THE PENNSYLVANIA CONNECTION: JASPER AT MASSACHUSETTS SITES.

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Jasper, often referred to explicitly as "Pennsylvania jasper", is found in small quantities fairly often at Massachusetts sites, and is even sometimes considered diagnostic of the Middle Woodland period (Borstel 1984:244). Occasionally people have questioned whether this jasper is actually from Pennsylvania and whether it is associated always and exclusively with Middle Woodland assemblages. This paper will survey most of the known jasper sources in the Northeast and attempt to determine where the jasper found at Massachusetts sites came from and when it arrived at those sites.

SOURCES OF JASPER IN THE NORTHEAST.

Jasper, as used here, refers to a fine-grained, glossy variety of chert that can range in color from mustard (or golden, or honey) yellow to bright red to brown. A geological definition is, "A dense, opaque to slightly translucent cryptocrystalline quartz containing iron oxide impurities; characteristically red." (Parker 1984:376). Most cherts are composed of almost pure silicon dioxide, though they all also have varying amounts of "trace elements", or minor impurities present in proportions of a few parts per million (Luedtke 1978). However, the proportion of elemental iron in jaspers is usually significant, ranging from less than 0.1% to more than 5%. Often the iron is in the form of the mineral goethite, a yellowish iron oxide. When heated to about 400 degrees Celsius, goethite will turn to hematite and yellow jasper will turn red (Schindler, Hatch, Hay, and Bradt 1982). Such heat treating can be achieved in campfires, and will also make the jasper more lustrous and easy to flake.

Rhyolite "Jaspers".

Not all the materials called jasper in New England fit the above definitions. For example, Saugus "jasper", actually a rhyolite, was first described in 1886 by Henry Haynes, who recognized its igneous origin. "This is not a true jasper, but a compact, non-porphyritic petrosilex of a light red color. It occurs only in a small outcropping on the south side of the Saugus River, a short distance to the northeast of the railroad station at Saugus Centre" (Haynes 1985:42). Haynes reports that this outcrop was surrounded by chipping debris; more recently, it is said to have been destroyed by construction in the area. I suspect that this outcrop was an intrusive deposit into the Lynn Volcanics, to which Saugus rhyolite bears a strong chemical resemblance (Luedtke 1980b). There are persistent rumors that similar deposits may exist elsewhere in the Boston area, and this would not be surprising. The material is also available, usually in small fragments, in glacially deposited gravels on Boston harbor beaches. In terms of its visible characteristics, Saugus rhyolite can be confused with red jasper if the observer is not careful. It ranges in color from dark red (10R 3/3 on the Munsell color chart) to pink (10R 4/4), often with one to three millimeter thick veins of a cream or pale yellow color (10YR 8/4). It is never gold, and never has the veins of translucent chalcedony that are often found in true jaspers. Saugus rhyolite is fine grained but often shiny on the outside and dull on the inside, just the opposite of the weathering pattern for true jaspers. It also often bleaches to a pink color upon prolonged exposure to sunlight.

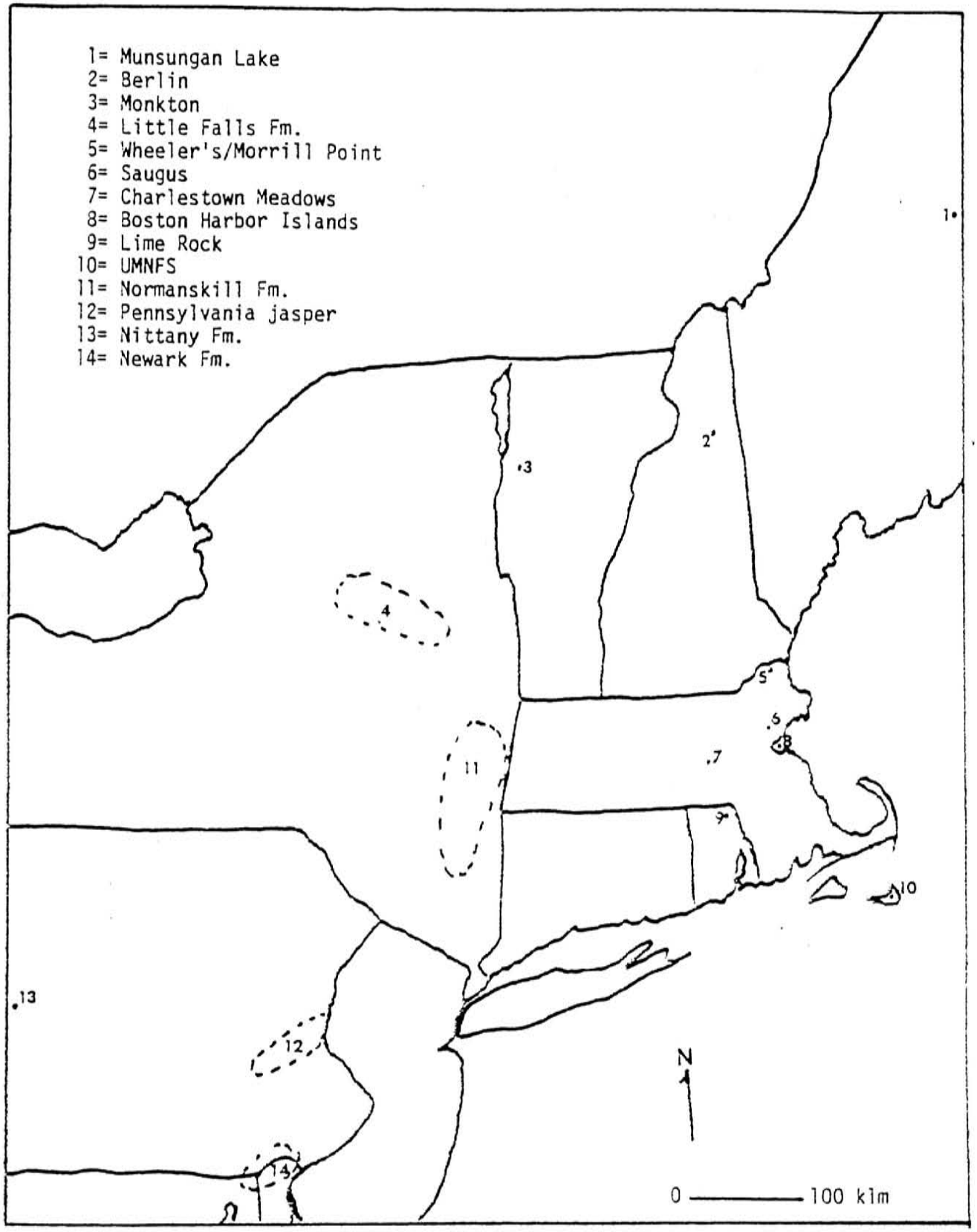

Figure 1. Sites and Lithic Sources Mentioned in Text.

Similarly, Berlin "jasper" from New Hampshire is an intrusive igneous rock, not a chert (Gramley and Cox 1976). This material is less easy to confuse with true jasper; when freshly broken it is greyish-green, though it weathers to a patchy brick-red. Flow banding is clear in both weathered and unweathered fragments.

Pennsylvania Jasper.

By far the most famous and extensive source of true jasper in the Northeast is the strip of outcrops in southeastern Pennsylvania extending some 60 kilometers from the Delaware River in Bucks County, through Lehigh and Berks Counties to the Schuykill River (Figure 1). Ten major quarries are known, including the best known ones at Durham, Vera Cruz, Macungie, and Bowers Station, and numerous minor quarries can also be found. At most of these there is extensive evidence of open-pit mining. The ground surface is pocked with quarry pits ranging from 0.3 to three meters in depth and from seven to 20 m in diameter, often with edges overlapping (Hatch and Miller 1985). The quarries show evidence of use beginning in the PaleoIndian period and continuing on throughout the entire prehistoric sequence. Around the quarry pits there are numerous workshops with evidence of all stages of tool manufacture and of heat treating (Thomas nd). Although this is not the only source of jasper in the state of Pennsylvania, it is the variety commonly referred to by archaeologists as "Pennsylvania jasper".

The jasper itself has formed by replacement of sandstone and quartzite in the Hardyston Formation, which is of lower Cambrian age (Lavin 1983:140). The jasper can occur in beds up to three meters thick (Thomas nd), but most of the quarries are located where the jasper is available as cobbles in the soil (Hatch and Miller 1985). The material itself varies from a dark gold (10YR 4/6) to bright red (10R 3/3) to dark brown (2.5YR 2/4). When heat treated, the yellow varieties turn red. Pennsylvania jasper is usually opaque and quite shiny, though it may weather to a dull patina. It is sometimes mottled and often shows a distinctive "wood grain" effect. It also often has tiny veins of translucent chalcedony.

Lime Rock Jasper.

Chert of any kind is rare in southern New England, so there was considerable excitement among regional archaeologists when a true jasper source was discovered at the Conklin Quarry in Lime Rock, Rhode Island. This jasper is predominantly dark gold in color (10YR 6/6) ranging to dark brown (7.5YR 3/2). It is mostly opaque, but a translucent grey variety is also present. It has tiny veins of translucent chalcedony, much like Pennsylvania jasper, and bears a marked resemblance to that more famous material. It would undoubtedly turn red if heat treated.

Not long after its discovery, Dr. Maurice Robbins, who was then State Archaeologist of Massachusetts, asked Clifford A. Kaye of the United States Geological Survey to make a study of this quarry. Dr. Kaye reported the following observations in a letter to Dr. Robbins dated April 11, 1979:

> ". . . fortunately, the origin of the Lime Rock chert is quite evident from its field relationships. I feel fairly sure that this is a collapsed sinkhole deposit formed during Tertiary or even Cretaceous time in the large lens of Precambrian marble that crops out here. We can see in the quarry side today the outline of the sinkhole and the rather spectacular mineralogy of the secondary deposits that formed in it. There are masses of pure goethite and manganese oxide dripstone. But more important, there are veins of clear, banded chalcedony as well as hard chert-like masses where

this secondary silica has impregnated the yellow ferruginous clay that is the principal material filling the sinkhole. These are the honey-colored chert boulders. This is, therefore, a secondary chert and is to be distinguished from primary cherts of marine origin which make up most artifact cherts.

I think it quite likely that all ferruginous cherts - particularly of this characteristic color - are of secondary sinkhole origin similar to that at Lime Rock and were formed in the rather special climatic and geochemical conditions that prevailed during the Tertiary in sinkhole environments. This means that in the late Tertiary, wherever slightly siliceous and highly calcareous limestones and marbles occurred, there were deposits of honey-colored chert; and because limestones and marbles of the required composition are fairly widespread, there were undoubtedly many such occurrences. While it is true that in eastern New England there are no wide-ranging limestones or marbles, lenticular marbles are known in several areas besides that of Lime Rock (see: B. K. Emerson, 1917, pp. 27-28, 42, 72, 83-84, as well as others I know about). In western New England, of course, there is a very prominent north-south marble belt. Glacial erosion during the Pleistocene removed most of the Tertiary sinkhole material but evidently remnants of larger and deeper sinkholes were left here and there, as at Lime Rock."

In my own visit to this quarry, I observed that the remaining part of the chert deposit appeared to be located well below the top of the quarry wall, suggesting that it might not have been exposed until modern quarrying uncovered it. The deposit may have originally extended to the surface, but it is also possible that this specific jasper source was not available to prehistoric people. However, as Kaye states above, other similar deposits are likely to have formed in similar geological circumstances, and some of them may have been exposed by erosion or glaciation. Jasper pebbles are occasionally found in glacial gravels along the north shore of Long Island Sound, and are also reported in conglomerates near Newport, Rhode Island (Kay and Chapple 1976). The new jasper source recently discovered in the western part of Massachusetts may also be an example of such a pocket of jasper that was made available to prehistoric people by erosion (Parrett 1985).

Other Sources.

There are still other sources of red chert in the Northeast, in the form of both bedrock deposits and of gravels or conglomerates derived from the bedrock. True jasper occurs in the Nittany dolomite of central Pennsylvania (Miller 1982), the Newark Formation of New Jersey (Lavin 1983:54-57), and the Monkton Chert of western Vermont (Lavin 1983:141). The Normanskill and Little Falls formations of eastern New York (Lavin 1983:70, 117) and the Munsungan formation of northern Maine (Pollock 1983) all produce red varieties of chert, though most of the chert from these formations is of other colors. In general, none of these red cherts are as fine quality as Pennsylvania or Lime Rock jasper, and most have coarser textures, duller lusters, and muddier colors. However, individual fragments of all these varieties of chert can be mistaken for each other.

THE SOURCE OF THE JASPER AT MASSACHUSETTS SITES.

Jaspers all tend to appear similar because they all get their coloring from iron. Therefore, simply looking at jasper artifacts can lead to incorrect identifications. A more reliable method of identification is to examine thin sections with a petrographic micro

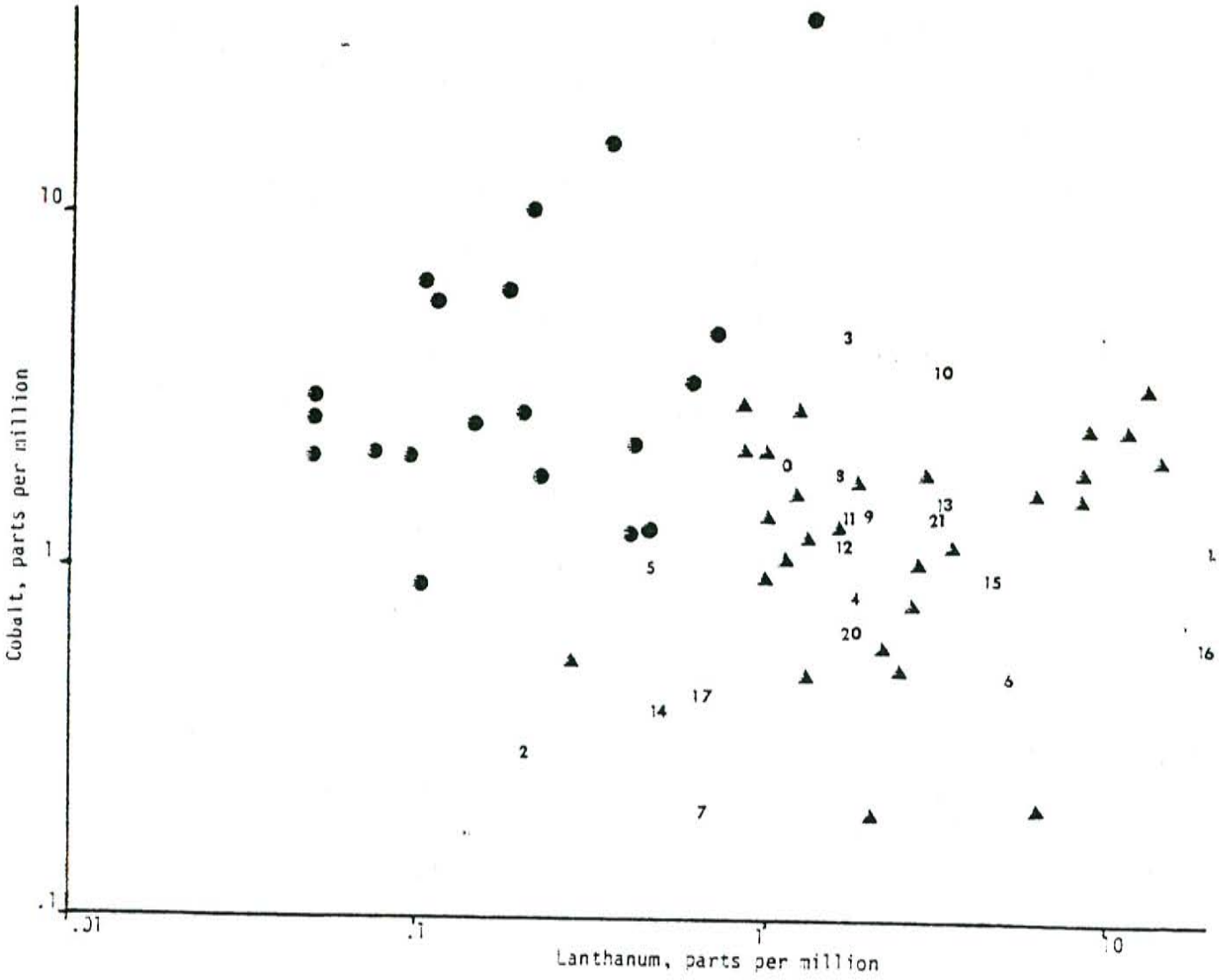

Figure 2. Trace Element Concentrations for Lime Rock Jasper (circles), Pennsylvania Jasper (triangles), and Artifacts (numbers).

scope, because many cherts have distinctive minerals and textures (Lavin 1983). Most cherts are also chemically distinct (Luedtke 1978), and one exploratory study of jasper in particular found clear differences between the Nittany, Hardyston ("Pennsylvania jasper") and Little Cattail Creek (Virginia) jaspers (Hatch and Miller 1985).

In order to determine more precisely the source of the jasper from Massachusetts sites, I used neutron activation analysis to obtain chemical data on 16 trace elements in samples of jasper from the Pennsylvania jasper and Lime Rock quarries, and also for jasper flakes from several eastern Massachusetts sites (Table 1 and Figure 1). The jaspers from Lime Rock and from Pennsylvania differ for many trace elements, but Figure 2 shows that there is good separation for proportions of the elements lanthanum and cobalt. It is also clear from this figure that the artifacts are more similar to the geological samples from

TABLE 1. Analyzed Jasper Artifacts.

SAMPLE #	SITE	PROVENIENCE	REFERENCE
0	Wheeler's	S12,14/E20,22, F. 18	Barber 1982
1	Wheeler's	S34,36/E20,22 F. 4	Barber 1982
2	Wheeler's	S28,30/E20,22 F. 28	Barber 1982
3	Morrill Point	S7,9/E19,20	Barber 1979
4	Wheeler's	S12,14/E18,20 F. 36	Barber 1982
5	Wheeler's	S12,14/E18,20 F. 16	Barber 1982
6	Morrill Point	S8,10/E19,20 L. 1	Barber 1979
7	Charlestown Meadows	surface	Hoffman 1984
8	Charlestown Meadows	S46 W33	Hoffman 1984
9	Charlestown Meadows	S49 W34	Hoffman 1984
10	Charlestown Meadows	S52 W34	Hoffman 1984
11	Charlestown Meadows	S55 W35	Hoffman 1984
12	Charlestown Meadows	S58 W34	Hoffman 1984
13	HL-7	TP3, L11, #31	Luedtke 1975
14	HL-7	TP3, L12, #33	Luedtke 1975
15	HL-8	TP2, L2, #3	Luedtke 1975
16	HL-8	TP1, L3, #29	Luedtke 1975
17	HL-8	TP4, L5, #97	Luedtke 1975
20	HL-22	seacliff profile	Luedtke 1975
21	UMNFS	61/180-6	Luedtke 1980a

Pennsylvania than to those from Lime Rock. This finding is true for the trace elements not shown as well. Furthermore, none of the Massachusetts artifacts had trace element proportions similar to those reported for the Nittany, Little Cattail Creek, or Newark jaspers.

A few of the artifacts are somewhat different from the Pennsylvania jasper samples, and could possibly have come from another jasper source. However, this is more likely to be a factor of the sampling. Most of the samples of Pennsylvania jasper I analysed came from the Vera Cruz quarry, and Hatch and Miller's data demonstrate that there is a certain amount of chemical variation between quarries of the Hardyston formation. Thus, some of these artifacts may simply have come from Pennsylvania jasper quarries other than the one at Vera Cruz.

These results do not mean that all jasper from Massachusetts sites will be found to have come from southeastern Pennsylvania. More thorough testing of artifacts and sources is of course necessary before such a statement could be proven. However, for reasons that will be discussed in the last section of this paper, I suspect we will find Pennsylvania was the primary source for the jasper that reached Massachusetts.

WHEN WAS JASPER BROUGHT TO MASSACHUSETTS?

Jasper has been found at many PaleoIndian sites in the Northeast, including Bull Brook (Byers 1954), Wapanucket (Robbins 1980:274, 282) and Reagan (Ritchie 1953). Only a few pieces of jasper were found at these sites, however, and other "exotic" cherts were more common.

During later periods in Massachusetts, locally available lithic materials were used almost exclusively. An exception is the Middle Woodland, when cherts from a variety of locations, including New York and Pennsylvania, appear in Massachusetts, sometimes in surprising quantities. For example, Barber reported that jasper made up 17.4% of the mass of the debitage at the Wheeler's site (Barber 1982:52).

In order to test the proposition that jasper is found primarily at Middle Woodland sites in eastern Massachusetts, I used a sample consisting of 22 sites I have tested or excavated, so that I could be sure the raw materials had been identified consistently. These sites include components ranging from the Middle Archaic to the Late Woodland, and stretch through the coastal zone from Shattuck Farm in the north (Luedtke 1985) through the Boston Harbor Islands (Luedtke 1975, 1984) to Nantucket (Luedtke 1980a). I tabulated which sites (or separable components of sites) had produced jasper, as well as which had produced artifacts diagnostic of the Middle Woodland period, such as Jack's Reef or Fox Creek projectile points and grit tempered ceramics decorated with rocker stamping and dentate stamping. Table 2 shows the results of this small study. For my sites, jasper was found only at sites which also produced Middle Woodland artifacts, and sites without such diagnostics did not have jasper. However, it should be noted that some sites with Middle Woodland diagnostics did not produce jasper.

TABLE 2. Association Between Jasper and Middle Woodland Components.

	Jasper present	Jasper absent
Sites with Middle Woodland components:	6	8
Sites with no Middle Woodland components:	0	8

This could simply be a sampling problem; jasper is relatively rare at Massachusetts sites, and it would be easy to miss the few jasper flakes present at a site if only a small proportion of it was excavated. However, at least two of my sites (Shattuck Farm Locus G and HL-11) produced large samples of flakes, yet absolutely no jasper (Luedtke 1985).

A second possibility is that jasper was not used throughout the entire Middle Woodland period. In the Northeast, the Middle Woodland is commonly divided on stylistic grounds into an early and a late phase; for example, in southern New England Snow defines a Fox Creek phase from A.D. 350 to 700, followed by a Fourmile Creek phase from A.D. 700 to 1000 (Snow 1980:281-282). Support for the idea that different patterns of stone tool material procurement may have existed during these periods comes from two shell middens on Long Island in Boston Harbor (Luedtke 1984). Both sites had considerable Middle Woodland components and many other similarities, but they produced quite different lithic assemblages. On the basis of differences in ceramic thickness and decoration (Luedtke 1986), I have suggested that one was used primarily during the earlier part of the Middle Woodland and the other during the later Middle Woodland. Jasper was found associated only with the later component. Furthermore, of all the Middle Woodland components in the sample of 22 sites described above that could be assigned primarily to the earlier or later portions of the Middle Woodland (on the basis of either radiocarbon dates or ceramic attributes), jasper was associated with only one of the six "earlier" components, but with five of the six "later" components.

Other Massachusetts sites support the suggestion that jasper is associated primarily

with the later Middle Woodland. The jasper-rich Wheeler's site produced radiocarbon dates ranging from A.D. 750 to 1250 (Barber 1982:14). The nearby Morrill Point site also produced jasper. Though considered by Barber to be predominantly of early Late Woodland age, it produced pottery that suggests to me that it was also used during the very end of the Middle Woodland period (Barber 1979:433). The Cunningham site on Martha's Vineyard also produced jasper artifacts in late Middle Woodland context (Ritchie 1969:122).

Further support for this hypothesis is provided by archaeological data from the Pennsylvania jasper quarry area itself. The Vera Cruz quarry was used during all pre-historic time periods, but was exploited intensively during the Middle Woodland (Hatch and Miller 1985:227). Lavin surveyed lithic materials at sites along the Delaware River drainage, just to the east of the Pennsylvania jasper quarries, and found that Pennsylvania jasper was rarely used during the Early Woodland but began to appear more frequently during the early Middle Woodland. It became a very important material at Delaware River Valley sites only during the late Middle Woodland, and then its use tapered off again during the Late Woodland. Specifically, Lavin says that Delaware watershed assemblages are mostly made of local raw materials during the early Middle Woodland Abbott Phase (associated in this region with Fox Creek projectile points), but mostly of jasper and other non-local cherts during the later Middle Woodland Point Penninsula Phase (associated in this region with Jack's Reef projectile points [Lavin 1983:247-248]).

REASONS FOR THE "PENNSYLVANIA CONNECTION".

Why was jasper brought more than 400 km from Pennsylvania to Massachusetts during the PaleoIndian and later Middle Woodland periods, despite the availability of many closer lithic sources? For the PaleoIndian period, the presence of small quantities of jasper is not at all surprising. Exotic lithic materials are characteristic of virtually all North American PaleoIndian assemblages. The PaleoIndians flourished in a difficult post-glacial environment, and their success was probably due in part to their organizational and technological flexibility, their seasonal movements over large territories, and to kinship and trade mechanisms which functioned to keep people in contact with one another. The presence of exotic lithic materials may simply be a reflection of these factors (Wilmsen and Roberts 1978:177-179). It is also possible that the PaleoIndians deliberately sought exotic lithic materials, perhaps to increase success in hunting. Snow points out that the dramatic color change that occurs when jasper is heat treated, and the similarity between the color of bright red jasper and of blood could have made jaspers especially attractive to hunting peoples (Snow 1980:132, 134).

The Middle Woodland period in eastern North America is also noted for the existence of large scale trade networks and long distance trade in lithic materials (Griffin 1983:265), but the motivations for this trade were surely very different than for the PaleoIndians. Exotic lithic materials are prominently associated with burial ceremonialism at Middle Woodland sites in the Midwest, and probably also served as status symbols in societies that were apparently beginning to evolve hereditary leadership and class differences (Griffin 1983:270). The great Hopewell trade networks had collapsed by A.D. 400, but some of the same social and ideological trends that stimulated interest in long-distance trade in the Midwest may have begun to influence southern New England at a somewhat later time.

Massachusetts has traditionally been seen as only marginally involved in Middle Woodland ceremonialism and trade, because of the lack of the more obvious manifestations such as moundbuilding, complex burial practices, and the manufacture of such artifacts as platform pipes, sculptures, and zoned rocker-stamped ceramic vessels (Snow 1980:285). However, the demonstrated trade in exotic cherts, and especially jasper from Pennsylvania, suggests that Middle Woodland people in Massachusetts were actively involved in relations

with neighboring groups. Jasper may simply be the tip of a "trade iceberg"; extensive trade networks focussed primarily on furs, shells, and other organic materials would leave few traces for archaeologists to find. The jasper itself may also have had ideological or aesthetic value simply because it is so very different from most local materials. At the Wheeler's site, Barber suggests that jasper artifacts were acquired as finished tools (judging from lack of evidence for on-site manufacture), and were highly valued (judging from the higher rate of resharpening, compared to tools made of other materials) (Barber 1982:103).

Many interesting research questions remain to be pursued. This study has focussed on eastern Massachusetts, and primarily on the coastal zone. Is jasper also found at inland sites and sites further north during the late Middle Woodland? Does its distribution follow the coastline, rivers, or both? Are there any indications of what materials might have been traded south in return for jasper? Did jasper function as a status symbol in Massachusetts? Was access to jasper restricted to certain individuals or families within the larger society? The "Pennsylvania Connection" was a unique phenomenon in Massachusetts prehistory, and it provides a fascinating opportunity for research on Middle Woodland trade and social relations.

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