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THE MEANING OF VOLCANIC ASH CHARACTERISTICS FOUND IN THE ARCHAEOLOGICAL POTTERY OF CHICHEN ITZA, YUCATAN, MEXICO

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ABSTRACT

The Yucatan peninsula is a limestone based karst region. However, most of the pottery fragments from the *Mayan Postclassic* period of Chichen Itza, Yucatan, Mexico, contain volcanic materials as temper. Petrographic thin section analysis of pottery from Chichen Itza and related Yucatan archaeological sites shows that volcanic materials in the paste composition have two distinguishing characteristics. The glass shards and pumice fragments found in the pottery are fresh in form, mineralogically homogeneous and their size consistent with the size of components generally found in airborne volcanic ash. And, lithic fragments in the clay matrix indicate a pyroclastic origin, though their degree of weathering is variable. Considering these facts we conclude that the volcanic materials in northern Yucatan pottery originated from different time lapse tephra, manifesting from strong volcanic eruptions during the *Classic* and *Postclassic* period of the *Mayan* civilization. The study of pottery composition suggests that the volcanic eruptions and the consequent influence upon ancient *Mayan* civilization.

KEYWORDS: pottery composition, petrography, volcanic ash, Chichen Itza

1. INTRODUCTION

The Yucatan peninsula of Mexico is a limestone based karst region. As a result almost all clay in the region contains carbonate. However, the most frequently found pottery type of Chichen Itza does not contain carbonate but has volcanic glass as temper (Smith 1971; Chung 2009). The presence of volcanic glass has long been a theme of discussion (Brainerd 1958; Smith 1971; Chung et al. 1995, 2008) because the presence of volcanic glass in the pottery of Chichen Itza appears to be related to the history of the site. Chichen Itza was a city which flourished *Postclassic Mayan* civilization due to the influence of foreigners named *Itza* who migrated from Peten, Guatemala (Piña Chan 1987: 14; Roys 2008). The people of northern Yucatan, Mexico and Peten, Guatemala had engaged in interactive relationships related to both material and people from very early times, stemming back as far as 400 A.D. (Ibid). However, significantly important immigration from Peten to Yucatan was only realized between 800-1000 A.D. when the *Classic Maya* civilization of Peten, Guatemala was in decay (Ibid.). Following 1000-1200 A.D, the *Postclassic* period, Chichen Itza was considered the most powerful city in the northern Yucatan peninsula. After flourishing for 200 years at Chichen Itza, the *Itza* returned to their homeland in Peten and Chichen Itza began to decline (Morley 1987).

The earliest discovery of pottery containing volcanic glass in Chichen Itza was around 400 A.D., with other early findings around 875 ± 88 A.D., and the most frequent occurrences during the period 1000-1200 A.D. (Chung 2009: 92). After 1200 A.D. pottery containing volcanic glass were rarely found. These dates align perfectly with the history of the migration of the Itza to Chichen Itza. This means that pottery containing volcanic glass appeared very early in the settlement of Chichen Itza, and was found in great abundance during Itza occupation periods, and disappeared with the return of the Itza to their homeland.

Chichen Itza was not the only site in the northern Yucatan to have pottery containing volcanic glass. Volcanic glass was found in the pottery of almost all archaeological sites of the north-western Yucatan peninsula, such as Dzibilchaltun, Xcambo, Siho, Uxmal, Edzna, etc. These potteries were used during the similar period as those from Chichen Itza (Smith 1971; Simmons and Brem 1979; Jimenez 2002; Chung 2009). The problem in understanding the existence of volcanic glass in pottery is that to date, no source of volcanic glass has been identified in the northern Yucatan (Isophording and Wilson 1974: 486; Bautista et. al. 2011: 12). This fact influenced investigators to suspect volcanic material for use as temper or even the pottery itself was imported from volcanic regions which might be near the homeland of the Itza. However, the quantity of volcanic glass contained in the pottery collected from archaeological excavation leaves some room to doubt the volcanic material was imported (Ford and Rose 1995: 154), even less the pottery itself (Chung, 2009). If this was not the case, how was it possible that the use of volcanic glass as temper was so common in Yucatan for a period of time, and then such use disappeared suddenly?

The aim of our investigation was to determine the compositional character of the volcanic glass contained in the pottery and to establish a hypothesis of the possible source of the volcanic glass. The result will help to understand the phenomenon of using volcanic glass as temper in a karstic area and furthermore the history of ancient Chichen Itza.

2. METHOD AND SELECTION OF SAMPLES

Petrographic thin section analysis was applied to determine the paste composition. Comparing crossed and plane polarized transmitted light images for thin sections of pottery permits us to identify the constituent materials such as glass, rock fragments and minerals, to distinguish the character of these materials, and to obtain information on the firing conditions of the ceramic paste (Kerr 1965; Chung 2009: 151-152; Montana et al. 2009: 95-97). Since there is no reported volcanic source in the northern Yucatan, we first studied pottery fragments from the archaeological sites which flourished during Classic periods and are located relatively near volcanoes, such as Yaxchilan, Bonampak and Las Margaritas in Chiapas (Fig. 1). Next we observed the characteristics of the paste composition of samples of our target area, from Chichen Itza, Dzibilchaltun and Xcambo in Yucatan. And finally we compared the composition of the pottery samples from both regions and subsequently established our hypothesis on the source of the material used.

For the characterization of the mineralogical components of Chichen Itza, Xcambo and Dzibilchaltun we restudied thin sections used for the former study by Chung (2009: 243-259). For the study of Yaxchilan, Bonampak and Las Margaritas samples are selected for present study. Samples from Chichen Itza and Dzibilchaltun which were from various test pits, are representative of all periods of the sites. Samples from Xcambo are constituted mostly by pottery from Classic to early Postclassic period. Samples from Yaxchilan were selected arbitrarily. Samples from Bonampak and Las Margaritas represent all periods of those sites. As a result, of the 159 samples from Chichen Itza 104 samples contained volcanic glass. In 105 samples from Xcambo 56 contained volcanic glass, and in 31 samples from Dzibilchaltun 23 contained volcanic glass (Chung 2009: 243-259). Also 4 of 5 Yaxchilan samples have volcanic glass (Chung & Lee 2004), 10 of 17 Bonampak samples and 12 of 14 Las Marigaritas samples have volcanic glass. From the 331 pottery thin sections we studied 209 which contained volcanic glass, and selected compositionally the most representative thin sections to discuss here. The results are presented through photomicrographs with magnification of 50 and 100 times. In all figures from 2 to 13, photomicrograph images taken under transmitted plane polarized light are on the left and photomicrograph images of the same sample from the same spot taken under transmitted crossed polarized light are on the right.

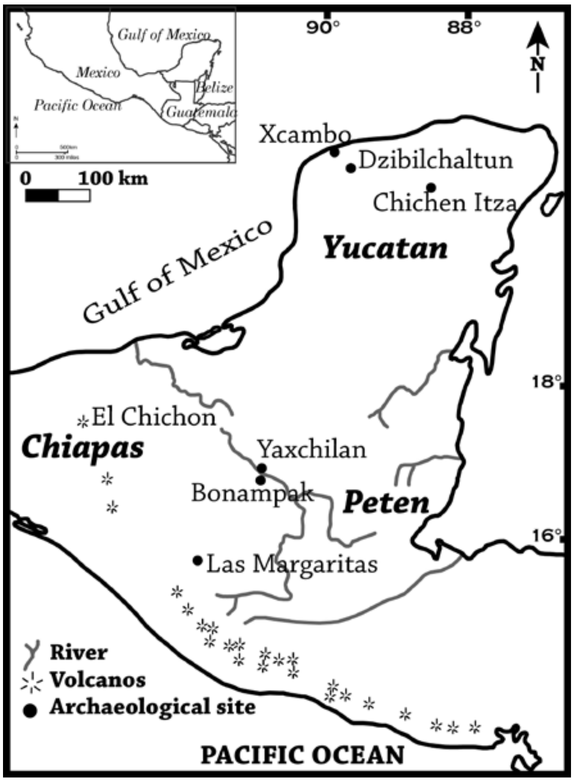


Figure 1. Map of archaeological sites, showing the distribution of active volcanoes and the studied archaeological sites. Map drawing by author based on Ford and Rose (1995: 151)

3. RESULTS

3.1 Results of Chiapas Samples

After analysis of 26 pottery fragments, four thin sections from Yaxchilan, Bonampak and Las Margaritas were selected as representative. As expected, it was observed that they have a high content of material with volcanic origin in the ceramic paste. In most of the samples from Yaxchilan, Bonampak and Las Margaritas the pottery paste was composed of glass shards, phenocryst (< 350 μm in length) plagioclase, biotite and pumice fragments. In the microphotographs of the Yax2 (Fig. 2), high concentrations of pumice fragments, plagioclase and biotite are evident. The prevailing size of the plagioclase is 50-150 μm in length, the biotite is 200-300 μm, and the pumice fragments are 200-350 μm. The pumice fragments that have numerous vesicles present mostly oval. The oval form of the pumice fragments indicates the ash accumulated to reach some depth and was then pressed by weight. The pottery from Bonampak, B4 has almost the same composition as the Yax2 sample. But the feature of components looks different (Fig. 3). The size of the plagioclase at 80-180 μm and the biotite at 200 μm is consistent. However, pumice fragments were broken into shards with size of 60-100 μm and fragments at 120-160 μm. Also it is observed unidentified microcrystallines abundantly in a matrix of B4. Pottery samples from Las Margaritas show a similar composition as samples from Bonampak and Yaxchilan. There are however, no biotite is observed in Las Margaritas samples. LM3 in that the paste is, with small quantity of plagioclase, composed almost completely of glass shards and pumice fragments (Fig. 4). In contrast, the thin section of LM14 shows a large volume of phenocryst plagioclase and quartz (Fig. 5).

3.2 Results of Yucatan Samples

In our study we divided the 183 pottery fragments containing volcanic glass analyzed from Chichen Itza, Xcambo and Dzibilchaltun, into two groups based on compositional characteristics. The first group is comprised of pottery fragments that contain mostly glass shards or pumice fragments. The glass shards and pumice fragments are generally very well sorted. That is, the glass shards and pumice fragments present are of a consistent size, and show a mineralogically homogeneous aspect. The composition of the second group is characterized a greater abundance of lithic fragments. In addition a different degree of weathering of the lithic fragments was observed in this group. Also it has glass shards, but generally the quantity of glass shards is reduced substantially as compared to the potteries of the first group. The compositional character of the second group is more common in Yucatan pottery than that of the first group.

We divided the first group of pottery into two types. The first type is composed of an abundance of glass shards as observed in P27 (Fig. 6). Most shards are 50-100 μm in length. The largest one is 180 μm. It also contains a small quantity of quartz and hematite. All shards have a clearly preserved angular form, suggesting the clay used for P27 came from a tephra that was fresh and did not suffer from weathering. The second type, Xbo12 contains well sorted pumice fragments and some glass shards (Fig. 7). The pumice fragments present oval form as observed in Yax2. It also appears that the pumice fragments are from fresh deposits without weathering. The large volume of quantity and well sorted in size of both the glass shards and the pumice fragments in the matrix of p27 and Xbo12 respectively permit us to presume these elements are from the clay itself, with no additional material added as temper.

However, the paste types above are not as common as the paste types of the second group which are characterized by having relatively abundant and well sorted glass shards, lithic fragments, and some quartz. The second group of pottery could be subdivided into three types. The following thin sections of Chp76 and Dz33 are the most common two types. Of note in the third type in this group such as Dz60, contain carbonate between the glass shards and lithic fragments.

Chp76 has well sorted glass shards and lithic fragments that look like clay lumps (Fig. 8). It is the most common type of pottery composition found in Chichen Itza pottery. In the photomicrographs angular or semi-rounded lithic fragments are observed abundantly in the matrix. Also, an abundance of glass shards are present. The prevailing size of the lithic fragments is 120-200 μm and the glass shards size is 40-80 μm. In the photomicrograph taken under transmitted plane polarized light (Fig. 8, left), it is difficult to distinguish lithic fragments from the clay matrix. In a former study, lithic fragments were considered to be clay lumps (Shepard's report in Smith, 1971). A clay lump refers to a rounded clay particle put in clay as temper.

Table 1. Prevailing size of major components in pottery paste, size in μm
Abbreviate indicates the following components. Pl: Plagioclase, Bi: Biotite, Q: Quartz, Ca: Carbonate

Sample	Glass s Shards	Pumice	Lithic Oxidized	Fragments Non-oxidized	Mineral
Yax 2		200 -350			50-150 (Pl), 200-300 (Bi)
B4	60-100	120-160			80-180 (Pl), <200 (Bi)
LM3	<100	70-150			
LM14	100-300				150-350 (Pl)
P27	50-100				
Xbo12	100-150	200-260			<100 (Q)
Chp76	40-80		80-250	120-200	
Dz33	<80		250-300	150-200	50 (Q)
Dz60	50-120	150-200	250-350		
Xbo75	40-120		300-400	600	
Dz40-	<100		100-150		330 (Ca)

In observing the lithic fragments, since they appear to have lost almost all of their characteristic mineral components as a result of weathering, it is possible for them to be misidentified as clay lumps. However, in photomicrographs taken under transmitted crossed polarized light (Fig. 8, right), their form and the appearance of the remaining minerals in them, indicate they are not clay lumps but lithic fragments that probably came from volcanic tuff. The photomicrographs of Dz33 more clearly show the presence of lithic fragment. The angular oxidized lithic fragments are easily distinguished by color from lesser weathered lithic fragments that appear gray in color under transmitted plane polarized light (Fig. 9, left). The size ranges of the oxidized and the non-oxidized lithic fragments are 300 μm and 200 μm, respectively. The third common paste type of the second group can be observed in Dz60. It is characterized by abundant round lithic fragments, some glass shards and quartz in the calcareous matrix (Fig. 10). The lithic fragments have unidentified microcrystallines. The size of lithic fragments of Dz60 is larger than those of the other potteries. The prevailing size of the lithic fragments is approximately 250-350 μm in length. The quantity and size of glass shards are relatively small that ranges between 50-120 μm. In comparing Chp76, Dz33 and Dz60, the paste of each looks different in appearance, but they have very similar components. There are glass shards that appear fresh and lithic fragments that appear to have preserved original components. However, the quantity of glass shards in Dz33 and Dz60 is much smaller than in Chp76, and show a difference in the state of oxidation of the lithic fragments. The quantity of shards and the state of oxidation could be an indication of the degree of weathering. The smaller quantity of shards and more oxidized components indicate higher levels of suffering from weathering. And also, the degree of oxidation is an indication that the potteries were fired under different conditions (Mirambel et al. 2005: 64-66). The yellowish green color of Chp76 suggests firing in a reduced condition and the yellowish red color of Dz33 suggests firing occurred in an oxidized condition (Shepard 1976: 217-219).

4. DISCUSSION

4.1 Characteristics of paste composition of Yucatan pottery

In comparing the characteristics of Yucatan pottery to samples from Chiapas, which were located closer to the volcanic areas than the northern Yucatan, the potteries of both regions share similar components of volcanic origin such as glass shards, pumice fragments, and minerals like plagioclase, quartz and biotite. However, they are quite different from each other in the size and the fabrics of the components. Weathered lithic fragments are evident in Yucatan pottery, but not in Chiapas. Furthermore, with the exception of Las Margaritas the pottery of Chiapas commonly has some biotite, whereas the pottery of the Yucatan rarely it has.

We believe the glass in Yucatan pottery came from tuff. Chp 31 shows a phenocryst lithic fragment (> 700 μm) constituted by abundant glass shards and some crystals (Fig. 11). When a lithic fragment like this was broken, possibly it remained in the form of shards. There are potteries from Chichen Itza that have exclusively shards (Figs. 6, 8) in contrast to those from Chiapas which contain more fragments of pumice than shards (Figs. 3, 4). Xbo12 from Xcambo shows another feature of glass containing paste that consists of pumice fragments (Fig. 7). The most similar Chiapas sample to Xbo12 is Yax2 (Fig. 2). Besides having an abundance of pumice fragments, Yax2 has large amounts of plagioclase and biotite. Meanwhile Xbo12 presents exclusively pumice fragments with small quantities of quartz.

The most noticeable characteristic of the Yucatan pottery was the presence of lithic fragments. Chp76, Dz33 and Dz60 show an abundance of lithic fragments (angular or round) together with glass shards (Figs. 8, 9, 10). Unlike P27 and Xbo12, the paste components of these potteries manifest evidence of a different weathering process in each. Occasionally this distinction can be observed in the same pottery paste as shown in Xbo75. In the photomicrographs for Xbo75 (Fig. 12), a lithic fragment with a weathered and oxidized rim (left bottom) is shown, in which some minerals and glass shards are still distinguishable. Another fragment on the right is not oxidized as compared to the one on the left. Also of note on this sample is a deeply oxidized lithic fragment (left above). The degree of oxidization is such that it does not permit us to distinguish the mineral composition. From the observations of weathering process we conclude that the lithic fragments frequently found in pottery from the northern Yucatan originate from volcanic tuff.

The last point to discuss is the presence of volcanic glass in carbonate. Since all samples of the Yucatan are from a karstic rock zone it is natural that the local clay of the Yucatan peninsula has carbonates. But curiously, carbonate is rare when the pottery contains volcanic glass. However, in the Dz60 glass shards and oxidized lithic fragments in a calcareous matrix are observed (Fig. 10). Especially, in the photomicrograph of Chp17 observe pumice fragments that have the void partly filled by carbonate (Fig. 13). It shows also a glass wall that was preserved from calcification. In the Yucatan peninsula it has been observed that carbonate within the soil has been moved vertically by flowing water and the carbonate accumulated towards the center of sinkholes (Bautista F. et al. 2011: 12). It is probable that tephra was deposited near a *cenote* (natural sinkhole in Yucatan peninsula) and then mixed with carbonate. In fact, potters from Uayma, Yucatan which is located close to Chichen Itza, obtain clays from near a *cenote* (personal conversation in 1992).

All of the above indicate clay used for Yucatan pottery was obtained from airborne pyroclast sediment.

Fig.2-13 show Photomicrographs of thin sections: photomicrograph images of transmitted plane polarized light are on the left and images of transmitted crossed polarized light from the same spot are on the right. Abbreviate indicates the following components. P: Pumice fragment, Pl: Plagioclase, Bi: Biotite, Sh: Glass shard, Lo: Oxidized lithic fragment, Ln: Non-oxidized lithic fragment, Ca: Carbonate.

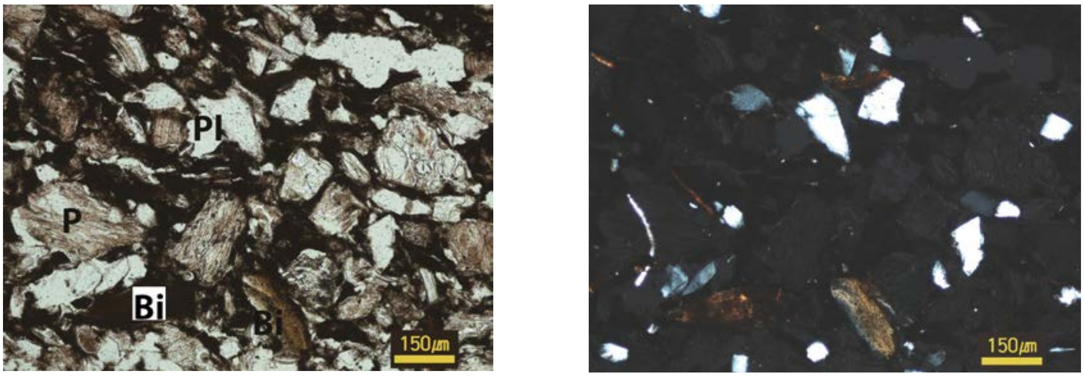
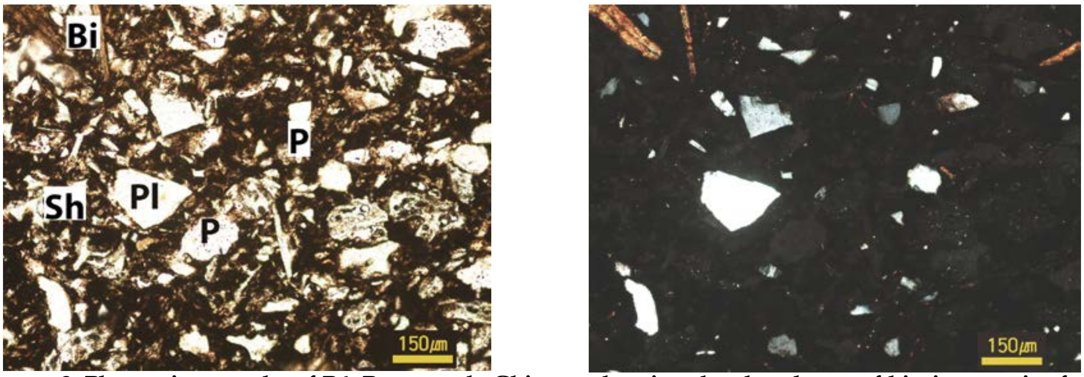


Figure 2. Photomicrographs of Yax2, Yaxchilan, Chiapas, showing the abundance of fresh pumice fragments (black), plagioclase (white), and biotite (elongated reddish brown).



Figurer 3. Photomicrographs of B4, Bonampak, Chiapas, showing the abundance of biotite, pumice fragments, glass shards, and plagioclase in a matrix of opaque minerals.

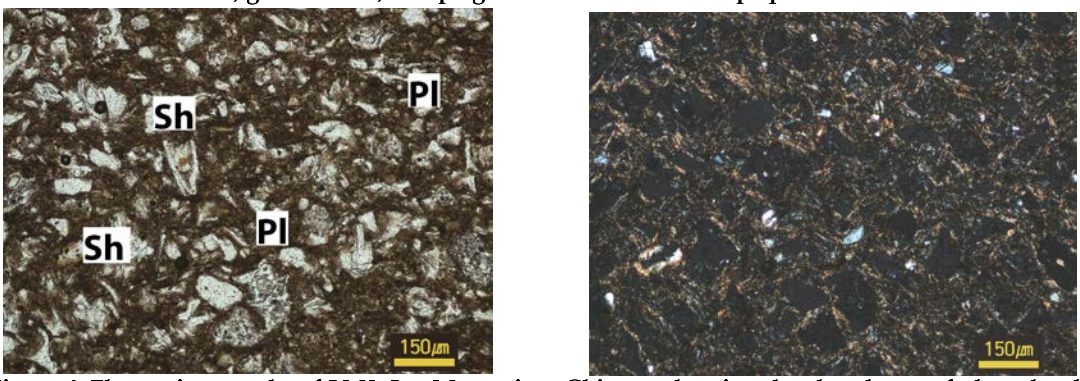


Figure 4. Photomicrographs of LM3, Las Margaritas, Chiapas, showing the abundance of glass shards (black) and sporadically distributed plagioclase (white).

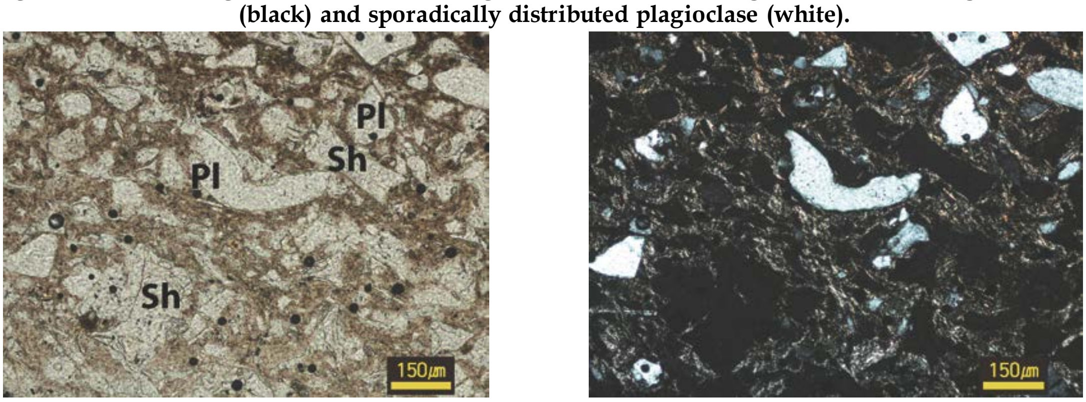


Figure 5. Photomicrographs of LM14, Las Margaritas, Chiapas, showing the abundance of penocryst plagioclase(white) and glass shards(black) in a matrix of opaque minerals.

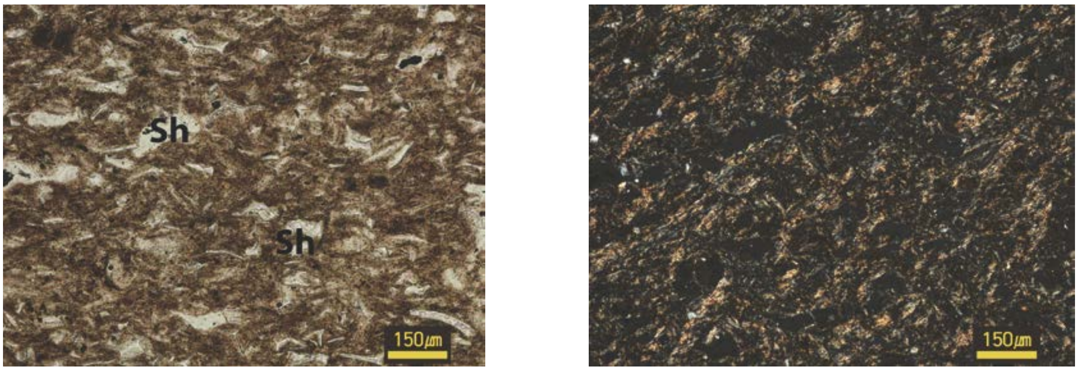


Figure 6. Photomicrographs of P27, Chichen Itza, Yucatan, showing, the abundance of glass shards and sporadically diffused hematite and quartz in a clay matrix.

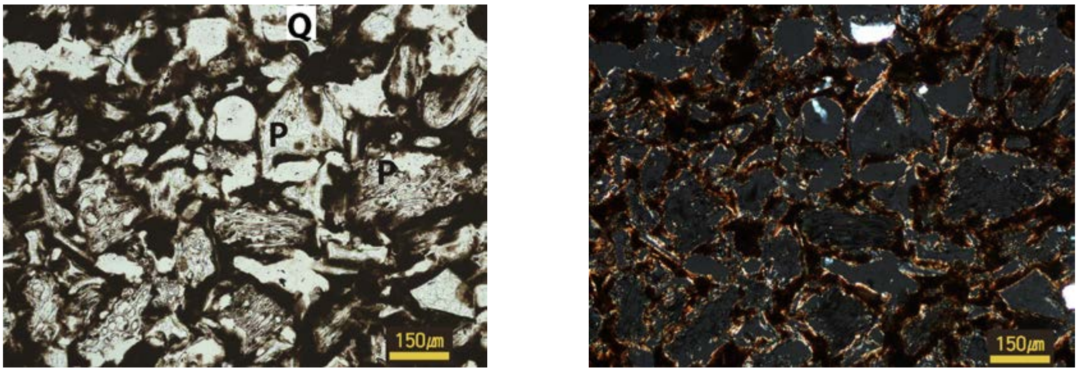


Figure 7. Photomicrographs of Xbo12, Xcambo, Yucatan, showing, the abundance of pumice fragments, and a few of quartz crystals.

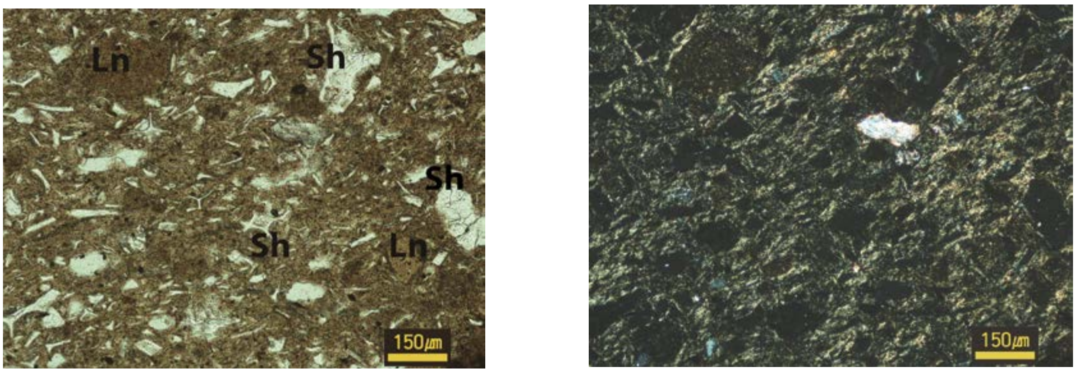


Figure 8. Photomicrographs of Chp 76, Chichen Itza, Yucatan, showing the abundance of glass shard and non-oxidized lithic fragments (sub-rounded brown).

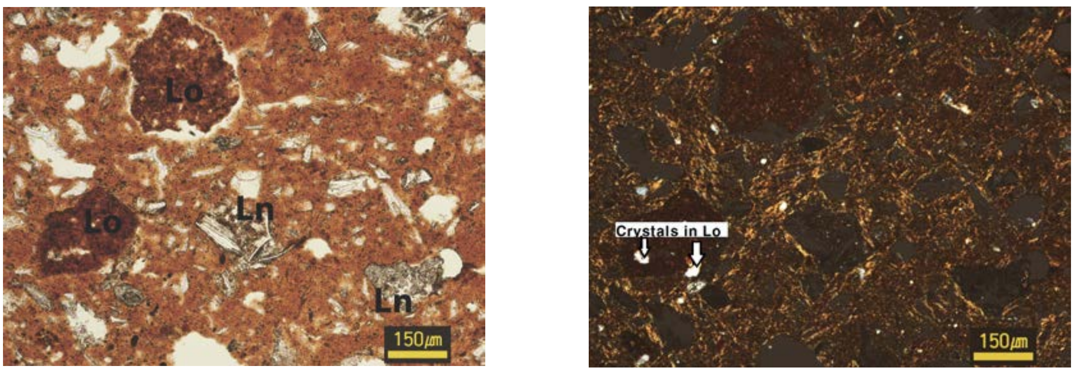


Figure 9. Photomicrographs of Dz33, Dzbilchaltun, Yucatan, showing glass shards, oxidized (sub-rounded reddish) and non-oxidized lithic fragments (sub-rounded grey), and some quartz crystals. Oxidized lithic fragments have angular form and show some crystals remnants suggesting volcanic origin.

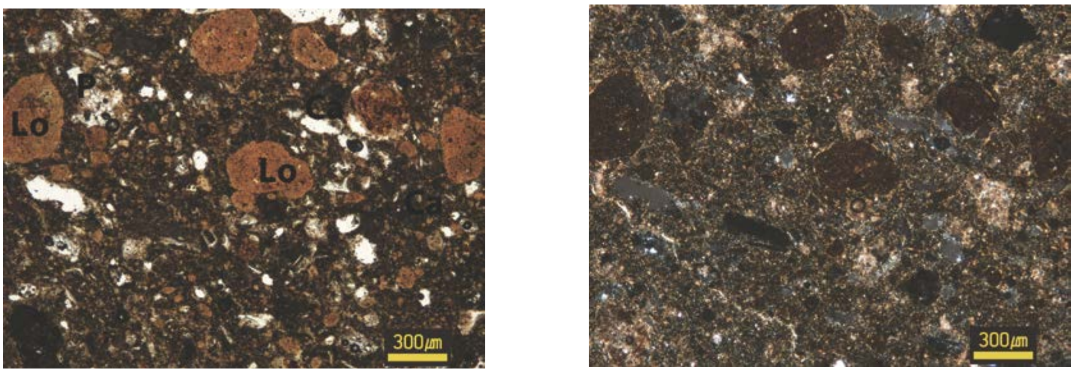


Figure 10. Photomicrographs of Dz60, Dzbilchaltun, Yucatan, showing the abundance of lithic fragments (yellowish brown fragments) in calcareous matrix that has micritic clots.

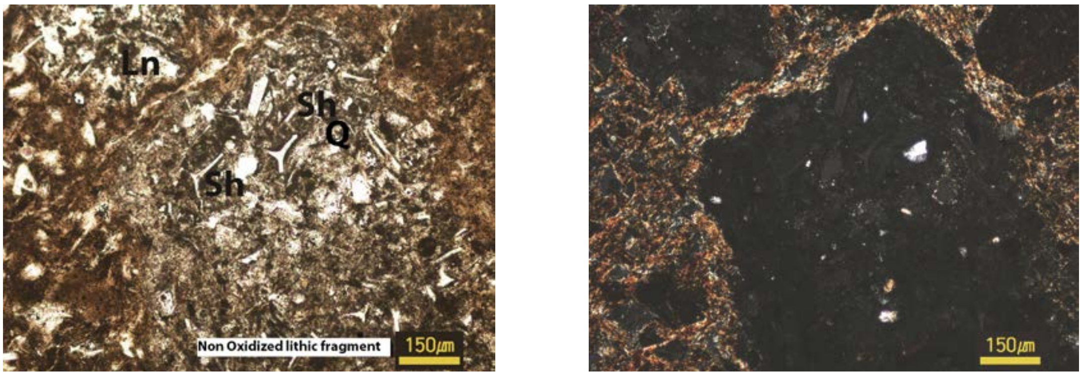


Figure 11. Photomicrographs of Chp31, Chichen Itza, Yucatan, showing non-oxidized penocryst lithic fragments that contain a lot of glass shards, some quartz crystals and pores. The groundmass consists of opaque minerals.

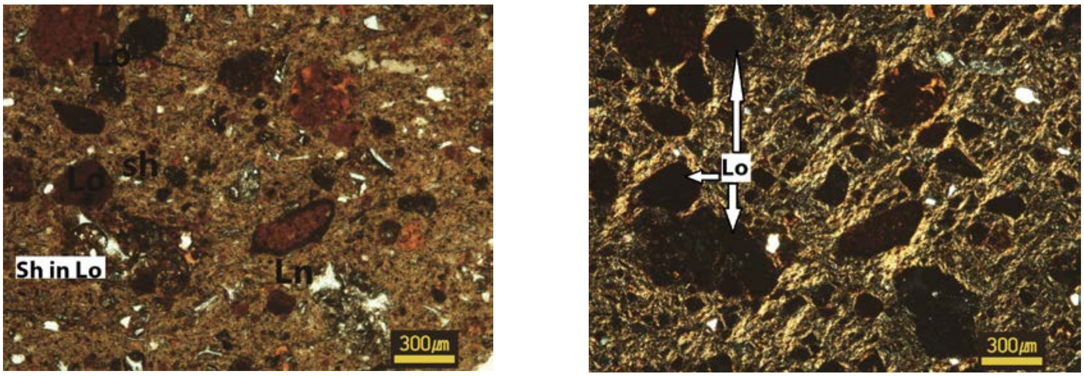


Figure 12. Photomicrographs of Xbo75, Xcambo, Yucatan, showing the abundance of lithic fragments and glass shards in a clay matrix. The lithic fragments show various degrees of oxidation. Some fragments (e.g. a fragment in lower left) include rather fresh glass shard remnants, though deeply weathered, and clearly suggesting volcanic origin.

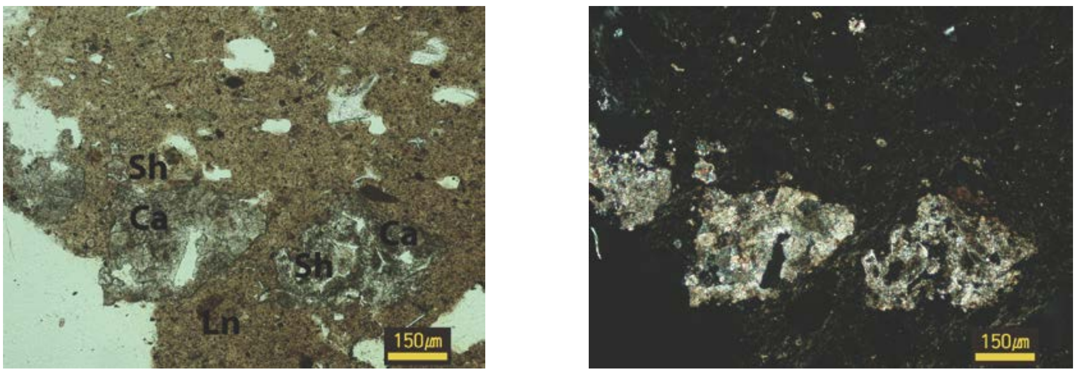


Figure 13. Photomicrographs of Chp17, Chichen Itza, Yucatan, showing carbonate (secondary calcite of recrystallization) filling most pores of the pumice fragments, but the glass walls (black line in right picture) of pumice were preserved from calcification.

4.2 The Possible source of clay used for northern Yucatan pottery

Clay constituted by abundant pumice fragments and glass shards such as in Xbo12 was rarely used for pottery in the Yucatan. It was reported for several samples of Xcambo (Jimenez 2002), and a similar paste was also found in Yaxchilan in this study. Our assumption is that this type of pottery was traded from near the Yaxchilan region.

The coexistence of fresh glass shards with weathered lithic fragments permits us to establish the hypotheses that multiple volcanic eruptions occurred and that ash from these eruptions fell at the same points to form multiple layers of tephra. If a volcano erupted in an area previously covered by tephra, additional ash resulting from the subsequent volcanic explosion would have been carried and deposited on the former tephra. The tephra would then contain glass with both fresh preserved sharp form and weathered lithic fragments from the previous eruptions. Another possibility is that a volcano erupted underneath existing tephra, causing ash that contained various minerals, lithic fragments, and glass together to become airborne. Since some minerals, oxidized and non-oxidized lithic fragments are heavier than the glass the ash was sorted during airborne travel. The sorting process depends on the distance from the site where the eruption occurred. Because the Northern Yucatan is located a great distance from the volcano zone, possibly Yucatan potters could obtain well sorted tephra, comprised exclusively of shards. This hypothesis of airborne transportation is sustained by the size and mineralogically homogeneous aspect of the Yucatan pottery. In Yucatan pottery the prevailing size of glass shard is 40-150 μm and the lithic fragments is 100-600 μm (Table 1). The size of all components found in the Yucatan pottery are consistent with that of volcanic ash (<2000 μm in size, Schmid, 1981; Heiken & Wohletz 1992).

The fact that the fresh glass shards and weathered lithic fragments exist together makes us to establish further hypothesis. Usually it does not take a long time for weathering to occur in rainy tropical areas like Yucatan peninsula. Frequently lithic fragments are totally oxidized and weathered in several months (Luhr 1984: 73). And the sharp form and cleanness of the glass shards manifest that a tephra layer was deposited just prior to being used. To have deposits of shortly different time lapse tephra, for Yucatan potters the pyroclast was deposited repeatedly during the time when *Postclassic* Yucatan Maya people lived.

No volcano exists in the northern Yucatan peninsula. But there are many volcanoes from Tabasco, Chiapas to El Salvador (Fig. 1, Ford and Rose 1995: 51). However, there are few volcanoes of which the magnitude and the location are adequate so that ash from the eruption would reach the northern Yucatan peninsula. Since the wind direction and air movement is from the south-west to north-east, a volcano would need to be located south-west of the study area to carry ash by air (Macias et al. 2008: 453). One possibility is the El Chichon volcano of Chiapas which experienced multiple eruptions and strong enough to reach to northern Yucatan. When El Chichon erupted in 1982 the pyroclasitc ash cloud was dispersed blanketing the area from Chiapas as far as the Gulf of Mexico and the north-west Yucatan peninsula (Ibid: 452-3; Bonasia et al.: 46). El Chichon erupted 11 times, including eruptions during *Mayan* civilization period of 550, 900, and 1250yr BP (Macias et al 2008: 448). Between the sediment layers from these eruptions, the 550yr B.P. tephra is enriched in volcanic glass whereas the 1250yr B.P. tephra contains a large amount of plagioclases, rock fragments and biotite (Solleiro et al. 2007: 451). This means that the composition of tephra is different depends on eruption. Plagioclase and biotite flakes are commonly observed in the pottery paste of Chiapas. So that the composition of 1250yr B.P. (760 AD) tephra and the time of volcanic eruption are consistent with the date of production of Chiapas pottery which belong to 600-900 AD, Classic Mayan period. But Yucatan pottery from the studied sites was produced mostly during 1000-1200 AD with the earliest produced 800-900 AD (Chung 2009: 92).

Considering the periods of pottery production, it is possible that pyroclastic sediment of 900yr B.P. (1100 AD) eruptions could be the source of clay for Yucatan pottery.

Events very similar occurred in *Minoan* culture. Around 1570 BC, the Thera volcano erupted on the Santorini Islands (Höflmayer 2012: 444; Ramsey et al. 2004: 336). The eruption was predicted and the residents of the islands were evacuated. However, the eruption caused major damage to the island of Crete. The population of Crete was forced to move to the Mainland (Nafplioti 2008: 2307). This was a significant factor in the decline of *Minoan* culture (1490/1470 BC). However, after brief cultural discontinuity, Crete was populated again by Mycenean people who returned from the Mainland and enjoyed the most developed period of the era, the reign of Knossoss. Although forced to face hazardous eruptions, peoples of both civilizations found it worthwhile to live in a volcanic zone.

Characterization and provenance of ceramic ware from Aegina and elsewhere in the Aegean and interpretation has reported hornblende and phenocrysts in volcanic rocks, which constitute a "volcanic fabic" (http://www.indiana.edu/~sava/Provenancing%20Report.pdf).

Moreover, pottery kiln activities were dated by thermoluminescence and archaeointensity during Late Minoan period (Liritzis & Thomas, 1980), and in general life continued volcanic aftermath. The present work, however, provides evidences about contradictory effects of volcanic eruption on ancient civilization.

5. CONCLUSION

The impact of volcanic eruptions on ancient civilization is one of the most popular and widely studied themes in archaeological study.

The El Chichon volcano eruption destroyed many of the *Mayan* cities in the area. The destruction and subsequent social upheaval caused the collapse of the *Classic Mayan* civilization. As well, the eruptions forced the population to leave their homeland and move far from the volcanoes, to the area around Chichen Itza in the Northern Yucatan. However, instead of falling into decay, the *Mayans* adapted to the new land and flourished in the new era, the *Postclassic* period.

The pottery containing volcanic glass from northern Yucatan peninsula has similar components as the pottery samples of Chiapas which are located near volcanos. Generally the components of Yucatan pottery are well sorted and of a smaller size than those of Chiapas, manifesting airborne tephra origin. Additionally Yucatan pottery presents lithic fragments that were originated from tuff with different degrees of weathering. The coexistence fresh glass shards and weathered lithic fragments suggest that the potters of Yucatan obtained clay in relatively short time after the tephra deposited. It means that the volcano ejected pyroclast even during they were lived. This leads us to surmise that the peoples of Chiapas, living near the volcanoes, may have initially abandoned the area and immigrated to the northern Yucatan at the end of *Classic* period (760 AD) when El Chichon erupted. And when it occurred again during *Postclassic* period (1100 AD), the already established *Mayan* people in the northern Yucatan where is located safely far from volcano enjoyed to make their pottery with such a good clay formed by the pyroclatic sediment and developed *Postclassic Mayan* civilization.

This work was focused on showing airborne tephra material tempered character of pottery paste and subsequent hypothesis of the possible source, tephra sediment. To date, there is no comparison study between Yucatan pottery and tephra layers. To identify the source EPMA will be crucial method for future study. It needs the interdisciplinary study of tephra layers between archaeology and the volcanology for understanding ancient civilizations that experienced destruction and post-development.

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