

TRADE AND EXCHANGE NETWORKS IN IRON AGE CAMBODIA: PRELIMINARY RESULTS FROM A COMPOSITIONAL ANALYSIS OF GLASS BEADS

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ABSTRACT

Glass and stone beads found at Iron Age period sites (500 BC – AD 500) in Southeast Asia are amongst the first signs for sustained trade and sociopolitical contact with South Asia. Because of this, they have become important artifacts for scholars wishing to better understand trade networks and sociopolitical development during this period. Using compositional analysis, scholars can identify the recipes used to make these glass beads and in some cases this can be tied back to specific places or time periods. Current research indicates there were multiple glass bead production centers across South and Southeast Asia during this period. However there has not yet been a comprehensive examination of glass beads from Iron Age sites in Cambodia. This paper aims to fill this gap by presenting the results from a compositional analysis of glass beads from six Iron Age sites in Cambodia. Using a virtually non-destructive compositional technique (LA-ICP-MS), I was able to determine the presence of at least two glass bead-trading networks in Cambodia during the Iron Age.

INTRODUCTION

The Iron Age period of Southeast Asia (approximately 500 BC-AD 500) is when we see the first concrete evidence for sustained trade and sociopolitical interaction with South Asia (primarily the regions of modern day Sri Lanka, India, and possibly Bangladesh). Beads made of glass and stone were amongst the first signs of contact with South Asia. As such they have become important artifacts for scholars wishing to better understand trade networks and sociopolitical development during this period (e.g. Bellina 2003; Theunissen 2003). Glass beads in particular have been the focus of several comprehensive compositional studies (e.g. Dussubieux 2001; Lankton and Dussubieux 2006), which have shed light on the many different types of glass present at sites across South and Southeast Asia during the Iron Age period. By examining the compositions of different glass beads scholars can identify

the recipes used to make the glass, and in some cases can be tied back to specific places or time periods when the glass was in circulation. Recent research has even uncovered evidence for local production of glass in Southeast Asia (see Lankton et al. 2008).

The last ten years of archaeological research in Cambodia has produced several studies of glass beads at the individual site level (Gratuze 2005; Haidle 2001; Haidle and Neumann 2004; Latinis 2004; Lapteff 2006; Song 2008; Stark and Dussubieux 2002; Vanna 2007). However, there has not yet been a comprehensive examination of glass beads from Iron Age sites across Cambodia. The current paper aims to fill this gap by presenting the results of compositional analysis of glass beads from six Iron Age sites in Cambodia. The beads were examined using a virtually non-destructive compositional analysis technique called laser ablation-inductively coupled plasma-mass spectrometry, or LA-ICP-MS. Using this technique I was able to determine the presence of at least two glass bead-trading networks in Cambodia during the Iron Age, which connected sites in Cambodia to one another and to sites across South and Southeast Asia.

IRON AGE SITES IN CAMBODIA

In 2008 with support from Fulbright IIE and the Center for Khmer Studies I traveled to Cambodia to undertake doctoral dissertation research on Iron Age trade networks in Southeast Asia through a study of stone and glass beads. I was able to examine bead collections from six different Iron Age sites: Phum Snay, Prei Khmeng, Prohear, Bit Meas, Village 10.8, and Phnom Borei (Figure 1). Nearly all of the beads studied were excavated within the last ten years and have a good provenience. Over 3,000 glass beads were examined and from these 157 were selected for LA-ICP-MS analysis in the United States (Table 1). Permission for this analytical study was generously provided by the Cambodian Ministry of Culture and Fine Arts (MoCFA) and the APSARA Authority. All of the glass beads, unless otherwise noted, were small mono-

Site Name	Dates	Glass Beads Examined using LA-ICP-MS	Total number of glass beads recorded
Bit Meas	Contemporary with Prohear	5	5
Phnom Borei	1 st – 2 nd Centuries BC	6	48
Phum Snay	350 BC–AD 200	30	285
Prei Khmeng	1 st – 6 th centuries AD	42	2056
Prohear	200 BC – AD100	59	550
Village 10.8	400 BC – AD 50	15	209
Total	-	157	3151

Table 1: Number of glass beads examined per site.

chromatic annular or globular beads of a type known as Indo-Pacific beads, which were widespread across the ancient world (Francis 2002). Other glass artifacts such as bangles, earrings, and ring fragments were also analyzed (Figure 2). Agate, carnelian, and garnet beads were also examined as part of this research, but are beyond the scope of the current paper.

Phum Snay

Phum Snay is a small village located on the edge of a natural mound along Route 6 in Banteay Meanchey province in northwest Cambodia. The site was discovered during road construction in 2000 and subsequently looted. Salvage excavations were undertaken from 2001- 2003, which uncovered numerous burials and grave goods (Domett and O'Reilly 2009; O'Reilly and Pheng 2001; O'Reilly et al. 2004). Recently, additional excavations have been undertaken by a joint Japanese-Khmer archaeological team (Yasuda et al 2008; Yasuda 2009). Phum Snay is perhaps the best-studied Iron Age site in Cambodia and several scholars have examined beads from this site (Gratuze 2005; Lapeteff 2006, 2007; Sophy 2008; Vanna 2007). Pheng Sytha from the Royal University of Fine Arts in Phnom Penh, kindly granted permission to study beads from the 2001 and 2003 excavation collections. Beads from these collections are from a cemetery radiocarbon dated to 350 BC- AD 200. 285 glass beads were recorded and 30 were selected for further analysis using LA-ICP-MS.

Prei Khmeng

The site of Prei Khmeng is located in the Angkor region, the Khmer capital from the 9th to 15th centuries AD, and is home to a small pre-Angkorian brick tower and lintel, one of the oldest in the Angkor area. Three excavations by the MAF-KATA mission (École Française d'Extrême-Orient, henceforth EFEO and Apsara Authority) led by Dr. Christophe Pottier uncovered several prehistoric burials and an occupation area that dates from the 1st-6th centuries AD (Pottier, personal communication, 2009; Zoppi et al. 2004). Interest-

ingly, nearly all of the beads from this site are glass (n=2056) and it had the highest number of glass beads found at any site in the study, with one burial having over 1700 beads. Of the over 2000 beads recorded, 42 glass beads and artifacts from four different burials were analyzed using LA-ICP-MS.

Prohear

The site of Prohear is located in Prey Veng province in south-eastern Cambodia. In early 2007 villagers found ancient artifacts and began looting the site. Several Cambodian archaeologists discovered the looting and tried to stop it, but it was not until 2008 and 2009 that salvage excavations could take place. A joint German-Cambodian team excavated in one of the few places that had not yet been destroyed by looting: the main road. From these small excavations 52 burials were uncovered, along with an impressive array of grave goods including pottery, approximately 2700 beads, and gold, silver, bronze and iron artifacts (Reinecke et al 2009). The cemetery has been dated from 200 BC to AD 100 (Reinecke et al. 2009:100). Glass beads were common artifacts; of the 52 burials at the site only six did not have glass beads, although these were partially disturbed burials (Reinecke et al 2009:118). As part of the current study 550 glass beads held at the Memot Centre for Archaeology were recorded. Of these, 59 glass beads and artifacts including rings, earrings, and bangle fragments were selected for further LA-ICP-MS analysis.

Bit Meas

Bit Meas is a small village located eight kilometers southwest of Prohear and was nearly completely looted by villagers in 2006. The Royal University of Fine Arts undertook a small salvage excavation and recovered few artifacts (Reinecke et al 2009:19-21). Cambodian archaeologists collected several glass and stone beads from the site and five glass beads were brought to the United States for LA-ICP-MS analysis. Based on some of the reported finds, including Dong Son drums and gold jewelry, archaeologists believe it dates to the Iron Age



Figure 1. Map of relevant Iron Age sites in Cambodia. Adapted from Higham 2002

and was roughly contemporary with the site of Prohear (Reinecke et al. 2009:149, 152).

Village 10.8

Village 10.8 is a cemetery site located in the red soil region of Cambodia, Kampong Cham province. The site was first identified in 2000, and several excavation campaigns in 2001, 2002, and 2004-6 were undertaken by a joint German-Cambodian archaeological team, including the Memot Centre for Archaeology (Heng 2004, 2005). Decorations on a Dong Son drum found at the site are similar to other designs from the 3rd-1st centuries BC and radiocarbon dates range from 400

BC to AD 50 (Heng 2005). More than 40 burials have been uncovered and 209 glass beads, held in the collections at the Memot Centre for Archaeology in Phnom Penh, were recorded for this study. Fifteen glass beads and artifacts were selected for compositional analysis.

Phnom Borei

Phnom Borei is a small site located about five kilometers south of the site of Angkor Borei and may have been a locus of the larger Angkor Borei settlement (Stark, personal communication, 2010). A survey and small excavation led by Kaseka Phon uncovered nine burials, numerous pottery frag-

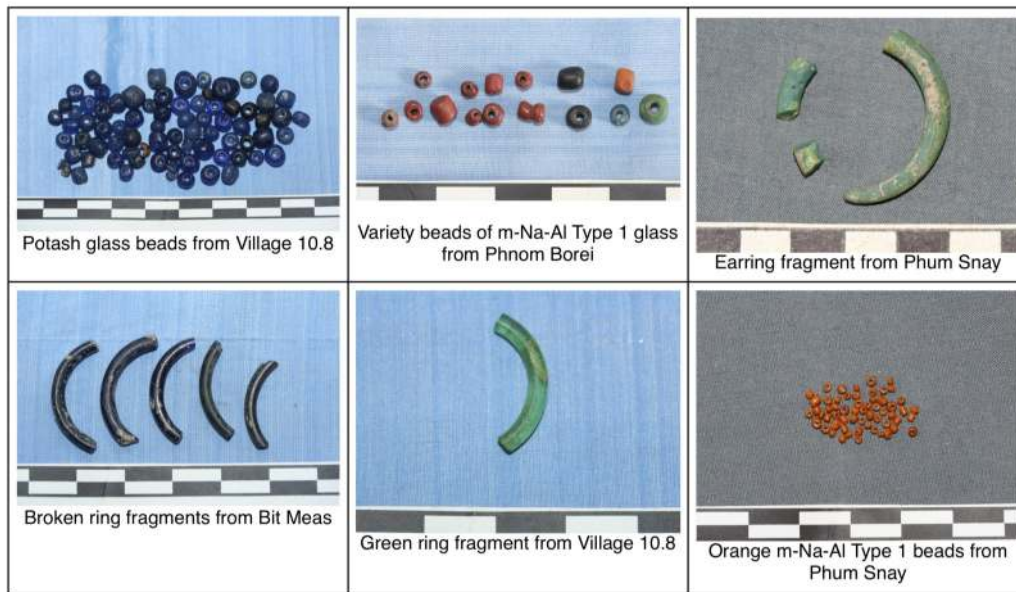


Figure 2: Examples of some of the glass beads and artifacts examined in this study.

ments, iron slag, bronze fragments, animal bones and beads. Ceramics at the site are quite similar to those found at Angkor Borei and radiocarbon dates place Phnom Borei in the last few centuries BC (Phon 2004). A total of 48 glass Indo-Pacific beads were found during excavations and six glass beads were selected for analysis.

RESULTS FROM LA-ICP-MS ANALYSIS OF GLASS BEADS

The glass beads and artifacts were analyzed by the author in the LA-ICP-MS laboratory at the Field Museum in Chicago, Illinois, managed by Dr. Laure Dussubieux. LA-ICP-MS is an ideal technique for analyzing artifacts. It requires no sample preparation and is virtually non-destructive, causing almost no visible damage to the sample. The machine used is a Varian ICP-MS connected to a New Wave UP213 laser (for more details on the technique and its performance see Dussubieux et al. 2009). Detection limits for most elements range from 10 ppb to 1 ppm, with an accuracy of 5-10% depending on the elements and their concentrations. A total of 55 elements were recorded in the final results (Figure 3). The analytical protocol and calculation methods used were adapted from Gratuze (1999); final measurements for all the samples are listed in Appendix 1.

Results from the analysis of glass beads and artifacts indicate a dichotomy between sites in the southeast (Prohear, Bit Meas, and Village 10.8) that are dominated by potash glass, and sites in the rest of the country, which have predominantly high-alumina soda glass. Figure 4 and Table 2

demonstrate the distribution of glass types analyzed at each site in more detail. The samples selected for analysis represented the range of glass found at each site. Based on these results, I also estimated the make-up of the entire glass artifact collection at each site by comparing similarities between analyzed and unanalyzed artifacts (Figure 5). The difference in glass type distribution indicates the presence of multiple glass bead trading networks.

Potash Glass

Potash glass, which uses potash (K_2O) as a flux to lower the melting point of the glass, is one of the most common types of glass found in Southeast Asia, however it has also been described as one of the “least understood” (Lankton and Dussubieux 2006:135). No potash glass workshops have yet been discovered, however the presence of different sub-types of potash glass indicate the possibility of multiple production centers, with some possibly located in Southeast Asia (Lankton and Dussubieux 2006). The potash glass sub-types vary by differing levels of CaO and Al_2O_3 , which are added as glass stabilizers, although the boundaries between these different sub-types are still nebulous. The three currently classified potash glass sub-types are: potash glass with moderate amounts of CaO and Al_2O_3 (m-K-Ca-Al), potash glass with low calcium oxide (m-K-Al low C), and potash glass with low alumina (m-Ka-Ca low A). All the sites examined in this study had some amount of potash glass except for Prei Khmeng. Interestingly, an earlier study of glass from the site of Angkor Borei also did not find any potash glass

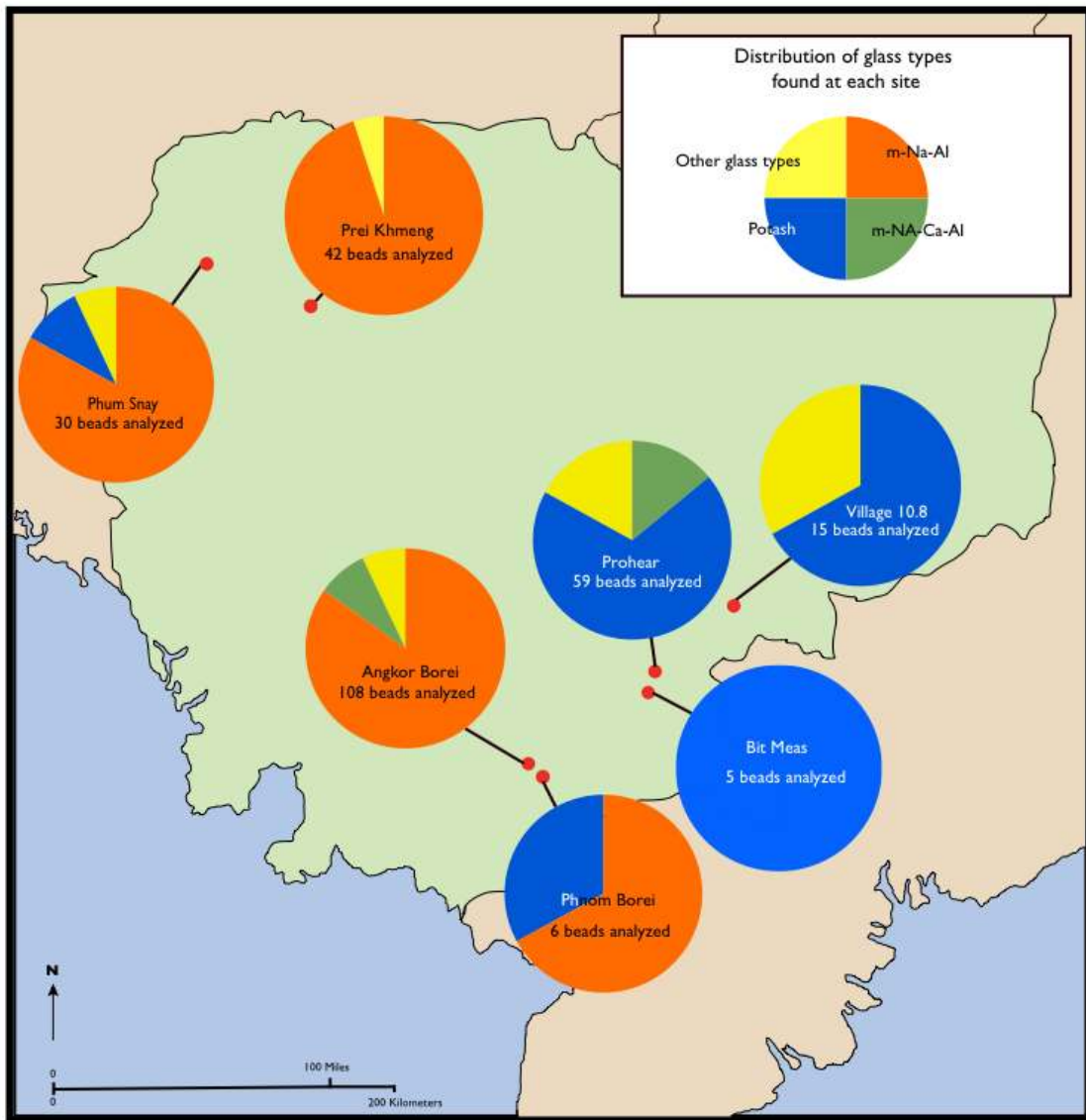


Figure 4: Distribution of glass types at each site based on LA-ICP-MS analysis. Data on the Angkor Borei glass collection from Dussubieux 2001.

vessel fragments made from this type of potash glass were identified in Han-period tombs in China. Furthermore, vessel fragments have been identified in peninsular Southeast Asia at the sites of Tha Chana and Phu Khao Tong (Lankton et al. 2009). In fact, the predominance of m-K-Al glass in East and Southeast Asia suggests it may have been manufactured in this area (Lankton and Dussubieux 2006: 136-7). In Cambodia, this type of potash glass has the same distribution as m-K-Ca-Al glass. At Phnom Borei, one dark blue glass bead belonged to the low CaO potash sub-type, as did four glass beads in a variety of colors (blue green, light blue, dark blue,

dark purple) from Bit Meas. At Village 10.8 five dark blue beads belonged to this sub-type. Previous research on a violet bead and a green bead from Village 10.8 also placed them in this m-K-Al low-C subtype (Haidle and Neumann 2004). At Prohear there were fourteen beads in blue, green, yellow-green, purple, and black colors as well as four ring/earring fragments in dark blue, purple, green, and black.

Only one potash glass object had alumina under one weight percent: a black ring/earring fragment found at Prohear. Low-alumina potash (M-K-Ca low A) glass has been found at Ban Don Ta Phet, Thailand and Giong Ca Vo, Vi-

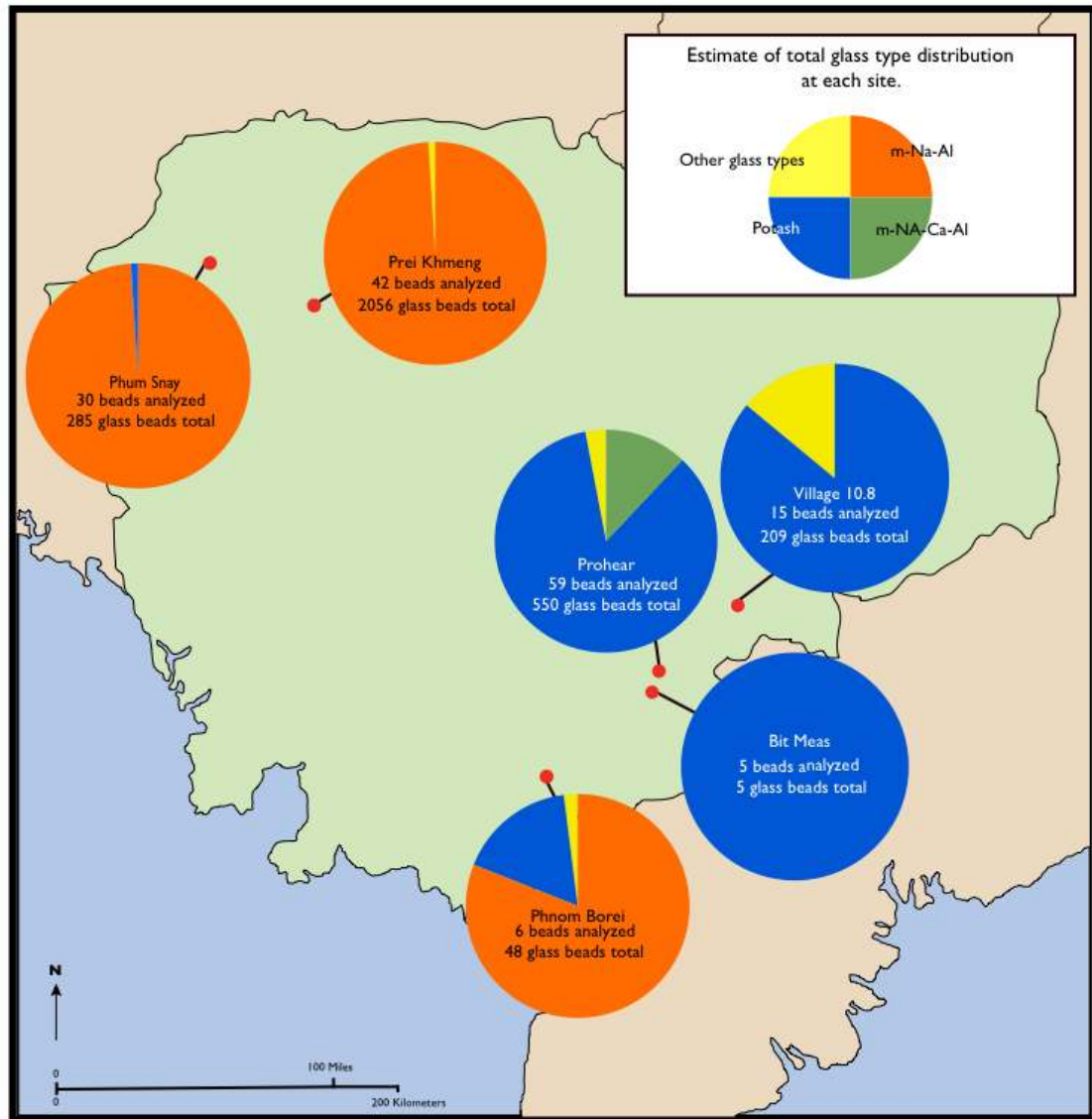


Figure 5: Estimate of the total glass distribution at each site by percentage.

etnam, but has not been found in South Asia indicating it may have been locally produced in Southeast Asia (Lankton and Dussubieux 2006). This sample is more consistent with the moderate or low CaO potash glass than the low-alumina glass from Ban Don Ta Phet, therefore it is important to consider that the low alumina may have been caused by weathering (Lankton and Dussubieux 2006:136). Nevertheless, it appears that low alumina potash glass was not widely traded in Cambodia.

High-Alumina Soda Glass

High-alumina soda glass (m-Na-Al) is the most abundant type of glass found in South and Southeast Asia. In contrast to potash glass, high-alumina soda glass uses soda (Na₂O) as a flux and high levels of alumina (Al₂O₃) as a stabilizer. Dussubieux et al (2010) have identified five different types of mineral soda alumina glass, of which m-Na-Al Type 1, identified by its low uranium and high barium content, is the most prevalent during the Iron Age of Southeast Asia. All of the high-alumina soda glass found at the Iron Age sites in Cambodia belonged to the m-Na-Al 1 group and were found in large quantities and varieties of colors at Phum Snay (n=25), Phnom Borei (n=4), and Prei Khmeng (n=40). Earlier stud-

ies at Phum Snay have also identified several m-Na-Al 1 glass beads (Gratuze 2005; Vanna 2007; Song 2008).

Interestingly, no m-Na-Al 1 glasses have been found thus far at Bit Meas, Prohear, or Village 10.8. Lankton and Dussubieux have identified a regional shift from potash glass to high-alumina soda glass around the turn of the millennium BC/AD. They observe that: “the different glass compositional groups change more by the dates of the sites, rather than by their locations within Southeast Asia. Whatever happened was a regional phenomenon, occurring across the expanse of Southeast Asia,” (Lankton and Dussubieux 2012). These changing bead trade networks could account for the different distributions of glass seen at sites across Cambodia (Figure 4). Dussubieux (2001; see also Stark and Dussubieux 2002) has already remarked on the lack of potash glass at burials in the Vat Komnou cemetery at Angkor Borei (dated 2nd century BC- 2nd century AD), providing a range for this shift from potash glass to m-Na-Al glass. The implications of this shift will be discussed further below.

Other glass types

Several other glass types were identified in analysis, albeit in smaller quantities. At Prohear there were eight blue glass beads identified as a type of mineral soda glass with variable amounts of alumina and lime (m-Na-Ca-Al). This type of glass also appears at other Iron Age sites in Southeast Asia including Angkor Borei, Cambodia, Lach Truong, Vietnam, Ulu Leang, Indonesia, and Khlong Thom, Thailand. At Khlong Thom, there is also evidence for production. Additionally, m-Na-Ca-Al glass has been found at sites in South Asia including Arikamedu, Anurdhapura, and Ridiyagama in Sri Lanka (Dussubieux and Gratuze 2003; Dussubieux and Gratuze 2012; Lankton and Dussubieux 2012). The m-Na-Ca-Al glass appears to be related to another unique glass type known as Arika glass (Dussubieux 2001; Dussubieux and Gratuze 2010). As its name implies, this type of red, green, and black glass was first identified in great quantities at the site of Arikamedu (Dussubieux 2001). In Southeast Asia, Arika glass has an “uneven distribution,” with the largest quantity coming from the peninsular Thai site of Phu Khao Thong (Dussubieux and Gratuze 2012). At Prohear, three red glass beads and possibly one black bead were identified as belonging to the Arika glass category. One yellow lead glass bead was also identified at Prohear. Lead glass is rare at sites in Southeast Asia. Only small quantities have been recovered, and only at a few sites in mainland Southeast Asia, including Angkor Borei, Cambodia and Ban Non Wat, Thailand (Carter and Lankton 2009). These beads are believed to be of Chinese origin (Lankton and Dussubieux 2006).

Another glass type found at both Phum Snay and Prei Khmeng is a soda lime glass with a plant ash alkali source, known as v-Na-Ca glass. From Phum Snay, one bead in the current study was found to belong to this glass type, in addi-

tion to four v-Na-Ca beads found during an earlier study of looted beads from this site (Gratuze 2005; Vanna 2007). At Prei Khmeng two beads, a dark blue bead and a short black bicone with red trim around the middle, were classified as belonging to this glass type. During later periods, this type of glass was most likely imported from the Middle East. However, Lankton and Dussubieux note the presence of V-Na-Ca glass at early sites in Sri Lanka and Southeast Asia and question its Middle Eastern origin during this early phase. At present, current evidence leaves the origin of this glass unclear (Lankton and Dussubieux 2012).

Although no glass artifacts from the circular earthwork site of Krek 52/62 were a part of the current study, an earlier study analyzed five green glass bracelets found during excavation (Haidle and Neumann 2004). Recently, these green glass bracelets have been identified as being similar to the m-Na-Al 3 glass found, and possibly manufactured at, the peninsular Thai site of Khao Sam Kaeo (Lankton et al. 2008). M-Na-Al 3 glass differs from the previously discussed m-Na-Al 1 glass by its higher levels of uranium and low barium, strontium, and zirconium. As of yet, no KSK m-Na-Al glass has been identified at any other sites in Cambodia, although a similar bracelet found at Village 10.8 may also belong to this glass type (Lankton, personal communication, 2009).

Other Iron Age Sites in Cambodia with Glass Beads

Several other Iron Age period sites in Cambodia have produced glass beads and artifacts that have not yet been well studied or analyzed. The sites of Thmar Puok and Phuorn Banana Farm in Banteay Meanchey province were the focus of excavations by the Royal University of Fine Arts and the organization Heritage Watch in 2006 (Latinis 2006). Several burials and glass beads were uncovered. Examination of several small (1-2 mm) orange glass beads found with the burial of a child at Phuorn Banana Farm suggest they were quite similar to those found at Phum Snay, Prei Khmeng, and Phnom Borei, and most likely belong to the m-Na-Al Type 1 group.

Glass beads were also recovered at Krosaing Thmei, an Iron Age site located just a few kilometers from the site of Phum Snay. As with Phum Snay, Krosaing Thmei was discovered during road construction and heavily looted before excavations were undertaken by Sok Keo Sovannara from 2003-2005 (Sok 2005). The site has been dated from the 1st century BC- 2nd century AD and a small number of glass beads were found with burials. The beads were described as being orange and blue in color and ranged in size from 1mm-5mm. The orange beads could most likely be classified as m-Na-Al Type 1, however it is impossible to determine the glass type for the blue beads without further examination and analysis.

A final example is Phum Sophy, another Iron Age cemetery site located in the Banteay Meanchey province. A small

excavation in 2009 uncovered burials with glass and stone beads (O'Reilly, personal communication, 2010). Beads are primarily orange, yellow, black, and turquoise in color, which is consistent with the m-Na-Al 1 glass found at the nearby site of Phum Snay.

DISCUSSION AND FUTURE RESEARCH

The results of the current study raise several important points that shed new light on our understanding of Iron Age Cambodia. Based on the distribution of glass beads, there appear to have been two major glass bead-trading networks at play in Cambodia, and they were separated by time and space. Thus far, no Iron Age sites excavated in Cambodia have had significant numbers of both potash glass beads and high-alumina soda glass beads, which would indicate participation in both glass bead trading networks. One hypothesis for this dichotomy can be related to the changing nature of trade with South Asia over the Iron Age period (Lankton and Dussubieux 2012). Bellina and Glover have identified two distinct phases of trade with South Asia, with a shift towards more intensive trade with South Asia emerging around the second-fourth centuries AD (2004:80). In Cambodia, the presence of sites with large quantities of high-alumina soda glass and very little potash glass appear to reflect these changing trade networks. It is possible that the new m-Na-Al glass bead trade network was part of the changing trade patterns that eventually brought Angkor Borei and the Mekong Delta to power.

Stark has argued that the Mekong Delta polities may have been "focused southwards toward the China Sea network until some point after the 4th century AD," (2006b: 100). However the current research indicates that these networks may have begun to shift even earlier. Reinecke has observed that at Prohear "the southern influence seems to weaken at about 100 BC, and is later clearly obscured by the stronger relationship with sites to the north," (2009:166). Riverine trading networks may have connected people in the Mekong Delta with those at sites such as Prei Khmeng, Phum Snay, and possibly even as far as the Mun River Valley (Theunissen 2003) via a prestige good exchange network involving glass and stone beads. Perhaps as sites in the Mekong Delta were participating in, and possibly controlling, these new prestige good exchange networks, previously important sites such as Prohear were excluded and began to decline.

However, the distinction between the m-Na-Al and potash glass networks is not as clear, as there is archaeological evidence for interaction between sites. For example, Reinecke has identified a similarity between "buffalo bracelets" found at Phum Snay and similar artifacts from Prohear (Reinecke et al. 2009: 146). Similarities with ceramics from Angkor Borei also point towards a relationship between the two sites (Reinecke et al. 2009: 43,165). The lack of potash

glass at Angkor Borei may not be so surprising as only a small portion of the over 300 hectare site has been excavated. If we consider Phnom Borei to be a locus of the broader Angkor Borei settlement, then the presence of potash glass demonstrates the occurrence of some kind of potash glass bead trading network in the Mekong Delta region. Further excavations at Angkor Borei could uncover additional burials with potash glass beads. Indeed, further research of available data from all the sites will help elucidate this complex chronology and better determine the timing of the glass bead shift and its impact on interaction networks within Cambodia.

Combining data from the examination of stone beads with that already collected for glass beads should also help us better understand how these two types of artifacts were related to one another, if they were part of overlapping exchange networks, and how these networks changed over time. Beads were an important prestige object and by expanding the study of beads into Cambodia and using advanced non-destructive compositional techniques we are able to better understand prestige good exchange networks and their impact on the socio-political and economic trajectories of the Iron Age across mainland Southeast Asia.

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