Beads, Exchange Networks and Emerging Complexity: A Case Study from Cambodia and Thailand (500 BCE–CE 500)

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Control over the exchange of prestige goods is an important component of emerging socio-political complexity in many ancient societies. During the Iron Age period (500 BCE–CE 500), communities in mainland Southeast Asia were undergoing rapid socio-political changes, due in part to new interactions with societies from South Asia. As objects made from exotic raw materials and using complex technologies, stone and glass beads are one type of prestige object from South Asia that were exchanged widely across Southeast Asia. This study examines beads from 12 sites in Cambodia and Thailand. Morphological and compositional analyses using LA-ICP-MS resulted in the identification of different bead types that were circulated in distinct exchange networks. Initially, beads were exchanged within a pre-existing South China Sea network. However, as trade with South Asia intensified in the late Iron Age, exchange networks in Southeast Asia expanded, with an increase in the quantities of beads circulated. These results show the utility of studying beads as a means of examining trade and emerging socio-political complexity. Lastly, in considering evidence for control over the exchange of beads, I propose looking to an emerging state in the Mekong Delta.

Introduction

The Iron Age period (500 BCE–CE 500) was a time of great social change in Southeast Asia.[1] Increasing trade networks oriented both east (towards East Asia) and west (towards South Asia) brought new goods and ideas to communities in Southeast Asia and moved Southeast Asian commodities outward. In large parts of mainland Southeast Asia, it is contact with South Asia that became especially influential and is believed to have been a key factor in the emergence of sustained social and political hierarchies (e.g. Bronson 1977; Coedès 1968; Glover 1989; Hall 1985; Higham 2014; Kulke 1990; Mabbett 1977a,b; 1997; Van Leur 1955; Wheatley 1979; 1983; Wisseman Christie 1990; 1995). Several researchers have more specifically argued that the presence of a new class of imported objects, such as stone and glass beads, provided an opportunity for Southeast Asian elites to expand their power by controlling the trade and exchange of these goods (Bellina 2003; Bellina & Glover 2004; Bronson 1977; Francis 1996; Higham 2014; Wisseman Christie 1995).

Many scholars have noted the role of imported stone and glass beads in Southeast Asian communities as 'status markers' (Bellina 2003, 287; Francis 2002, 47), or 'prestige objects' (Glover 1989, 11; Ray 1996, 43; Theunissen *et al.* 2000). It has been well established in the archaeological literature that control over the manufacture and/or distribution of prestige goods is a key component of emerging complexity and maintenance of power in many complex societies (Blanton *et al.* 1996; Brumfiel & Earle 1987; D'Altroy & Earle 1985; Dillian & White 2010; Helms 1992; 1993; Kipp & Schortman 1989; Renfrew & Shennan 1982; Sabloff & Lamberg-Karlovsky 1975; Schortman & Urban 1992). Elites could use prestige goods to create bonds or loyalties with other elites and maximize their networks

Cambridge Archaeological Journal 25:4, 733–757
doi:10.1017/S0959774315000207 Received 31 Oct 2014; Accepted 09 Apr 2015; Revised 08 Apr 2015

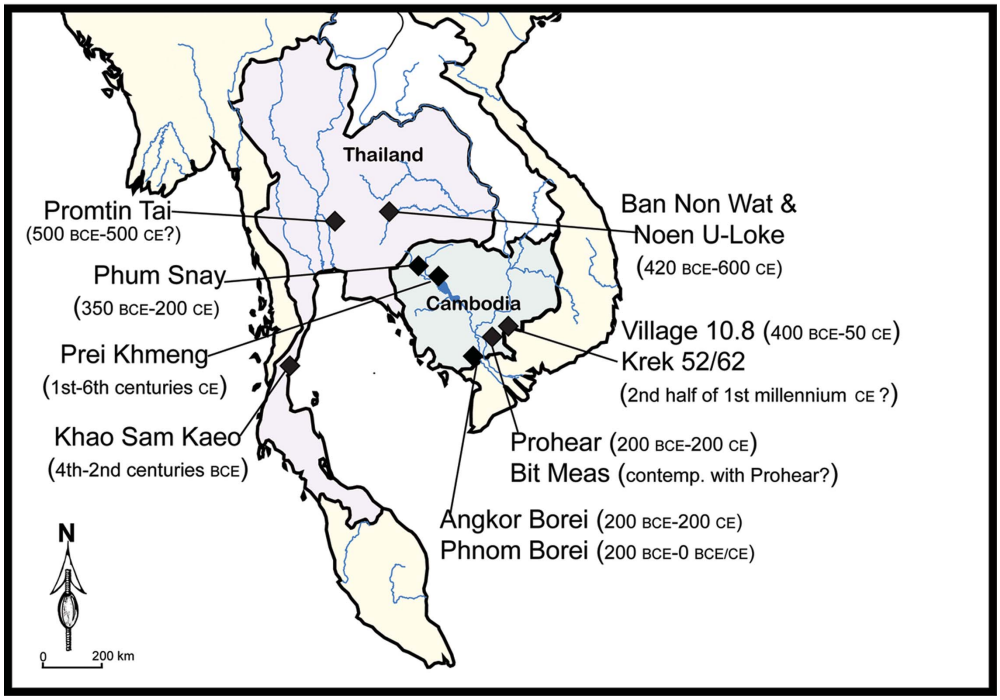

Figure 1. *(Colour online) Map of sites with bead collections examined in this study.*

of alliances, allowing for expanding power and centralization of control (Blanton *et al.* 1996; Frankenstein & Rowlands 1978). Friedman and Rowlands (1978, 224) have noted that the availability of mass-produced goods is an important component to this process. Others have observed the reorganization of socio-political systems due to the increased availability and greater numbers of exotic goods (e.g. Kristiansen 1987). Increasing control over trade can also lead to the development of increased coercive power (Kipp & Schortmann 1989). The exchange of prestige goods can also play an important role in displaying status and creating and reinforcing hierarchical networks (Kenoyer 2000).

As stone and glass beads were widely traded in Southeast Asia, an examination of their exchange has the potential to identify interaction networks during the Iron Age. As prestige objects, a study of their distribution patterns can shed light on changing socio-political dynamics in the region, as emerging elites likely sought to control their exchange and used beads as a means to create alliances with other communities or elites (Bellina 2014, 370–71). In this paper, I present the results of an analysis of stone and glass bead collections from 12 Iron Age sites in Cambodia and Thailand (Fig. 1). Through stylistic, morphological, and compositional analyses, I have identified several distinct bead exchange networks, which vary over time and space, reflecting changing interaction networks with South Asia. Particular types of early stone and glass beads from South Asia appear to have been circulated through a pre-existing South China Sea network, which linked coastal communities in mainland and island Southeast Asia to one another and to key sites further inland. However, higher quantities of new types of (often mass-produced) beads began to appear in the first few centuries CE as trade with South Asia was intensifying, and were circulated in different exchange networks. I propose that these changing bead exchange networks are likely associated with the growth of an early state in the Mekong Delta region of Cambodia and Vietnam, which may have been using beads and other exotic objects as part of a network-based political strategy (Blanton *et al.* 1996). Based on evidence presented in this paper, it does not appear that elites in the Mekong Delta were participating in the earlier pre-existing South China Sea prestige goods network, suggesting that the expansion of this polity was timed with intensified exchange with South Asia, and not merely the presence of new exotic goods.

Trade and socio-political development in mainland Southeast Asia

As noted above, historians and archaeologists have underscored the importance of exchange between South and Southeast Asian communities during the

https://doi.org/10.1017/S0959774315000207 Published online by Cambridge University Press

Iron Age. Based on his excavations in Thailand, Glover (1989; 1996) argued that exposure to a World Trading System (Wallerstein 1974) transformed pre-existing down-the-line, reciprocal exchange networks into long-distance commercial exchange, akin to that seen between India and Rome. The looting and subsequent excavation of Ban Don Ta Phet and Khlong Thom sites in Thailand brought to light a great diversity of bead types and accentuated the trade contacts between India and Southeast Asia (Glover 1989). More recent work has divided contact and trade with South Asia into two phases (Bellina & Glover 2004). During Phase One (fourth century BCE to second century CE), exchange with South Asia was less intense, with small quantities of diverse artefacts. These objects, such as pottery, bronze containers and beads, were frequently found in 'non-Indianized' contexts, such as burials (Bellina & Glover 2004, 73). During Phase Two (second–fourth centuries CE), exchange between the two regions, as well as within Southeast Asia, increased dramatically. Greater quantities of Indian objects were found at Southeast Asian sites, but there was less diversity in artefact types.

In addition to work exploring long-distance exchange, intra-regional exchange in mainland and island Southeast Asia has been the focus of several recent archaeological studies and has especially emphasized the South China Sea as a conduit for interaction (Bellina *et al.* 2014; Calo 2014; Hung & Bellwood 2010; Hung *et al.* 2007; 2013). These studies have shown that objects such as nephrite ear ornaments (Hung & Bellwood 2010; Hung *et al.* 2007; 2013) and Dongson style bronze drums (Calo 2014) were widely exchanged between Southeast Asian coastal communities during the early Iron Age. Evidence from the study of nephrite suggests exchange of this stone may date as far back as 1500 BCE (Hung *et al.* 2013). Both of these locally (Southeast Asian) produced artefacts were considered to be objects denoting status (e.g. Nitta 2007; Reinecke 1996), and in the case of the bronze drums, ceremonial objects (Bernet-Kempers 1988; Calo 2014). Their widespread circulation during the period just before and overlapping with the earliest evidence for exchange with South Asia indicates the presence of a prestige-goods exchange network amongst ranked societies in Southeast Asia prior to intensive contact with South Asia.

Of course, coastal sites were not only connected to one another, but were also linked to sites further inland. Dongson bronze drums and other bronze artefacts were exchanged largely along river systems to inland sites (Calo 2014; Nitta 2007). Nephrite ear ornaments have also appeared at inland sites such as Ban Don Ta Phet, Thailand, and Samrong Sen, Cambodia (Hung & Bellwood 2010; Hung *et al.* 2007). Indeed, exchange between coastal and inland sites extends back to the Bronze and Neolithic periods, where we see, for example, the movement of marine shell objects from the coast to sites in northeast Thailand (Higham 2014).

More recent research specifically on stone beads has allowed for a deeper understanding of the active role that Southeast Asian people had in the bead trade. Geochemical analyses of stone beads from the site of Noen U-Loke in northeast Thailand have suggested that some stone beads may have been made in Southeast Asia, perhaps under the control of local elites, and using a stone source in Lopburi province, central Thailand (Theunissen 2003; Theunissen *et al.* 2000). While this study has provided evidence that there were likely multiple sources used to make stone beads, more recent work does not support the widespread use of Southeast Asian stone sources to produce beads (Carter 2013; Law *et al.* 2013).

Bellina (2003; 2007; 2014) and Bellina & Glover (2004) have identified several bead shapes, such as notched agate pendants, which have been found exclusively in Southeast Asia. As these bead types have not been found in South Asia, Bellina (2003; 2007; 2014) has argued that they may have been commissioned by Southeast Asian elites for the local market. Recent work at the site of Khao Sam Kaeo has produced convincing evidence that Indian craftsmen were living at the site, perhaps under the patronage of local elites (Bellina 2003; 2007; 2014). The current study builds on this earlier work by providing additional evidence that early stone and glass beads were circulating in pre-existing South China Sea prestige-good networks.

The sites in this study and their bead collections

Glass, garnet and agate and carnelian beads (Fig. 2) were examined from 12 sites in Cambodia and Thailand. Table 1 notes the sites, their dates and the number of beads studied from each site.[2] Beads from 10 of the 12 sites came from graves or associated cemetery contexts, such as grave fill. Beads were not evenly distributed between sites, or amongst burials within sites (Table 2). For example, only two of the 111 excavated burials at the site of Angkor Borei, Cambodia contained stone beads, with each burial containing only one carnelian bead. Conversely, 10 of the 50 excavated burials at Village 10.8, Cambodia contained stone beads, including one burial with 14 carnelian beads. Only two of 23 burials from Phum Snay in northwest Cambodia contained stone beads, of which

https://doi.org/10.1017/S0959774315000207 Published online by Cambridge University Press

Figure 2. *(Colour online) Examples of different bead types considered in this study. Upper left: agate bead; upper right: carnelian bead; middle left: garnet bead from Angkor Borei; middle right: garnet bead from Village 10.8; lower left: glass beads from Prohear; lower right: glass beads from Angkor Borei.*

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Table 1. *List of stone and glass beads recorded at each site. *The bead collections at Ban Non Wat and Noen U-Loke were only briefly examined and not recorded in as much detail as other sites in this study (see discussion in text). [A] denotes the quantity of agate beads; [C] denotes the quantity of carnelian beads.*

Site	Context	Dates	Glass	Agate/carnelian	Garnet	Total
Angkor Borei, Cambodia	Vat Komnou cemetery – burials and associated contexts	200 BCE–CE 200	1368	12 [A–1] [C–10] [1 quartz bead]	5	**1385**
Bit Meas, Cambodia	disturbed cemetery	contemporary with Prohear?	5	2 [A–1] [C–1]	5	**12**
Krek 52/62, Cambodia	circular earthwork site	approx. 500 BCE	0	1 [C–1]	0	**1**
Phnom Borei, Cambodia	cemetery – burials and associated contexts	approx. 200 BCE–CE 200	48	2 [C–2]	0	**50**
Phum Snay, Cambodia	cemetery – burials and associated contexts	350 BCE–CE 200	285	50 [A–1] [C–49]	0	**335**
Prei Khmeng, Cambodia	cemetery – burials and associated contexts	first–sixth centuries CE	2056	1 [C–1]	0	**2057**
Prohear, Cambodia	cemetery – burials and associated contexts	200 BCE–CE 100	550	6 [A–4] [C–2]	2	**558**
Village 10.8, Cambodia	cemetery – burials and associated contexts	400 BCE–CE 50	209	53 [A–8] [C–45]	11	**273**
Ban Non Wat, Thailand	cemetery – burials and associated contexts	Iron Age 1: 420–150 BCE Iron Age 2: 150 BCE–CE 200 Iron Age 3: CE 200–400 Iron Age 4: CE 400–600	746	56* [A–41] [C–15]	0	**802**
Khao Sam Kaeo, Thailand	disturbed – bead manufacturing area?	fourth–second centuries BCE	glass beads not examined in this study	18 [A–13] [C–5]	0	**18**
Noen U-Loke, Thailand	cemetery – burials and associated contexts	Mortuary Phase 3: 100 BCE–CE 200 Mortuary Phase 4: CE 200–400 Mortuary Phase 5: CE 400–600	3531	stone beads not examined in this study	0	**3531**
Promtin Tai, Thailand	cemetery – burials and associated contexts	500 BCE–CE 500	960	43 [A–22] [C–21]	0	**1003**
Total			**9758**	**244**	**23**	**10,025**

one contained 35 carnelian beads, the largest number of stone beads found in a single burial considered in this study.

Generally, glass beads were more common and found in greater quantities than stone beads. Only Village 10.8 contained a higher number of burials with stone beads (n = 10) than glass beads (n = 6). At Angkor Borei, 29 burials contained glass beads, and at Prohear, Cambodia, all the undisturbed burials contained glass (Reinecke *et al.* 2009). Two burials in this study contained over 1700 glass beads: one burial from the site of Prei Khmeng, Cambodia and a second from the site of Noen U-Loke in northeast Thailand. In contrast, only one carnelian bead was found at the Prei Khmeng site; however, this object was unavailable for study.

It is difficult to draw broad, statistically significant conclusions from these burial data; many sites were heavily looted and some were more extensively excavated than others. Additionally, we must also

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Table 2. *Total number of burials excavated at each site and total number of burials with stone and glass artefacts. *One carnelian bead was found within a burial context at Prei Khmeng; however, it was not available for study. **Additional garnet beads were reported in burials from Prohear, but not available for study.*

Site	Total burials	Burials with glass artefacts	Burials with agate/carnelian artefacts	Burials with garnet beads
Angkor Borei, Cambodia	111	29	2	3
Ban Non Wat, Thailand	160	13	12	0
Noen U-Loke, Thailand	120	56	N/A	0
Phnom Borei, Cambodia	9	0	1	0
Phum Snay, Cambodia	23	7	2	0
Prei Khmeng, Cambodia	7	3	1*	0
Prohear, Cambodia	52	46	5	2**
Promtin Tai, Thailand	35	8	6	0
Village 10.8, Cambodia	50	6	10	5

consider that individuals and communities may have had different attitudes regarding the use of beads in mortuary ritual. However, I argue that these data support the assessment from earlier scholars that stone and glass beads were valued objects and that their distribution was socially circumscribed. Thus, some sites appear to have had greater access to certain types of beads and individuals within these communities were interred with more beads than others.

Beads were also examined from two non-mortuary sites. A single carnelian bead was examined from the Krek 52/62 circular earthwork site in Cambodia, although other beads have been found and discussed in previous publications (Albrecht *et al.* 2001; Haidle 2001; Haidle & Neumann 2004). A selection of 18 agate and carnelian beads, including some unfinished pieces, were examined from the stone and glass bead production site of Khao Sam Kaeo, Thailand. The site has been heavily looted, with more than half the beads from a recent study deriving from non-excavation contexts (Bellina 2014, 350). Beads from the recent excavations had been accessioned by the local museum, making them unavailable for study. Therefore, the 18 beads included in this study were from a collection donated to researchers by villagers who identified the general locations where the beads had been found (Bellina 2014; Bérénice Bellina, pers. comm. 2010).

Time constraints prevented an in-depth examination of the entire collection of beads from Ban Non Wat, Thailand. Assessments were made based on in-person recording of some beads and examination of published materials. Of the 56 agate and carnelian beads found at the site, 43 are considered in this study and all but five were found in a burial context that has been carefully dated and seriated into a specific mortuary sequence (see Higham 2011; Higham & Kijngam 2012). Stone beads from Noen U-Loke, Thailand, have been considered elsewhere (Theunissen 2003; 2007). However, glass beads from this site were available for study and discussed below.

The examination of agate and carnelian beads

Agate and carnelian are both a type of microcrystalline quartz (Luedtke 1992). The term agate has generally been used to describe banded translucent or opaque stones that are usually shades of white, grey and brown. These colours are sometimes enhanced by bead-makers using a dying process, resulting in darker browns and blacks that archaeologists have called onyx (Francis 2002; Kenoyer 2003). Carnelian refers to translucent rocks that range from yellow and orange to deep red which are naturally occurring or enhanced by heating the stone (Kenoyer 2003). Morphological, stylistic and technological analyses were undertaken on agate and carnelian beads in which the bead shape, stone and manufacturing quality and perforation size were recorded. Geochemical analysis using laser ablation-inductively coupled plasma-mass spectrometry (LA-ICP-MS) was also undertaken; however, this research is being explored in other publications (Carter & Dussubieux n.d.).

The study of agate and carnelian beads followed research undertaken by Bellina (2003; 2007; 2014), who identified beads associated with distinct manufacturing traditions. Bellina (2007, 32) also noted differences between agate and carnelian beads from earlier and later period sites in Southeast Asia. I have adapted these attributes for use in the current study, which are summarized in Table 3. Beads that I call Type 1 are generally made with higher-quality manufacturing techniques, frequently found in more complex shapes and with small perforation sizes. These beads are generally found at early Iron Age sites. Type 2 beads refer to those generally produced in simpler shapes

https://doi.org/10.1017/S0959774315000207 Published online by Cambridge University Press

Table 3. *Characteristics of Type 1 and Type 2 agate/carnelian beads.*

Type 1 beads	Type 2 beads
Generally found at earlier Iron Age sites	Generally found at later Iron Age sites
More complex shapes, including faceted beads and geometric shapes	Primarily found in more simple shapes, including spherical and barrel-shaped beads
Generally made from higher-quality stone	Made using middle- to low-quality stone
Higher standard of craftsmanship/higher-quality beads	Lower standards of craftsmanship/lower-quality beads
Smaller perforation diameters	Larger perforation diameters

and with evidence for lower manufacturing quality and larger perforation sizes. These beads are more frequently found at later Iron Age sites. Differences between earlier- and later-period beads in Southeast Asia may be related to shifting and intensifying interaction networks with South Asia over time (Bellina & Glover 2004). Many later-period beads may have been mass-produced, which Bellina (2003; 2007) argues could have been taking place in Southeast Asia or by Southeast Asian craftsmen, although supporting evidence for this outside Khao Sam Kaeo is lacking (Carter 2013).

In the following sections, I discuss how the beads in this study were classified according to the attributes from Table 3. Evidence from the sites in this study is consistent with earlier work identifying different bead types present in Southeast Asia, which are likely related to different manufacturing traditions. While the two bead types appear to be associated with different time periods, the presence of Type 1 and Type 2 beads at roughly contemporary sites suggest that these beads may have circulated in different trade networks that overlapped chronologically.

Simple vs complex bead shapes

The distinction between simple and complex shapes was assessed based on the skill and time needed to create the bead shape. Simple shapes included beads that were spherical, barrel-shaped, bicones or cylindrical. Complex beads include more difficult to produce shapes such as pendants, geometric shapes, and faceted beads. Table 4 lists the quantity of the most common simple and complex bead shapes recorded at each site. Sites with high quantities of complex-shaped beads (Ban Non Wat, Promtin Tai, Khao Sam Kaeo, Phum Snay and Village 10.8) had components that dated to the early Iron Age period (late centuries BCE), consistent with Bellina's (2014) observation that complex bead shapes were more common in early Iron Age sites. Ban Non Wat and Promtin Tai have the longest use and occupation periods, which is a likely factor in the high quantity of different bead shapes found at these sites. In general, there were higher numbers of simple-shaped beads in circulation (n = 184) than those with complex shapes (n = 57). This is due to the extra time and skill needed to manufacture complex beads; simple-shaped beads, such as barrels or spherical beads, would be easier and faster to produce.

Manufacturing and stone quality

The quality of the beads was also assessed, with beads classified into one of two broad categories: high-quality or low-quality.[3] The most important criteria used to assess quality were related to the manufacturing methods used to produce the beads. High-quality beads were those that had a medium or high polish, a smooth surface with few nicks or chips from the manufacturing process and a symmetrical appearance. Low-quality beads were those with a low polish or incompletely polished surface and an asymmetrical appearance.

Asymmetrical beads are frequently indicative of low skill or carelessness in the manufacturing process. One example is 'rough spherical' beads, or spherical beads that have a large flake scar around one bead hole. This flake scar is caused by drilling the bead from only one side, a technique that is faster than drilling from each end. However, as the drill exits the bead on the opposite side, pressure from the drill frequently causes a 'pop out', producing a concave scar on the surface of the bead. Other asymmetrical beads include poorly made faceted bicones, common at Phum Snay, in which the facets were not evenly spaced around the bead. Asymmetrical beads, such as those described here, were automatically classified as low-quality beads.

Symmetrical beads were assessed to determine their level of polish (low, medium, or high) and the presence of chips or flakes on the surface that may result from the manufacturing process. The level of polish or shine was related to the time and effort put into polishing and finishing the beads. High polish beads would have required repeated grinding using a variety of abrasives, a time-consuming technique (Kenoyer 2003). However, low polish beads were frequently polished using a mass polishing technique in which dozens of beads were placed in a leather bag

https://doi.org/10.1017/S0959774315000207 Published online by Cambridge University Press

Table 4. *The quantities of the most common simple and complex bead shapes at each site. The Khao Sam Kaeo numbers represent only the beads examined in this study, and not the total diversity of bead shapes found at the site (see Bellina 2014). Hex = hexagonal; * = includes one unfinished bead in this shape; ** = one unfinished bead whose final shape is unclear;, ^ = includes a broken bead whose shape is unknown; ^^ = does not include the single Prei Khmeng bead, which was not examined.*

	Common simple shapes								Common complex shapes						
Site	**Spherical**	**Rough spherical**	**Long barrel**	**Short barrel**	**Long bicone**	**Short bicone**	**Long cylindrical**	**Other simple shape**	**Long hexagonal bicone**	**Short hexagonal bicone (rough)**	**Long hexagonal barrel**	**Hexagonal flattened bicone**	**Pendant (with/ without notches)**	**Other complex shape**	**Total**
Angkor Borei, Cambodia	3	5	1	–		1	–		–	1	–	–	–	1	**12**
Ban Non Wat, Thailand	3	–	6	5	3	16	1	3	–	–	4	–	10	5	**56**
Bit Meas, Cambodia			1						1						**2**
Khao Sam Kaeo, Thailand	1	–	3*	2*	2	–	1	1	–	–	–	1	1	5	**18****
Krek Earthwork 52/62, Cambodia	1	–	–	–	–	–	–	–	–	–	–	–	–	–	**1**
Phnom Borei, Cambodia	2	–	–	–	–	–	–	–	–	–	–	–	–	–	**2**
Phum Snay, Cambodia	22	16	2	–	–	–	–	–	–	–	–	10	–	–	**50**
Prohear, Cambodia			1	1	1		1					2			**6**
Promtin Tai, Thailand	3	8	6	1	4	5	1	5	1	–	2	1	3	2	**43^**
Village 10.8, Cambodia	1	–	2	8	8	8	1	18	4	–	–	–	–	3	**53**
Total	**36**	**29**	**22**	**17**	**18**	**30**	**5**	**27**	**6**	**1**	**6**	**14**	**14**	**16**	**243^^**

Table 5. *Quantities of high-quality, low-quality and unknown or unfinished beads by site.*

Site	High-quality	Low-quality	Unknown/ unfinished	Total
Angkor Borei, Cambodia	2	10	0	**12**
Ban Non Wat, Thailand	17	24	15	**56**
Bit Meas, Cambodia	2	0	0	**2**
Khao Sam Kaeo, Thailand	11	2	5	**18**
Krek 52/62, Cambodia	1	0	0	**1**
Phnom Borei, Cambodia	2	0	0	**2**
Phum Snay, Cambodia	20	30	0	**50**
Prohear, Cambodia	5	1	0	**6**
Promtin Tai, Thailand	31	12	0	**43**
Village 10.8, Cambodia	52	1	0	**53**
Total	**143**	**80**	**20**	**243**

with water and an abrasive and rolled or shaken for approximately 15 days (Kenoyer 2003). If flake scars were not completely ground away earlier in the manufacturing process, this method can produce a low lustre polish on these scars (Kenoyer *et al.* 1991, 54). The bag polishing technique also produces distinct markings on the bead surface, including the edges of the bead perforation (Bellina 2014, 315; Kenoyer *et al.* 1991). Faceted beads and other complex shapes would still have been polished by hand in order to preserve their shape (Kenoyer 2003).

The stone type and internal inclusions and striations were also recorded, but were not a major factor in determining the quality of the beads. One notable pattern is that early Iron Age sites and the Thai sites tended to have higher quantities of agate beads *versus* carnelian beads (Table 1). Contemporary bead manufacturers select nodules for bead manufacturing that are free from inclusions and irregularities and produce an even homogenous colour (Kenoyer *et al.* 1991). In a few cases, for example, there were symmetrical carnelian beads with a high polish that had dark or light inclusions in the stone. This was noted, but did not change the overall quality determination. Throughout the manufacturing process, carnelian nodules and beads would have been heated multiple times in order to reach a red-orange colour (Kenoyer 2003) with beads being heated up to 10 times to obtain a deep red colour (Kenoyer *et al.* 1991, 51–2). Carnelian beads with a deep red colour would therefore indicate additional time spent during the manufacturing process, and reinforce an assessment that the bead was a high-quality one, made with care.

Table 5 lists the number of high-quality, low-quality and unfinished beads at each site. Beads from the early Iron Age sites of Village 10.8, Promtin Tai and Khao Sam Kaeo are notable for their large numbers of high-quality beads. Conversely, Phum Snay, Angkor Borei and Ban Non Wat had higher quantities of low-quality beads.

Bead perforation size

Bead perforations for all stone beads were measured and the mean and standard deviation were calculated for each site (Table 6). Perforation sizes from both sides of a single bead were included in this calculation. Bellina (2007) has noted that earlier agate and carnelian beads generally have smaller perforations than later Iron Age beads. Khao Sam Kaeo, Promtin Tai and Village 10.8 have bead assemblages with smaller average perforations (less than 1.5 mm) while Prohear, Angkor Borei and Ban Non Wat have bead assemblages with average perforations above 1.5mm.

The difference in bead perforation size over time may also signal a shift in the manufacturing process. All of the bead perforations examined in this study showed evidence for having been drilled using a diamond drill.[4] The agate and carnelian bead industry of western India has long used a drill with two diamond chips, a technique which may date back as far as 600 BCE (Kenoyer 1992; Kenoyer & Vidale 1992). Double-diamond drills perforate beads faster and have a larger perforation size than beads drilled with a single-diamond drill (Kenoyer 1992). Therefore, the increase in perforation size seen over time may also be related to changes in the manufacturing techniques that would facilitate mass production of agate and carnelian beads, similar to the employment of the bag-polishing technique.

Type 1 and Type 2 beads by site

The aforementioned data are synthesized in Table 7 for sites with large bead collections. Two sites contained beads that clearly fall into the Type 1 bead category. Village 10.8 and Khao Sam Kaeo both had a diverse set of complex bead shapes, high-quality beads

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Table 6. *Mean and standard deviation (SD) of perforation hole sizes for all the agate and carnelian beads at each site.*

Site	Mean	SD
Angkor Borei, Cambodia	1.63	0.26
Ban Non Wat, Thailand	1.66	0.68
Bit Meas, Cambodia	1.14	0.16
Khao Sam Kaeo, Thailand	1.24	0.25
Krek, Cambodia	1.26	0.48
Phnom Borei, Cambodia	1.17	0.21
Phum Snay, Cambodia	1.72	0.30
Prohear, Cambodia	1.59	0.47
Promtin Tai, Thailand	1.47	0.33
Village 10.8, Cambodia	1.33	0.27

Table 7. *A summary of the quantity of beads with Type 1 and Type 2 attributes at each site. The Khao Sam Kaeo data refers only to beads analysed in this study, but is consistent with a broader study of the beads from this site (Bellina 2014). Beads from Bit Meas, Krek 52/62, Phnom Borei and Prohear are not included due to their small sample size.*

	Type 1 beads			Type 2 Beads		
Site	Complex shapes	High-quality beads	Small perforation sizes (<1.5 mm)	Simple shapes	Lower-quality beads	Larger perforation sizes (>1.5 mm)
Angkor Borei, Cambodia	less common (n = 2)	less common (n = 2)		more common (n = 10)	more common (n = 10)	X
Ban Non Wat, Thailand	high diversity of complex bead shapes (n = 19)	Slightly less common (n = 17)		higher quantities of simple-shaped beads (n = 37)	slightly more common (n = 24)	X
Khao Sam Kaeo, Thailand	high diversity of complex bead shapes (n = 7)	More common (n = 11)	X	slightly higher quantities of simple-shaped beads (n = 10)	less common (n = 2)	
Phum Snay, Cambodia	less common (n = 10)	Slightly less common (n = 20)		more common (n = 40)	slightly more common (n = 30)	X
Promtin Tai, Thailand	high diversity of complex bead shapes (n = 9)	More common (n = 31)	X	higher quantities of simple-shaped beads (n = 33)	less common (n = 12)	
Village 10.8, Cambodia	high diversity of complex bead shapes (n = 7)	More common (n = 52)	X	high quantities of simple-shaped beads (n = 46)	less common (n = 1)	

and beads with small perforation sizes.[5] Both sites are amongst the earliest examined in the current study, dating to the last few centuries BCE (Table 1). The stone beads from Khao Sam Kaeo were only a small sampling of the diverse types found at the site and examined by Bellina (2007; 2014). Conversely, Angkor Borei and Phum Snay have bead collections that can be comfortably classified as Type 2. These sites largely fall into the later Iron Age period (first few centuries CE).

The assemblage from Promtin Tai contains Type 1 and 2 beads. However, a significant proportion (31 beads, or 72 per cent of the total collection) can be classified as belonging to the former, as there were a fairly large number of complex bead shapes, including several types of faceted beads, numerous well-made beads, and overall the perforation sizes were less than 1.5 mm. Furthermore, the collections from Promtin Tai and Khao Sam Kaeo share additional characteristics that suggest a connection between the two sites, including large numbers of agate beads as compared to other sites in this study, and the presence of two unique shapes: notched agate pendants and hexagonal flattened bicones. The glass bead assemblage from Promtin Tai also suggests additional connections

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with peninsular sites (discussed below) (Carter 2013; Lertcharnrit & Carter 2010).

The placement of beads from Ban Non Wat into Type 1 and Type 2 categories is tentative as not all of the beads were examined in depth.[6] However, both Type 1 and Type 2 beads were identified, which is unsurprising considering the long period of occupation. Six of eight beads from Iron Age 1 (420–150 BCE) burials were assigned to the Type 1 group. Although they were made in simple shapes, the long agate barrel or bicone beads and spherical carnelian beads in this category were well made, with smooth medium to high polish surfaces. The two Type 2 beads consisted of long barrel beads with a low polish: the agate barrel appears to be unfinished with no polish, while the carnelian barrel had a low polish and a large bead perforation. Only one bead was found in an Iron Age 2 (150 BCE–CE 200) burial, an asymmetrical agate bicone classified as a Type 2 bead. There were 27 beads found in Iron Age 4 (400–600 CE) burials at Ban Non Wat. Of these, 19 were classified as Type 2 beads. Many of these were simple-shaped agate barrels and bicones, with a low polish, as well as asymmetrical faceted carnelian beads. Of the eight Type 1 beads found in Iron Age 4 burials, four were agate pendants, three were more finely made agate barrel/bicones and one was a faceted carnelian barrel bead.

The agate pendants found at Ban Non Wat are unusual, in that they have primarily been found at sites in northeast and central Thailand (Theunissen 2003; 2007). Recent work at Khao Sam Kaeo suggest that these agate pendants might have been produced there during the early centuries CE; however, Bellina (2014, 360) suggests that the beads found at Khao Sam Kaeo were made using mass-production techniques and were of a lower quality. Three of the four pendants at Ban Non Wat were broken, as were many of the agate pendants found at the nearby site of Noen U-Loke (Theunissen 2007). I have classified these pendants as being Type 1 beads due to their unusual shapes and medium polish.

While the overall patterns at Ban Non Wat reflect the shift towards higher quantities of Type 2 beads seen at other sites in Southeast Asia, the presence of the agate pendants are also indicative of a localized exchange of a specific bead type (Theunissen 2003; 2007). This distribution pattern is also reflected in a unique type of mixed alkali glass bead, which was circulated primarily amongst sites in northeast Thailand (discussed below). Although the current study emphasizes broader exchange networks, this work reminds us that regional exchange networks were also an important factor in the circulation of beads (see Carter 2010; Carter & Lankton 2012).

Lastly, the overall bead assemblages from four sites were difficult to classify due to their small sample sizes. Although numerous agate and carnelian beads were found during excavations at Prohear, only six were available for study. Beads were generally of a high quality with several complex shapes, including a deep red hexagonal flattened bicone bead, a form also found at Khao Sam Kaeo and Promtin Tai, and which has been found at sites involved in coastal exchange networks (Theunissen 2003). The nearby site of Bit Meas was completely looted; however, artefacts from this site were reported to be similar to that found at Prohear (Reinecke *et al.* 2009). The two beads from Bit Meas examined in this study belong to the Type 1 category. Two spherical carnelian beads were found at Phnom Borei. Both had small bead perforations (under 1.5 mm), and a medium polish with some small imperfections on the surface. There was one spherical carnelian bead recorded from the circular earthwork site of Krek 52/62, with a low polish. Without additional specimens from these sites, it is impossible to determine if there are patterns in the overall assemblage pointing towards the Type 1 or Type 2 group.

Agate and carnelian beads: discussion

The morphological and metric analysis of agate and carnelian beads shows the saliency of the different bead types identified by Bellina (2003; 2007; 2014). The two earliest sites in this study, Khao Sam Kaeo and Village 10.8, had large quantities of high quality Type 1 beads, while Angkor Borei and Phum Snay had large numbers of beads classified as belonging to the Type 2 category. While there certainly seems to be a time dimension to the distribution of the two bead Types, it should be noted that Angkor Borei and Prohear, two contemporary sites, have seemingly different bead assemblages (discussed further below).

The bead collections at Promtin Tai and Ban Non Wat, sites with the longest occupation sequences in the study, unsurprisingly contained both bead Types. The burials at Promtin Tai have not been seriated, so it is not yet possible to determine if there was a change in the type of beads over time, although this is likely. At Ban Non Wat, there is a general shift from Type 1 to Type 2 beads, although there also appears to have been a localized exchange of agate pendants, which makes this site unique in this study.

It is important to emphasize the need to examine a large bead assemblage in order to classify bead collections as belonging to the Type 1 or Type 2 groups. Ideally, future studies that undertake this kind of morphological and metric analysis will examine a large number of beads from well-dated contexts. It is hoped that, with further morphological, metric and

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Table 8. *Number of beads analysed using LA-ICP-MS from each site.*

Site	Total glass artefacts recorded	Glass artefacts analysed using LA-ICP-MS
Angkor Borei, Cambodia	1368	15
Ban Non Wat, Thailand	746	29
Bit Meas, Cambodia	5	5
Noen U-Loke, Thailand	3531	29
Phnom Borei, Cambodia	48	6
Phum Snay, Cambodia	285	30
Prei Khmeng, Cambodia	2056	42
Prohear, Cambodia	550	59
Promtin Tai, Thailand	960	24
Village 10.8, Cambodia	209	14
Total	**9758**	**253**

compositional analyses, we may be able to identify beads from particular workshops and manufacturing traditions and follow their distribution over time and space. While identifying Type 1 and Type 2 beads is of limited interpretive value on its own, when combined with an analysis of glass beads (below) these data can be more informative about the different Iron Age trade networks in Southeast Asia.

The examination of glass beads

Major glass types found in Southeast Asia

The glass beads analysed in this study were primarily small, oblate, monochromatic Indo-Pacific beads (Fig. 2) (Francis 1990); however, small numbers of other bead types as well as ring, earring and bangle fragments were also examined. Because of the visual similarity of the glass beads, LA-ICP-MS was used to undertake compositional analysis and determine the glass recipes used to produce the beads (Table 8). The methodologies of this technique and some preliminary results have been summarized elsewhere (see Carter 2010; 2013). Notably, the divisions identified between sites with Types 1 and 2 agate and carnelian beads are echoed in the presence of beads made from different glass recipes. In this section, I briefly describe some of the major types of glass that have been identified in Southeast Asia during the Iron Age period. The following section presents the results of compositional analysis on glass beads from the sites in this study.

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; it has also been described as one of the 'least understood' (Lankton & Dussubieux 2006, 135). Three different sub-types of potash glass have been identified, with variations seen in differing levels of lime and alumina. No potash glass workshops have yet been discovered, however the presence of different sub-types indicate the possibility of multiple production centres, with some possibly located in Southeast Asia, specifically northern Vietnam or southern China (Lankton & Dussubieux 2006). Many of the potash glass beads identified in Southeast Asia are dark blue and have been coloured with cobalt.

High alumina soda glass (m-Na-Al) is the most abundant type of glass found in South and Southeast Asia, and uses soda as a flux, with high levels of alumina added as a stabilizer. Dussubieux and colleagues (2010) have identified five different types of mineral soda alumina glass, of which m-Na-Al 1 is the most prevalent during the Iron Age of Southeast Asia. The m-Na-Al 1 glass is found in a wide variety of colours, including opaque red, orange, yellow, green, light blue, black and translucent light blue. However, beads in this glass type were not coloured with cobalt (Dussubieux *et al.* 2010). This glass was likely produced at the site of Giribawa, Sri Lanka, and imported to Southeast Asia (Dussubieux 2001; Lankton & Dussubieux 2006; 2013).

Although potash glass and high alumina soda glass are the most common types of glass found in Southeast Asia, they are rarely found in the same site at the same time (Lankton & Dussubieux 2006; 2013). During the early centuries CE, there appears to have been a shift from potash glass to high-alumina soda glass. Lankton & Dussubieux (2013, 433) note that this change is regional and happened across all of Southeast Asia around approximately 200 BCE–CE 200 (Lankton & Dussubieux 2013, 435).

It should also be noted that other glass types circulated during this period, albeit in smaller quantities. Some of the earliest evidence for glass and glass production in Southeast Asia comes from the site of Khao Sam Kaeo (Lankton & Dussubieux 2013; Lankton *et al.* 2008). Drawn glass beads and bangles, as well as beads worked in a lapidary style, have been identified (Lankton *et al.* 2008). The most common glass type at Khao Sam Kaeo is a unique type of high-alumina mineral soda glass (m-Na-Al 3), distinct from the m-Na-Al 1 type that became more widespread during the first few centuries CE. These beads were circulated amongst sites in the South China Sea network (Bellina 2014) and have been found at sites in Cambodia, the Philippines and Vietnam (Lankton *et al.* 2008).

Another mineral soda glass type, with variable levels of alumina and lime (m-Na-Ca-Al) has been found at early Iron Age sites across Southeast Asia. It appears to be related to glass found at the site of

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Arikamedu in south India (Dussubieux & Gratuze 2013; Dussubieux *et al.* 2012). High quantities of this glass have been found at Khlong Thom, where it may have been manufactured nearby (Lankton & Dussubieux 2013, 438) as well as at the site of Phu Khao Thong, Thailand (Dussubieux *et al.* 2012).

Mixed alkali glass, or glass with over five per cent of both potash and soda, is also frequently found at sites in Southeast Asia. Drawn glass beads in either a copper blue or red colour were found at Khao Sam Kaeo in a particular composition that suggest the mixture of the local m-Na-Al 3 glass with a particular type of potash glass also found at the site (Lankton & Dussubieux 2013, 430). Mixed alkali beads of the same composition have also been found at the site of Ban Don Ta Phet (Lankton & Dussubieux 2013, 432–3). Mixed alkali glass beads are also commonly found in opaque orange or red colours in both South and Southeast Asia (Dussubieux & Gratuze 2013). Recent studies of the orange mixed alkali type have identified a wide range of compositions that likely reflect multiple manufacturing locations (Carter & Lankton 2012).

The glass types discussed here reflect the major types identified in the current study; however, they are not the only types of glass in circulation during the Iron Age period. Other glass types, including lead glasses imported from China and soda lime glasses, likely imported from the Middle East, have been identified at several sites and are considered in other publications (e.g. Borrel *et al.* 2014; Carter 2013; Carter & Lankton 2012; Dussubieux 2001; Dussubieux & Gratuze 2010; Dussubieux *et al.* 2012; Lankton & Dussubieux 2006; 2013, 438–9; Lertcharnrit & Carter 2010).

Glass types found at sites in Cambodia and Thailand examined as part of this study

A selection of 253 glass beads was analysed using LA-ICP-MS, from an overall collection of almost 10,000 glass beads and objects from the 10 sites included in the study (Table 8). Glass from Khao Sam Kaeo and Krek 52/62 was not included, as this material was not available for study and had previously been examined by other scholars (Haidle 2001; Haidle & Neumann 2004; Lankton & Dussubieux 2013; Lankton *et al.* 2008). However, 29 glass beads from the site of Noen U-Loke, an Iron Age cemetery site located 1.8 km from Ban Non Wat, were added to the study. The overall quantity of each glass compositional type was estimated for each site, based on visual similarities between analysed and unanalysed beads and the context in which beads were found. Figures 3 and 4 show an estimate of the distribution of the different major glass types amongst the sites in this study.

Figure 4 specifically estimates the quantities of glass types at the nearby sites of Ban Non Wat and Noen U-Loke through time. It is not representative of all the glass beads uncovered at both sites, as not all of the beads were available to be recorded. Nevertheless, it presents the broad trends in glass compositions seen at the two sites over the entire Iron Age period. The m-Na-Ca-Al and potash glass beads are considered together, as they were sometimes difficult to distinguish from one another. A small quantity of additional glass types (e.g. lead glass) was identified at both sites and is considered in more detail by Carter and Lankton (2012).

There is a notable dichotomy between sites with large amounts of high alumina soda glass (Angkor Borei, Phnom Borei, Phum Snay, Prei Khmeng, Promtin Tai and Noen U-Loke) and those that are dominated by potash glass and contain no high-alumina soda glass (Prohear, Bit Meas and Village 10.8). Previous studies on glass from Angkor Borei and Oc Eo in the Mekong Delta have emphasized the higher proportions of high-alumina soda glass in comparison to other sites in the region (Dussubieux 2001). However, in this study eight potash glass beads were identified at the nearby site of Phnom Borei. Both Phum Snay and Ban Non Wat had small quantities of potash glass artefacts. Interestingly, these artefacts are not beads, but earring or ring fragments. Promtin Tai was the only site to contain significant quantities of both high-alumina soda glass and potash glass beads.

The m-Na-Ca-Al glass type was found in small quantities at several sites. In an earlier study, Dussubieux (2001) found nine green and yellow beads at Angkor Borei. An additional three dark blue beads were identified in the current study. Eight m-Na-Ca-Al cobalt blue beads were also analysed from the site of Prohear. In Thailand, three m-Na-Ca-Al cobalt blue beads were identified at the site of Promtin Tai, a single cobalt blue bead was found at Ban Non Wat and two were found in the collection from Noen U-Loke. This particular bead type seems to have had a fairly wide distribution during the mid–late Iron Age period. However, the quantities of m-Na-Ca-Al glass are much smaller than the high-alumina soda glass or potash glass beads found at the same sites.

Mixed alkali glass was only identified at Ban Non Wat and Noen U-Loke, primarily in burials and layers dated from 200 BCE–CE 400 (Fig. 4) (Carter & Lankton 2012). The orange opaque mixed alkali glass beads were not drawn, as were other Indo-Pacific glass beads in this study, but instead wrapped around a metal rod to produce long thin tubes or sliced into disc beads

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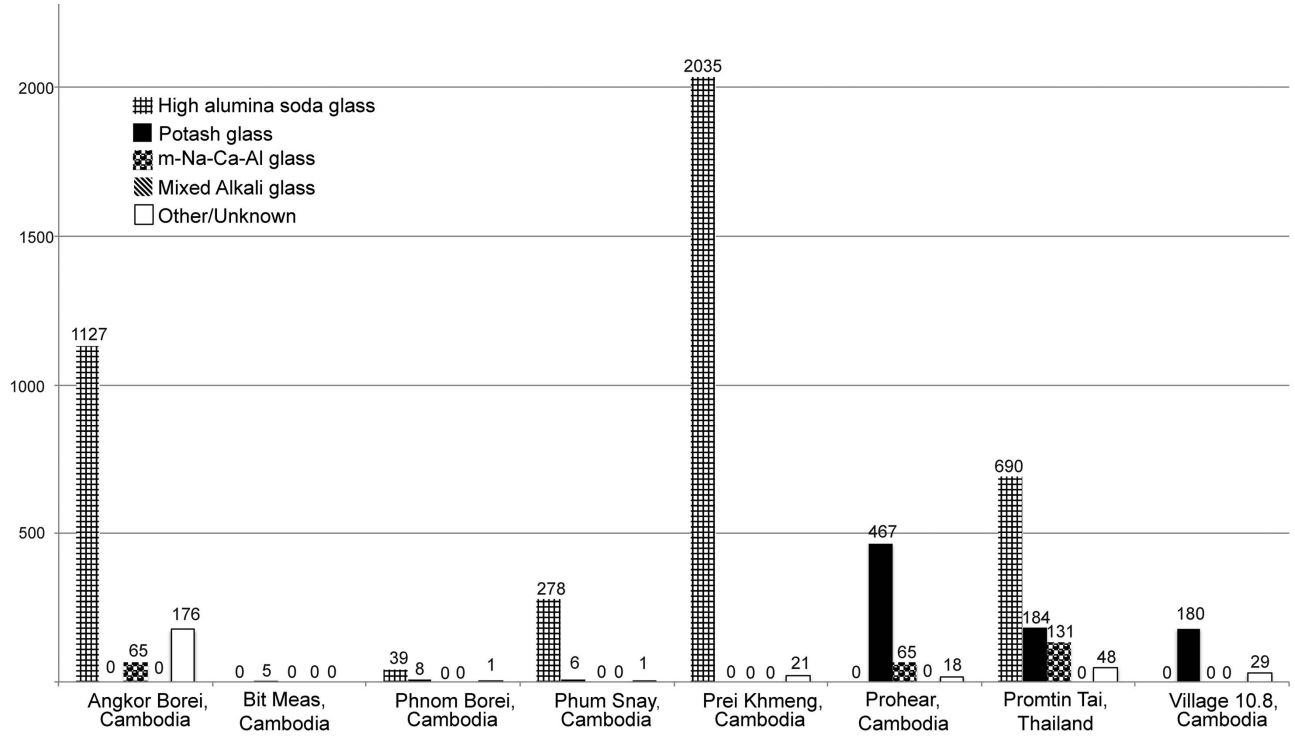

Figure 3. *Estimated quantity of major glass types found at sites in Cambodia and at Promtin Tai, Thailand.*

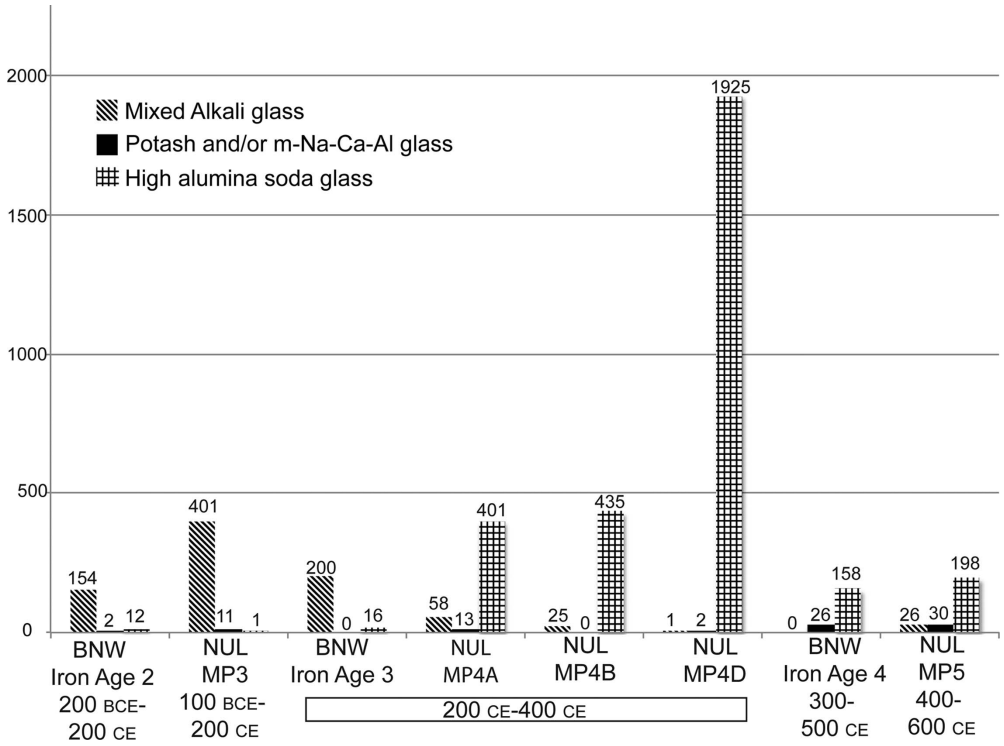

Figure 4. *Estimated quantity of major glass types at Ban Non Wat (BNW) and Noen U-Loke (NUL) through time. MP = mortuary phase.*

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with a large hole (see Saitowitz & Reid 2001). Similar beads have been found at other sites in northeast Thailand (Carter & Lankton 2012; Pilditch 1992; Saitowitz & Reid 2001). A comparison by Carter and Lankton (2012) of the beads from Ban Non Wat and Noen U-Loke with mixed alkali glass beads found elsewhere in South and Southeast Asia shows some compositional similarities between the beads in this study with those found in other sites in central and northeast Thailand and sites in India. The presence of these glass beads primarily at sites in northeast Thailand echoes the unique distribution of agate pendants at many of the same sites.

Promtin Tai had the most diverse assemblage of glass bead types in the current study. In addition to the glass types discussed above, there was also a gold-glass bead that may have been produced in the Mediterranean or Middle East, an imitation agate bead made from potash glass and several faïence beads, similar to those found at the site of Ta Chana in peninsular Thailand (Carter 2013; Lertcharnrit & Carter 2010). The diversity of glass types found at Promtin Tai is likely due to both its long occupation and central location near multiple exchange networks (Lertcharnrit 2014).

Dussubieux and others (2012) have proposed three phases of glass bead trade in Southeast Asia. A small number of sites dating to the 'very early period' (fifth–first centuries BCE) contain beads made from m-Na-Al 3 and potash glass (Dussubieux *et al.* 2012). This 'very early period' was not well represented at the sites in this study, except for Khao Sam Kaeo, where previous research identified the likely production of m-Na-Al 3 glass artefacts (Lankton & Dussubieux 2013; Lankton *et al.* 2008). Interestingly, m-Na-Al 3 glass bangle fragments have been found at the site of Krek 52/62 in southeast Cambodia (Haidle & Neumann 2004; Lankton *et al.* 2008).

As noted earlier, a shift between potash glass and high alumina soda glass has been observed regionally, dating from approximately 200 BCE–CE 200 (Lankton & Dussubieux 2006; 2013); however, data from Prohear and southeast Cambodia complicate this hypothesis. Both Angkor Borei and Prohear date to approximately 200 BCE–CE 200. No high-alumina soda glass beads have been found at Prohear and no potash glass has been found at Angkor Borei, although a small quantity was noted at the nearby site of Phnom Borei. Both communities share similarities in certain unique ceramic forms, and it is presumed that they were aware of one another (Reinecke *et al.* 2009, 41, 165). Nevertheless, the glass bead assemblages from both sites are different, and as discussed above, the agate and carnelian beads also appear to be distinct from one another.

This compositional shift appears to be tied to changes in where and how glass production was organized. During the early Iron Age, many glass beads and objects appear to have been produced in Southeast Asia for local consumers. The m-Na-Al 3 glass composition at Khao Sam Kaeo shows affinities with glass found in northern India (Dussubieux & Kanungo 2013; Lankton & Dussubieux 2013, 432). Conversely, the m-Na-Ca-Al glass shows strong linkages to glass produced at Arikamedu in south India (Dussubieux & Gratuze 2013; Dussubieux *et al.* 2012; Lankton & Dussubieux 2013). During the first few centuries CE, the quantity of high-alumina soda glass greatly increases, indicating mass production of this bead type from workshops likely located in south India or Sri Lanka (Dussubieux & Gratuze 2013). During this same period there was an increase in glass from farther-flung regions, such as the Middle East, also indicating that trade networks were expanding in the early centuries CE (Dussubieux & Gratuze 2010).

The examination of garnet beads

Garnet beads were found at only a few sites in Cambodia, of which two distinct types were identified (Fig. 2). The bead shapes, drilling techniques, and geochemical analysis of the stone indicates that these two bead types represent distinct manufacturing traditions (Carter 2012, in press). One type of garnet bead was found only at sites in southeast Cambodia (Prohear, Bit Meas, Village 10.8), but has also been reported at nearby sites in Vietnam (Carter 2012). These beads appear to have been small stones that were not shaped or polished, with large drill holes and evidence for multiple drilling methods (Carter 2012). Garnet beads were also found at Angkor Borei. However these beads were spherical, with a medium–high polish, and drilled using an Indian-style diamond drill, typical of the agate/carnelian beads in this study.

Based on the morphological and geochemical differences, I argue that the garnet beads found in southeast Cambodia were produced locally and exchanged within a restricted geographical area. Interestingly, this bead type was primarily found at sites that also contained large numbers of potash glass and Type 1 agate and carnelian beads. Conversely, the garnet beads at Angkor Borei were manufactured using South Asian techniques and likely brought to Cambodia as part of long-distance exchange networks. The presence of locally made garnet beads exchanged within a restricted network of sites may indicate that these objects had unique and locally specific

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meanings to these communities. Additionally, these beads demonstrate the persistence of localized networks during a period in which long-distance exchange and new goods and ideas were becoming increasingly common.

Discussion

In synthesizing the stone and glass bead data several patterns emerge. First, sites with Type 1 agate and carnelian beads frequently have large quantities of potash glass. Conversely, sites with Type 2 beads also contain high quantities of high alumina mineral soda glass beads. Other scholars have already noted a time dimension between the two different varieties of agate/carnelian beads and the high alumina and potash glass compositions. I argue that the presence of these two distinct bead groups is related to changing trade and interaction networks with South Asia (Bellina & Glover 2004). Type 1 beads and potash glass more frequently appear at early Iron Age sites, during a period with less intense interaction with South Asia and evidence for small-scale local production. During the later Iron Age, contact with South Asia amplified, the number of Indian goods in Southeast Asia increased, and Type 2 stone beads and high-alumina soda glass beads became more common.

Type 1 stone beads and potash glass beads were also frequently found at sites with nephrite ear ornaments, Dongson drums, and other artefacts associated with South China Sea exchange networks (Bellina 2007; Bellina *et al.* 2014; Hung *et al.* 2013). Figure 5 displays a map of sites with Type 1 agate and carnelian beads (from Bellina 2007), potash glass (from Lankton and Dussubieux 2013) and nephrite ear ornaments (from Hung *et al.* 2007). This figure shows the considerable overlap between these categories, supporting the assertion that early agate/carnelian and glass beads were circulated on this pre-existing network.

Figure 6 notes the sites in the current study that contained significant quantities of potash glass and Type 1 beads. These sites also show evidence for participation in the South China Sea exchange network. Dongson bronze drums or drum fragments were found at Prohear, Village 10.8 and Bit Meas in southeast Cambodia (Heng 2004; 2005; Reinecke *et al.* 2009). It is likely that Krek 52/62, the circular earthwork site located near the aforementioned sites, was also participating in this coastal exchange network. While the single carnelian bead included in this study was not diagnostic, evidence from glass artefacts shows connections to Khao Sam Kaeo in their glass compositions (Lankton *et al.* 2008) and locally made garnet beads link this site as part of the local exchange network.

Stone bead evidence from Khao Sam Kaeo included in this study is consistent with earlier work demonstrating this site's importance as a craft and trade centre. In addition to beads, nephrite ear ornaments and Sa Huynh style pottery link this area with the South China Sea exchange network (Bellina 2014; Bellina *et al.* 2012; 2014). Approximately 17 per cent of Promtin Tai's overall glass bead collection was made from potash glass and, as noted above, several Type 1 agate and carnelian beads were identified. While nephrite ear ornaments and Dongson or Sa Huynh artefacts have not been found at the site, the bead collection, and especially the diverse glass bead assemblage, suggest connections with sites in peninsular Thailand and beyond (Carter 2013; Lertcharnrit & Carter 2010). Furthermore, the central Thai site was well situated to participate in multiple trading networks to the north, south, east and west (Lertcharnrit 2014).

These data support the conclusion that stone and glass beads were initially incorporated into pre-existing long-distance exchange networks in Southeast Asia that circulated locally produced prestige objects such as Dongson drums and nephrite ear ornaments (Dussubieux *et al.* 2012, 325; Lam 2011; Wisseman Christie 1995). Stone and glass bead data from Khao Sam Kaeo demonstrate that some beads may have been produced locally by South Asian craftsmen, in addition to the circulation of finished products from South Asia (Bellina 2014). People in the Mekong Delta and later Iron Age communities located further inland, such as Phum Snay and Prei Khmeng, were not major participants in this early exchange network, as they contain few of these diagnostic artefacts.

By the turn of the millennium BCE/CE, exchange relationships with South Asia began to intensify (Bellina & Glover 2004). Higher quantities of stone and glass beads were being produced, but not employing the same time and skill as in the earlier period. It is clear from the stone bead data that mass-production techniques (e.g. bag polishing, double-diamond drills) were being employed. These changes may also be related to expanding or shifting relationships with particular areas of South Asia. Glass data from Khao Sam Kaeo suggest early connections with northern India (Dussubieux & Kanungo 2013), while the later high-alumina mineral soda glass (m-Na-Al 1) was produced in southern India or Sri Lanka (Dussubieux & Gratuze 2013).

As relationships with South Asia were intensifying, we also see an expansion of exchange networks within Southeast Asia (Bellina & Glover 2004). Type

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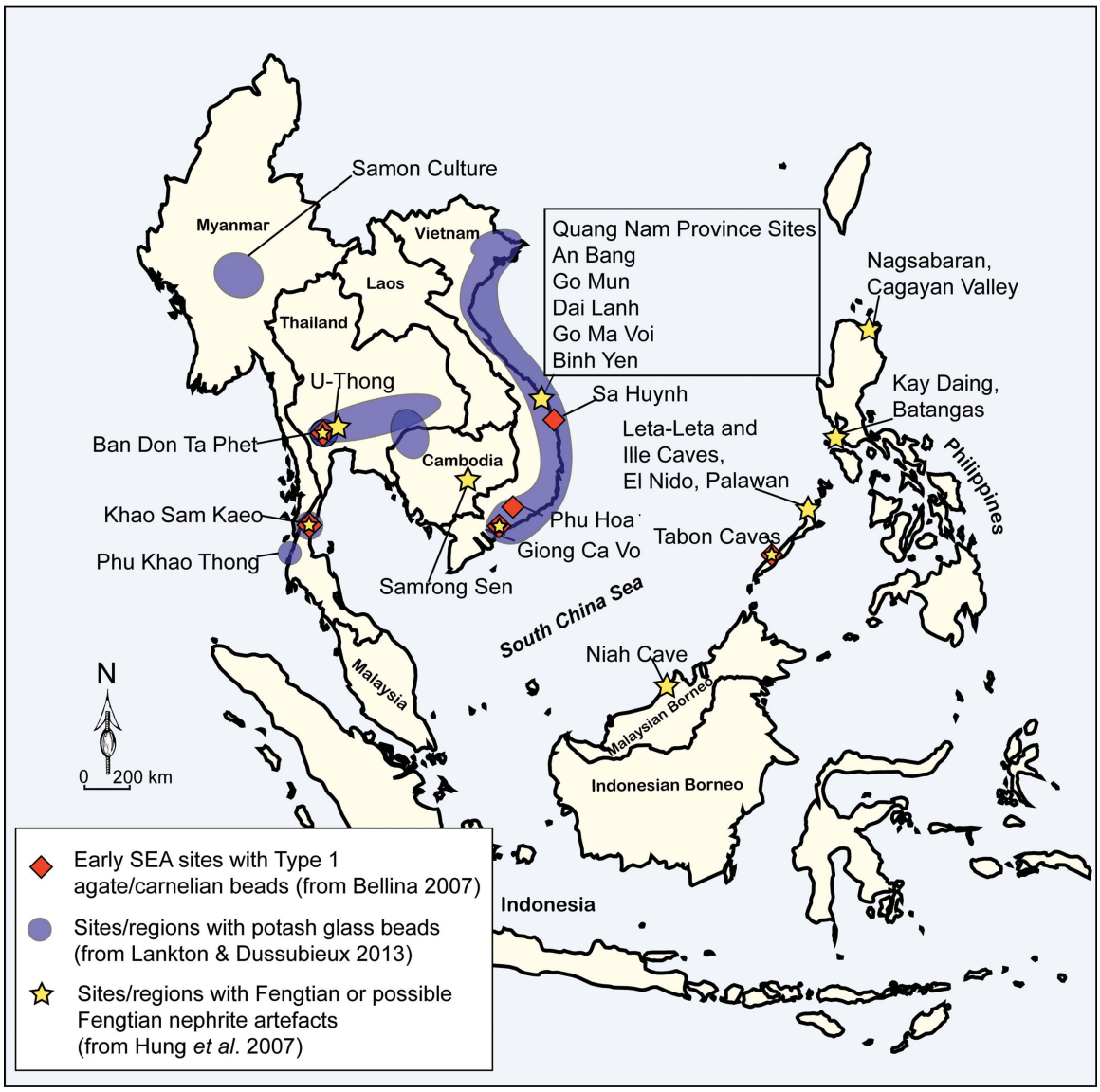

Figure 5. *(Colour online) Map showing the overlap between sites with Type 1 style agate and carnelian beads (from Bellina 2007), potash glass artefacts (from Lankton & Dussubieux 2006; 2013) and nephrite ornaments (from Hung* et al. *2007).*

2 stone beads and high-alumina mineral soda glass beads were found at sites like Angkor Borei, Phnom Borei, Phum Snay, Prei Khmeng and the later phases of Ban Non Wat and Noen U-Loke (Fig. 7), which were not heavily involved in the earlier South China Sea exchange networks.

Socio-political implications

The appearance of agate/carnelian and glass beads in pre-existing exchange networks did not have far-reaching transformative effects on socio-political complexity in Southeast Asia during the early Iron Age period. Instead, the socio-political effects appear to have been more localized, as seen at sites like Khao Sam Kaeo (Bellina 2014) and Ban Don Ta Phet (Glover & Bellina 2011; Glover *et al.* 1981). More widespread socio-political changes are not apparent until the first few centuries CE, as exchange with South Asia was intensifying (Bellina and Glover 2004). This is primarily evidenced in the emergence of one of the earliest state-level societies in Southeast Asia, the civilization called Funan, located in the Mekong Delta region of Cambodia and Vietnam (Stark 2004). Based on the data presented above, it is also during this period that

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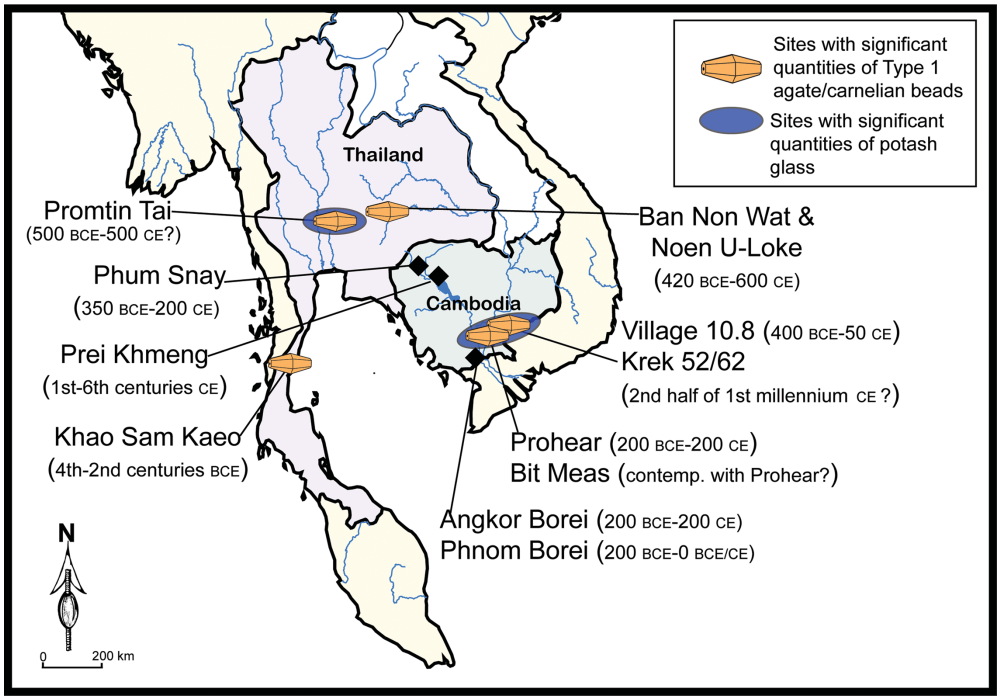

Figure 6. *(Colour online) Map of sites in this study with significant quantities of potash glass beads and Type 1 agate and carnelian beads.*

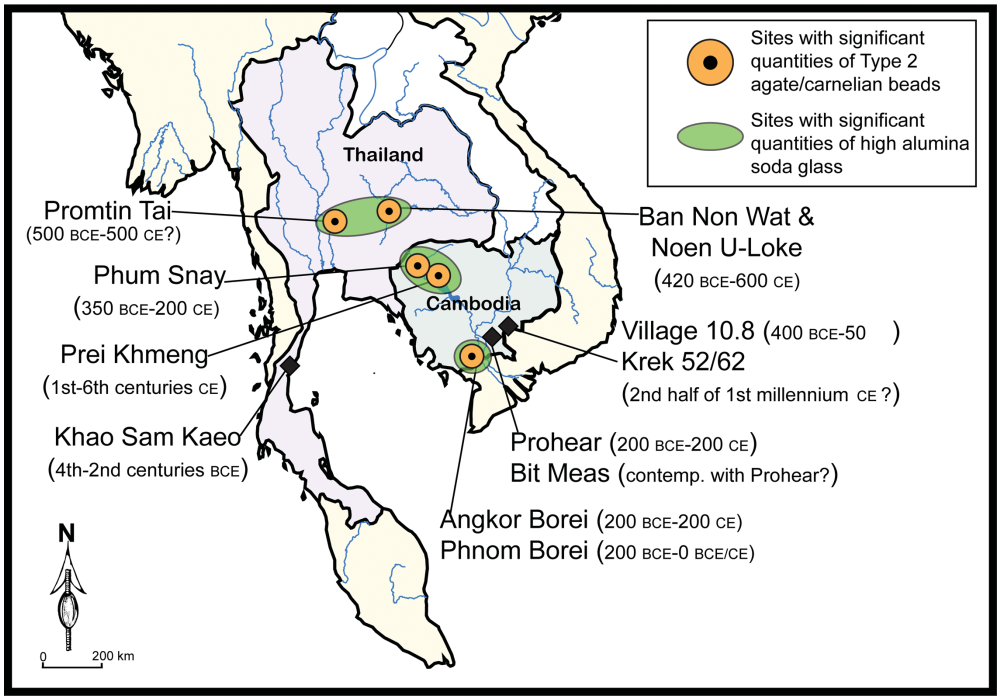

Figure 7. *(Colour online) Map of sites in this study with high alumina mineral soda glass beads and Type 2 agate and carnelian beads.*

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we begin to see new sites receiving stone and glass beads through an expanded bead exchange network, and the presence of higher quantities of beads, many of which were mass produced.

Evidence from the bead data presented here suggests that people at Angkor Borei and other sites in the Mekong Delta were not major participants in the pre-existing South China Sea exchange network, which I argue is significant. Wisseman Christie (1995) has argued that early maritime trading centres may have grown out of pre-existing polities that were already controlling the movement of goods between the coasts and inland areas prior to contact with India. Yet the evidence presented here indicates that occupants of the Mekong Delta were not in fact major players in the South China Sea exchange network.

Instead, the occupants of the Mekong Delta appear to be involved in something new. First, they may have been recent inhabitants to the area. Archaeological research at Angkor Borei, Cambodia, and Go Thap, Vietnam, provide the earliest evidence for occupation in the Mekong Delta from *c.* 500–300 BCE (Manguin 2009; Stark 2004). However, Reinecke (2012) has noted that the Mekong Delta, and especially the region southeast of Oc Eo, was largely uninhabitable until the early first millennium CE. Similarly, Manguin (2009, 108) has remarked that the appearance of Oc Eo culture sites in Vietnam is rather 'sudden'. One can imagine, then, that if this region were sparsely inhabited it would not have been a major stopping point on the South China Sea exchange route. Population movement into this region appears to have increased during the early first millennium CE. It is currently unclear if these communities were made up of new populations who were affiliated with the pre-existing South China Sea exchange network, or if there were different groups of people. Of course, emerging elites in this region must have had some kind of pre-existing relationships on which to build upon as trade networks were expanding (e.g. Brumfiel & Earle 1987; D'Altroy & Earle 1985). Bioarchaeological and isotopic research may be able to shed light on these questions in the future.

Many historians and archaeologists have argued that elites at urban centres in the Mekong Delta were using control over the exchange of exotic goods from India as a means to build their power and facilitate the emergence of a complex polity (e.g. Hall 1985; Higham 2014, 335–46; Mabbett 1997, 346–7; Manguin 2009; Wisseman Christie 1995). Junker (2004) has noted that network power strategies and alliance building networks were key factors of later second-millennium CE maritime states in Southeast Asia and proposed that due to demographic, ecological and geographic factors, these were likely important in earlier complex societies as well. Many of these models were drawing on limited archaeological data, primarily the excavations of the site of Oc Eo, Vietnam in the 1940s, which showed evidence for long-distance exchange (e.g. Malleret 1962). However, this study provides new and clear evidence for fluctuating and evolving trade networks in the form of changing bead types. These changing bead types include a shift towards mass production of beads, which is associated with intensified exchange with South Asia. It is through the study of beads, then, that we can begin to see the growth of a network-based political economy in the Mekong Delta, in which elites may have used beads and other exotic goods from South Asia in alliance-building networks. The key to this growth was not the presence of these objects themselves, but the intensified exchange and increased availability of these objects during the first few centuries CE.

Direct evidence for control over the exchange of beads by elites in the Mekong Delta is still lacking. However, other lines of evidence support the presence of powerful elites in this region. There is a high diversity of bead types identified in excavations at Oc Eo, including beads made from amethyst, garnet and quartz crystal (Malleret 1962). However, these beads are rarely found at inland sites (Theunissen 2003), suggesting that someone was deciding not to include these objects as part of the broader exchange of agate/carnelian and glass beads.

Another indirect line of evidence for control over the exchange of exotic goods by elites in the Mekong Delta comes from material evidence for the considerable power they seem to have exerted. Studies of contact-period communities in Africa and North America have described political fragmentation and competition between elites as a particular group lost control over exclusive access to exotic European goods (Håkansson 1998; Wesson 2002; see also Friedman & Rowlands 1978). Political fragmentation in the Mekong Delta is not evident until the mid first millennium CE, after long-distance exchange networks moved out of the Delta to island Southeast Asia (Stark 2006b). It is during this period that Khmer language inscriptions describe competition between rival elites (Vickery 1998).

However, prior to this period, during the early first millennium CE, elites in the Mekong Delta region were able to command labour for large-scale construction projects. Both the major urban centres of Angkor Borei, Cambodia (300 ha) and Oc Eo, Vietnam (450 ha) were surrounded by moats and massive brick walls, with the construction of the wall around Angkor Borei dating to the first few centuries CE (Stark *et al.* 2006).

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Angkor Borei and Oc Eo were also connected to one another and other sites in the region through a massive canal system, parts of which date to 0 BCE/CE (Sanderson *et al.* 2003; 2007; Stark *et al.* 2006, 117). Historic documents from Chinese visitors to the region in the third century CE describe rulers, walled villages, craftsmen, taxes and a written script (Coedès 1968; Ishizawa 1995). These same documents also note that the civilization called Funan was established in the late first or early second century CE (Ishizawa 1995, 14).

Of course, the nature of trade between the Mekong Delta and inland sites is still poorly understood. Recent studies have demonstrated that ceramics were not extensively exchanged between Angkor Borei and sites in the northwest, such as Phum Snay (Fehrenbach 2010; Stark 2006a, 100). This suggests that beads were circulated on a different network, perhaps one dedicated to high-value objects. At the same time, bioarchaeological studies in the Vat Komnou cemetery at Angkor Borei have identified evidence for four individuals with filed teeth, a modification that has also been seen at sites in northwest Cambodia, including Phum Snay (Domett *et al.* 2011; Ikehara-Quebral 2010). Additional research is needed the better to understand the connections between these communities.

Elites in the Mekong Delta were likely not the exclusive provider of beads to communities in Southeast Asia. Data from northeast Thailand point towards the presence of a strong regional exchange network, for example. As additional bead collections are studied from other sites, especially those in Vietnam and Myanmar, we will come to a better understanding of the various interaction networks at play in Southeast Asia during the Iron Age period. It should also be noted that the South China Sea network did not disappear. A study of mitred Vishnu sculptures has identified continuing connections between mainland Southeast Asia and the Thai–Malay peninsula across the South China Sea in the first millennium CE (Dalsheimer & Manguin 1998). There is also evidence for shared ship-building traditions across communities in the South China Sea (Manguin 1993).

It is also important to acknowledge the agency of the individual traders, craftspeople and consumers of stone and glass beads (see Oka & Kusimba 2008). With further research on beads at other sites in Southeast Asia, we might not only find evidence for other sources of beads and prestige goods exchange networks, but also evidence for the exchange of beads that existed outside the control of elites. The presence of regional exchange of mixed alkali glass and notched agate pendants in northeast Thailand and locally produced garnet beads in southeastern Cambodia and neighbouring regions of Vietnam are indicative of such networks.

Furthermore, many scholars have noticed the natural progression from control over the exchange of exotic prestige goods to control over their manufacture (e.g. Brumfiel & Earle 1987; D'Altroy & Earle 1985; Friedman & Rowlands 1978). As discussed earlier, Bellina (2007; 2014) has shown clear evidence for production of stone and glass beads at Khao Sam Kaeo during the early Iron Age period. However, she has also argued that lower-quality agate and carnelian (e.g. Type 2) beads may also have been produced at the site during the first few centuries CE (Bellina 2014, 368). Unfortunately, these beads have come from a disturbed context, and evidence for agate and carnelian bead production at other sites in Southeast Asia is problematic and difficult to interpret due to heavy looting (see Carter 2013, 157–63; n.d.). As many of the Type 2 beads appear during a period of increased trade with South Asia and are circulating in the same exchange networks as the Sri Lankan-produced high-alumina soda glass (m-Na-Al 1), I argue that it is likely many of these beads were manufactured in South Asia. However, we cannot rule out the local production of stone and glass beads in Southeast Asia during the later Iron Age period as well; further research from undisturbed contexts is needed.

Conclusion

This study has shown the utility of using beads to study interaction networks and their changes over time. As small objects, beads are easily transportable, yet they contain information on how they were made, which can frequently be tied to when and where they were produced. Careful examination of stone beads for details regarding their manufacture, as well as compositional analysis of glass beads, can provide valuable information related to changing manufacturing techniques and culturally specific methods of production. Furthermore, I argue that examining stone and glass beads together can provide depth to studies of exchange, with evidence in this case complementing one another. Although this case study focused on an example from Southeast Asia, the methods used to study stone and glass beads can be applied to beads from a variety of cultures and time periods.

An examination of the distribution of beads found at Iron Age sites in Cambodia and Thailand has identified multiple distinct exchange networks. During the early Iron Age period, high-quality Type 1 agate and carnelian beads and potash glass were found at certain coastal and some inland sites that were also participating in the exchange of other

https://doi.org/10.1017/S0959774315000207 Published online by Cambridge University Press

locally produced prestige goods (e.g. Dongson drums and nephrite ear ornaments) along a South China Sea exchange network. During the first few centuries CE, trade with South Asia intensified (Bellina & Glover 2004), bringing a greater number of goods into Southeast Asia. This shift corresponds with the presence of Type 2 agate and carnelian beads and high-alumina soda glass beads. However, these beads were not being exchanged on the same South China Sea networks as in the early period. Instead, they were circulating on newly expanded exchange networks, including sites in the Mekong Delta and northwest Cambodia.

Although considered in more detail elsewhere (Carter 2012; Carter & Lankton 2012), an examination of beads also identified specific bead types (e.g. garnet beads, mixed alkali glass) that were exchanged in smaller regional exchange networks. The identification of specific bead types that had a more restricted distribution highlights the importance of local connections between communities that persisted as broader regional trade and interaction networks were changing. Studies of ceramics in Thailand have also shown evidence for strong localized traditions (White & Eyre 2009), highlighting the fact that research on exchange and socio-political change should be undertaken at multiple scales in order to account for this diversity.

Based on the stone and glass bead data presented above, I propose that the intensified trade with South Asia and the introduction of greater quantities of mass-produced stone and glass beads into circulation in Southeast Asia were likely a factor in the growth of a state-level society in the Mekong Delta. In this model, beads were part of a network strategy in which elites controlled the exchange of prestige goods in order to build alliances with inland communities (Blanton *et al.* 1996). However, it is acknowledged that more work is needed in order to understand the nature of exchange between elites in the Mekong Delta and inland communities, as well as the potential for the local manufacture of beads, and the presence of competing suppliers and exchange networks elsewhere in Southeast Asia. It is hoped that future researchers will consider the utility of studying beads to elucidate economic and social relationships between communities, and as indicators of changing socio-political dynamics.

Notes

1. This time period has frequently been called the Iron Age (see Higham 2014, 15–17). However, Stark (2004) has noted that developments in the Mekong Delta are quite different from elsewhere in Southeast Asia and has opted to refer to this time period as the 'Early Historic' period. As the current study draws heavily on the work of other scholars who have referred to this period as the Iron Age, I will use this terminology to remain consistent.
2. For a more detailed discussion of these sites and the contexts in which beads were found, see Carter (2013).
3. These two categories served the purpose of the current study, which was to identify broad patterns in the bead collections from multiple sites. However, a more detailed method for assessing quality was recently described by Bellina (2014, 352) and may be of interest to future researchers.
4. Impressions of the bead perforations were taken using dental impression material, which was then examined under a scanning electron microscope. For more details on this method, see Carter (2013, 140–42).
5. In Bellina's more recent work (2014) she has identified additional hard stone bead groups at Khao Sam Kaeo based on the different technologies used to produce the beads and their style.
6. Of the 56 beads from Ban Non Wat, I was unable to record enough information on 16 of them to assign them confidently to either the Type 1 or Type 2 group. Of these, 14 were not directly associated with burials, while two of the beads belonged to Iron Age 1 burials (420–150 BCE).

Acknowledgements

I wish to acknowledge the governments of Cambodia and Thailand for their permission to examine and analyse these beads and especially the Apsara Authority, the Ministry of Culture and Fine Arts, Cambodia, the National Research Council of Thailand and the Fine Arts Department of Thailand. Thanks also to Drs Bérénice Bellina, Charles Higham, Thanik Lertcharnrit, Dougald O'Reilly, Christophe Pottier, Andreas Reinecke, Miriam Stark, Pheng Sytha, Rachanie Thosarat, as well as Heng Sophady, Phon Kaseka, Seng Sonetra, Tep Sokha, Vin Laychour, Voeun Vuthy, the École française d'Extrême-Orient and the Suthiratana Foundation for access and assistance with the bead collections studied in this research. Compositional analysis was undertaken at the Elemental Analysis Facility at the Field Museum, managed by Dr Laure Dussubieux. Funding for portions of this project was provided by the Henry Luce Foundation/ACLS Grants in East and Southeast Asian Archaeology and Early History Dissertation Fellowship, Fulbright IIE, The Center for Khmer Studies, the Bead Society of Los Angeles, the Portland Bead Society, the Bead Study Trust, Graduate Women in Science–Beta Chapter, Geological Society of America and the Center for Southeast Asian Studies at the University of Wisconsin-Madison. Thanks also to Drs Charles Higham and Kurt Gron, Paul Madavi and the anonymous reviewers for their helpful comments on earlier drafts of this article.

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https://doi.org/10.1017/S0959774315000207 Published online by Cambridge University Press

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