GEOARCHAEOLOGICAL TRAVERSE: SOAPSTONE, CLAY AND BOG IRON IN ANDOVER, MIDDLETON, DANVERS AND SAUGUS, MASSACHUSETTS

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From

Wall, S., Eby, G. N., and Winter, E. (2004) Geoarchaeological traverse: soapstone, clay and bog iron in Andover, Middleton, Danvers and Saugus, Massachusetts. In Hanson, L. (ed.) Guidebook to Field Trips from Boston, MA to Saco Bay, ME. New England Intercollegiate Geological Conference, Salem, MA, pp. 257-276.

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INTRODUCTION

Geologic information has long been useful to the study of archaeology. Decades of collaboration between geologists and archaeologists have resulted in the development of the practice of geoarchaeology in which the principles and methods of the geo-sciences are directly applied to archaeological research. This fieldtrip will present three geoarchaeological topics in Essex County, Massachusetts. These are in order: Prehistoric and historic use of soapstone at the Skug River I and II Sites, Andover, MA; Native American and seventeenth century use of glacial marine clays in the Danvers Pottery (Rebecca Nurse Homestead) Danvers, MA; and, seventeenth century iron production using bog iron, (Saugus Iron Works National Historic Site), Saugus, MA. The principal prehistoric use of soapstone was in the making of cooking bowls two of which are shown in Figure 1.

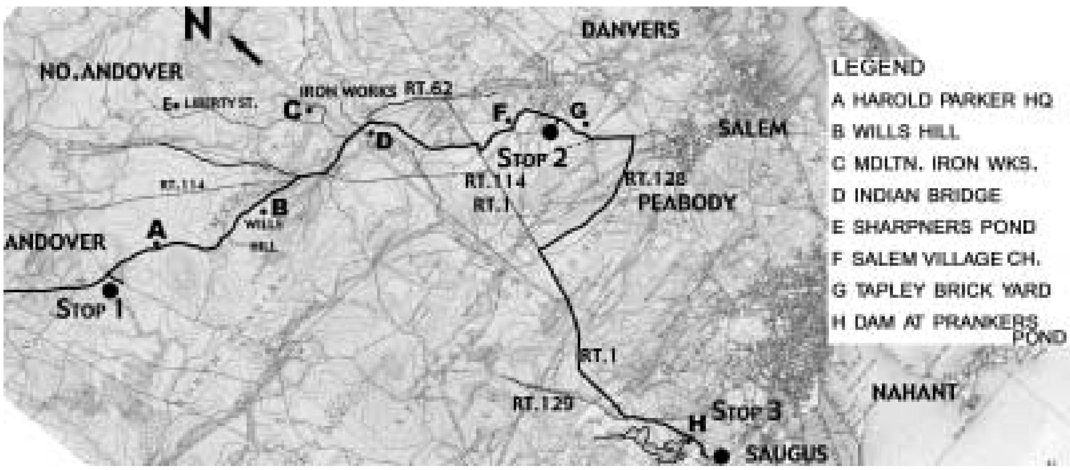
The field trip begins in the eastern portion of the Nashoba Terrane, crosses the Bloody Bluff Fault Zone in Middleton, and continues through the Avalon Terrane to Danvers and Saugus. Since quarrying is the topic at the first stop, bed rock geology will be addressed in detail at the Skug River Sites. The surficial geology for the terrain south of the Andover Granite to Danvers is largely dominated by the landforms of stagnation zone retreat, with knobby discontinuous exposures of bedrock and kame and kettle topography, but without large-scale morphosequences (Koteff, 1974; Koteff and Pessl, 1981). Below Middleton Center, drumlins dominate the landscape to beyond Rte. 1 (The Newburyport Turnpike). Glaciofluvial and glacial marine features predominate in Danvers. Thick beds of glacial marine clay (Sears 1905) were utilized by the Danvers Pottery for 400 years.

Figure 1a. Late Archaic, single lug green soapstone bowl from the Chadwick Site in Boxford, MA
(Courtesy R.S. Peabody Museum, Andover, MA)

Figure 1b. Reconstructed large soapstone bowl from collector in Reading, MA
(Courtesy R.S. Peabody Museum, Andover, MA)

Both the Danvers and Saugus sites are located within the marine margin. The Rebecca Nurse Homestead occupies the south flank of a drowned valley, and the Saugus Iron Works occupies a sand plain formed at a bedrock escarpment. This sudden change in bedrock elevation provided the hydraulic gradient needed for early industrialization. The focus of the last two stops will be to explore how Colonial Americans interacted with the glacial landscape. Since they are fully operating museums, both seventeenth century home life and industrial life are amply covered in the field. This paper will outline the geologic setting and briefly discuss the historic significance of these two stops.

Figure 2. The Field Trip stops are as follows: Stop 1: Skug River I and Skug River II; Stop 2: Rebecca Nurse Homestead, Danvers MA; and, Stop 3: Saugus Iron Works National Historic Site, Saugus, MA. Locations A-H are historic points of interest listed in the Road Log.



HISTORIC AND ABORIGINAL QUARRIES AND WORKSHOPS AT THE SKUG RIVER SITES

The Skug River winds its way through the dead ice terrane on the eastern margin of the Andover Granite. Skug is a Native American word for snake (Eugene Winter, personal communication). The kame and kettle terrane, bedrock knobs, complex fracturing, and large glacial erratics, produced its winding form and protected its secret for centuries. Haphazardly strewn among the bedrock knobs are bodies of serpentenite and talc rich metamorphic rocks. These 'soapstones' of Essex County lie within the Nashoba Terrane and are diverse, diffuse, and small. Their contacts are convoluted, poorly exposed and pay only minor regard to major Acadian structural trends. The outcrops and boulder fields at the Skug River Sites represent two of seven varieties of soapstone, and mark the western edge of a zone of outcrops that extends eastward to Boxford and northward into Groveland, Massachusetts. Soapstone boulder fields have been observed southward in the glacial drift in Danvers and Peabody Massachusetts. As a result of geologic reconnaissance, several outcrops and boulders have been observed with marks similar to the Native American use described in the Skug River II Sites. These are in Lawrence, Andover, North Andover, and Middleton. These areas are smaller than the Skug Site, many are disturbed, and the grooves and pecking are less distinct. Suzanne Wall is in the process of recording them with the MHC.

Soapstone was quarried at the Jenkins Quarry in Andover during the 1830's and 1840's. Listed as Hill's Quarry by Ripley Bullen (1949) it is the only known historic soapstone quarry site in the area. William Jenkins exploited an outcrop of dark bluish grey soapstone listed as "old blue soapstone" in his indenture of 1834. Before this he was a sawyer. Having been blessed with little but stone, and stone starved soil, and stone stunted wood, the best industry was offered by the Skug River and the hard, splayed roots of his boney wood lots. He sawed ships knees at what would become the quarry and much later apparently turned the same saw on the soapstone. Concurrent with his sawing but before the soapstone, he was also quarrying deeply weathered granite 2 km south east of the Soapstone quarry (Andover Biotite Granite). His indenture contains a reassurance that the new stone was strong. Jenkins for all his industry however, was not the first to use the soapstone.

Light grey, green, and black soapstone bowls, pipes, atl-atl weights and other artifacts are well represented in local museum collections. Known prehistoric soapstone quarries are located in Worcester and Westfield, Massachusetts, Rhode Island and Connecticut. However no prehistoric quarrying of the Essex County soapstones had been reported. The prehistoric quarry and workshops of the Skug River II Site date from the Late Archaic period. They are unique in that blocks and blanks of soapstone were removed from boulders, reduced, and processed. Some small boulders were cleaved and used as bowl preforms. Native American cultural material also included bowl blanks, rhyolite (felsite) flakes, and a firepit feature. The suite of pecked grooves, "V" shaped notches, and coalesced holes, at the Native American Quarry are distinctly different than tool marks attributed to the stone cutting and dressing which occurred at the historic quarry. The Prehistoric marks also do not resemble glacial striations visible in the area. Previous assessments of aboriginal soapstone quarrying have indicated that both ledge and boulder sources were exploited (Bullen 1940; Fowler 1942; Dunn 1945; Dixon 1987)

BEDROCK GEOLOGY OF ANDOVER, NORTH ANDOVER, AND MIDDLETON MASSACHUSETTS

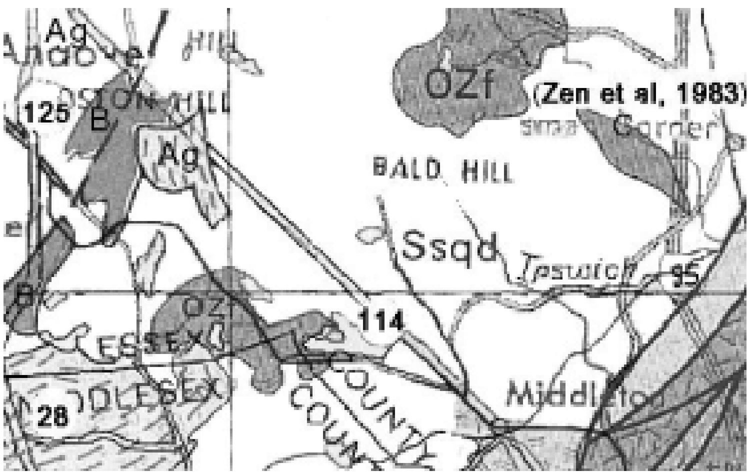


Figure 3. The bedrock geology in the vicinity of the Jenkins Quarry consists of four formations within the Nashoba Terrane. These include; the Andover Granite, Sharpners Pond diorite, Boxford Formation and Fish Brook Gneiss. The Andover Granite contains numerous small outliers of the Boxford formation. Many of these are associated with faulting and/or pegmatites. The Sharpners Pond diorite has intruded the Boxford Formation along old structural features.

Five names have been used historically to describe the soapstone in Essex County. In particular, William Jenkins called it Blue Freestone in his Indenture of 1834. According to the terminology of the time, freestone referred to any stone that broke freely and was dressed and cut without splitting. Sears (1905) calls it a Biotite Mica Peridotite, indicating he recognized its ferromagnesian composition. Goldsmith (1932) refers to the 1841 "Reports on the Geology of Massachusetts" by Professor Edward Hitchcock who lists the William Jenkins Quarry under "Steatite or Soapstone". Although some of the soapstones of Essex County are in the serpentenite family, this paper will use its historic name, soapstone. Soapstone is often referred to as steatite in archaeological literature, however in current geologic usage; steatite refers to a form of talc. "Soapstone is a metamorphic rock of massive, schistose, interlaced fibrous or flaky texture, and soft unctuous feel." (Bates and Jackson, 1980)

Lithologic Setting

The soapstones of Essex County lie in the eastern portion of the Nashoba Terrane, which is comprised of volcanic rocks and sedimentary rocks derived from volcanic rocks. These have been multiply metamorphosed, deformed, and intruded by dioritic and granitic plutons. Malcolm Hill describes the stratified rocks as "Largely high grade meta-sediments and amphibolites in the mid-to-upper amphibolite facies" (Hill et al, 1984). Hill states that stratified sequences, such as the Boxford Formation, contain abundant meta-basaltic flows. The repeated metamorphism and deformation of the Boxford Formation and Sharpners Pond Diorite have produced the zones of hydrated metamorphic rocks referred to as soapstones in this paper. Within the field trip area, the Nashoba lithologies include: the Fish Brook Gneiss, Boxford Formation, Sharpners Pond Diorite and the Andover Granite. (Clapp 1921; Toulmin 1964; Zartman and Naylor, 1984; Zen et al, 1983; Hill, et al, 1984; Hepburn et al, 1993, Hepburn 1995)

Andover Granite. The Nashoba Terrane was intruded by several granites including the Andover Granite. "The Andover consists of a series of foliated and unfoliated peraluminous, garnet bearing muscovite-biotite granites and pegmatites, thought to have been generated in part by anatexis of the Nashoba Formation." (Hepburn and Munn, 1984) The younger unfoliated granites truncate the Sharpners Pond Diorite and are dated at 412+/- 2 Ma (Hepburn et al., 1995). Some of the foliated Andover Granite was deformed during the metamorphic event (425 Ma) which foliated portions of the Sharpners Pond Diorite. The granite and diorite are commingled near their boundary (Hepburn et al., 1995). Highly altered zones within this portion of the Andover Granite are deeply weathered.

Sharpners Pond Diorite. The Sharpners Pond Diorite is one of the calc-alkalic plutons of the Nashoba Terrane and consists of hornblende-biotite diorites and tonalites. Hill et al., (1984) report a possible continental arc genesis and describe it as heterogeneous. "The Sharpners Pond Tonalite, is here named for the generally melanocratic igneous rocks, well exposed in the vicinity of Sharpners Pond, North Andover" (Castle, 1964). Zartman and Naylor (1984) date the time of crystallization of the Sharpners Pond Diorite as 430 +/- 5 Ma. Formerly, it was mapped as Salem Gabbro-Diorite (Clapp, 1921; Toulmin, 1964). Castle (1964, p. 236) described 3 gradational phases intruded in order, from southeast to northwest: massive hornblende diorite and minor gabbro; biotite hornblende tonalite; and biotite tonalite.

According to Castle, the Sharpners Pond Diorite is described as follows:
The **massive hornblende diorite and minor gabbro** is composed chiefly of plagioclase and hornblende with quartz and biotite. Accessories include; titanite, apatite, and magnetite; secondary chlorite and epidote can compose up to 15%. Ilmenite and magnetite may comprise up to 10% of the rock.
The **biotite hornblende tonalite** is younger than the hornblende diorite. It was distinguished by a 10% biotite content, a greater degree of foliation, and contained the same accessory minerals.
The **biotite tonalite** is the most heterogeneous. In the north part of the Reading quadrangle, it is transitional with the Andover Granite and the contact is indistinct because of the mixing between the two magmas (Castle, 1964). Hornblende is absent or subordinate to biotite and the tonalite is somewhat foliated. It contains 28-56% plagioclase which is bent and fractured and increases in quartz percentage directly reflect the decrease in hornblende and biotite.

Boxford Formation. Robert O. Castle in his 1964 thesis "Geology of the Andover Granite and Associated Rocks" mapped the Boxford Formation as discontinuous bands of highly deformed poly-metamorphosed schist gneiss and amphibolites. Small bodies of the Boxford Formation are contained within the eastern zone of the Andover Granite. Some of these outliers were too small to be included on the current state map (Zen et al, 1983) Castle maps the Boxford as four units and 3 main members, the Upper, Undifferentiated Upper, Middle and Lower members.

The Upper member is chiefly a foliated, thinly layered, grey to black schist and gneiss. The Undifferentiated Upper member includes calc-silicate rock, amphibolite, quartz-feldspar gneiss, and andalusite-sillimanite-sericite schist. The amphibolite in the Upper member is fine-grained, foliated, grey to black amphibolite and consists largely of hornblende and plagioclase. The discontinuous Middle member is a quartz-plagioclase gneiss with minor chlorite. The Lower member is predominantly fine- to medium-grained schists, gneiss and amphibolite. The schist is…"commonly bluish-grey and composed mainly of muscovite, biotite, and quartz with minor amounts of andalusite and fibrolitic sillimanite."(Castle 1964) He describes the associated gneisses as containing quartz, plagioclase and actinolite in varying amounts. The amphibolites of the lower formation are coarser than the upper member.

Castle maps both the Boxford Upper member, and the Boxford Undifferentiated west and north of the Jenkins Quarry. Outcrops of the Sharpners Pond Diorite contact the soapstone body on the north and crop out 30 m west of the quarry. Castle (1964) has mapped this as a biotite-hornblende tonalite facies. He describes it as medium grained, vaguely foliated to massive, grey tonalite. Additional work is necessary to further delineate the soapstone contacts and the relationship between the Sharpners Pond Diorite, the Boxford Formation and the Andover Granite. The schists and amphibolites of the Boxford Formation may account for some of the soapstone outcrops. Hydrothermally altered diorites and gabbros within the Sharpners Pond Diorite may account for other outcrops of soapstone. To complicate the picture further, Castle (1964) also maps amphibolite bodies within the Sharpners Pond Diorite.

Fish Brook Gneiss. The Fish Brook Gneiss is a light grey, fine to medium grained, biotitic, feldspathic gneiss of age 499 +6/ -3 Ma (Hepburn et al, 1999). It is characterized by a unique swirled biotitic foliation up to several centimeters in diameter. Castle (1964) states that the gneiss is distinctly foliated but not layered, and that locally, the internal structure of the Fish Brook Gneiss is conformable with the Boxford Formation. "Blocks of amphibolite and thinly layered biotite gneiss commonly are included in the Fish Brook Gneiss, particularly along its northern edge. All the inclusions contained within the gneiss are rock types common to the adjacent Boxford Formation… The foliation in the surrounding gneiss is characteristically continuous with that of the inclusions…" (Castle, 1964). These may correlate with the amphibolites of the Boxford Formation.

The Soapstones

New England soapstone is generally classified as peridotite, serpentenite, or schist. These field descriptions are largely textural and influenced by the presence or absence of biotite and muscovite. Based on chemical analysis, Greene (1970) reports soapstone in Francestown, New Hampshire as dark green foliated talc phlogopite schist, and grey green talc phlogopite actinolite schist. Dunn (1945) reports the parent material of a bowl fragment at the Oaklawn Soapstone as "chlorite schist". Seven varieties of soapstone have been observed in Essex County. Petrographic analysis has been done for, the Jenkins blue, massive green, schistose green, and the black dioritic soapstone. The latter is from well within the Sharpners Pond Diorite in North Andover.

Jenkins Blue Soapstone. The Jenkins blue soapstone has a massive texture. In boulders weathering surfaces are light grey and powdery. In outcrop it is highly sheared with nearly vertical planes set approximately 0.5 to 1 meter apart. The vertical shearing planes lend themselves easily to quarrying and therefore to William Jenkins description as "blue free stone".

Green Soapstone. The green soapstone exhibits two textures, massive and schistose. The *schistose* variety is a pearly grey green to dark green schist with many platy partings. Its association is unclear at this time. In outcrop, the sheared surfaces are slickensided and have a talcy feel. This schistose green soapstone has three healed partings and tends to be more brittle and deformed than the more massive variety. The *massive textured* green soapstone tends to be greener and darker. The stone is similar to the Jenkins blue in texture with the exception of color. The massive green soapstone has relict crystal structures and characteristic blebs of altered black minerals. It is rare in outcrop but a boulder field of the massive green soapstone was utilized by Native Americans and is largely the subject of the Archaeological section which follows.

Black Soapstone. The black soapstone is distinctly different from the other varieties. It appears black on weathered faces, although it is a very dark grey. Its most distinguishing feature is the presence of relict altered pink or white feldspathic phenocrysts, which can be abundant. It appears in outcrop to be a gabbro or diorite gneiss with epidote veins. Hepburn (Personal Communication) indicates it may have originated as gabbroic cumulates during the magmatic phase of the Sharpners Pond Diorite. He attributes the formation of soapstone to metamorphic waters.

Mineralogy

Jenkins Blue Soapstone. The rock is essentially composed of an aggregate of chlorite, clinoamphibole (actinolite?) and talc (Figure 4a and 4b). The chlorite occurs as long laths and more rarely scales. Twinning is common. The pleochroic formula is light yellow-brown to light green. Anomalous blue interference colors are occasionally observed. The clinoamphibole (actinolite?) is colorless, shows an elongate habit, and has interference colors ranging to the low second order, and small extinction angles (15^o to 20^o) in elongate sections. The talc occurs as fine platy to fibrous aggregates and has maximum third order interference colors. The elongate minerals show a random orientation. Magnetite and anhedral calcite occur as minor minerals. Also noted are remnant grains of primary amphibole and feldspar. The primary amphiboles are often extensively altered to chlorite + magnetite.

Figure 4a. Jenkins blue soapstone. Chlorite, clinoapmphibole (actinolite?), talc, and magnetite. Field of view, 2 mm. Plane light.

Figure 4b. Crossed polars.

Massive Green Soapstone. Similar mineralogy to Jenkins blue except chlorite and talc are now the dominant minerals (Figure 5a and 5b). The elongate grains are randomly oriented, hence the massive texture observed in hand specimen. Several large, extensively altered, amphibole grains were noted in this specimen.

Figure 5a. Massive Green Soapstone. Chlorite, talc, clinoamphibole, and magnetite. Field of view, 2 mm. Plane light.

Figure 5b. Crossed polars.

Schistose Green Soapstone. The sample essentially consists of a mosaic of chlorite laths with interstitial calcite (Figure 6a, 6b). Remnant amphiboles were noted. Minor minerals are magnetite and apatite.

Figure 6a. Schistose green soapstone. Chlorite, carbonate. Field of view, 2 mm. Plane light.

Figure 6 b. Crossed polars.

Black Soapstone. The Sharpners Pond Diorite (Black Soapstone) essentially consists of hornblende and intermediate plagioclase. The specimen is cut by veinlets filled with epidote (Figure 7a, 7b). Magnetite is an accessory mineral.

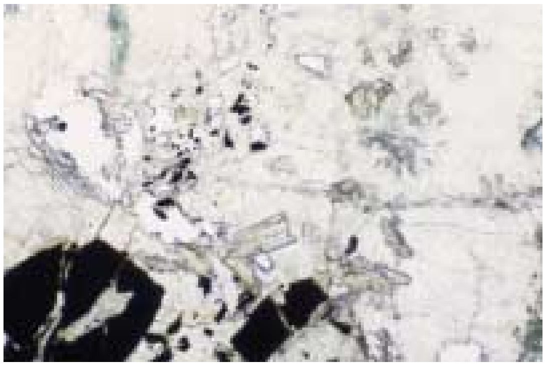


Figure 7a. Epidote veinlet in Sharpners Pond diorite. Magnetite crystals and remnant hornblende. Field of view, 2 mm. Plane light.

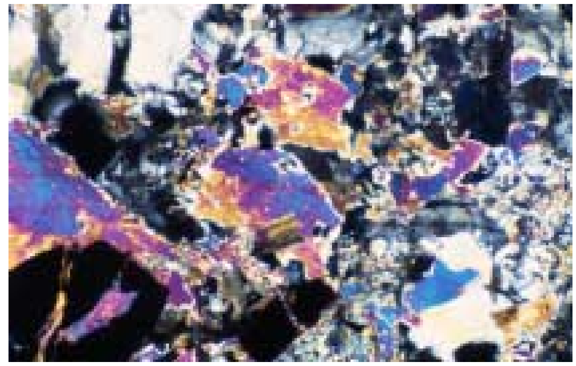


Figure 7b. Crossed polars.

Soapstone Genesis

The Soapstones of Essex County are not thought to be of ultramafic origin but fall into the categories of highly altered mafic metavolcanic rocks and altered igneous rocks of dioritic and gabbroic composition which formed as fractional cumulates within the Sharpners Pond Diorite. Magma differentiation within the Sharpners Pond Diorite may be observed as gabbroic cumulates (Castle 1964, Hepburn et al., 1995). Some of these bodies have been altered to soapstone. Since these soapstones grade laterally into competent rock of gabbroic and/or dioritic composition, field evidence suggests they are associated with hydrothermal venting along old structures reactivated during the emplacement of younger igneous bodies such as the Andover Granite. Structural trends including faults, shear zones, fractures relict bedding and other lineations trend generally N25E, N80E, N5E, and N40-60W. Such diverse origins can account for the 7 varieties of soapstone thus far observed as sinuous and sporadic outcrops in Essex County. It is undeniable that the Native Americans viewed them with great interest. Since the Native Americans were more attracted to the malleable properties of soapstone, and not its field associations, finding the location of native quarries is as complex and obscure as understanding the structural relationship between the soapstones the Andover Granite, Boxford Formation, Fish Brook Gneiss, and the Sharpners Pond Diorite. (See Hepburn et al this Volume)

ARCHAEOLOGY

Aboriginal Workshops at the Skug River II Site and Historic Quarrying

The soapstones at the Jenkins Quarry (Skug River I) and the green soapstone boulder field and related workshop at the Skug River II Site were both utilized by Native Americans. However we will focus on the Native American quarrying features from the latter site and conclude by contrasting them with historic quarrying techniques visible at the Skug River I Site.

A boulder field is a glacial deposition feature where boulders comprise a major part of the landform. They are often the product of frost wedging and glacial plucking of rock ledge. Howes (1944), states that the Native Americans quarried boulders in Wilbraham by digging pits within an area 350 feet long by 200 feet wide. At the Skug River II site, some of the boulders have been disturbed by gravel operations while a few dozen remain in-situ. Immediately outside the graveled area, the remnants of aboriginal workshops cover several hundred square meters. These contain numerous worked boulders, bowl blanks, abundant small soapstone flakes and dust, and small pit features.

The most striking cultural feature in the boulder field is the removal of blocks of soapstone from the boulders. These removals are characterized by pecked grooves, often in arcs rather than straight lines. The grooves enter v-shaped notches along the boulder's edge and often continue over the back of the boulder (Wall, 2003). Nearly all the grooves run along natural cracks that have been expanded through pecking. This method of block removal to create bowl preforms has not previously been described. In addition to block removals, smaller cobble-sized stones (20 to 60 cm) were split and utilized as preforms as well. The splitting of cobbles and small boulders to produce bowl blanks has likewise not been addressed in the literature (Wall, 2003). Finished Late Archaic bowls from Massachusetts' site collections are presented in Figures 1a and 1b.

Large Boulders. Within the boulder field and workshop area, a few dozen large boulders remain in place. At least five show evidence of extensive block removal and enlargement of natural cracks. Soapstone dust, smoothing stones, and chips were also noted beneath the leaf duff at this location. The largest stone is 1 meter tall and 2 x 3 meters square and is shown in Figure 8. Dixon, (1987) describes two 50 cm bowl removals from the rock face at Johnston, Rhode Island. A similar size removal (20 cm) is visible on the face of the largest boulder. Howes (1944) has described Native Americans removing bowls in Westfield, Massachusetts by pecking grooves.

Utilized Small Boulders. Ripley Bullen (1940) reports, that boulders ranging from 11 to 34 kg were utilized at the Dolly Bond Quarry in Millbury, Massachusetts. This size range matches the utilized and pecked green soapstone boulders observed at the Skug River II Site. These small (25 to 60 cm) boulders are also a strong visual match to an incomplete green soapstone bowl recently found in Andover north of the quarry and a small

Figure 8. The top surface has two sets of nested pecked grooves that exceed one meter in length. These grooves are 3 to 4 cm wide and 1 cm deep. The grooves appear to be enlargements of natural fractures in the stone. At the edge of the stone, 5 of the grooves become pecked notches. One notch is V-shaped, 4 to 8 cm deep, is 8 cm wide at the top, and tapers back towards the groove. Over the side, the grooves continue off plumb along the crack.

Figure 9. The boulder is flat and has a circular groove pecked into its surface. It continues under the leaf litter. A 10 cm long groove has been cut 2 cm deep at the edge of the boulder. Four small (.5cm) C-shaped holes were pecked to create the groove and are identical to the small holes observed at other locations. If the worker had completed this groove, a 30 cm wide bowl blank would have been cleaved from the stone. Note that the left corner has already been removed by the same methods.

complete bowl excavated from the Late Archaic Chadwick Pond Site in Boxford, Massachusetts. Based on the presence and depth of weathering rinds, it is apparent that complete small boulders were pecked into bowls. Some small boulders also appear to have been split to create bowl blanks with flat tops and bases (Wall, 2003). This technique has not been described previously. Several of these cleaved small boulders have been observed in the field trip area.

Historic and Prehistoric Quarrying Features. While evidence of Native American soapstone use at the Skug River II site is abundant, the principal focus of quarrying appears to have been boulders and not ledge. This is in contrast to other known quarrying localities in New England. Since glacially plucked boulders are often deposited adjacent to the source ledge, it is possible to see both utilized boulders and ledge as at the Skug I site. The following discussion focuses on two topics: a comparison of Skug River II site quarrying features with those of historic quarries, and a comparison of the massive green soapstone of the Skug River II with Late Archaic soapstone artifacts from sites in greater Andover.

In comparison to the historic quarry, the green soapstone boulder field and associated workshops contain a distinct and separate set of tool markings. The large and small boulders and workshop areas of the Skug River II site show the pick marks, grinding, grooves, notches, holes, cavities, dust and flakes one would expect to see in areas where blocks of soapstone were removed, hammered, spalled and reduced into bowl preforms and/or bowls (Wall, 2003). In contrast, at the Jenkins quarry, the visible historic tool marks are dominantly clean, fresh and linear; only slightly weathered; and consistent with those described by Gage and Gage (2002). Marks and techniques include scored lines made with a chisel, holes cut with a drill, the use of feathers and wedges, and evidence of sawing. These quarry marks are sharp and clear in contrast to the marks that occur on native worked surfaces. It is important to note the grooves and notches at the boulder field are not glacial striations.

The collections at the Robert S. Peabody Museum, Andover, were studied to determine if the local soapstone varieties were represented among the artifacts. Strong visual similarities were observed between the green and black soapstone and artifacts, primarily bowl fragments from Late Archaic sites in the Tyzzer and Shellnut collections. Tools from the Murphy Farm site of North Andover include picks of Sharpners Pond Diorite and Merrimack Quartzite, very similar to those observed at the Skug River II workshop site.

Field observations from these localities imply long term use of the soapstone resources by Native American populations in the greater Andover, North Andover, Boxford, Middleton and Reading areas. The massive green soapstone was principally used by Native Americans at the Skug River II site, and the Jenkins blue soapstone was used historically. These Soapstones are primarily associated with the Boxford Formation and the Sharpners Pond diorite. Areas tentatively identified as Native American workshop floors located within the Sharpners Pond diorite have pecked boulders, flakes and dust comprised entirely of the same metamorphosed diorites. Artifacts of meta-gabbroic composition are also represented in the collections. Therefore, additional geological research and survey should be done, to further define the relationship of these soapstone bodies to the lithic members of the Nashoba Terrane, and Native American utilization.

REBECCA NURSE HOMESTEAD

The Skug River I and II sites lie at the head of tributaries for the Parker, Ipswich and Shawsheen Rivers and the convoluted pathways that evolved between these ancient ways to the sea. Some of these pathways were used by Jenkins to haul lumber and ships knees to Danvers. In the early seventeenth century, tributary streams to Danvers and Salem Harbor could be reached by canoe, with short portages, from the Ipswich River drainage. By Jenkins' time Danvers was nearly 200 years old and hungry for wood for its oldest industries, the building of small boats and coastal traders, and the pottery. Although domestic pottery production was in decline by the early 1800's, Danvers' glacial marine clays were in no short supply. Danvers waters were shallow for the clays, the ships were small for the shallows, and by Jenkins' day the production of pedestrian brick became its paramount industry. The open waters the first settlers saw in the 1630's were now well silted in. Unlike Salem, its China trading sister to the south, which was approaching its zenith, Danvers was becoming a silty shallow back water. Its ports served more pedestrian needs such as boat building, fishing and coastal trading of lumber, barrels, ships knees, rope, coal, hides, shoes, pottery and brick. Its Pottery could not match the delightful and vitreous porcelains imported to Salem and was in decline.

Danvers had originally been blessed with open estuaries and at the Contact Period had been the home of Naumkeag Indians. Naumkeag means “fishing place” (Eugene Winter, personal communication). Since ancient times, sections of Danvers such as the Rebecca Nurse Homestead (5000 y BP) had been attractive to human settlement. The well drained upland soil; springs, and small ponds; clay and cobbles for tool making; and, water fowl, alewife, eels, and shellfish, made the lands of the Nurse Homestead an ideal place to thrive. With open waters on the Crane River during the mid seventeenth century, Francis and Rebecca Nurse prospered.

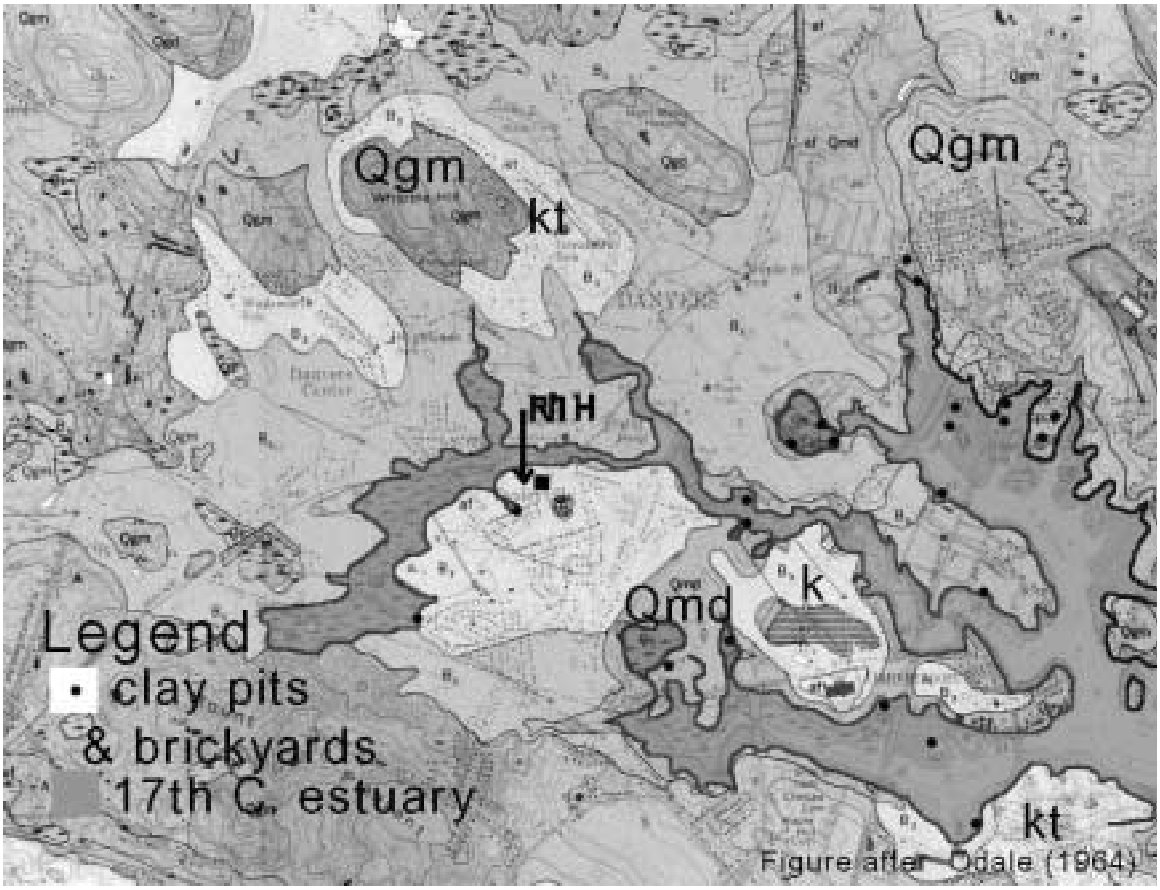


Figure10. The map of the surficial geology of Danvers, MA is shown above (after Oldale, 1964). Included are: the limit of high level glacial marine deposits (Qmd); clay pits and brickyards; and, an estimate of the seventeenth century estuarine limits. The brickyard and clay pit locations are after Proctor (1832), McIntyre, (1852), Sears (1905), Oldale (1964), and Watkins (1978).

Geology

Essex County has a coastline of drowned-valley estuaries, and steep rocky head lands. Relative to Middleton and Beverly, Danvers occupies a structural low, and bedrock’s most prominent role has been to pin the receding ice front long enough to produce the uplands between Porters, Crane, and Waters River estuaries. The Danvers area is underlain by a series of interbedded glaciomarine deposits including deltaic and glaciomarine sediments as mapped in Stone and Pepper, (1982). Robert Oldale (1964) recognized a contemporaneous relationship between some of the early glaciofluvial deposits and the highlevel marine deposits (as shown in figure 10). He noted that; “The highlevel marine deposits overlie the tills and other collapsed glaciofluvial deposits with a sharp contact … They are in turn interbedded with and in part overlie the later glaciofluvial deposits”…(Oldale, 1964). He included the blue glacial marine clays in the high level marine deposits. He notes the smaller ice contact features are coarser and more collapsed than the larger features. Below Purchase Street in Danversport, marine clay deposits are predominant.

Glaciofluvial Deposits. In the area of the Rebecca Nurse Homestead, south of the Crane River, the marine margin was stationary long enough to produce what appears to be an ice contact delta (Koteff, personal communication). Preliminary observations made during site reconnaissance in preparation for this field trip by Suzanne Wall indicate that stoney coarse gravelly sands underlie the broad ridge occupied by the Nurse House and out-buildings. They are visible in exposures to the west and in the ridge immediately south, of the Nurse House. The property has been plowed since the seventeenth century and the stratified deposits are likely mixed. On the western end of the homestead property, the broad ridge beneath the burial grounds is comprised of yellow brown fine to coarse sands. Remnants of a pale brown very-fine sandy, medium to coarse silt are visible south of the house. The silt is partly cemented and in the dry state resembles a fine to medium sand. The deposit is thin, discontinuous and has been used as a borrow.

At the Rebecca Nurse Homestead, the deltaic sediments (described by Oldale, (1964) as early glaciofluvial deposits; B3) extend southward from the Crane River toward Purchase Street, and appear similar to marine delta sequences described in Weddle et al, (1993). Between Purchase and Endicott Streets, Latimer and Lanphere (1925) map “stoney and gravelly loams”; and “silt loams” below Endicott Street. Oldale (1964) maps the majority of the area below Purchase Street as “highlevel marine deposits”. At the Peabody Pottery’s clay pits on the Crane River at Purchase Street, J.H. Sears (1905, p.359) took careful record of the relationship between the stoney coarse gravels and underlying fossiliferous glacial marine clays. Sears’ photograph shows over 2 meters of alternating 30 and 50 cm packets of “pebble gravels and stone gravels”. The gravel feature is underlain by a thin 20 cm sand layer and then bluish glacial marine clays. The stoney coarse gravels show relatively high angle settlement fractures which propagate downward directly into the clays. Within the clay mass the fracture inclines in a lower angle failure envelope more typical of clays and amply demonstrated by the even shallower gradients of the clays in the estuaries.

Along the Crane River, above the Purchase Street clay pits, silty fine sands replace the stoney coarse gravels. The sands are well exposed along the south bank Crane River on the Rebecca Nurse Property in the Tappleyville section of Danvers. Topographically, “The feature underlying Tappleyville appears to be a marine delta, formed at the ice margin on its northwest side”. (Koteff, personal communication) Bedrock outcrops immediately southwest of the Rebecca Nurse Homestead (between Collins and Andover Sts.) may have aided the development of the delta.

Glacial Marine Clays. The Glacial marine clays are a variable mixture of silt and clay and minor amounts of sand (Goldthwait, 1953). In the Danvers area Oldale (1964) has included the marine clays within the “highlevel marine deposits” as shown in Figure 10. The marine clays, coincidently, were mapped extensively in the Essex County Soil Survey (Latimer and Lanphere, 1925) as the Orono sandy and silty loam series. The waters which deposited the marine clays were cold, supporting species of Portlandia Arctica, and Saxicava Arctica (Sears, 1905). Sears photographed the fossils in situ in the thick sequences of marine clays which enveloped them. Goldthwait (1953) discusses the nature of the marine clays in New Hampshire and states that they are generally browner near the surface and blue-gray with depth, and attributes the red brown color to oxidation.

Sears (1905) describes the Danvers glacial clays in detail. His upper reddish-grey brick clays appear to be the same material as the Orono sandy loams of Latimer and Lanphere (1925) and the weathered red-brown marine clays of Oldale (1964). He describes the upper clays as containing more sand, pebbles and small boulders than the lower clays (1905); and notes that the well rounded boulders are “...pieces of hornblende granite or diorite...” He calls the upper reddish clays “brick clays”, and describes the clays at E. Carr’s pits on Liberty St., Danvers, as grayish- red clays 12 feet thick that have fine sand layers every few inches. He reports an early hygrometer test as follows: “Four ounces of clay from the brick clay pit of Edward Carr, Liberty street, (sic) Danvers, when washed , gave one ounce of fine sand , the residue being silty mud, which in ten hours’ time settled to the bottom of a jar of water, leaving the water clear. …under microscopical examination, was found to be composed of grains of feldspar, quartz, mica-plates, epidote, chlorite, and a flocculent mass of chlorite and kaolin” (Sears, 1905 p 358). Cobbles of Sharpners Pond Diorite and soapstone are well represented on the property.

On the Homestead property, glacial marine clays were observed in test pits excavated by Suzanne Wall during reconnaissance in the low areas and pond between the Nurse House and the burying grounds on Collins Street. Two test pits were excavated at the east end of the pond. In the first test pit, stiff grey and yellow brown mottled glacial marine clay was encountered at a depth of 20 cm and extended to termination depths of 107 cm. In the second test pit disturbed organic soils and muck extended to 70 cm where a fragment of grayish glazed, beveled, low fired, tile/brick was encountered. The clays began at 72 cm. The hole was terminated at 80 cm in grey fine to medium sandy silty clay with carbonized plant fragments. The test pits were 10 meters apart and 3 to 4 meters from the pond.

On the Crane River, the reddish gray clays are underlain by 6 inches of rounded gravel, which is underlain by blue to black "leda-clays" (Sears, 1905, p. 357). He describes the glacial marine clays as containing few pebbles but numerous fossils of arctic species. At the Peabody Pottery, below Purchase St., Danvers, Sears describes the leda-clays as containing thousands of fossils in beds dipping 25 degrees to the southwest. He states, "...along the bedding planes, numerous fossil shells were exposed….which proved to be *Portlandia Arctica,* Gray all being small in size, none measuring over 8 mm long by 6mm wide" (Sears, 1908 p 364). "Half an ounce of fine quartz sand was obtained from eight ounces of this clay when washed and placed in a sieve, ninety mesh to an inch. The residue, a fine silty mud, when well shaken in a jar of water, settled to the bottom in fifteen hours, leaving the water clear. A microscopical examination proved this clay to be composed of grains of quartz, feldspar, epidote, calcite, a few small plates of mica, some tourmaline and garnet sand, masses of chlorite, and kaolinized feldspars, several shells of species *Foraminifera,* spicules of sponges, spines of echini, and some diatoms." (Sears, 1905, p. 364). Oldale (1964) notes that the clays extended northward in Frost Fish Brook in a narrow sequence that ended just south of Putnam Hill. These clays were used by the seventeenth century potters, Kettle and Hayward.

Archaeology and History

Probably having co-opted the farm fields of the Native Americans whose populations had been depleted by disease earlier in the century, the first settlers to the Danvers peninsulas followed their Native American predecessor's practice of planting their corn in bottom lands. The estuaries and bottom lands were attractive. Broad and gently sloping, they reflected the angle of repose characteristic of undercut saturated clay deposits. For centuries, until 1628, the Naumkeag Indians had occupied various sites in Danvers, including Danversport and Northfields (currently the adjoining parts of Beverly, Danvers, Peabody and Salem). In that year, John Endicott, first Governor of the Massachusetts Bay Colony, arrived in Naumkeag (Salem) with a company of 100. By 1632 he received the first King's Grant of land (Orchard Farm in present day Danversport). This property was later known as Endicott's Orchard and the clayey soils supported, in turn, the first fruit tree nursery in North America, Tapley's brickyard (in the late 19th Century), and now the Liberty Tree Mall.

The Church. In 1636 Townsend Bishop received a grant of 300 acres of land south of the Crane River. By 1648 the land was purchased by Governor Endicott, "improved", inherited by his son John Jr., and subsequently his wife Elizabeth. The property was later transferred from Elizabeth or her estate to James Allen, and the Endicott family desired its return. In 1678 Allen entered a 20 year rent/ownership agreement with Francis Nurse (Nourse) In 1638 the court at Salem allowed a group to settle the head of the Porter River about 5 miles northwest of the center of the town of Salem. This settlement was established as a separate parish (Salem Village) in 1672 with the authority to hire a minister, build a meetinghouse, and gather taxes for public improvements. "The Church of Christ at Salem Village" was organized by 1689 with 27 parishioners, including Rev. Samuel Parris who signed the church covenant. This church was the epicenter of the Witch Hysteria.

The Potters and Churchmen. Salem Village was well established when the first potter, James Kettle (b.1664/1665) bought land in 1687 on Frost Fish Brook from Jacob Barney. James Kettle married Elizabeth Hayward, and her brother Jonathan Hayward a potter trained by Kettle, married Mary Flint. According to research and excavations by Watkins (1968) James Kettle and Jonathan Hayward's pottery and kiln were on Frost Fish Brook (head of the Porter River). One or both of these lived at the current 73 Connant St. Between 1687 and 1695 Jonathan and Mary Hayward had transferred their membership to the church in Salem Village. The Nurses were covenant members of the church in Salem Town, but attended services in Salem Village as it was much closer. (Glen Mairo, personal communication) It is possible that both the Haywards and the Nurses were members of the congregation during the witchcraft incident. Rebecca Nurse was accused of witchcraft in 1692 by young Sarah Holten who lived across the Crane River (Holten St.). Rebecca was 71 years old when she was hung; July 1693. Her monument is in the Burial Grounds in the ridge of sands which occupies the west end of the current property.

During these years and beyond, the Kettle and Hayward Pottery on the Frost Fish Brook produced household wares including: yellow on tan slip decorated pans; fine thin necked drinking jugs with an unusual dark brown glaze; and roof tiles, among other items. The low-fired tile/brick (mentioned on page C3 11) was excavated in August 2004 in the second test pit east of the lower pond on the Rebecca Nurse (Nourse) Homestead. It was beveled and stamped SMNo or &MNo. The remainder of the name was broken off. Although intriguing, it will take more time to evaluate the significance of the find. [Watkins (1968) lists S Norcross, b. 1729, of Newton, Massachusetts as a brick maker in Cambridge in 1770; and M. Norcross, 1848, Farmington Maine; and, N. Norton, 1806 in Bennington Vermont.] Samuel Nurse inherited the Homestead in 1695 when Francis died. Phineas Putnam purchased the property in 1784. James Kettle's son Jonathan Kettell (b. 1701) built a pottery on the western end of the Crane River before 1731. Although Watkins (1968) lists the current address as 31 Andover St., South Danvers (Rte. 114), some caution must be taken with this location. However, it does bolster the possibility that glacial marine clays were used on the Rebecca Nurse Homestead. Watkins (1970) notes, that the Andover Road (Rte 114), where Kettle situated his pottery works, was completed in South Danvers, Massachusetts before 1700. At the time, the bridge over the Ipswich River in Middleton, Massachusetts (1/2 km east of Rte. 114) was the better crossing, especially for fragile goods.

Seventeenth Century Clay Industry. There are certain facts of the seventeenth century clay industry in the Massachusetts Bay Colony which it would be well to mention. The industry was considered a priority. The first recorded brick kiln was built in Salem in 1629 near Salem Willows (Rte. 1a) (Watkins, 1968). In Boston in 1635, Watkins reports that Thomas Mount fenced a section of marsh in front of his house to make bricks. The importance of the brick and pottery industry is further underscored by the heavy regulation of size, mix moisture and preparation. "The General Court of Massachusetts Bay Colony ordered June 10, 1679 that all bricks when made should measure nine by two and one quarter by four and one half inches, and the molds should be "well shod" with iron...The addition of salt or brackish water to temper the brick was forbidden" (Watkins, 1968, p.15). Glazes applied to pottery made from salt tainted clay will slump in the kiln and not adhere to the pot. Since clays were dug in November, turned in February and used in the spring, salt tainted clay would not be detected until the glaze (second) firing of the pots, and thus ruin the annual income of a potter. If there is too much water content in a brick, the high temperatures of firing causes micro-explosions producing an air-riddled "light brick" which has no strength to moisture, frost, or time.

The coastal trading of redware was an early and profitable trade out of Essex County, Boston and Charlestown. Coastal trading of pottery throughout New England was almost the sole propriety of these Massachusetts potters. Watkins (1968, p. 15) reports that coastal trading sloops were the "shops" from which Connecticut colonists bought their pottery and no potterys were established in the Connecticut Valley until the mid eighteenth century. Early potters had docks and several had their own boats for transport of their wares and raw materials. The principal means of transportation and movement of bulk commodities was by water. The glacially influenced shape of Danvers's estuaries, and the shallow clay dominated waterways intertwined the Danvers pottery, small boat building industries, and coastal trading for centuries.

THE SAUGUS IRON WORKS

The Saugus Iron Works was the second works in the Massachusetts Colony, but the first in Essex County. The trade in ores and charcoal for Saugus had great influence on the farmers, in the dead ice terrane of Middleton, South Andover and Boxford. Bogs and stone weren't hospitable to seventeenth century farmers and early settlers had their minds on iron (Watkins, 1970). Iron bars from Saugus and overland trade goods from Salem Village bumped and wound their way northward on ancient Indian trails; and shingles, barrel staves, charcoal and ore wound their way back down. Where the narrow twisted routes to Andover cross the Ipswich River in Middleton Village (Maple St.), they pass just south of the early eighteenth century Middleton Iron Works. The Saugus Works were failing in the 1670's and both the Saugus and Middleton works were ended long before Jenkins carted his way down to the sea.

At the Saugus Iron Works, the blast furnace, fineries, chafery, machine hammer, forge, and slitting mill were all located at the head of tide on the Saugus River. Unlike the low lying clay dominated tide heads in Danvers, the Saugus River is a steep rocky stream wedged in a large north to south fracture in the Dedham Granite and the Lynn Volcanic complex (Clapp, 1921; Kaye, 1980; Kaye, 1984). The Dedham, which outcrops 3 km to the northwest at Appleton's Pulpit, (on Appleton Street, Danvers) is a medium-coarse grained grey to pink equigranular altered granite. Kay (1984) describes the Lynn Volcanics as rhyolite, agglomerate, and tuff. The Walden Pond Fault (Kaye 1980) passes to the north of the iron works. The iron works occupies a headland within a fault bound block. The contact of the Dedham Granite and the Lynn Volcanics is a narrow zone of brecciated wall rock adjacent to the volcanic explosion pipe occupied by the Lynn Volcanics. This zone is a narrow concave arc opening southeastward with an apex roughly underlying Central St. at Marion St. The steepness of the glacially plucked bedrock rise (Kay 1980)) provided significant elevation for waterpower and sufficient restrictions for Richard Leader to construct an unusually large reservoir. At the iron works site, out wash sands overlay marine clays. The nature and extent of the clay bodies are unknown, although Lynn clays were utilized in the forming of molds for iron pots (White, 2003).

History and Geology

Richard Leader, the builder and first Ironmaster at Saugus, replaced John Winthrop Jr. as iron master in Braintree, Mass. in the summer of 1646. The Braintree furnace was completed in 1644 under Winthrop but by 1647 had run out of ore and was abandoned (Mulholland, 1981). Winthrop was a poor manager and the Braintree furnace location, although efficient by British transportation standards of the time, was not suitable. Because the Braintree operations were inefficient, Leader used the balance of the investor's funds to establish the iron works at Saugus. On completing the forge at Braintree in 1646, Leader chose a location where he could combine the operations of the mill on one site thereby eliminating some of the inefficiencies that plagued the Braintree Furnace and Winthrop. By January 1646, Leader, after complex dealings, had purchased the glacial outwash plain and portions of the Saugus River valley from a colonist named Thomas Dexter who was a rascal. The first deed reads in part. "All that parcel of land neere adjacent to the Grantor's house wch shall necessarily be overflowed by reason of a pond of water there intended to be stopped vnto the height agreed upon betwixed them, and also convenient land and sufficient for a water course intended to be erected together wth the land lyeing between the ould water course & the new one. As also five Acres & half in the Cornfield next to the grantors house, & two convenient cart ways one on the one side of the bargained premises & another on the other side thereof…"(Hartley, 1971). Hartley (1971) notes that water was held back by a large stone and earth dam on the Saugus River creating a large pond as noted in Figure 11. A canal sixteen hundred feet long connected the pond to a central reservoir. From the reservoir, wooden flumes controlled the flow to the forge, furnace and slitting mill.

Although the iron works was producing about 7 tons of cast iron per week the profits were low and expenses high. Richard Leader was feeling pressure from the backers of the iron works and by 1650 was replaced by John Gifford as manager. James Mulholland (1981) writes that Gifford had trouble distinguishing his funds from company funds. By 1652 the venture collapsed in lawsuits due to poor management by Gifford and other complications of cost and supply.

Making Iron. By the start of the sixteenth century, the bloom hammering (direct) methods had been replaced throughout Europe by the blast furnace method. In a blast furnace, charges of charcoal, limestone and ore were poured into the furnace top. The carbon created a reducing atmosphere of carbon monoxide and acted as a fuel. The limestone acted as a flux to carry away the siliceous fraction of the ore. The reducing atmosphere and heat broke the oxide bonds and the ore was reduced to liquid iron. After the slag was let out, the iron was either cast into pigs, the principal product, or in to a production line including pots, salt pans, and stove plates.

Because the carbon content often approached 4%, the cast iron products and pig iron were brittle. A finery hearth removed the carbon. The iron was then shaped under a water driven hammer into an anchony, which resembled a dumbbell, and which was fired again in a chafery forge where it was hammered into either plate or bar iron of standard sizes. After hammering it was known as wrought iron, and much of the slag and carbon had been removed by repeated heating and hammering. Considering that 400 bushels of charcoal and three tons of ore were needed to produce 1 ton of iron, and additional charcoal was consumed in all the refining steps, it seems the cost of charcoal and the cost of transporting bulk commodities were significant factors limiting profitability.

Bog Ore and Nahant Gabbro. The source of ore for the furnace at Saugus was bog iron. In the seventeenth century, "any competent blacksmith could make test of a sample of iron ore and produce small quantities of iron in his forge…Because of limitations of hearth size and the problem of handling and hammering hot metal, the output from a single bloomery was small…" and used locally (Mulholland, 1981, p. 69). Hartley (1971, p.166) speculates that Leader had men in the company who were engaged in searching for suitable ores and their primary assay tool was the lodestone. He states, "The useful content is a hydrated sesquioxide of iron ($FeO(OH).nH2O$), is [sic] on the order of from 35 per cent to 55 per cent in the specimens uncovered at the Hammersmith site." (Hartley, 1971, p. 167) Some ores were from under the water and others were dug on dry land. He indicates the former were lake or pond ores. These ores are deposited when ferrous iron dissolved in groundwater accumulates as iron oxides on subsurface materials at the groundwater/surface water interface. Ore deposition is influenced by biogeochemical processes. The bog iron received by Winthrop, Leader and Gifford was deposited in an environment with a pH probably ranging from 3.0 to 4.7 (White, 1941). The variability of pH in the lacustrine environment influenced the location and volume of ore deposition.

Iron also accumulates as ocher deposits at the seepage face and precipitates from percolating rainwater at the water table. This process has been observed by Suzanne Wall in the glacial sediments above the Sharpners Pond Diorite where Native Americans were exploiting this ocher near Liberty Street in North Andover. At the interface where ground water carrying ferrous iron enters a more oxic pond, the iron precipitates. The iron cements the constituent soil grains making the original exit relatively impermeable. This groundwater interface adjusts upward or downward creating another zone of accretion. The interface movement is controlled by hydraulic gradients (Wall-Porter, 1987), changes in pond water levels, and changes in the vertical and lateral characteristics within the interface sediments (Wall-Porter, 1988). From Leader's perspective, the zones of greatest ground water discharge into a surface body are the last to freeze and therefore easily recognized as good areas to survey. Charette and Sholkovitz (2001) describe the accumulation of an iron curtain in a Cape Cod estuary at the ground water-seawater interface.

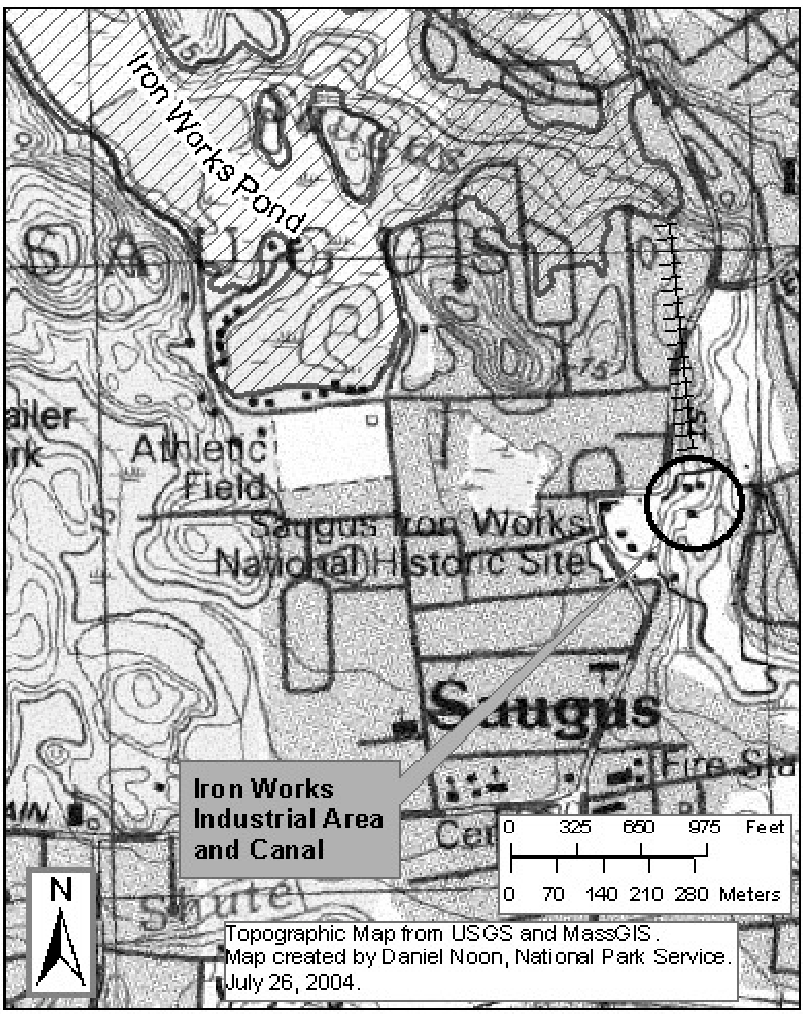


Figure 11. The Saugus Iron Works occupies a sandy terrace at the head of tide on the Saugus River. A canal thought to date from the time of the Iron Works is shown extending northward from the Iron works. The northern terminus of the canal is a dam built under the direction of Richard Leader. The Iron Works Pond extended to the northwest along the Saugus river drainage to the vicinity of Rte.1 and Walnut St.

In the furnace at Saugus, the sand and sediments entrained in the ferric matrix were removed by a flux of Nahant gabbro. Although limestone was normally used as a fluxing agent, and some shells and coral were found at Saugus (Hartley 1971, p. 167), the gabbro proved sufficient as a fluxing agent (C. White, personal communication). Hartley reports an iron content of 15% for the gabbro and states it was used in a ratio of 40 % to

60% bog ore. Charles H. Clapp (1921) lists the gabbro as diabase porphyry grading to a gabbro, and reports a total iron content of 11.25%. Of metallurgical interest, the Nahant has 10.99 % calcium and 4.23% titanium (Clapp, 1921). This may account for the total of 15% reported above. Clapp states briefly that the gabbro is highly altered. Suzanne Wall reports cutting and shaping samples of the gabbro that have a hardness of 3-5. Ironically, the altered gabbro is a soapstone. It may have been selected as a flux either because it was mistaken for limestone, or its ease of excavation, regardless, it was utilized at Saugus. The quarrying of the gabbro at Nahant was done by burning and hammering methods (Hartley, 1971) which involved heating the stone and beating it till it broke away from the ledge. These methods are outlined in Gage and Gage (2002). Moisture was not a friend in the furnace and both the bog ores and gabbro were roasted in layers of charcoal in kilns prior to their use in the furnace. This improved the quality of the ores (Hartley, 1971). Since Hartley reports the chemical content of excavated ores, it is possible he has sampled some of the roasted and improved bog iron.

Some of the stones lining the furnace are visible in structures on site. The slag can be seen fused to the stone and the intense heat appears to have re-crystallized the facing of the stone. Finding refractories that could hold up to the intense heat of the furnace was a problem. The stones at Saugus appear to be the local Dedham granite. Comment and input from fieldtrip members would be appreciated by the National Park Staff as to the nature of the stone and the deteriorated surfaces. The limited supply of lime fluxes and transport of the bog ores doubtless began to build in costs over time as nearby supplies became exhausted. The Saugus Iron Works was receiving ore from Middleton. The fact that Middleton Iron Works on Mill Street began in 1708 (Watkins, 1970) is no surprise. It was on the main highway to Andover and New Hampshire; Liberty Street. It was close to the bogs of Middleton, Reading, Boxford and Topsfield. But, of most note, it was closest to the bogs of Sharpners Pond, the type area for the iron-rich Sharpners Pond Diorite.

ACKNOWLEDGMENTS

Our thanks are extended to Dr. Thomas Weddle for initiating the idea for a geoarchaeological field trip at the 96th GSA meeting and his enthusiastic discussions of the Saugus Iron Works and iron making in Maine. Thanks also to Dr. Carl Koteff for his interpretation of the topography at the Rebecca Nurse Homestead and helpful direction towards surficial geological references for the Danvers area. We gratefully acknowledge Curtis White, Neil Trubowitz, Daniel Noon, Michelle Blees, Amy Curry, Janet Reagan and Richard Provenzano of the National Park Service at Saugus Iron Works for historic facts, discussions of iron production, and drafted figures. Thanks to Mr. Osgood and Glen Mairo for historical commentary on the Rebecca Nurse Homestead, the collection of historic maps of Danvers and notes on brick making in Danvers. Our thanks are extended to Richard Scott, Supervisory Ranger of Harold Parker State Park for his support. Eugene Winter provided guidance and was characteristically generous with books from his extensive New England historic and archaeological reference collection. In 2000, Mr. Winter requested some geologic reconnaissance to determine the provenance of the green soapstone bowls found in Essex County. Thanks also to Donnie Slater of the Robert S. Peabody Museum in Andover for collections access and his assistance with generating maps and figures, and thanks again to Malinda Blustain. Mr. Raymond Potvin, a member of the Massachusetts Archaeological Society first asked for a geologic review of the Jenkins soapstone quarry in 1999, and his enthusiasm is gratefully acknowledged.

IRON WORKS POND AND INDUSTRIAL AREA
(Courtesy of Saugus Iron Works. Drawing by Charles Overly)

ROAD LOG

8:00 Arrive at the Home Depot Parking Lot Danvers, MA; located at the northeast corner of the interchange of Rte. 114 (Andover Street) and Rte. 1 (Newburyport Tpk.) Danvers MA (01923). Consolidate vehicles here.

Please bring your cameras but do not bring, use, or think of using, rock hammers at these State and National Park Sites. Damaging and/or removing artifacts is illegal.

<u>8:20</u> Depart: Turn Right (north) onto Rte. 114 west toward Middleton. Travel 6.9 miles. (Pass Rte. 62, Middleton Center, and the North Andover Town Line) Turn Left onto Harold Parker Road. Travel 1.1 miles. Turn Left on Salem St. / Middleton Rd. travel 0.2 miles. Turn Left in to Park Headquarters. Richard Scott of Harold Parker State Park will provide an environmental and historical perspective. Consolidate vehicles here for Stop 1 only. We will return after 11:00 and "Un-consolidate", so to speak, for the remainder of the field trip.

MILEAGE
(Due to the sensitive nature of some of the locations in this area, the road log and stop description has been modified for Stop 1. Only the Jenkins Historic quarry is described in this version of the field trip guide. It is easily accessible from the Skug River trail. Directions may be obtained at Harold Parker headquarters.)

STOP 1. Jenkins Quarry (2 HOURS) Travel ten minutes by foot to the historic Jenkins soapstone quarry (1830's). It includes partly completed architectural stone in the quarry yard, and soapstone exposures, contacts, and saw mill ruins.

(Road log interrupted)

From park headquarters

3.3 Harold Parker headquarters.
Mostly Sharpners Pond Diorite but some stringers of quartz and soapstone.

3.8 Pass into North Reading and continue on Salem St.

4.1 Salem St. ends. Take Left on Forrest St. towards Middleton Center.

4.3 "Entering Middleton" sign. *Wills Hill, on the right, is the 1659, 700 acre farm of Bray Wilkins and John Gingell both of Dorchester and Lynn. The purchase was made with a deposit of 25 pounds (1 lb. in cash, 24 in bar iron). The south side of the hill was the home of a Native American, Will, who farmed the meadow and is buried there. Wilkins and Gingell agreed to pay Gov. Richard Bellingham 100 pounds in one year when they found iron or "mines or minerals" on the property (Watkins, 1970). Ahead, note that Rte. 114 did not exist. Forrest St. and Essex St. forked here. To travel to Andover from Middleton, this was the "The parting of the ways". In 1688, Essex St. passed over Gingell's meadow and Pout Pond Brook as a causeway and bridge. Quicksand made it an interesting tale.*

6.4 **Caution!** At stop sign, Turn Right onto Rte. 114. Enter left lane.

6.5 Take Left at light in Middleton Square (Rte. 62 toward Danvers). **Regroup** and head down hill on Rte. 62. Note that you are entering ye olde center part of Middleton (formerly Boxford). Note Liberty St. on left and the Ipswich River crossing. Prepare to turn Right. *Liberty St. was the first "Old Andover Road". The ford "Indian bridge" was ¼ mile south of the current Bridge. Liberty St. was an Indian Trail.*

7.2 *On left, sign that point out First Town meeting.*

7.3 Liberty St. *About 1/3 mile up, Mill St. enters from the right. Emerson Brook crosses Mill St. at the 1708 Middleton Iron works site.*

7.6 Ipswich River

7.7 Turn Right at light by Dunkin' Doughnuts, onto Gregory St.
To the left is a drumlin field. Nichols (1651), the first inhabitant, lived farther east near Copper Mine Road, beyond the drumlins. As you drive along Gregory St., notice the characteristic landscape of gently rolling terrain. We are crossing the bloody bluff fault zone

8.8 **<u>Do not enter Rte. 1.</u>** Turn Right onto Armory Rd., and take an immediate Left under Rte. 1.onto Center St., Danvers. Follow signs for Center Danvers.

10.4 *You have entered shallow bedrock and glacial marine deposits in the Historic Danvers District.*

10.6 Take Left on to Hobart St. at the Holten house and the Church of Salem Village (after 1697). Slow down and Look left. *The monument is at the location of the Church of Salem Village, famed for the witch craft trials.*

10.8 Continue on Hobart St. *Cemetery is in glacial fluvial deposits that flank Whipple Hill.*

11.2 Take a Right on to Pine St., at stop sign.

11.5 Intersection of Holten St. *Sarah Holten accused Rebecca Nurse of being a witch.*

11.6 Pass over Crane River.

11.7 Take Right into Rebecca Nurse Homestead. (149 Pine St., Danvers Mass.)

STOP 2. Rebecca Nurse Homestead (1.5 HOURS) the seventeenth century salt box Nurse House has 3 restored period rooms. A guided tour is provided. The 1681 Zerubabel Endicott house frame holds an exhibit of first period architecture and a gift shop. A reproduction of the 1672 Salem Village Meeting House features a multimedia program explaining the witchcraft outbreak in 1692. Eugene Winter will make a presentation of Native American Pottery. The property occupies 27 acres of glaciofluvial deposits, and a clay pit pond. A mixed group of geologists and archaeologists are welcome to tour the property and discuss small exposures and the Native American history of the site.

12:30 Depart.

12.1 Exit the Homestead and turn Right onto Pine St. towards Tappleyville. *The major clay pits were to the east and south.*

12.9 Pine St. and Sylvan St. bear Right onto Sylvan St. Stay in right lane. *To the left are low lands which are underlain by glacial marine clays, areas of Native American occupation, the 19th century Tappley brick yard, the 17th century tree nursery of Governor Endicott, and the Liberty Tree Mall*. Stay right past the Sylvan St. Grille

13.4 Enter left lane and take Rte. 114 East to Salem, MA. Proceed in the center lane on 114 E. *This upland is occupied by the North Shore Parking Center. More clay works were down on the low lands to the left. The Peabody potter's shops were located along Lowell, Washington and Boston Streets in Peabody.*

13.8 Take Right onto Southbound ramp for Rte. 128.

15.5 Enter right lane.

16.6 Exit to Rte. 1 South to Lynn. Take Left lane. Follow signs for Rte. 1 SOUTH! Go by the Ship and Christmastree Shop. See Saugus Iron Works sign. Space out vans. Watch for Rte. 129 West/Walnut Street exit. See Stone Yard. Take second Ramp, Walnut Street.

19.4 Exit onto the Walnut St. ramp. Turn Right at end onto Walnut St. *The mall on right occupies the drained pond bottom of the Saugus Iron Works Reservoir.*

20.5..Turn Right at light to Central St. and follow signs for the Iron works.

20.8 Follow Central Right. at fork to the Saugus Iron Works. Turn Left and Park.

STOP 3. Saugus Iron Works (1.5 HOURS) The Saugus Iron works is a Seventeenth Century industrial site, the best of its time. All the operations of iron production were at this one site. Curtis White, Lead Interpretive Ranger, will provide a tour of the facility. The Museum focuses on the history of the Iron works and the historical archaeology of the site. Dr. Tom Weddle of Maine Geological Survey will provide a brief talk on the iron works in Maine. Suzanne Wall will comment on the trade in bog ores and the Nahant gabbro, topics which she researched for this paper. This is the picnic lunch stop. The trip will disband from here.

END TRIP

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