A BRIEF STUDY OF CAMBODIAN CIRCULAR EARTHWORK CERAMICS AS EXPLAINED THROUGH EDXRF ANALYSIS

D. Kyle Latinis[1] and Michael Dega[2]

[1]University of Cambodia; ruijingzhu@yahoo.com
[2]Naga Research Group; mike@scshawaii.com

ABSTRACT

Prehistoric circular earthwork sites occurring across the basaltic plateau of eastern Cambodia/western Vietnam are internally homogenous in terms of site characteristics and material record. Energy Dispersive X-Ray fluorescence (EDXRF) analysis of several earthwork ceramic assemblage samples was studied in efforts to determine whether ceramic production centers could be recognized within the circular site grouping. The EDXRF study provides an additional level of analysis to show that earthwork pottery was not being traded further south, into the Mekong Delta floodplains, and vice-versa.

INTRODUCTION

In the mid-1960s, the late French historian Bernard Phillipe Groslier referred to one circular mounded and internally moated archaeological site located east of the Mekong River and southwest of the central Vietnamese Highlands as "one of the most important prehistoric sites in South-East Asia" (Groslier 1966:195; Figures 1 and 2). With his ground breaking research, Groslier set the stage for much additional inquiry into the origins and nature of the sites. This research has proceeded from 1995 through present times and revealed much information about the sites (see Dega 2002 for a summary).

Over 55 circular earthworks, or *banteay kou* in Khmer, have been identified to date, with c. 15 having been subjected to intensive analysis. The sites were occupied from c. 2300 BC to 300 BC, the eastern sites being older than the western sites. The sites occur across a discrete swath of eastern Cambodia/western Vietnam, and are distinctly associated with the *terre rouge* or red soil area of the hills and plateaus above the floodplains. The sites are tethered to the transitional facies of lowland plains and upland terreces. The sites average 250 m in diameter or about 5 hectares, no one site truly dominating in size (site size mean 250 m² or 4.96 hectares; site range 220-285 m²; see Dega 2002). The sites are all circular and have similar, fairly redundant parts: outer earthen wall, interior depression or "moat", platform, and an entry/exit point. Site material cultural is also fairly homogenous, displaying an internally diverse lithic and ceramic assemblage, while the vertical and horizontal distribution of artifacts was similar at each investigated site.

This empirically tested homogeneity led to questions of group adaptation and collegiality, as no one site emerged as a focal point of the population. It has been argued that past inhabitants were interacting and frequently communicating (Dega 2002). Given this baseline, this paper generally illustrates how the EDXRF method provides a parallel interaction pattern seem amongst ceramics uncovered from the circular earthworks. It also suggests that there was homogeneity in both ceramics and site characteristics, all of which seem to suggest collegiality amongst habitants of these sites, which forms a distinctive terre rouge cultural tradition called the "Memot Culture" by B.P. Groslier.

The current investigation utilized EDXRF analysis to assess a sample of earthenware potsherds from circle sites across the region. The goal was to determine whether different sources or technologies were evident in the pottery of the circle site grouping, as well as to ascertain whether production centers could be recognized. Descriptions of the pottery assemblage, as well as chemical and physical soil analyses are presented elsewhere (see Albrecht *et al*. 1999, Dega 1999, 2002).

EDXRF (ENERGY DISPERSIVE X-RAY FLUORESCENCE)

EDXRF yields a partial ratio of atomic elements in a tested material, or a fingerprint of sorts. The material of concern here is earthenware pottery (both low and high-fired ceramics) and some stoneware. The earthwork sites have only yielded low-fired earthenwares. The 'material' includes the clay plus inclusions or inclusive substances (both

Figure 1: Cambodia Circular Earthwork Regional Location.

Figure 2: Circular Earthwork Sites.

intentionally added tempering agents such as rice, as well as natural inclusions, absorbed chemicals, and such.

Resultant ratios, or recipes, can be reduced to comparable values using principal component analysis. This helps to determine the degree of relationship of each partial ratio in a given set. Tight clustering represents a group of similar recipes. When values are plotted on a scatter graph, it is often quite easy to visually determine discrete groups.

Due to geology, parent material rock, and other complexities in clay formation and deposition, different pottery clay sources and/or technologies may have significantly unique signatures (compositions). Clays from different drainages frequently have different compositions, based ultimately on differences in parent rock contributions. Concerning the present dataset, this observation leads to introductory questions such as: Can different sources and/or technologies be identified in the circular earthwork pottery assemblages on an inter-site and intra-site basis? Would similarities and differences in the assemblages, as seen through EDXRF analysis, support the notion of increased or decreased communication and interaction within the earthwork grouping? Are there ceramic differences between the earthwork assemblages and contemporary floodplain groups? Can any earthwork site(s) be suggested as production centers with distribution to other communities, or were any of the earthwork sites importing pottery produced externally?

DATA ANALYSIS

The following graphs and explanatory text provide baseline results of the EDXRF comparison study. These preliminary results are summarized below and provide a foundation for additional inquiry into the social (and ceramic) nature of the earthworks.

Figure 3 shows a principal component plot (23 elements) for a number of samples. The pottery samples are from "Metal Age" (Iron/Bronze/pre-Funan) and pre-Angkor/ Angkor era floodplain sites, as well as Kampong Cham circular earthwork sites and one earthwork site (Loq Ninh) in neighboring Vietnam. The results of the component plot clearly show that the Kampong Cham circular sites contain pottery of a uniquely similar composition. The earthwork

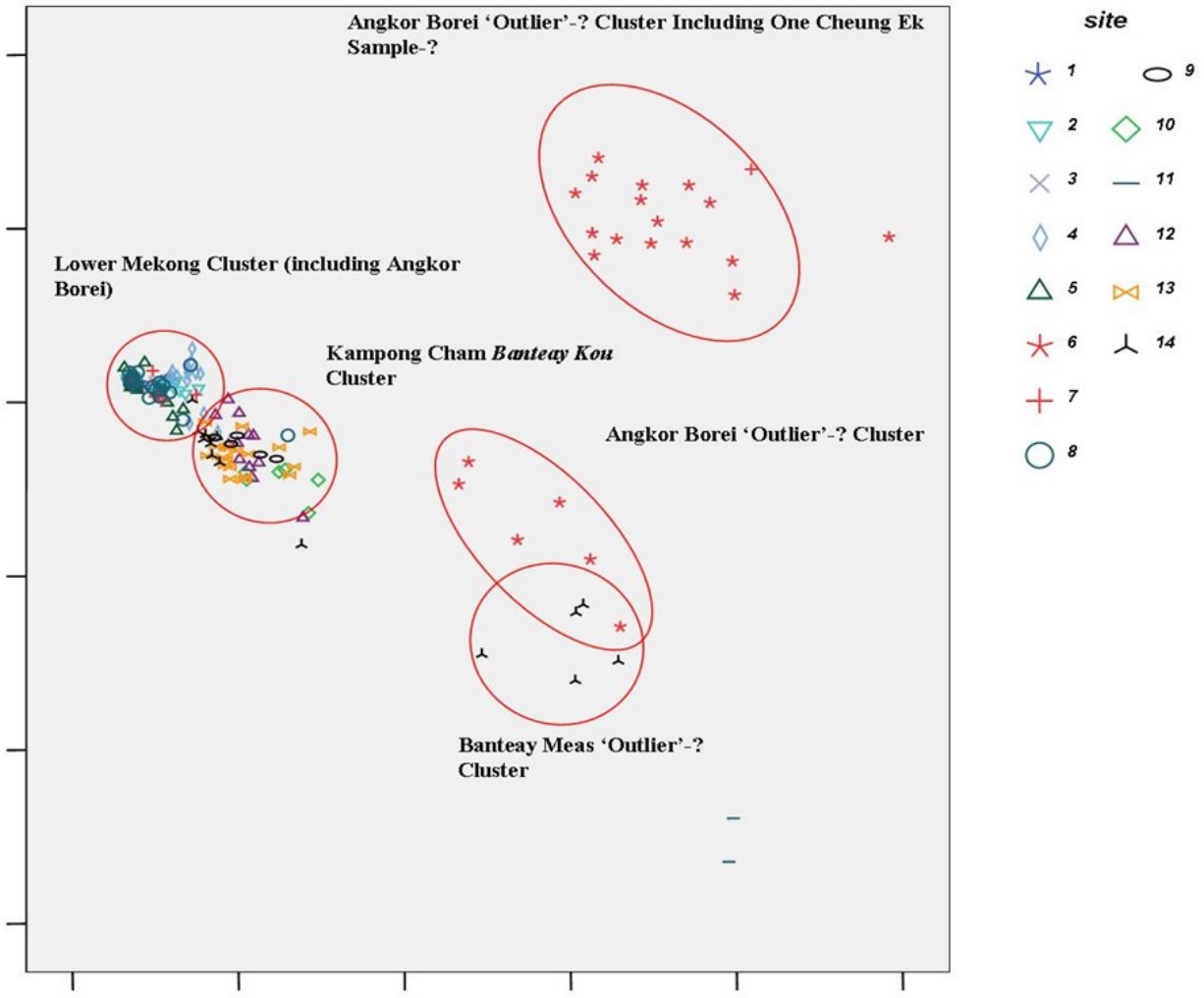

Figure 3: Principal Component EDXRF Analysis of Cambodian Pottery (23 elements).

pottery material (clay plus inclusions, additives, and absorbed material) is distinctive from the floodplain sites. There is some relational overlap between the two geographic areas though, as expected, due to the fact that soils from Kampong Cham, the area of the earthworks, drain into the Mekong and Bassac Rivers at upriver locations. The clays derived from these alluvial processes are major components of floodplain pottery, and on a moderate scale, share a similar origin with the earthwork clays. Soil samples from the Angkor Borei area (floodplain) and several circular earthwork sites (*terre rouge* plateau) fall within the main cluster ranges, a finding which suggests soils were mainly obtained locally, in both instances, for pottery manufacture. That is, *terre rouge* clays were used for pottery found at earthwork sites and floodplain clays were used for pottery found at floodplain sites.[1]

Another revelation of the principle component plot is that there is practically no main cluster overlap between the earthwork and floodplain samples. The distinction suggests that floodplain sites were not receiving pottery from the circular earthwork site area and vice versa. In chronological terms, occupation of the prehistoric earthwork sites decreases simultaneously with major settlement of the neighboring floodplains around 300 BC. Given the temporal distinction, the differences are not unexpected. However, exact terminal occupation of the circular sites remains unknown, and many floodplain sites existed during the latter phase of the circular earthwork occupation sequence. There is temporal overlap. The N.18 site (Sophady 2005) is the only documented site to date in the *terre rouge* region that may straddle the temporal, material cultural, environmental/ecological, and geographic

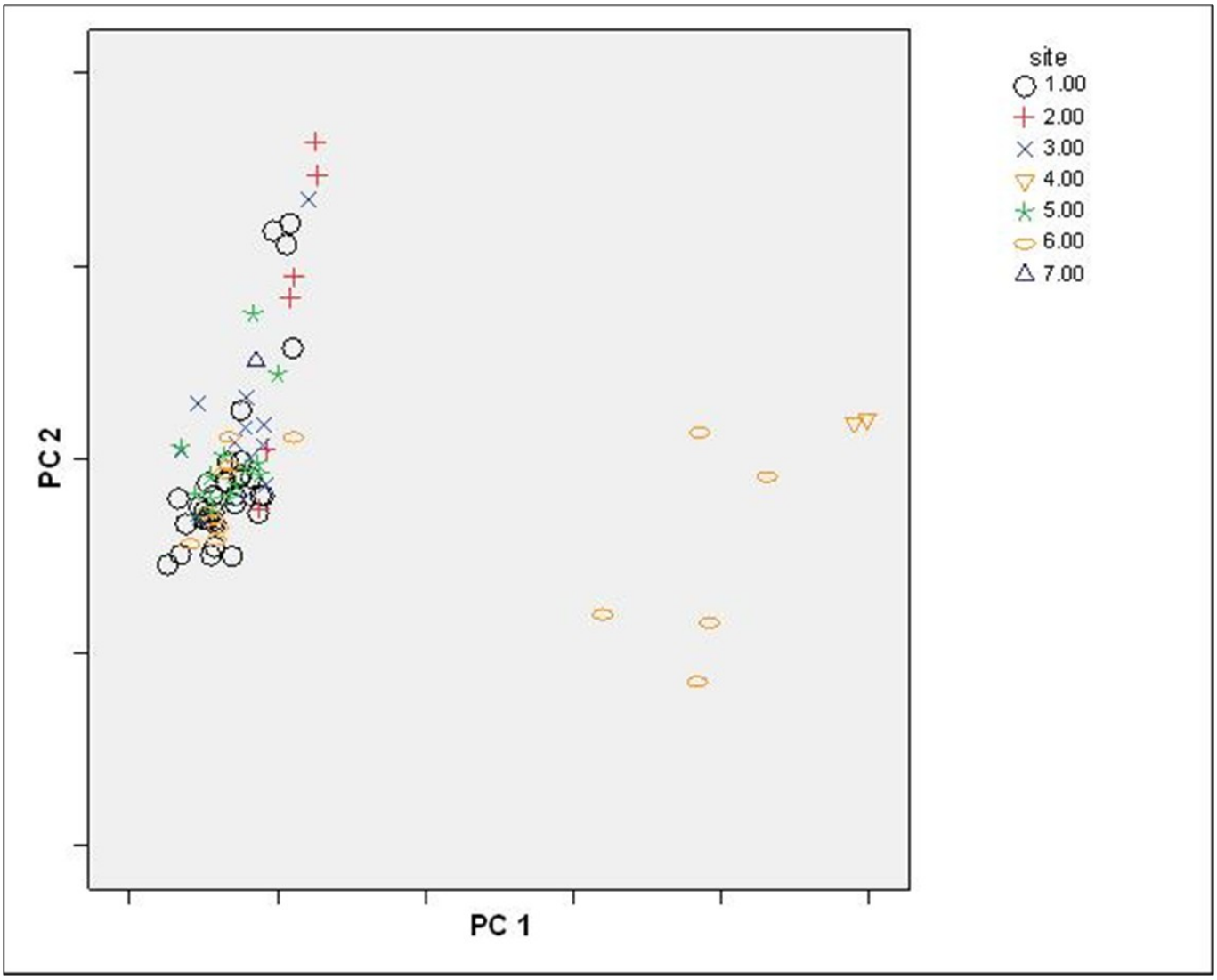

Figure 4: Principal Component Analysis (19 elements) of Earthwork Sites.

transition marking abandonment of the earthworks and settlement of the floodplains.

Although major settlement in the floodplains developed just prior to and around 300 BC, the same time of decreasing evidence of occupation or human activities in the circular earthwork area, there is no indication that people were moving out of the circular earthworks to the floodplains and bringing their ceramics with them. There is also no indication that floodplain ceramics were making their way into the last hundred years of earthwork occupation sequences. However, a larger data set and further research in the floodplains is needed to strengthen this argument.

Finally, in terms of the component plot, both the Angkor Borei site sample and one of the earthwork sites, Banteay Meas, have significant outliers/outlier clusters. Phnom Borei, however, has no major outlier clusters, a pattern similar to the majority of earthwork sites. Shawn Fehrenbach's (2009) neutron activation analyses of Angkor Borei pottery also demonstrated a set of significant outliers.

Figure 4 displays a principal component analysis of only circular earthwork sites. Although not exceptionally clear in the scatter plot, one main cluster can be identified as representing one main, generic source of the pottery clay. It is difficult to determine how geographically large and generic the source may be is difficult to determine at present with this method. There are likely one or two other sources, as seen in possible Clusters A and B.

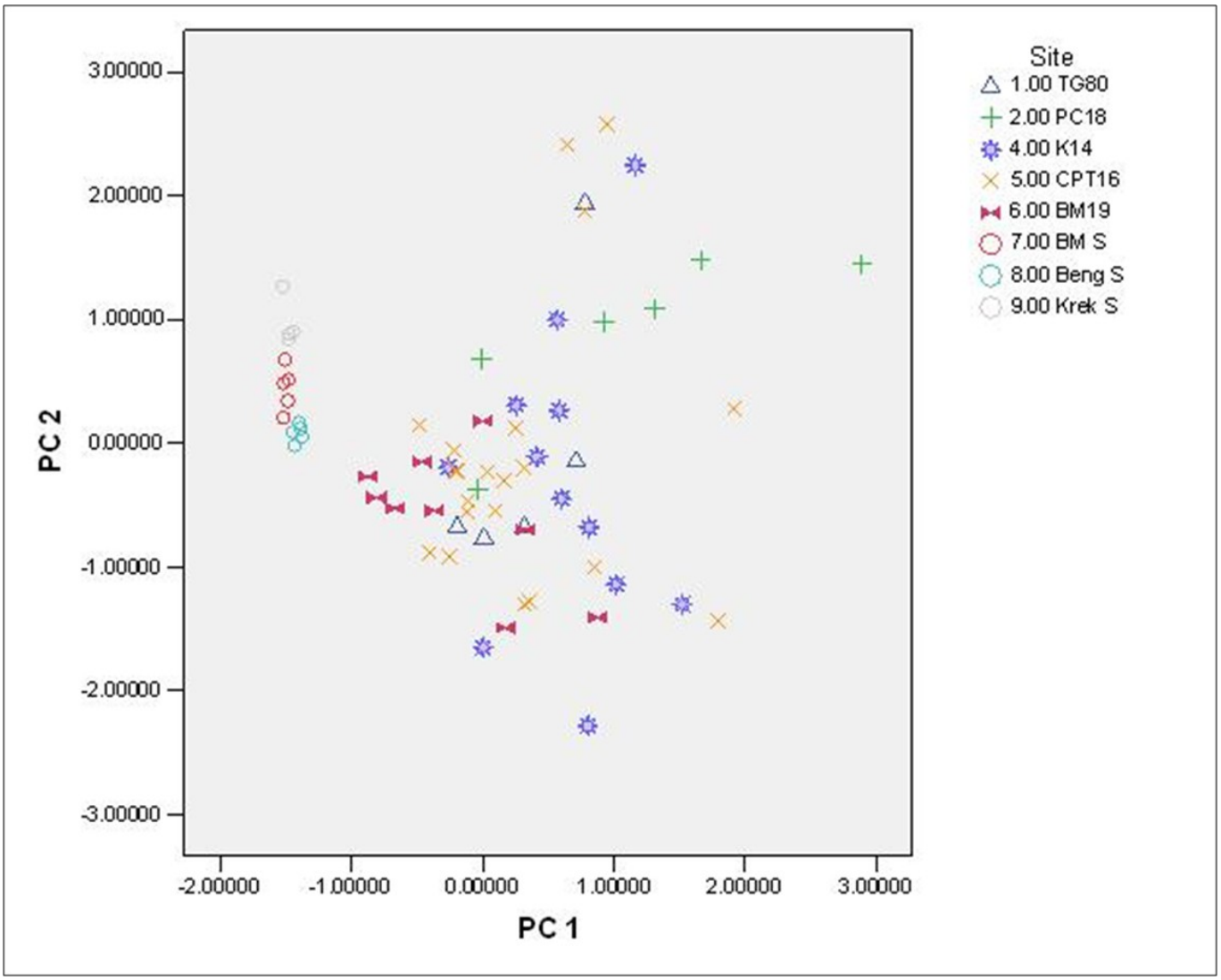

Figure 5: Principal Component Analysis of earthwork sites (minus outlier samples) and soils.

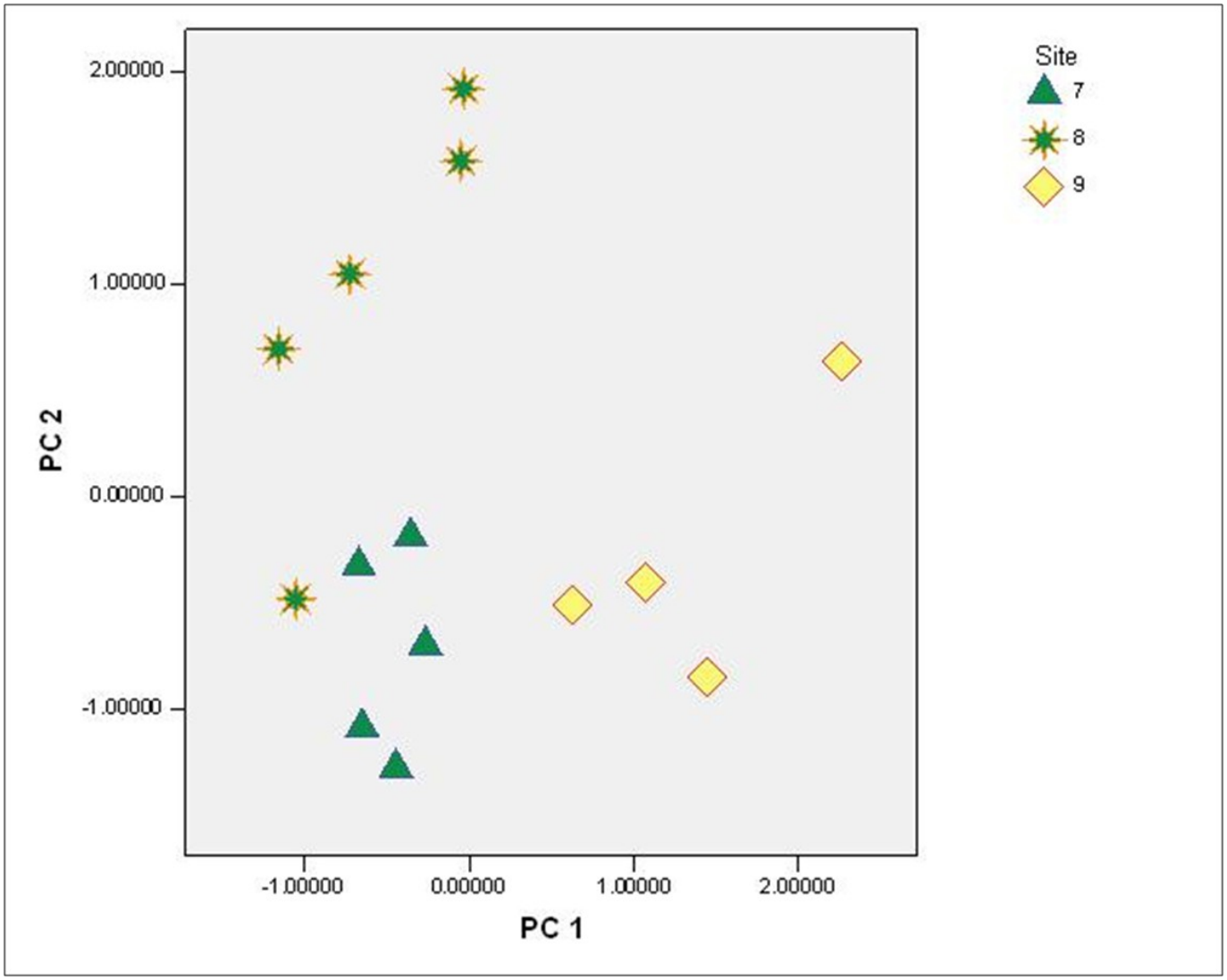

Figure 6: Principal Component Analysis of earthwork soils only (6-10 elements).

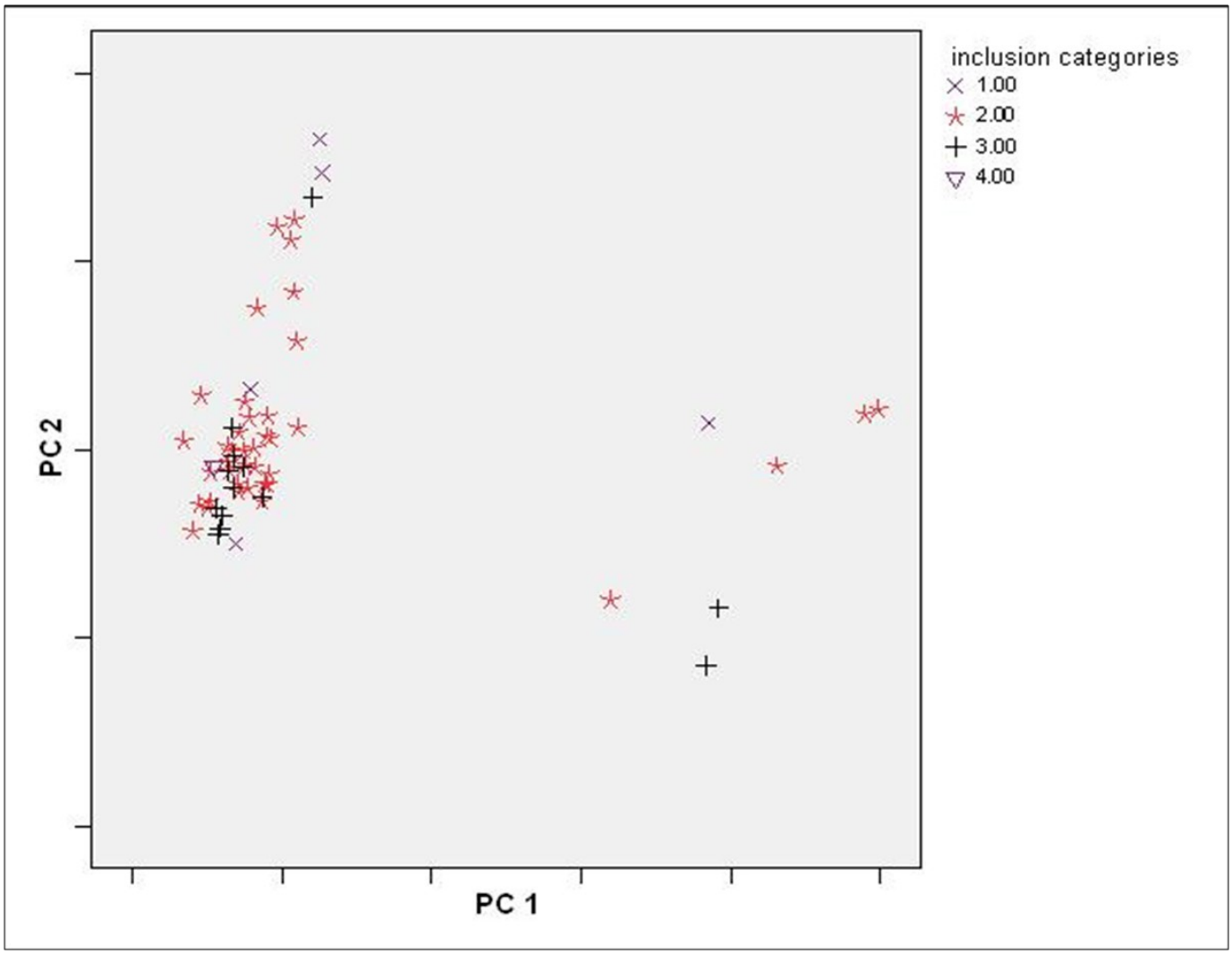

Figure 7. Principal Component Analysis, Inclusion Comparison (temper, additives, paste, etc.) of Three Earthwork Sites.

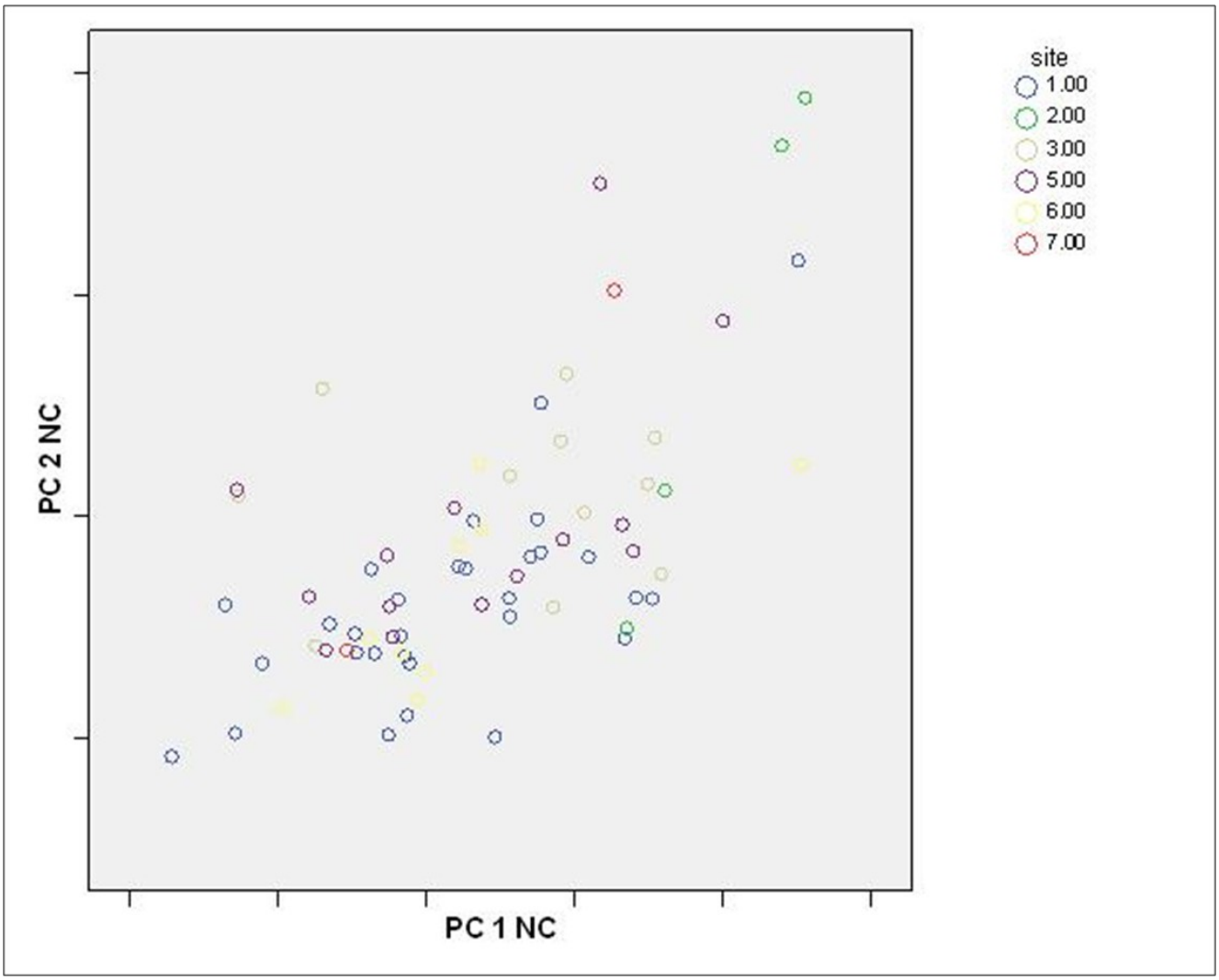

Figure 8. Principal Component Analysis of Earthwork Main Cluster/Source.

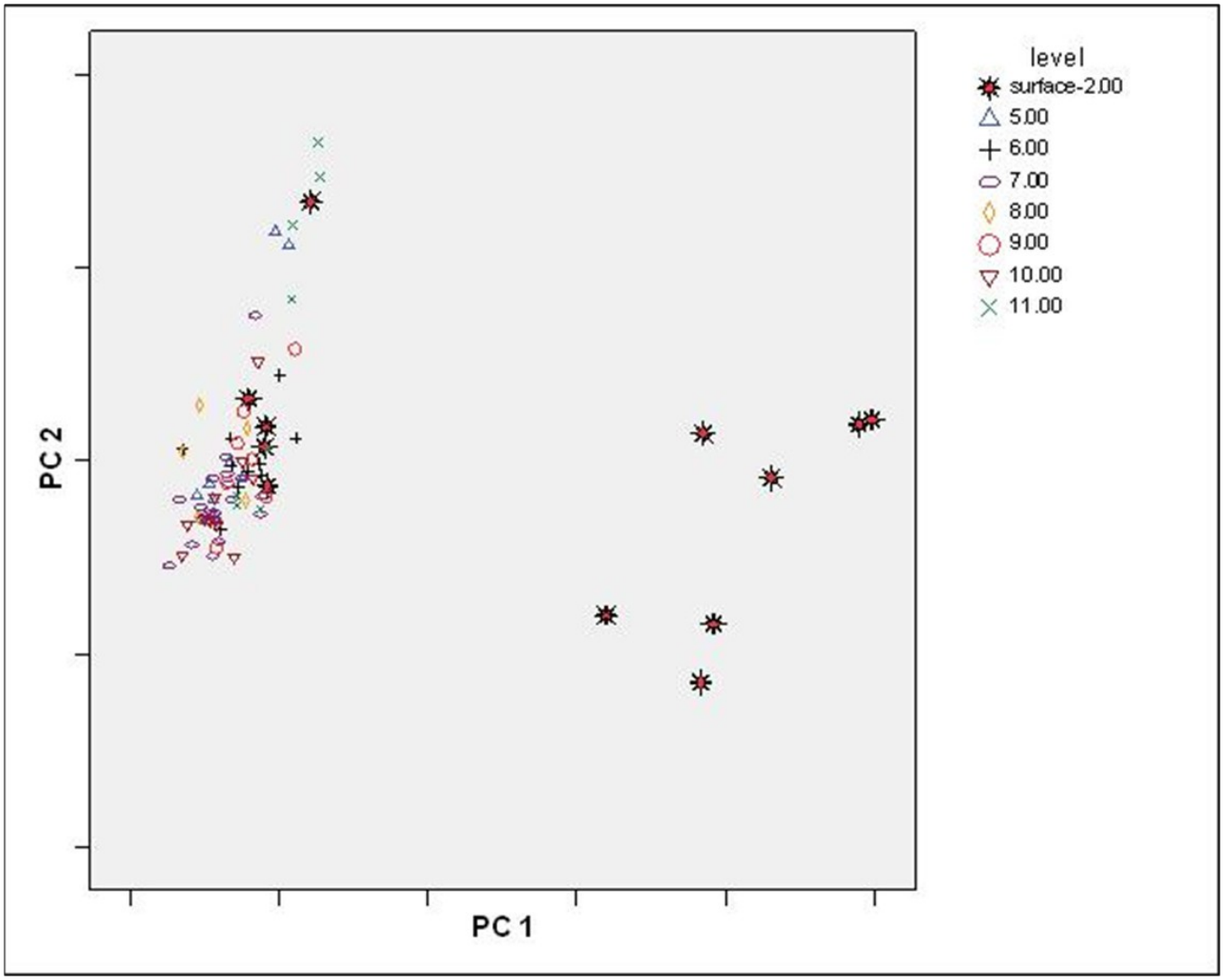

Figure 9: Principal Component Analysis of Earthwork Site Sherds by Depth in Deposits.

If the main cluster and possible clusters (A and B) represent different sources, then all earthwork settlements except Banteay Meas are more or less mining clay from multiple sources. They could also have been trading the pottery vessels. Given the almost exactly similar settlement morphology and size, geography, geology, environment, and local ecology of all the circular sites, and their relatively close geographic proximity, it is most probable that the past inhabitants were interacting and frequently communicating. The pottery designs and stylistic morphological attributes are also fairly homogenous between sites, an observation which further implies social interaction, not exclusion, isolation, or identification with distinct, separate and opposing groups. At first glance, the circular earthen walls do seem to suggest fortification and perhaps exclusion of neighboring communities. However, it is argued that the earthen encircling walls could have functioned to retain or exclude animals, formed habitation mounds, or been utilized for household or small-scale agricultural purposes, among other possibilities (see Dega 2002).

Functionally and stylistically, on an inter-site basis, there seems to be no indication that there were significant differences among the sites on the basis of material culture. Adherence to similar designs and vessels represents a larger, unified social group; *i.e.*, social collegiality. Importantly, it

does not appear that one or a few villages monopolized pottery production with a larger area.

Figure 5 represents a principal component analysis of the circular earthwork sites (6 elements), with the inclusion of three site soil samples. Although separate in this plot, the soils are well within the normative range of the larger group cluster (*i.e.*, Kampong Cham generic soils). There are no outliers indicating soil cum pottery from outside the earthwork region.

Figure 6 shows that although closely related, the soils are distinctly grouped. This suggests that local soils have useable, discrete signatures at a much more local scale than expected.

Figure 7 is a principal component plot to determine if visible paste and inclusion differences (*i.e.*, paste quality, tempers, additives, etc.) affected distributions. As shown in the plot, the four categories of inclusions (Category 4 being a very limited sample) do not appear to affect groupings. This means that inclusions were also fairly standardized in each site assemblage.

Figure 8 is a principal component analysis of the main cluster. The variability is more random, as would be expected. There do not appear to be any sub-clusters from the main cluster. This presumably represents single source variability, but perhaps may also be related to the limitations of the analysis itself.

Figure 9 highlights different clusters by pottery depth below surface. All extreme outliers noted in Figures 1 and 2 regarding the earthwork sites are located at surface or near surface levels. The most parsimonious explanation is some form of chemical/substance absorption or the Latrine Effect.[2]

Several two element tests show consistent clustering patterns for the earthwork sites. Ternary diagrams of three element tests and other statistical methods not shown here were consistent as well.

Several conclusions are drawn from this brief paper on EDXRF analysis of several earthwork assemblages, as well as several samples from floodplain sites, for comparative purposes:

1. Circular earthwork sites contain pottery of a uniquely similar composition (internally) and are different from the floodplain pottery sites (external).
2. Local soils were utilized for earthwork pottery manufacture. This is also suggested by the high frequency of anvils and wasters recovered from the sites.
3. Circular earthwork site occupants were mining clay from many local sources, trading pots, or both to some degree. This equates to frequency in interaction, communication, and again implies cultural affiliation between the earthwork sites.
4. One or several of the circular earthworks did not monopolize pottery production within a larger area of distribution, unlike the situation which developed later for the floodplain sites dating from the first millennium BCE through the Angkor period..
5. Circular earthwork pottery was not distributed to floodplain sites and vice-versa, during possible overlap in occupation periods.
6. The thesis that the circular sites represent a distinctive cultural grouping or tradition still remains most plausible. Communication, or what we now see through the archaeological record in the form of sites, artifacts, and paleoenvironmental data, between the group (sites) was high, from macro levels (site distribution, site physical features) to micro levels (artifacts, etc.).

NOTES

Please note that this paper is being expanded, as part of an historical ecology study of the earthwork sites (Latinis and Dega, *in preparation*). Additional SRF studies have also been conducted in 2010 with expanded sample sets and site by Latinis and A. Cowan, with the results of these studies available in the near future.

1. It should be noted that the floodplain ceramic industry may not have intensified in "capital" centers such as Angkor Borei, but rather, centers of production and distribution may have formed in a few other locales. One area to explore further is Cheung Ek, located near Phnom Penh, which may have emerged as a major production center by the Funan period. Early dates (5th and 7th centuries) for possible kiln production of pottery production have been noted (Phon 2002; Phon and Latinis 2009).

2. Surface samples from floodplain and other sites recovered in locations near toilets and waste disposal areas were tested against subsurface and other surface samples. Even after thorough cleaning by numerous methods, the results indicated significant differences. The tentative explanation is that substantial absorption of modern chemicals, etc. occurs and thus, contaminates samples. However, there is an outlier cluster in the floodplain sample set that may indicate a significant source difference.

REFERENCES

Albrecht, G., M. Haidle, S. Chhor, L.H. Heang, S. Heng, T. Heng, S. Mao, K. Sirik, S. Som, C. Thuy, and L. Vin. 1999. *Recent Studies of Circular Earthworks by the Faculty of Archaeology.* RUFA, Phnom Penh: Royal University of Fine Arts, Phnom Penh, Kingdom of Cambodia.

Dega, M.F. 1999. Circular Settlements within Eastern Cambodia. *Bulletin of the Indo-Pacific Prehistory Association* 18: 181-190.

_____. 2002. *Prehistoric Circular Earthworks of Cambodia*. BAR International Series 1041. Archaeopress: Oxford.

Fehrenbach, Shawn. 2009. *Traditions of Ceramic Technology: An Analysis of Assemblages from Angkor Borei, Cambodia*. Unpublished MA Thesis, University of Hawaii.

Groslier, B.P. 1966. *Indochina.* Miller: London.

Heng, Sophady. 2005. *Village 10.8: Excavation Results of an Iron Age Cemetery in the Red Soil Region, Eastern Cambodia.* On file with the Ministry of Culture and Fine Arts and the Memot Centre for Archaeology.

Phon, Kaseka. 2002. *Ancient Kiln Site at Cheung Ek.* Unpublished MA Thesis, Royal Academy of Cambodia, Phnom Penh.

Phon, Kaseka and D. Kyle Latinis. 2009. *Kiln Fields at Cheung Ek: Recent Archaeological Investigations near Phnom Penh, Cambodia.* On file with the Ministry of Culture and Fine Art and the Khmer Archaeological Society (a revised version has been submitted for review with BIPPA).