in a forthcoming issue of the well respected international peer-reviewed journal *Geochronology*. The authors kindly provided an advance copy of the report along with all of the supporting supplemental documentation submitted to the journal. The supplemental materials included testing procedures, data from the test results, report on how the soil samples were collected and other technical information.

Native American Architectural Traits

Native American stone building architecture, unlike Euro-American architecture, had no formal roots. Its basic core construction concepts were based on religious needs not embedded in formal structural concepts like those of the Euro-American culture (M. Gage 2006a). There was no need for perfectly straight, flat faced walls with square-corners. There was a need to build walls that were self-supporting and could hold stone slabs in place on top. This was basic to both cultures, but how the Native Americans achieved that was slightly different.

Hunts Brook Chamber (Montville, Connecticut)

It has a long, narrow, tunnel passageway with a stone slab roof that connects with a corbelled chamber. James Whittall documented the structure in detail in 1984 (Figure 22). He describes the chamber as follows:

> *"To enter the passage, one must crawl through an opening 22" by 22" for a distance of 8 feet to a point where one can continue on hands and knees for another 20 feet. In a crouched position, the final distance can be covered to a little corbelled chamber at the end; a total distance of 37.5 feet from the entrance. The walls of the passageway are straight-sided, dressed drywall stonework, never exceeding 2 feet in width (see drawing). The end wall of the chamber is cut into a ledge which has been roughly quarried to shape and level its contour" (Whittall 1984: 7).*

Whittall describes the walls as "straight-sided" and "dressed". The photographs confirm the walls are vertical and straight-sided; however, they are not dressed in stone masons' terms. The stones are irregular and *not* flat-faced; they jut in and out creating an uneven, rough surface (Whittall 1984: 10, top left-hand photo "Looking to the South").

This chamber with its long crawl-in height passageway is clearly not a root cellar, ice house or other historic structure. Its design is completely impractical for utilitarian purposes. Yet, it is clear much effort, thought, and labor went into its construction. The chamber's long, low, narrow passage is similar to "crawled into a narrow cave ... and keyhole passages" in the Mud Glyph Cave (Faulkner 1986) (see below the section on Interpretation of Ceremonial Usage). The Hunt's Brook Chamber took the idea of going deep into the underground literally in building its extra long, narrow passage into a small chamber room. There is no light present inside that chamber,

emulating deep underground caves totally devoid of light. It is an emotional, psychological, physical and otherworldly experience going into this man-made chamber (cave).

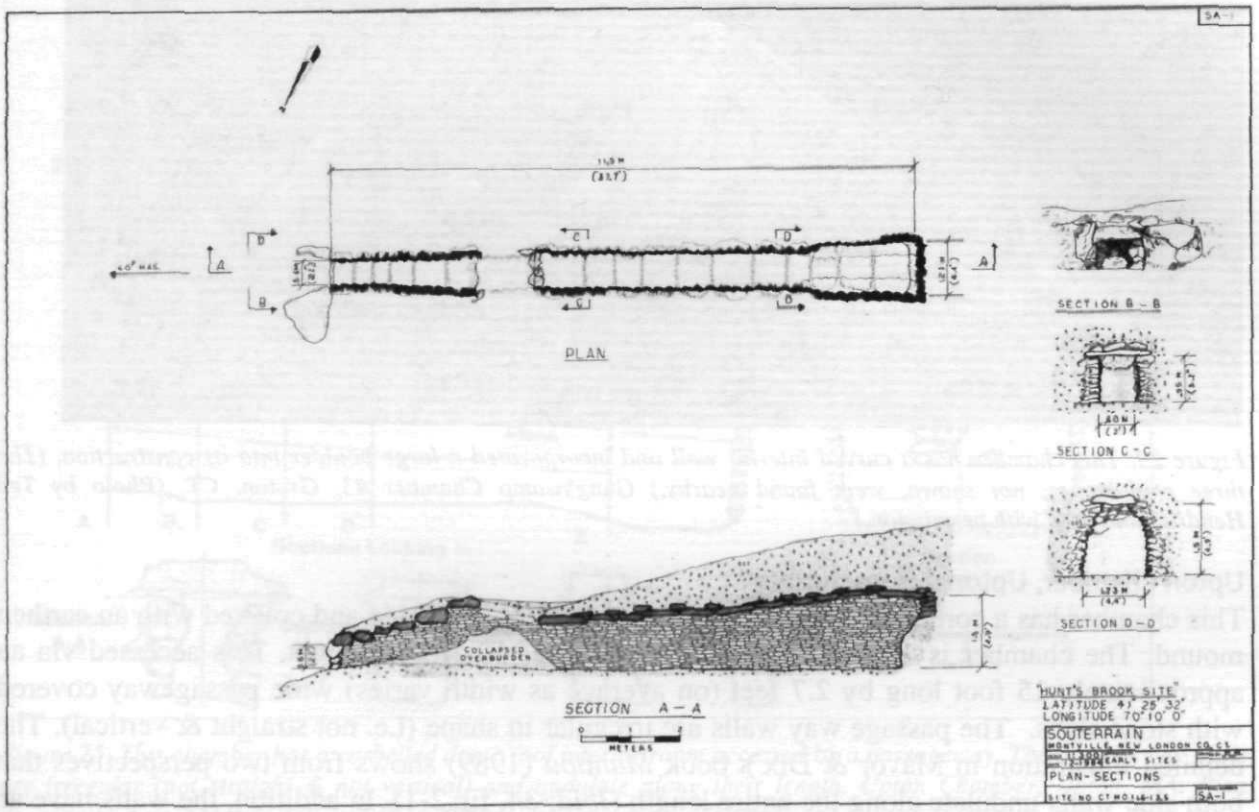

Figure 22. The Hunts Brook Chamber in Montville, CT has a 37 foot long crawl-in height passageway leading to a small interior room. (Plan drawing by James Whittall (1984). Reprinted with permission of New England Antiquities Research Association (NEARA).)

Pottie Chamber, Newton, New Hampshire

This chamber has vertical to corbelled walls with a roof of six stone slabs (Figure 23). It is 14 feet six inches long, five feet ten inches high, six feet wide at bottom, and two feet six inches wide at the roof. The side walls undulate along their lengths, bowing out in the middle section. The entrance is crawl-in height located midway in the chamber's overall height and goes directly into the chamber. The entrance's placement creates a short drop into the interior.

Figure 23. The Pottie Chamber has vertical to corbel walls. Charcoal found just above the roof stones produced a C-14 date of 850 BP +/- 140 years (uncorrected). Newton, NH.

Gungywamp Chamber #3, Groton, Connecticut

This chamber has a definitively curved wall arcing out from a glacial boulder (Figure 24). The boulder was used as a side wall. It is five feet nine inches wide by eight feet two inches long by three feet high (approximate). Three capstones

were used to roof the chamber (Barron & Mason 1994: 20-21). The wall was constructed with irregular stones that jut in and out creating a rough uneven surface.

Figure 24. This chamber has a curved interior wall and incorporated a large boulder into its construction. (The three roof stones, not shown, were found nearby.) Gungywamp Chamber #3, Groton, CT. (Photo by Ted Hendrickson, used with permission.)

Upton Chamber, Upton, Massachusetts

This chamber has a corbelled dome roof and was dug into a hillside and covered with an earthen mound. The chamber is 10 to 11 feet across and over 10 feet in height. It is accessed via an approximately 15 foot long by 2.7 feet (on average as width varies) wide passageway covered with stone slabs. The passage way walls are irregular in shape (i.e. not straight & vertical). The detailed illustration in Mavor & Dix's book *Manitou* (1989) shows from two perspectives that both side walls undulate along the entire length (*Ibid*: 34, fig.2-1). In addition, the walls have an uneven rough surface (*Ibid:* 35, fig.2-3). The stones are irregular and jut in and out. The stone slabs making up the roof are also at uneven heights. The interior room although called circular in the text has an irregular outline as shown in the Floor Plan. Its lower half vertical walls bulge in and out (Section E: E) (Figure 25). Although they are vertical they are not flush or flat-faced. The top half is a corbelled dome.

This chamber is located a short distance behind a farm house. Today it has standing water inside year round. Mahan in her research felt the water table on the farm was disturbed by humans altering the landscape, causing today's constant water problem.

> *"For purposes of estimating field moisture, we note the present floor level of the chamber is usually quite wet, with water in it much of the year. It is likely that this problem occurred when the area in front of the chamber was filled with earth fill around 1950. Formerly the chamber was dry most of the year, with water mainly present in the spring. The filling of the adjacent lowlands has raised the water table and even flooded the Upton Chamber within living memory ..." (Mahan et al. 2015).*

Root cellars and ice houses need to be dry. The seasonal water problem combined with the lack of American basic architectural traits shows this is not a historic structure. The chamber's recent OSL dating (see above) shows it was built by Native Americans. In turn, it confirms visual architectural traits can be used to differentiate between the Euro-American and Native American stone chambers.

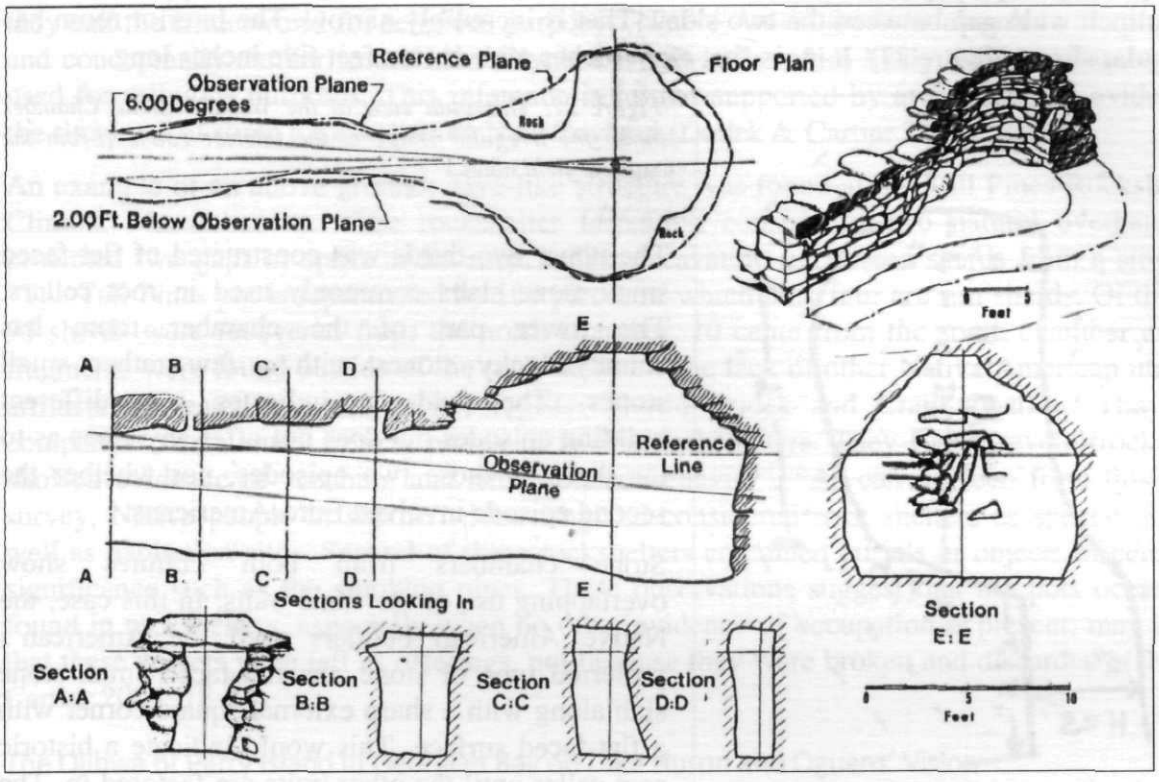

Figure 25. This chamber has a corbelled dome roof interior room accessed by a passageway. The passageway walls are irregular (not straight & not vertical) and undulate along their length. Upton Chamber, Upton, MA. Plan drawing by James Mavor & Byron Dix (1989). Used with permission of Diane Dix.

Webster Chamber, Webster, Massachusetts

The chamber has a passage way into an interior room. The passage way is two feet wide by six feet five inches long by six feet high (approximate, walk-in height). On the exterior, modern stone work has been added. It can be distinguished from the original stone work by the lack of green algae. The green algae are present on the interior passage way walls beginning at the entrance to about 1/3rd of the way down its length. (There is a stream next to the chamber & constant moisture, hence the algae buildup.) The upper one-third of the right wall leans outward along the whole length of the passageway.

Figure 26. The upper 1/3 of the right wall leans outward. This appears to be an intentional feature rather than structural failure. Stone Chamber, Webster, MA.

The passageway roof slabs are horizontal and show no sign of displacement, which indicates the outward lean of the wall is intentional rather than the result of structural failure (Figure 26). The left side wall has an unusual transition into the interior chamber room. It has two wall sections that jut outward

unevenly from the passage to the interior room. At the roof line, the transition was constricted to an eight inch wide gap between the two sides. That is incredibly narrow. The interior room has an irregular shape (Figure 27). It is six feet eight inches wide by ten feet five inches long.

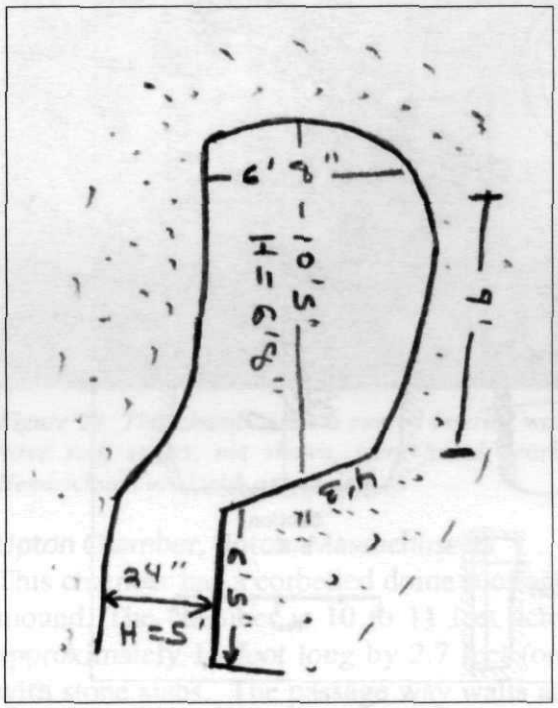

Figure 27. This plan view of the Webster Stone Chamber shows the irregular shape of the interior room. (From the authors' field notes.)

The upper two-thirds was constructed of flat-faced small stone slabs commonly used in root cellars. The lower part of the chamber room has chunky/blocky stones with a few rather small stones. The evidence indicates two different building episodes but does not offer any clues as to the dates of those two episodes, nor whether the second episode involved Euro-Americans.

Stone chambers from both cultures show overlapping use of the same traits. In this case, the Native American builders used the American's preferred type of stone, the flat-faced small stone slab along with a sharp external square corner with a flat-faced surface. This would indicate a historic root cellar until the other traits are factored in. The curved/bowed out wall, irregular shaped interior room and narrow, constricted top of wall transition shows the chamber is of Native American origin.

Key Traits for Native American Architecture

Undulating Walls – walls weave in and out along their lengths

Curved Walls – wall curves out in a crescent shape

Irregular Stones – non-descript shapes, sometimes mixed with slabs and blocks

Uneven rough surface – stones jut in and out on the face of the wall

Irregular shaped interior room – it does not conform to a circular or rectangular or square shape

INTERPRETATION OF CEREMONIAL USAGE

There is archaeological and historical evidence to show Native Americans used below ground and above ground caves for religious/ceremonial purposes. An example of Native Americans using an underground chamber for ceremonial purposes is seen in the Mud Glyph Cave.

> *"On a cold day in early 1980, two members of the U.S. Forest Service crawled into a narrow cave in an East Tennessee hillside. After scrambling through mud, knee-deep water, and keyhole passages in the rock, they found themselves face to face with ancient drawings of humans, animals, and symbols—a hitherto unsuspected body of prehistoric art" (Faulkner 1986, book jacket flap introduction).*

The Mud Glyph Cave shows Native Americans used caves that went deep underground in what they call the Underworld for religious purposes. Native American stone chambers are physically and conceptually similar to the Mud Glyph Cave. It is therefore likely that the chambers were used for religious purposes. This inference is further supported by archaeological evidence for the ritual use of some rockshelters in New England (Dudek & Cartier 2004: 18-24).

An example of an above ground, cave-like structure was found at the Tall Pines Rockshelter in Clinton, Massachusetts. "The rockshelter formation consists of two natural overhangs that protected two gaps or splits in the rock." The excavation uncovered sherds from a single pot. "The Tall Pines pot is represented by 109 pieces of which only four are rim sherds. Of this total, 95 sherds were recovered from the north chamber, 10 came from the south chamber and four fragments were found outside of the rock shelter." The lack of other Native American utilitarian artifacts interested the two archaeologists, Martin Dudek and Craig Chartier. They did a comparative data study from a survey of twelve rockshelters. They found several rockshelters showed evidence of "caching and ritual-related behavior". "As can be seen from this limited survey, Native people in southern New England considered rock shelters as special places as well as habitation sites. Several of these rockshelters contained burials or objects of ceremonial significance such as the smoking pipes. These observations suggest that the pots occasionally found in rockshelters, especially when no other evidence of occupation is present, may indicate that these vessels were left as offerings, not because they were broken and discarded" (Dudek & Cartier 2004: 18-24)

The Ojibwa of Parry Island in Georgian Bay on Lake Huron and Oguans' Vision

> *"The present-day [1935] Parry Islanders describe their early religion before the coming of the whites as menidokewin, 'manido rule or rule by supernatural spirits.' 'Just as Christians approach God for favours through his ministers or churches, so the Indian approached the servants of the Great Spirit, the manidos, and sought their aid'" (Mary Suedub, quoted in Jenness 1935: 47).*

One of the Parry Islanders was Ogauns, whose vision has been retold. In it Ogauns is sent to the Underworld by the master "Almighty" spirit of the Upperworld. He entered the Underworld via a chasm in the rock and was accompanied by Sun Spirit of Upperworld. He traveled through a world with benevolent and malevolent spirits to meet the master spirit of the Underworld. "... I pressed forward to the place where I should meet the blessed *manido"* (Jenness 1935: 55-59). In Oguans vision he goes into the Underworld seeking a spiritual favor and meets the blessed manido. This was a benevolent spirit with the power to grant requests made during visions. Oguans' name "blessed" indicates he was a Christianized Indian who continued to practice the old ways by meshing Christianity with his Native cultural beliefs. This vision is critical to understanding and interpreting stone chambers. From this vision we learn several key cultural and religious details:

(1) It shows ordinary people going into the Underworld for religious purposes. Access, at least amongst the Ojibwa, was not restricted to religious or tribal leaders.

(2) Access to the Underworld was through a chasm in the rock, where Oguans descended downwards several levels into an underground cave.

(3) Purpose of going into the Underworld was to meet and interact with the master spirit.

(4) An Upperworld spirit, Sun Spirit, went into the Underworld. The significance of this will be explained below.

Do any of the above details show up in the stone chambers or ceremonies?

Gungywamp Site, Groton, Connecticut

The large chamber has a shaft that channels a beam of sun light on the equinox sunset into the entrance of the small interior chamber (Barron & Mason 1994: 7-10). It is easy to interpret this astronomical alignment as having a calendrical purpose, marking the equinox. This interpretation overlooks the ritual and mythological aspects that pervaded Native American religions. In Oguans' vision, the Sun Spirit accompanied him into the Underworld. This can be compared to the sun beam physically entering the Underworld in the chamber. The fall equinox signals the beginning of cooler temperatures leading to the colder fall/winter season. The fall/winter season lacks the physical warmth of the sun, and it easy to conceive of the Sun Spirit as having left the sphere of the sun for those months, taking its warmth with it. (This is the reason for concluding it was a fall equinox as it is a sunset alignment, showing the sun leaving the Upperworld.) Where did the Sun Spirit go? The Ojibwa viewed the Underworld as a place without snow during the winter: "One winter a moose, in the form of a big old man, carried two boys away to a land where there was no snow. It was *bitokomegog*, the underground world, in which the moose have their village" (Jonas King, quoted in Jenness 1935: 24) One can extrapolate the idea that the Sun Spirit entered the Underworld for the cold months. In the springtime, the sun returns, bringing its warmth. This is attested to by the annual ceremonial cycle of the Iroquois of the Cayuga Long House, as described by anthropologist Dr. Frank Speck:

"VI. Sun Ceremony, *ede 'kwa ga 'kwa,* 'day sun'

Time: When the sun begins to feel hot in the spring, late in May

Duration: One day

Purpose: Appeal to the sun for continuation of the blessing of heat

Composition: The *Adowa*, with the passing of the sun disk symbol (P1 X E, XII B) as each performer sings and prays" (Speck 1995: 36).

Note: Not all Sun Ceremonies were held on solstices or equinoxes. Individual tribes appear to have had their own specified days on which to hold a Sun Ceremony.

The equinox alignment at the Gungywamp chamber can be interpreted as a ritual involving the spirit of the sun leaving the sphere of the sun for the cold months of the year. It goes into a world, the Underworld, where it is warm during the winter, the sun possibly being the source of the warmth. In the spring time, the spirit returns to the sphere of the sun. Most sites only have one part of this cycle, either the sun leaving or the sun returning, It is rare for a site to have both parts of the cycle. Of note, in the warm spring/summer season water from springs give people ice cold water for drinking. This may have been interpreted by the Native Americans as the Underworld turning cold during our warm spring/summer months.

In New England there are no natural deep underground caves; there are only natural rockshelters that sometimes were used for religious purposes. To augment the lack of natural caves the Native Americans built stone chambers. The skills to build a stone chamber can be traced through the sequencing of the chambers at America's Stonehenge in North Salem, New Hampshire. Contrary to common belief, the chambers were not completely rebuilt by any of the people who have

worked to save the site. Some have partial restoration work that has been identified. Others are in their original state. The restoration work did not rebuild the features; they were left intact. It was through the features and general construction that the chambers were sequenced. The sequence was traced back to two caves, so-called rockshelters on the west side of the property. The large rockshelter contained a large quantity of sherds from a single pot and a few sherds from a second pot, plus a single middle section of a projectile point. The broken pot and lack of other utilitarian artifacts suggest the large rockshelter was used for religious purposes.

The small rockshelter has key characteristics that show up in 95% of the stone chambers. The key characteristics are a small chamber on the end of a long tall wall, a recessed back corner plus a narrow step down gap in the bedrock. The combination of a long and tall wall showed up in four chambers. The long wall aspect showed up in five other chambers. The Native Americans copied what they observed in the natural world. The recessed back corner showed up in various forms in all the chambers. This feature was traced through all the major chambers on site, including the undisturbed chambers such as the Collapsed Chamber. It was interpreted as a spirit portal to the Underworld. By following the sequence it can be seen how the Native Americans learned how to build with stone by starting with stone wall structures without roofs called enclosures, and advancing to low roofed chambers leading up to later walk-in height roofed chambers (M. Gage 2014).

Stone chambers with darkened interior rooms and earthen mounds gave a sense of being deep inside a cave underground. The same condition was required by American farmers seeking a dark, cool interior room to store vegetables. The only difference was each culture's purpose. The American farmer used his stone chamber for utilitarian purposes. The Native American used his stone chamber for religious ritual/ceremonial purposes.

Native Americans built man-made stone chambers as a means to go into the Underworld for the purpose of working with spirits. Working with spirits covers a variety of different aspects from assisting a spirit such as Sun Spirit traveling from Upperworld to Underworld to interacting with Underworld spirits such as the Master Spirit of Underworld. We often forget Spring Water Spirit is also an Underworld spirit and that Rain Water Spirit needs to enter the Underworld to transition into Spring Water Spirit. The Underworld is a complex world where a lot took place spiritually.

Stone Chamber Conversions

New England farmers would recycle wood, bricks, and other materials from previous structures and incorporate them into new buildings. There is some archaeological evidence that they occasionally adapted and repurposed pre-contact stone chambers. Circa 1825, Jonathan Pattee of North Salem, New Hampshire built a house on top of Mystery Hill at what is today known as the controversial America's Stonehenge site. The house was built on top of a below ground level stone structure complex known as the "Sunken Courtyard." One of the house foundation's walls has non-interlocking junctions with the other walls. This is generally a reliable indicator that the wall was a newer modification of an earlier structure. There is additional evidence to suggest Pattee modified a pre-contact stone complex to use as a cellar for his house.

The Sunken Courtyard complex has two stone chambers, one finished and the other unfinished. The finished chamber was incorporated into the cellar of Pattee's house. The chamber has a rectangular room covered by stone slabs and is entered by a walk-in height doorway. It could

easily be mistaken as a historic root cellar but it is not. The chamber was built on sloping bedrock. On the upslope side, the chamber wall has two side by side openings in the exterior wall at the bottom. One opening leads to a stone-lined drain built behind the chamber, and the other opening is a drain leading directly into the room of the chamber. No farmer would intentionally build a drain feature that would direct water inside a root cellar where it could spoil the food.

Pattee made some repairs to the chamber. In the wall of the interior is a stone with the remains of a drilled blast hole. It is a replacement stone. The inside walls have evidence that Pattee plastered part of the inside of the chamber. The evidence shows Pattee altered a pre-existing chamber that ended up in the cellar of his house.

The Sunken Courtyard complex has a stone-lined "well" integrated into it. An excavation of the "well" determined that it was a vertical shaft that provided access to a bedrock fissure containing quartz crystals naturally covered with iron oxide (i.e., red ocher) (Stone 1963). Quartz crystals and red ocher were both considered spiritual items within the Native American culture (Hamell 1983:25; Lavin 2013:103,152,162-163,). The iron oxide covering the crystals mimicked the red ochre and, therefore, made the crystals extremely rare and extremely sacred beyond the already sacred nature of normal quartz crystals. The complex has a stone slab with an abraded groove and another slab with a circular pecked groove. Abrading and pecking are both stone working techniques found in Native American tool making. The evidence suggests a pre-contact date and Native American cultural affiliation for the structure. Pre-contact C-14 dates from other structures at the site, Native American artifacts, and additional examples of Native American worked stone suggest the entire site was Native American in origins (M. Gage 2006).

Proof of Concept Study

About the chambers in the study

The study was conducted using available photographs of a limited number of chambers in Connecticut. It is not a comprehensive listing and does not represent a survey of all the stone chambers. The numbers cannot be used to form ratios, as the authors had no control over what was photographed and what was not photographed. A total of forty-one chambers were used in the study.

Combined Traits Theory

Ted Hendrickson, a professional photographer, posted a collection of photographs of stone chambers in Connecticut on his web site (Hendrickson n.d.). In addition, Hendrickson provided unpublished photographs for the authors to use in their study. He had interior and exterior images. These were used along with other sources to track architectural features and construction methods. This gave the authors partial or full access to interior photographs of thirty-nine chambers; the remaining two were represented by exterior photographs only. The chambers were located in the Connecticut towns of Bozrah, Groton, Ledyard, Montville, North Stonington, Preston, Stonington and Thompson, plus two towns in Massachusetts: Webster (next to Thompson, Connecticut) and Upton (southeastern part of state). This confined the study to a specific geographical area – southeastern Connecticut and the Thames River Valley, from its northern border to its southern border.

The study looked at wall construction (vertical, horizontal, surface, corners, type of stone), roof interiors, entrances, passageways, niches, shafts, doors, floors, columns and exterior. When analyzed, the data showed specific features were repeatedly used with each other. Straight linear walls (front to back) had square corners and flat-faced surfaces. Undulating and curved walls had rough, uneven wall surfaces. That created two groups: A and B, each with its own set of *combined traits*.

A control study was conducted using house foundations in Sturbridge, Massachusetts and East Lyme, Connecticut, and a barn foundation in Thompson, Connecticut. It looked for architectural features (also see M. Gage 2015). The house and barn foundations had straight walls, square corners and flat-faced surfaces. This shows structures in group A were historic root cellars.

Group A stone chambers have straight (end to end) flat faced walls and square corners. The walls (top to bottom) are vertical or vertical with some corbelling near the top. The rooms are square or rectangular. The identified root cellars had walk-in or semi-walk-in height entrances, a characteristic that also showed up in some Group B chambers. Overall, Group A stone chambers reflect the historic stone foundations minus the stone roof (for examples, see Figures 28 & 29).

Figure 28. This root cellar is located in a farm field and the farm house is visible behind it. Ledyard, CT. (Photo courtesy of Dan Nelson.)

Figure 29. Interior of the Ledyard root cellar showing a rectangular room, flat faced straight vertical walls, and square corners. It is accessed by a stairway with stone steps. Note the curvature of the right wall in the photo is due to the wide angle of the lens. The wall is actually straight & vertical. (Photo courtesy of Dan Nelson.)

Are <u>all</u> straight-walled, square-cornered chambers root cellars? In the *Chamber Conversions* section, the finished stone chamber in the Sunken Courtyard complex at the America's Stonehenge site was discussed. This chamber had a walk-in height doorway, straight walls and square corners. An initial assessment would suggest it was an historic root cellar. The chamber has two additional features. One feature is a drain under the wall on the upslope side, which would have directed water into the chamber rather than away from it. The second is a niche-like opening from the exterior to interior that is located low on the wall next to the entrance (author's personal research). There is no practical reason for a niche on the <u>exterior</u> wall of a root cellar. Niches found in root cellars are always built into an interior wall to keep the food or dairy products placed in it cool and away from animals (Figure 30). These two features are not

consistent with root cellar construction. This example demonstrates the need to evaluate all the features of a given chamber before drawing conclusions about it.

Figure 30. Interior niche in the rear wall of a root cellar. The left hand wall is a 20th century addition that divided the original room into two sections. North Grosvenordale, CT. (Photo courtesy of Chris Pittman.)

Group B stone chambers have undulating and curved walls, and uneven, rough faced surfaces on the interior (For examples, see Figures 31 & 32). In addition, some have features. The Collapsed Chamber at the America's Stonehenge site has a niche on an exterior wall (Figure 33). It is completely out of the norm for root cellars, which have interior niches. Looking for what fits the normal and what is out of the normal can be used to identify the cultural affiliations of these stone chambers. The Montville Souterrain Chamber (a/k/a Hunts Brook Chamber) has a crawl-in height, thirty-seven foot long passage way ending in a small corbelled chamber (Whittall 1984). The French chamber has three standing stones on top of its exterior mound. It is located within a farm complex (Ferryn 1998: 263). These unique features are abnormal and do not fit the criteria for Euro-American construction.

Figure 31. Exterior view of a stone chamber showing the corbelled wall to slab roof design. Hoffman Evergreen Preserve, Stonington, CT. (Photo by Ted Hendrickson, used with permission.)

In 2014 the Upton chamber, with its undulating walls, uneven surface and irregular shaped interior chamber, was OSL dated to pre-European settlement (Mahan *et al.* 2015). The dating was used in conjunction with the abnormal features for root cellars to determine the Native American cultural affiliation of Group B.

Group A – Root Cellars

Connecticut

Bozrah; Ledyard 1; Ledyard 2 (Arched Roof); Ledyard 4-Ledyard 9; Ledyard 10 (Arched Roof); Ledyard 11*; Montville 4-5; North Stonington 1-2; North Stonington 3 (exterior slab stone construction, same as used in house foundation in background) No interior photos; North Stonington 5-6,8*; Preston 2-3*; Stonington 1-3*; Thompson (Arched Roof)[1]; Thompson–North Grosvenordale[2]

Total = 26

Group B – Native American Ceremonial Chambers

Connecticut

Groton - Gungywamp 1-3; Ledyard 3; Montville 1-3; Montville Souterrain (Hunt's Brook)[3]; Stonington Chamber Cave; Stonington – Hoffman Evergreen Preserve Chamber*; Stonington Chamber Cairn (no interior photos); Thompson 1 (Rocky Brook Site)[4]; Thompson 2 (Quinebaug River)[5]

Massachusetts (South-Central & Southeastern)

Upton; Webster[6]

Total = 15

* Unpublished photos provided by Ted Hendrickson

[1] Authors' photos http://www.stonestructures.org/html/thompson-root-cellar.html

[2] Christopher Pittman's photos http://stoneruins.cellarwalls.com/#!album-9-0

[3] See photos in Whittall 1984

[4] Authors' photos http://www.stonestructures.org/html/thompson-chamber.html

[5] Thompson 2 (Quinebaug River) – Whittall 1991a

[6] Authors' photos http://www.stonestructures.org/html/webster-ma-chamber.html

Figure 32. Interior view of the chamber in the Hoffman Evergreen Preserve, Stonington, CT. (Photo by Ted Hendrickson, used with permission.)

Viewing Photos of the Chambers in the Study

Unless otherwise indicated, the chamber photos can be viewed on Ted Hendrickson's website:

http://www.tedhendrickson.com under the section "Questions for a Stony Landscape: Chambers".

Conclusion

In the introduction, we proposed the unorthodox idea that the two major hypotheses put forth to explain the purpose and cultural affiliation of the nearly 700 stone chambers found in the Northeastern United States were in part both correct: some of the chambers were Native American ceremonial structures and some were historic root cellars. We conducted an extensive search for evidence that would prove or disprove each of these hypotheses. Although the

evidence we found is not abundant, the quality of the evidence was excellent and more than sufficient to draw a conclusion. An objective and honest review of the available archaeological and architectural evidence supports this dual hypothesis idea.

In light of these findings, the next logical step was to develop a set of criteria for distinguishing Native American stone chambers from historic root cellars. We approached this challenge by evaluating the architectural design, basic building principles, and construction methods used to build them. We explored and tested a number of different architectural criteria before arriving at the *Key Traits* presented in this article.

The study of Euro-American architecture showed it consistently exhibited box-like features. Some of the chambers in this study had box-like interiors. Closer examination found they shared a set of additional common traits: straight, linear walls, square corners, flat stones and flat interior surfaces. These were the same traits as found in house and barn foundations, and in wood, brick and stone buildings. The strong similarity between the traits of these particular chambers and Euro-American architecture indicates that some free-standing stone chambers were built by farmers.

To our surprise some root cellars with common Euro-American traits had corbelling near the top of the vertical walls. The use of stone corbelling in historic American buildings is rare and examples of it are hard to find. There is no mention of corbelling in the period literature on root cellar construction. The use of stone corbelling in Euro-American architecture appears to be restricted to root cellars roofed with stone slabs for the most part. This occurred because one cannot always get the proper length slab and therefore the ceiling width had to be slightly narrowed, as seen in the John Park House. Corbelling at the top of the wall was also reported for German Pennsylvania farm root cellars (Long 1972: 160).

Archaeological dating proved some free-standing stone chambers were built by the Native Americans. These chambers were architecturally different. They had one or more of the following traits: irregular interior chambers, undulating or curved out walls, and uneven, rough interior wall surfaces. Many of these chambers have the top layers corbelled but not all. Some are fully corbelled bottom to top. Chambers like the Upton Chamber have random rubble construction with irregularly shaped stones, undulating walls in its passage, an irregular shaped interior chamber (room) and a corbelled dome roof. None of these traits meet the historic criteria of Euro-American root cellar architecture. The pre-settlement OSL date confirmed this was a Native American structure. Chambers like Upton and the pre-contact dated Pottie Chamber served as a starting point for developing Native American architectural criteria.

It is important to note that the historic key traits are not unique to Euro-American architecture. Therefore, they should be treated as a minimum set of criteria for considering a stone chamber to be an historic utilitarian structure. The problem is that a few Native American stone chambers exhibit some or all of the historic key traits, creating a gray zone for interpretation purposes. These Native American chambers are generally identified by their additional non-historic features; e.g., a niche in an outside wall (Figure 33).

The Native American key traits go against the fundamental ingrained architectural values of Euro-American culture. The idea of intentionally building undulating and curved walls, rough uneven surfaces, and irregularly shape rooms was unthinkable in the American architecture and stone masonry traditions. Each stone chamber needs to be evaluated individually and one needs

to take into consideration all of its architectural elements. It is within the combination of traits that the builders of New England's stone chambers can be identified.

Figure 33. Niche in the exterior wall of the Collapsed Chamber, North Salem, NH.

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