REPORTS

THE ANALYSIS AND DISTRIBUTION OF VOLCANIC ASH-TEMPERED POTTERY IN THE LOWLAND MAYA AREA

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Petrographic analysis of potsherds from Dzibilchaltun and other Maya sites conclusively establishes the presence of volcanic ash temper in ceramics from northern Yucatan. The distribution of ash-tempered ceramics in time and space suggests import of ash in bulk from sources in highland Guatemala or El Salvador in exchange for salt. The homogeneous nature of the ash in northwestern Yucatan supports the idea that certain trading organizations enjoyed exclusive access to that region, while competing for markets in other lowland areas.

Trade among prehistoric peoples is currently a topic of great archaeological interest, and a number of articles and books have recently appeared on the subject. The Maya have received a considerable share of this attention, with long-distance trade in utilitarian or elite items seen as involved with the very beginnings and end of the civilization (Rathje 1971; Webb 1973). In a recent analysis of long-distance Maya exchange systems utilizing obsidian, Sidrys (1976:449) maintains that obsidian was the “only non-perishable good that was imported from long distances (100 km) in sufficient quantity to warrant this consideration as an everyday utilitarian item.” We believe that volcanic ash was utilized by Yucatecan potters and, like obsidian, was also imported in abundance.

Since the identification of the material called “volcanic ash” by archaeologists has recently been questioned, we present the results of petrographic analyses of potsherds suspected of having ash temper. Next, we present arguments in favor of import in bulk rather than as finished vessels. Finally, we discuss the distribution of sites in which ash-tempered ceramics occur and some implications of this distribution.

PRIOR ANALYSES

The presence of ash temper in Lowland Maya pottery was first noted in 1936 by Anna Shepard (1937:145) and discussed in detail in her report on the technological analysis of the ceramics of San Jose, British Honduras (1939:251–257). She noted the presence of considerable amounts of ash among the “several thousand sherds” that she analyzed for George Brainerd (Brainerd 1958:69), and she was responsible for the technological sections of the reports on ash-tempered Mars Orange ware from Uaxactun (Smith 1955:32) and the ash-tempered ceramics from Mayapan (Smith 1971:268–269). On several occasions she speculated on the reasons for the use of ash and the source from which it may have been derived (Shepard 1939:271–274; 1964:252). In recent years, however, her analysis has been questioned.
Figure 1. Areas with ash-tempered ceramics during (a) the Early Classic, (b) Late Classic, (c) Terminal Classic, and (d) Postclassic periods.
A geological and geographical survey of the northern Yucatan Peninsula by Isphording and Wilson (1974) failed to find any ash deposits, thereby virtually eliminating the possibility that the ash was obtained locally. No doubt impressed by Brainerd’s contention that “the quantities of this material which must have been used in [Yucatecan Slate wares, would] preclude the possibility of importation” (quoted in Isphording and Wilson 1974:484), they proffered an alternative explanation, that Shepard may have misidentified a local clay as ash. Of the four types of clay that they felt were “accessible and abundant enough” (1974:484) to qualify as volcanic ash, the mineral palygorskite, formerly thought to be derived from the breakdown of volcanic materials, seemed the best candidate (1974:487). Palygorskite was identified by high-temperature X-ray diffraction techniques as a component of the paste of a Classic slateware sherd from the site of Ni Puuc, near Edzna, Campeche. However, a careful microscopic examination of this sherd after disaggregation revealed “a complete lack” (their emphasis, 1974:486) of any materials of volcanic origin. If one overlooked the absence of expected volcanic minerals, they claimed, palygorskite could be confused with true volcanic clays (1974:486). They concluded that “pottery containing the palygorskite clays is that which has been described in past reports as ‘volcanic ash tempered’ ” (1974:486). We reject this claim on the basis of our petrographic analysis and suggest that their error resulted from analyzing a sherd from an area in which ash temper is noticeably rare (see distribution data and Figure 1).

PETROGRAPHIC ANALYSIS

A sample of nine potsherds from common wares in the northern Yucatan sites of Dzibilchaltun and Chichen Itza were selected for the initial petrographic analysis. Of those from Dzibilchaltun, six are Dzibical Black-on-Orange (Puuc Red ware), one is Balantun Black-on-Slate (Chichen Slate ware), and one is Muna Slate (Puuc Slate ware). One sherd of Dzitas Slate (Chichen Slate ware) from Chichen Itza completed the sample. Tentative temper identifications made with the aid of a

Figure 2. Photomicrographs of Dzibical Black-on-Orange sherds from Dzibilchaltun. (a) Volcanic ash and dust fragments comprised of colorless isotropic glass stand out clearly in this sherd (#M-107A). White bar = .5 mm in all photomicrographs. (b) Slightly larger ash and dust are present in sample #M-573, but the glass appears to be identical to that in all other samples. The dark rounded forms are red clay lumps. (c) In samples with abundant ash temper, such as #M-107A, occasional pumice fragments are present (center of photograph). (d) Volcanic tuff fragments (lithified volcanic ash and dust) are also present in samples with abundant ash temper as in this sample #M-571 (dashed lines outline parts of the fragments).
Table 1. Quantitative Analysis of Sherds from Dzibilchaltun and Chichen Itza Determined by Point Count.

<table>
<thead>
<tr>
<th>Field no.</th>
<th>Volcanic ash, dust, pumice(%)</th>
<th>Volcanic tuff(%)</th>
<th>Opaque, unidentified materials(%)</th>
<th>Red clay lumps(%)</th>
<th>Calcite(%)</th>
<th>Paste(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>M-107A</td>
<td>23.4</td>
<td>6.8</td>
<td>6.0</td>
<td>5.0</td>
<td>—</td>
<td>58.7</td>
</tr>
<tr>
<td>M-109A</td>
<td>16.0</td>
<td>3.3</td>
<td>3.9</td>
<td>6.2</td>
<td>—</td>
<td>70.2</td>
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<tr>
<td>M-200</td>
<td>15.3</td>
<td>4.2</td>
<td>4.0</td>
<td>9.6</td>
<td>—</td>
<td>66.5</td>
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<tr>
<td>M-558</td>
<td>14.8</td>
<td>6.7</td>
<td>3.3</td>
<td>7.6</td>
<td>—</td>
<td>67.3</td>
</tr>
<tr>
<td>M-571</td>
<td>11.2</td>
<td>9.9</td>
<td>2.1</td>
<td>17.2</td>
<td>—</td>
<td>60.0</td>
</tr>
<tr>
<td>M-573</td>
<td>17.7</td>
<td>0.6</td>
<td>1.3</td>
<td>13.3</td>
<td>—</td>
<td>67.1</td>
</tr>
</tbody>
</table>

Dzibilchaltun Black-on-Orange

| M-135     | 17.0                          | 4.8            | 1.6                              | 8.9            | —          | 67.2    |

Dzitas Slate

| Chichen Itza | 30.9                          | 2.1            | 3.6                              | 5.8            | —          | 58.1    |
| Average     | 18.3                          | 4.8            | 3.2                              | 9.2            | —          | 64.7    |

Muna Slate

| M-211     | —                             | 0.8(?)         | 2.8                              | 2.9            | 24.2       | 69.3    |

25-power binocular microscope suggested that eight of the sherds had ash temper. The sherd of Muna Slate was thought to be calcite tempered and was included in the test as a control.

Examination of standard .030 mm thick petrographic thin sections confirmed the presence of volcanic ash temper in eight sherds and of calcite temper in the control sherd. The ash consists of transparent, colorless glass shards of uniform size, ranging from .15 mm to .21 mm in maximum dimension (Figure 2a, 2b). Optical characteristics indicate that the shards are almost entirely isotropic glass with little devitrification. Typical flat, crescent, forked, or spindle-shaped shards constitute 11.2% to 30.9% of the pottery by volume and average 18.3% in the eight samples (Table 1).

Additional fragments of undoubted volcanic origin are also present. Small pumice fragments up to .5 mm long (Figure 2c) occur on occasion, and small fragments of indurated ash (tuff) are even more common. Rounded tuff fragments (Figure 2d) up to .6 mm in length constitute from .6% to 9.9% of ash-bearing sherds and average 4.8%. A few sherds also contained fragments of exceedingly fine-grained materials that could be intensely altered tuff fragments. Since they cannot reliably be distinguished from fragments of nonvolcanic origin, they have been considered separately. They never amounted to more than 6.0% of the total sherd volume in any sample.

The volcanic nature of the ash shards in the potsherds is demonstrated by comparison of these shards with similar materials in volcanic tuffs (Figure 3). Flat, arcuate, forked, or spindle-shaped glass shards are abundant in both the welded tuff (Figure 3b) and the air-fall tuff (Figure 3a). These shapes are nearly identical to sherd textures noted in the Dzibilchaltun and Chichen Itza sherds. In addition, larger fragments of vesicular glass in the air-fall tuff are very much like the small pumice fragments shown in the potsherds (Figure 2c).

Several minor differences are observed between known ash samples and the ash temper in the potsherds, but they do not detract from the conclusions. The glass shards in the two tuff samples (Figure 3) are considerably larger than those in the potsherds. This only indicates that ash used in the pottery was either initially finer grained or was ground prior to use.

The other slight difference between known tuffs and volcanic components in the potsherds is the proportion of phenocrysts (large crystals) and accidental rock fragments. Tuffs in Figure 3 contain abundant (more than 10%) phenocrysts and rock fragments, but the ash used as temper in
the pottery is very poor in both categories (less than 5%). This difference is not significant, because volcanic tuffs can contain from less than 1% to 40% or more phenocrysts and rock fragments. The paucity of both categories could be caused by a low initial phenocryst content of the magma and its mode of eruption or by selective settling of the denser phenocryst and rock fragments during long-distance transport of ash.

In spite of the low percentage of phenocrysts present, several different minerals can be recognized. Quartz is by far the most abundant, with lesser amounts of plagioclase, sanidine [a high-temperature polymorph of potassium feldspar], and pyroxene. The crystals are generally irregular fragments with only occasional partial crystal faces. Maximum crystal sizes are about .3 mm, with most being considerably smaller (.1 mm).

The control sample—a calcite-tempered sherd—has very different petrographic features (Figure 4). Cryptocrystalline and crystalline calcite are abundant (24.2%) and are present in subrounded to subangular fragments up to .5 mm in maximum dimension. The calcite ranges from a translucent gray in the cryptocrystalline varieties to a transparent light buff in the more coarse-ly crystalline varieties. The larger size of the calcite temper also shows up in the megascopic texture of the one example studied—the sherd is noticeably coarser grained and less dense.

In summary, petrographic examination of sherds from Dzibilchaltun and Chichen Itza leaves no doubt that volcanic ash was definitely used as temper. The presence of volcanically derived glass shards, pumice, tuff fragments, and sanidine in amounts sometimes exceeding 30% of paste volume argues against accidental inclusion, as well as hinting at the considerable quantities of ash that would have been required in production of large volumes of pottery.

EXPLANATIONS FOR THE PRESENCE OF ASH

Pottery with ash temper identical to that submitted for petrographic analysis exists in great quantity in northern Yucatan. One of us (Simmons) estimates having handled some 26,000 ash-tempered sherds from Dzibilchaltun in five ceramic wares. Another 12,000 or more ash-tempered sherds are likely from Mayapan and the Puuc sites, and 10,000 more from the few test trenches dug at Chichen Itza in 1954 (Smith 1971). From this sample of some 45,000 or so sherds at these few sites, and the knowledge that ash was abundantly utilized at others, one can get a feeling for the enormous quantities of ash that must have been used by northern Yucatecan potters. Such amounts would necessitate a sophisticated transportation and distribution system, if in fact ash was imported. Before presenting our arguments in favor of this claim, we consider the possibility that indigenous ash deposits were all found and utilized by prehistoric potters, thus explaining their absence in modern times.

Figure 3. Photomicrographs of volcanic tuff. (a) Transparent, colorless fragments of volcanic ash and dust exhibit typical flat, crescent, and forked shapes in this air-fall tuff (sample location uncertain). Slightly larger ash fragments (right-center of photograph) exhibit more angular outlines but otherwise resemble pumice fragment shown in Figure 2c. The extremely fine-grained dust matrix in this sample has been largely replaced by opaque minerals. (b) Pale brown, transparent ash and dust fragments in this welded tuff (Member I, John Day Formation, central Oregon) do not show random orientation like those in air-fall tuff, but rather exhibit parallel alignment of shard long axes and slight compression in vertical direction.
Figure 4. Photomicrograph of calcite-tempered sherd. Small subangular to subrounded fragments of translucent cryptocrystalline (dark fragment above scale bar) and transparent crystalline calcite comprise nearly one-quarter of sherd #M-211 (Muna Slate). Outlines of calcite fragments are clearly different from volcanic ash; so the two tempers can be easily and rapidly distinguished under the microscope.

Both Shepard (1939:271–274; 1964:252) and Brainerd (1958:70) speculate on the possibility that wind-borne ash from ancient volcanic eruptions might have been deposited in lenses interlayered with the limestone of the peninsula. The utilization of ash at the various sites is not consistent with this idea, however. Were the ash distributed in lenses, it might be expected that the distribution of ash-tempered ceramics would be somewhat sporadic in time and space, correlating with the ability of local potters to find and clean out one of these lenses. The regularities in our distribution data suggest that by far the greatest amount of ash was utilized by a few large sites controlling the ash trade. More to the point, the abrupt cessation of ash utilization all over the northern peninsula with the fall of Chichen Itza does not accord with a model postulating multiple local sources. The failure of a single means of supply seems to best explain the sudden break in the firmly established tradition of using ash for pottery temper. In any case, Shepard points out that mineral grains in some of the ash were too heavy to have been carried by wind from Guatemalan volcanoes to the Yucatan (1964:252), and the prevailing winds blow in the wrong direction (1964:251). Additionally, Ishphording and Wilson concluded that no deposits of a demonstrable volcanic nature had been found to date in the north (1974:487). Thus, the evidence seems against the former existence of indigenous ash sources.

The Maya Mountains of British Honduras adjoining the Peten are of ancient volcanic origin, and they have been suggested as a possible close source of ash. Shepard (1964:251) notes that "ashey layers" were observed in 1886 by one geologist, and another had noted "thin bands of volcanic ash in the marine limestones." John Hazelden, geologist with Norman Hammond's Corozal Project, provided a small sample of ash from a lens in the Orange Walk District of British Honduras, and Carol Gifford supplied sherds of Belize Red ware and Chunhuito Orange ware from Barton Ramie, previously identified as ash tempered by Anna Shepard and George Meyer. These samples permitted us to test the suggestion that British Honduras was the source of the ash.

Petrographic examination of both sherds substantiated the presence of ash. They contain abundant (15–20%) glass shards characterized as somewhat smaller than those seen in the ceramics from the north, with less complex forms. Other volcanic materials consisted of tuff fragments and
crystal fragments of quartz and clinopyroxene. Sanidine and pumice fragments, common in the northwestern potsherds, are noticeably absent or rare in the sherds from British Honduras. If the samples are assumed to be representative, then it is quite likely that Dzibilchaltun and Chichen Itza utilized a different source for ash from that supplying Barton Ramie.

Analysis of the ash from the Orange Walk lens makes it clear that this was not the source of the ash used in either the British Honduras or the northern Yucatan samples. Primary textures have been largely destroyed by the alteration of glassy materials, and the proportion of glass shards (ca. 5%) is lower than in the sherds from either location. There are far more crystals present in the ash sample than in the sherds, even if one allows for dilution factors. Finally, 30% to 40% of the crystals present in the Orange Walk ash are biotite, which is not present in any sherds examined. Thus, it is most probable that Maya potters in British Honduras, like their northern counterparts, relied on foreign sources for their volcanic ash.

Anna Shepard has pointed out that several different varieties of ash were used at Uaxactun (1964:251). Phenocryst-free ash facilitated smoothing and, unlike limestone, would not spall at firing temperatures. It was used extensively in some of the slipped and painted wares of the Classic period (A.D. 300-800) to preserve and enhance the lustrous decoration. Phenocryst-rich ash (crystal ash in Shepard's terms) was much less satisfactory and was employed only in the coarser wares (Shepard 1964:250-251). We cannot now test the possibility that phenocryst-rich ash like that from the Orange Walk District lens may have been transported to Uaxactun and other Peten sites, but if it was, we would expect to find abundant biotite in coarse ware sherds from the area.

If all indigenous sources can be eliminated, then ash or ash-tempered vessels must have been derived from a foreign source or sources. Clearly, it is only the tremendous quantities of ash or the numbers of vessels that would have been involved that give one pause; otherwise the absence of local ash sources would immediately suggest trade. But was trade in the form of finished vessels? We think not. In a few cases, the same ware may utilize but one temper at one site, while exhibiting two or more temper materials at other close-by sites. For example, Puuc Slate ware at Dzibilchaltun and Uxmal is found with volcanic ash, calcite, clay lump, or even potsherd temper, while at the geographically intermediate site of Oxkintok, it is tempered exclusively with calcite (Brainerd 1958: Figure 43; Smith 1971:268).

Secondly, different shapes within Puuc Slate ware may exhibit an overwhelming predominance of only one temper variety. For example, at Uxmal and Kabah ringstand bowls with exterior rim bevels are always ash tempered, while tripod flaring-side dishes are calcite tempered; basins with rounded bolsters use ash temper, but those with triangular rim bolsters use sherd temper. Smith correctly interprets this variation as the result of a number of different manufacturing centers, which the major Puuc sites drew upon with varying emphasis (1971:167-168).

Finally, Brainerd notes that Puuc “Thin Redware” shares most ceramic characters of slip, shape, and decoration with Thin Slate ware, yet the former is normally ash tempered, while the latter typically uses calcite (Brainerd 1958:28). At Uxmal, all the Thin Slate ware shapes are tempered with saccharoidal calcite, yet at nearby Kabah, about one-third of the round-side bowls employ volcanic ash (Smith 1971:Table 42). At Dzibilchaltun, Simmons has noted small percentages of ash-tempered sherds in all shapes in Thin Slate ware, and Brainerd found the ware to be largely ash tempered at Sayil and Labna (1958:22).

The presence of ash temper at some sites and its absence in the same wares at others, as well as the strong tendency for some shapes (or even rim modes) within a ware to be associated with only one type of temper can mean only that local northern potters utilized different ingredients in manufacturing vessels within ware traditions shared throughout the region. It seems likely to us that if finished vessels were imported from some foreign source, specific wares and vessel shapes would be consistently associated no matter where found.

It seems clear, then, that the volcanic ash used by these potters must have been imported in bulk, since it is highly improbable that they used multiple local sources. Furthermore, since the ash from the relatively close Maya mountains is quite different in character, we must look to more distant regions. The distribution of sites with ash-tempered ceramics and obsidian suggests that two or more sources in the southern Maya highlands were involved.
DISTRIBUTION OF ASH-TEMPERED CERAMICS

Our survey of Lowland Maya sites associated with ash-tempered ceramics is incomplete for at least two reasons. Either available site reports omitted temper designations, or the archaeologist identified temper with a 10-power hand lens. It is our experience that ash cannot be identified with certainty at this low magnification. Even so, when a description of paste texture suggests the presence of ash, we include the site with appropriate comment.

Sampling error presents a serious problem in assessing the sources of the ash in sherd s that were thin-sectioned. Only a relative handful of sherd s were available for anlaysia, and except for Dzibilchaltun, no site is represented by more than two thin sections. Given the minuscule sample size, it is very difficult to know if separate sources are indicated for ash of somewhat different mineral content or structural composition. Furthermore, we have no way of knowing the range of textures and particle sizes in potential ash sources so as to evaluate differences in those attributes between sherd s. We are aware of these serious limitations, and we present the results while admitting the extremely tentative character of the conclusions.

The Southern Lowlands

Except for the Palenque region, types of Mars Orange ware are the only ash-bearing ceramics found anywhere on the peninsula proper prior to Protoclassic times. Mars Orange occurs primarily at Barton Ramie, as well as Uaxactun, Tikal, Seibal, Altar de Sacrificios, and possibly other sites as far west as Trinidad (Willey et al. 1967:295). Though the ware may be imported from the Chalchuapa, El Salvador area, the ash is probably a natural component of the clay used as paste (Meyer, cited in Gifford 1976:75; Shepard, cited in Smith 1955:32) and is thus not directly relevant to questions about the use of ash as temper. The Protoclassic Floral Park complex at Barton Ramie, however, has ash-tempered ceramics as well as strong ceramic ties to the Chalchuapa zone (Sharer and Gifford 1970:454), suggesting the possible beginnings of trade in ash from highland sources. Even through Early Classic times, such trade must have been of low volume, since only a small number of ash-tempered types are found at Barton Ramie, though more occur at Uaxactun.

During the Late Classic, there is a dramatic increase in the amount of ash-tempered pottery in the British Honduras–east-central Peten region, with trade in ash reaching a maximum in Tepeu II and its equivalents. Uaxactun, San Jose, Benque Viejo, and Barton Ramie utilized quantities of volcanic ash in variants of Peten Gloss and Vinaceous Tawny wares (Smith 1955; Thompson 1939, 1940; Gifford 1976), and a poor quality, phenocryst-rich ash is even utilized in the unslipped pottery at Uaxactun (Shepard 1964:250). In the Terminal Classic, the use of ash drops considerably, although some may be imported as late as Postclassic times.

In the remainder of the Peten, ash-tempered ceramics are conspicuous by their absence, although this may simply be an accident of our sampling. We cannot say how far to the north of Uaxactun ash temper may occur, but except for rare imports, it does not appear as far north as Becan (Ball 1977), thus setting a northern limit to its Peten distribution. It is absent or very rare at Seibal (Sabloff 1975) and Altar de Sacrificios (Adams 1971) to the south. We have no information on Tikal, Piedras Negras, Yaxchilán, Bonampak, or other Peten sites.

In the foothills on the southeastern periphery of the lowlands, Shepard notes the presence of ash-tempered ceramics at Copan (1939:274) and San Agustín Acasaguastlán on the Rio Motagua. These sites are near our presumed source areas and would have had unimpeded access to the material.

Far to the west of Uaxactun, Rands (1974:55) notes ash temper in late Preclassic ceramics at Palenque. Presumably, proximity to sources in Chiapas might explain its presence at this time. Though ash temper is not present in the Early Classic period, ash-tempered Peten-like polychromes are abundant in the Late Classic Taxincham and Murcielagos complexes at Trinidad and Palenque, respectively (Rands 1973:178, 1967:124). The presence of abundant ash only during the relatively brief time that these sites are part of the Tepeu ceramic sphere suggests a possi-
ble connection with the Uaxactun–British Honduras area, rather than the use of a former Mexican source. Only analysis of this western ash can settle this question. In addition, Matheny (1970) reports storage jars of Panalac Pumice Tempered ware at Aguacatal on the southern Campeche coast, where they are also limited to the Late Classic period.

In summary, except for locally produced ceramics at Palenque, the only ash-bearing ceramics in the Preclassic period anywhere in the lowlands are variants of Mars Orange ware. This ware was most likely traded into the Peten up rivers from the coast of British Honduras. This implies water transport and the Chalchuapa–Barton Ramie connection suggests a possible source area. The appearance of Proto-Classic and Early Classic ash-tempered ceramics in Barton Ramie and Uaxactun suggests the beginnings of ash trade by the same route. Trade intensifies greatly during the Late Classic, with sites in both the eastern and western portions of the southern lowlands exhibiting ash-tempered ceramics in abundance. Late Classic trade with sites on the northern peninsula is equally intense, but when it drops off sharply in the south during the Terminal Classic period (Tepuz 3), it appears to increase in volume in the north.

The Northern Lowlands

Through the courtesy of Norberto Gonzalez C., director of the Centro Regional del Sureste of the I.N.A.H., Simmons had the opportunity to briefly examine ceramic collections from several northern sites and bring back a few sherds for petrographic thin sections. Analysis of these sections confirms Shepard’s earlier findings—that with the exception of Late Classic coastal Campeche, all other northern sites from the Puuc to Chichen Itza utilize the same ash (Shepard 1964:251). Ash from the Coba-Yaxuna region differs from northwestern ash and includes variants probably derived from more than one source.

Campeche. Three sherds were analyzed from the only ash-tempered ware found in the Late Classic in Campeche. This Celestun Red ware is found in quantity only along the coast, in sites from Campeche City north to Celestun, including the islands of Jaina, Piedras, and Guaymil. It occurs sporadically on the coast further north, but is found inland only at Dzibilchaltun, where it is also abundant. The ash in Celestun Red ware is notable for its paucity of pumice fragments, less complex shard forms, and larger shard, phenocryst, and tuff fragment sizes. The cores of tuff fragments are typically replaced by microcrystalline calcite that obliterates primary textures, giving them the appearance of gray limestone under a hand lens. The distinctive features of Celestun Red ware ash, compared with that of slateware from Dzibilchaltun, suggest that two separate sources were involved.

The situation in Campeche during the later Terminal Classic is not clear. On the coast, Celestun Red ware is succeeded by typical ash-tempered slate wares. Further inland, ash is either very rare, as at Holactun (Brainerd 1958), or not yet recognized, as at Dzibilnocac (Nelson 1973, though his Tor complex should be checked). A brief look at the I.N.A.H. Edzna type-collection uncovered only one ash-tempered sherd of Dzilam Oranged Fluted, and it was probably imported from Dzibilchaltun, where the type is common. The few Muna Slate sherds checked were all tempered with calcite.

In sum, Late Classic ash-tempered ceramics are limited to north coast sites, and the ash is different from that used elsewhere. Inland, except for rare imports, no ash temper occurs before Terminal Classic times, and it may be infrequent even then. The source of the ash used in Celestun Red ware is uncertain, although Shepard (1964:252) once suggested that calcite-impregnated ash might derive from the Alta Verapaz. The coastal distribution of this type of ash seems to demand transport by sea, however. Celestun Red ware appears at the same time and place as an early “Isla” Fine Orange variant (Ball 1978), and insofar as the Putun Maya sea traders may have been involved with any Fine Orange, they may have transported this ash as well.

The Puuc hills. Ash is definitely present in great quantities at Uxmal and Kabah (Smith 1971) and probably in equally great amounts at Sayil and Labna (Brainerd 1958:72). As noted previously, its use varies with ware and vessel shape. It is most commonly used in Puuc Slate ware, and ap-
approximately 50% of all such vessels at Uxmal are ash tempered (Smith 1971:28). It is limited to the Terminal Classic period at these sites.

The Northwestern plains. Ash is present in great quantities at Dzibilchaltun as primary temper in at least five ceramic wares. It first appears in trace quantities at the beginning of the Late Classic, increasing in abundance through that period. Puuc Slate ware, the most common slipped ware at the site, utilizes ash for temper in approximately 90% of all sherds through the end of the Late Classic, decreasing to about 75% in the early part of the Terminal Classic, and dropping to near-zero in the Postclassic. It is probably present in the same amounts at nearby Acanceh (Brainerd 1958:19) during the same time periods.

To the south, on the Puuc border, some ash-tempered pottery occurs at Dzun and probably at Mani and Champuc. Ash is “very rare” at nearby Oxkintok however (Brainerd 1958:72). Here, the abundant Puuc Slate ware is exclusively tempered with calcite, and ash does not occur as temper in any other ware at the site (Brainerd 1958:196). Oxkintok is a large site that flourished all through the Classic and Terminal Classic periods. In many respects, it is like Dzibilchaltun and Acanceh; thus the complete absence of ash is puzzling.

Finally, a small quantity of ash-tempered Puuc Slate, Chichen Slate, and Chichen Red ware is present at Mayapan (Smith 1971:164,188), but these wares occur well before the major occupation of the site. During the late Postclassic period (A.D. 1250–1450), ash is completely absent at Mayapan or any other Yucatecan site.

The Eastern plains. At Chichen Itza, ash like that at Dzibilchaltun is the temper for Late Classic slate wares from the Hacienda Cenote (Brainerd 1958:73) and for the abundant Chichen Slate and Chichen Red wares of the early Postclassic (A.D. 1000–1250). Ash is also probably present at Dzibilchaltun, just to the north. To the south and east of Chichen Itza, however, the character of the ash is different.

Ash is the primary temper of Brainerd’s Late Classic “Medium Redware” at Yaxuna and is present in abundance in the redware and slateware from Coba (Brainerd 1958; Simmons, personal observation). With the aid of Fernando Robles C., now analyzing the Coba ceramics, sherds of an early slate from Coba and redware from Coba and Yaxuna were selected for petrographic analysis. Although the ash in all three samples is fine grained, three separate sources are indicated. The Yaxuna redware sherd contained phenocrysts of hornblende and pumice with tubular vesicles, neither of which were observed in any other sample. The early slate from Coba contained thin-walled, wispy glass shards unlike any others previously examined. And the Coba redware sherd contained abundant ash shards with complex forms, but unlike northwestern sherds, there were few, if any, tuff fragments.

The ash in all the sherds from Coba and Yaxuna is different and is also different from ash in an equally early slate sherd from Dzibilchaltun. This sherd, dating to Tepeu I, contains ash that is indistinguishable from that noted in later wares at that site. On the basis of these observations, it is suggested that separate coexisting sources supplied the Dzibilchaltun–Chichen Itza and Coba–Yaxuna areas and, further, that more than one source supplied ash to the latter area.

East coast. Sanders (1960) noted slateware in the Late or Terminal Classic Vista Alegre–San Miguel complexes, and his description of paste texture suggests the possibility of ash temper. Simmons has seen ash-tempered sherds from Cozumel that probably dated to the Terminal Classic or early Postclassic, and Andrews and Andrews (1975:72,89,102) report some good Puuc Slate ware from Akumal and a few sherds of “Chichen Slate ware” from Xcaret. However, these last sherds and others like them from Postclassic Coba are like Chichen Slate ware in all respects except for their use of undifferentiated calcite as temper. This may indicate reduced Postclassic ash trade to Coba at the same time that it was at its height at Chichen Itza.

DISCUSSION

Our sample of sites is limited in number, biased toward the larger sites, and unbalanced in geographic coverage. Even so, it is clear that some regions are limited to but one ash variant. Hammond (1972) has suggested a model for trade in obsidian which postulates that two competing
obsidian sources enjoyed near exclusive access to certain lowland markets. Thus obsidian from El Chayal near Kaminaljuu is exported to sites in the central Peten and the Usumacinta River areas, while obsidian from Ixtepeque to the east is sent by boat to British Honduras and Yucatan. We thought a similar model might explain our distribution data, and we present the following reconstruction to test the possibility that competing trading organizations, possibly those involved in trade in obsidian, may have also controlled the distribution of volcanic ash.

During the Proto-Classic and Early Classic periods, the ash used in some Peten Polychromes is derived from sources in the general vicinity of Chalchuapa, El Salvador (Ixtepeque?) and is transported down the Rio Motagua for shipment by sea to the coast of British Honduras and thence inland. The absence of ash-tempered ceramics elsewhere suggests that only one source is involved at this time. During the Late Classic period, ash trade increases in volume, with Tepeu-sphere ceramics in both the southeastern and southwestern Peten utilizing ash. Hammond’s obsidian model might apply, were it not for the puzzling absence of ash-tempered ceramics at Altar de Sacrificios, midway on a major river between El Chayal and the Usumacinta region. Even so, the great increase in the use of ash in the Peten may mark the onset of aggressive trading efforts from the vicinity of El Chayal.

The Late Classic situation in the north is quite complex and seems to demand more than two trading organizations. When one notes the Peten-style calendrics and architecture at Coba, it is reasonable to suppose that the suppliers of ash to the Peten may deliver ash to eastern Yucatan as well. In contrast to the uniform character of the ash in other northern sites, that at Coba exhibits variation, as does ash at Uaxactun (Shepard 1964:251). It may be that a single supplier is utilizing ash from several beds, but it is possible that both sites are in areas of “market overlap” of competing sources, as with obsidian at Uaxactun (Hammond 1972:1093). Whichever the case, there is little probability that suppliers to the eastern Yucatan sites also supply those in the northwest.

During the Late Classic in the northwest, prior to the rise of the Puuc sites, Dzibilchaltun appears to be the only large site with abundant ash-tempered ceramics. Other sites in the region with lesser amounts either received pottery manufactured near Dzibilchaltun or had more restricted access to the traders. To the west of Dzibilchaltun, coastal Campeche sites exhibit a coarse variety ash, but Oxkintok, a large and geographically intermediate site, has no ash-tempered ceramics, nor do inland sites farther south in Campeche. With the rise of the ash-using Puuc sites in the Terminal Classic, the coarse ash disappears from the Campeche coast. We are still uncertain whether ash ever appears in any quantity in the inland Campeche sites.

The apparently exclusive access of Dzibilchaltun to fine-quality ash in the Late Classic implies a politico-economic barrier of some sort between Dzibilchaltun and Oxkintok and the inland Campeche sites. It could be argued that ash was shipped by boat to the Chetumal area, and then carried overland by the Bacalar-Merida trail skirting the eastern margin of the Puuc Hills (Hauck 1975:49), which would be a physical barrier to distribution farther west. This route would also help explain the appearance of quantities of ash-tempered ceramics at the inland Puuc sites which develop in the Terminal Classic, while the ash was still lacking in Campeche. The major argument against an overland route is that the immense quantities of ash involved are only economically transportable by water (cf. Rathje 1975:433). Of necessity, then, we must look to the coast north of Dzibilchaltun, where canoes bearing ash from the highlands would have landed. During the Postclassic, Chichen Itza absorbed nearly all the ash previously delivered to Dzibilchaltun and the Puuc sites. A. P. Andrews (1978) thinks Chichen Itza rose to power by usurping control of all the northern salt fields, which suggests that the bulk carriers of ash may have loaded up with salt for their continued journey. Considering the proximity of Dzibilchaltun to the northwestern salt fields, the same ash–salt relationship may explain Dzibilchaltun’s exclusive access to ash in that region in much earlier times.

The oddly coarse-textured ash of the Late Classic Campeche coast sites was also undoubtedly ship-borne, but probably not all the way from Honduras. Its association with a Fine Orange variant, and thus the Putun traders, suggests possible connections with the Agua catal or Trinidad ash, which may derive ultimately from El Chayal or the Alta Verapaz. It is impossible to say more without comparing actual petrographic samples from these southern sites, but it should be
remembered that salt flats also occurred in the coastal Campeche region where the coarse ash is found. At present, then, we feel that a minimum of three sources supplied ash to the northern peninsula.

SUMMARY

Petrographic analysis of potsherds from Dzibilchaltun and other northern Yucatan sites establishes the presence of volcanic ash temper in Yucatecan ceramics. With no local sources known, the variation in ash and the spatial distribution of ash-tempered sherds suggests that two or three distribution networks supply ash from distant highland sources. Hammond’s suggestion that some obsidian traders enjoyed exclusive access to certain markets, while competing for others, seems to fit the pattern of ash distribution in the north, with but one of the competing trading organizations having access to the coastal salt fields near Dzibilchaltun. We suggest that the same traders exchanged salt for ash in later times, but that control of the trade became the sole prerogative of Chichen Itza. Finally, the manufacture of ash-tempered pottery and the trade in ash ceases with the fall of Chichen Itza. Since trade in obsidian continues into the Late Postclassic (Jeremy Sabloff, personal communication), it is not known why the ash is no longer desired in the north.

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REFERENCES CITED

Adams, Richard E. W.

Andrews, Anthony P.

Andrews, E. Wyllys IV, and Anthony P. Andrews
1975 A preliminary study of the ruins of Xcaret, Quintana Roo, Mexico. Middle American Research Institute, Tulane University Pub. 40.

Ball, Joseph W.
1977 The archaeological ceramics of Becan, Campeche, Mexico. Middle American Research Institute, Tulane University Pub. 43.

1978 Archaeological pottery of the Yucatan-Campeche coast. Middle American Research Institute, Tulane University Pub. 46.

Brainerd, George W.

Gifford, James C.

Hammond, Norman

Hauck, Forrest R.

Ispahordin, W. C., and Eugene M. Wilson

Matheny, Ray T.
1970 The ceramics of Aguacatal, Campeche, Mexico. Papers of the New World Archaeological Foundation 27.
Nelson, Fred W., Jr.
1973 Archaeological investigations at Dzibilnocac, Campeche, Mexico. Papers of the New World Archaeological Foundation 33.

Rands, Robert L.

Rathje, William L.

Sabloff, Jeremy A.

Sanders, William T.

Sharer, Robert J., and James C. Gifford

Shepard, Anna O.
1939 Technological notes on the pottery of San Jose. In Excavations at San Jose, British Honduras, by J. Eric S. Thompson, Carnegie Institution of Washington Pub. 506.

Sidrys, Raymond V.

Smith, Robert E.
1955 Ceramic sequence at Uaxactun, Guatemala. Middle American Research Institute, Tulane University Pub. 20.

Thompson, J. Eric S.

Webb, Malcolm C.