THE RELATIONSHIP BETWEEN EARLY SOUTHEAST ASIAN AND INDIAN GLASS

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INTRODUCTION

In the course of a general survey of beads in Southeast Asia, Lamb (1965a:89) noted that "It is rather surprising ... that in the literature of Southeast Asian archaeology so little attention has been paid to beads". More than two decades later the scene was not much different. In the SPAFA Seminar on Prehistory of Southeast Asia, 12-25th January 1987, it was noted that

> In most parts of Southeast Asia, beads made of glass and semiprecious stone are the earliest signs of contact with East, South and Southwest Asia. And yet thus far we know relatively little about their dating, manufacture, possible sources, nor of the trade systems that brought them together (SPAFA 1987: 335).

Thus there is a need for a comprehensive study of archaeological beads, particularly glass beads from Asian sites. In this paper, the trade between India and Southeast Asia from about 400 BC to about AD 500 will be discussed with special attention to morphological and analytical studies of glass beads. In the discussion, the evidence from Ban Don Ta Phet is particularly important, because the numerous glass beads from this site are well dated and many have precise contexts and we know the material associated with them at burial; such detail is rare in the archaeology of Southeast Asia.

EARLY GLASS IN SOUTHEAST ASIA

There is no good evidence of glass beads in Southeast Asia before the Iron Age, that is before 600-400 BC. In Vietnam the earliest glass is dated to the 4th-3rd century BC (Nguyen Truong Ki 1983); in Thailand it is not much earlier than 400 BC (Basa n.d.), and in Malaysia the earliest glass beads are from Kampong Sungei Lang which yielded three radiocarbon dates ranging from the 5th century BC to the 2nd century AD (Peacock 1979:212-3). In Indonesia, radiocarbon dates are reported for only two sites (Gilimanuk and Pasir Angin) yielding early glass beads. The earliest of nine dates for Gilimanuk in Bali is 2020±65 BP (GrN-7129) (Bronson and Glover 1984:41). However, most of the

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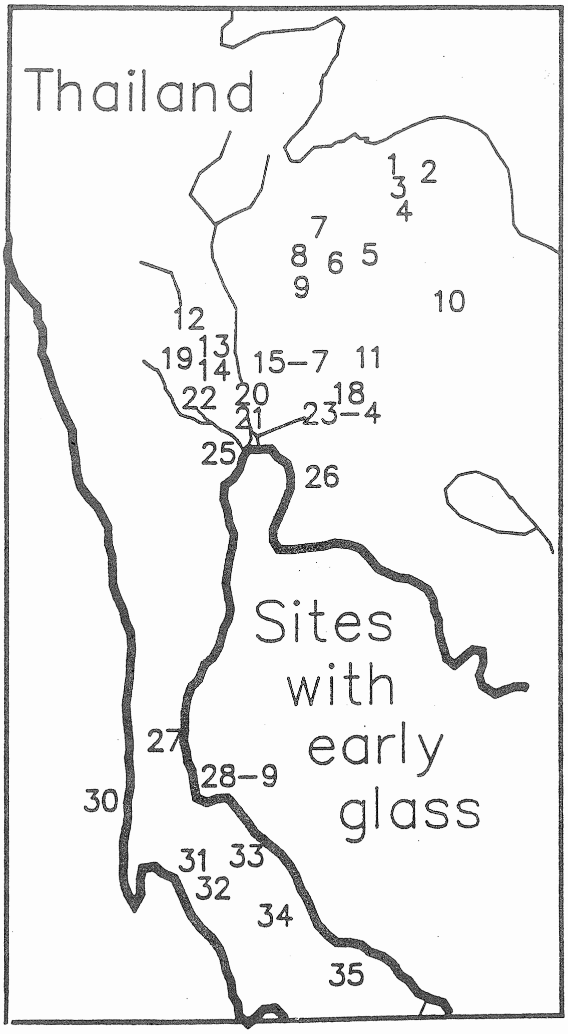
material is thought to belong to the early centuries AD (Indraningsih 1985:136). Pasir Angin in Java has four dates[1] but their contexts, associations and reliability must be suspect given their great age spread. In the Philippines, the earliest glass is said to be from the Early Metal Age site of Uyaw Cave from the level dated between 500-200 BC (Fox 1970:137; Solheim 1981:46), but again the dating is not secure. A more reliable date for glass is thought to come from Manunggul Cave, chamber B where there is a radiocarbon date of 2140±100 BP (Bronson and White 1984:15; Fox 1970:118). Thus, glass in Southeast Asia can not, at present, be dated much earlier than 400 BC and certainly not before 500 BC. In most cases, it appears with the first use of iron.



1 Non Ki Klang, 2 Ban Sa Baeng
3 Ban Chiang, 4 Ban Na Di
5 Non Chai, 6 Phu Kibao
7 Don Klang, 8 Non Pa Kluay
9 Non Muang, 10 Ban Chiang Hian
11 Ban Tarn Prasat, 12 Lum Kao
13 Chansen, 14 Ku Muang
15 Ban Tha Kae, 16 Wang Pai
17 Vichayen's House
18 Dong Si Mahapho
19 Tham Ongbah, 20 U-Thong
21 Ban Don Ta Phet
22 Prasat Muang Singh
23 Pra Pathom, 24 Khok Plap
25 Ku Bua, 26 Kok Ra Ka
27 Khao Sam Kaeo, 28 Wat Wieng
29 Laem Pho, 30 Ko Kho Khao
31 Kao Kant Nam
32 Khlong Thom
33 Nakorn Si Thammarat
34 Satingpra, 35 Yarang

FIGURE 1: SITES IN THAILAND WITH FINDS OF EARLY GLASS

GLASS BEADS FROM BAN DON TA PHET

The archaeological site of Ban Don Ta Phet lies on the southern edge of the village of that name in Kanchanaburi province of West Central Thailand (Fig. 1). It was excavated over three seasons, first by the Fine Arts Department under Nikom Suthiragsa, then under Chin You-Di in 1975-76, and subsequently in 1980-81 and 1984-85 by the University of London and the FAD (Glover 1981, 1983, 1990a; Glover *et al.* 1984). The site is an Iron Age secondary burial site with pottery, many semiprecious stone and glass beads, bronze vessels and ornaments, and iron tools and weapons. Glover (1990a) dates the site to a single episode in the early part of the 4th century BC (360-390 cal. BC) on the basis of five consistent radiocarbon dates made on organic temper extracted from pottery in five separate funerary deposits. Though rather earlier than once believed, such a date is not inconsistent with the age of similar etched carnelian and agate beads and glass in early historic India. The site is important in the context of this paper because it has yielded the best provenanced, largest corpus and widest range of glass beads of any site in Thailand (Figs. 2 and 3) and indeed in the whole of Southeast Asia. A few glass bangles and distinctive ear ornaments were also found.

Shapes	Translucent beads							Opaque beads		
	Colourless	Honey	Green	Blue	Violet	'Black'	Orange	Red	Dark Grey	Total
Spherical-elliptical	9	3	51	170		2		49	1	285
Barrel	54	1	452	135	2		3	509	3	1159
Annular	28		8	94	2	1	1	312		446
Cylindrical			151	67	3			222		443
Cornerless cube		2	1	4					1	8
Bipyramidal/biconical	54	45	18					20		137
Square prism	2	3	25						1	31
Hexagonal prism	3	26	55							84
Segmented				9						9
Fragmentary	4	51	38	37				4	77	211
Total	154	131	799	516	7	3	4	1116	83	2813

TABLE 1: GLASS BEADS FROM BAN DON TA PHET FROM ALL SEASONS, BY PRINCIPAL COLOURS AND SHAPES[2]

Although all the glass beads from Don Ta Phet are monochrome, there is a wide range of colours and tones which can be broadly grouped (Table 1) into translucent and opaque types. The former include colourless, honey, green, blue, violet, grey-black and orange; the latter include red (both opaque browny red and opaque orange red) and a few dark grey specimens. The opaque browny red and opaque orange beads are of the type often known as *mutisalah*, or "false pearl", an Indonesian term used by Rouffaer (1899) in his study of beads among the communities of Timor and Flores who regarded them as objects of great value. *Mutisalah* beads constitute about forty percent of the glass bead collection at Ban Don Ta Phet, about the same proportion as in the collections from Kuala Selinsing (2nd century BC to 10th century AD) and Pengkalan Bujang (12th-14th centuries AD) in Peninsular Malaysia (Lamb 1965a:96). Many of the *mutisalah* beads show striations parallel to the hole and flat ends indicating that they were drawn and cut from a

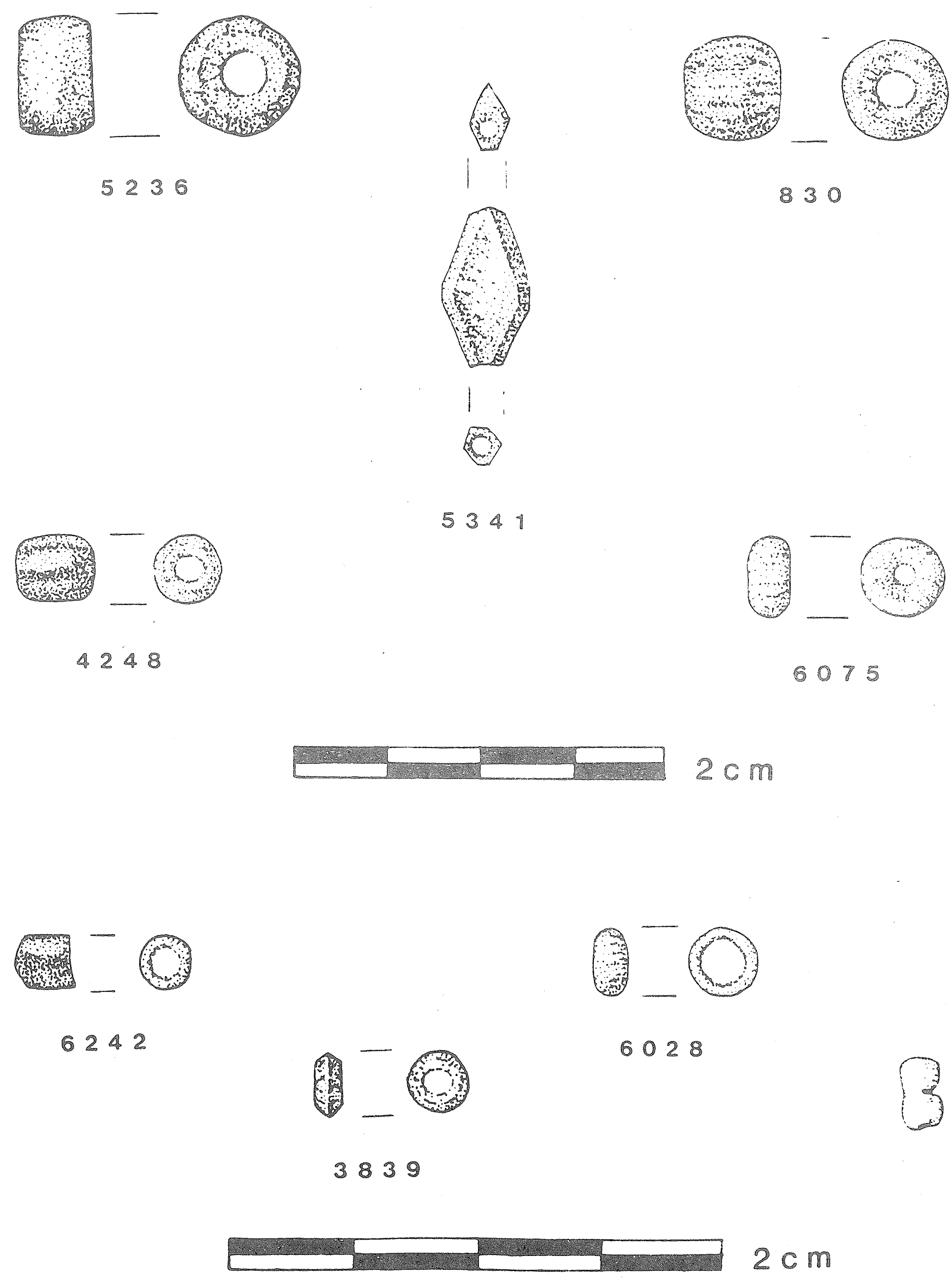


FIGURE 2: SMALL AND MAINLY NON-PRISMATIC GLASS BEADS FROM BAN DON TA PHET
5236 barrel; 5341 tabular diamond; 830 spherical; 4248 elliptical; 6075 and 6028 annular; 6242 cylindrical; 3839 biconical; lower right is segmented.

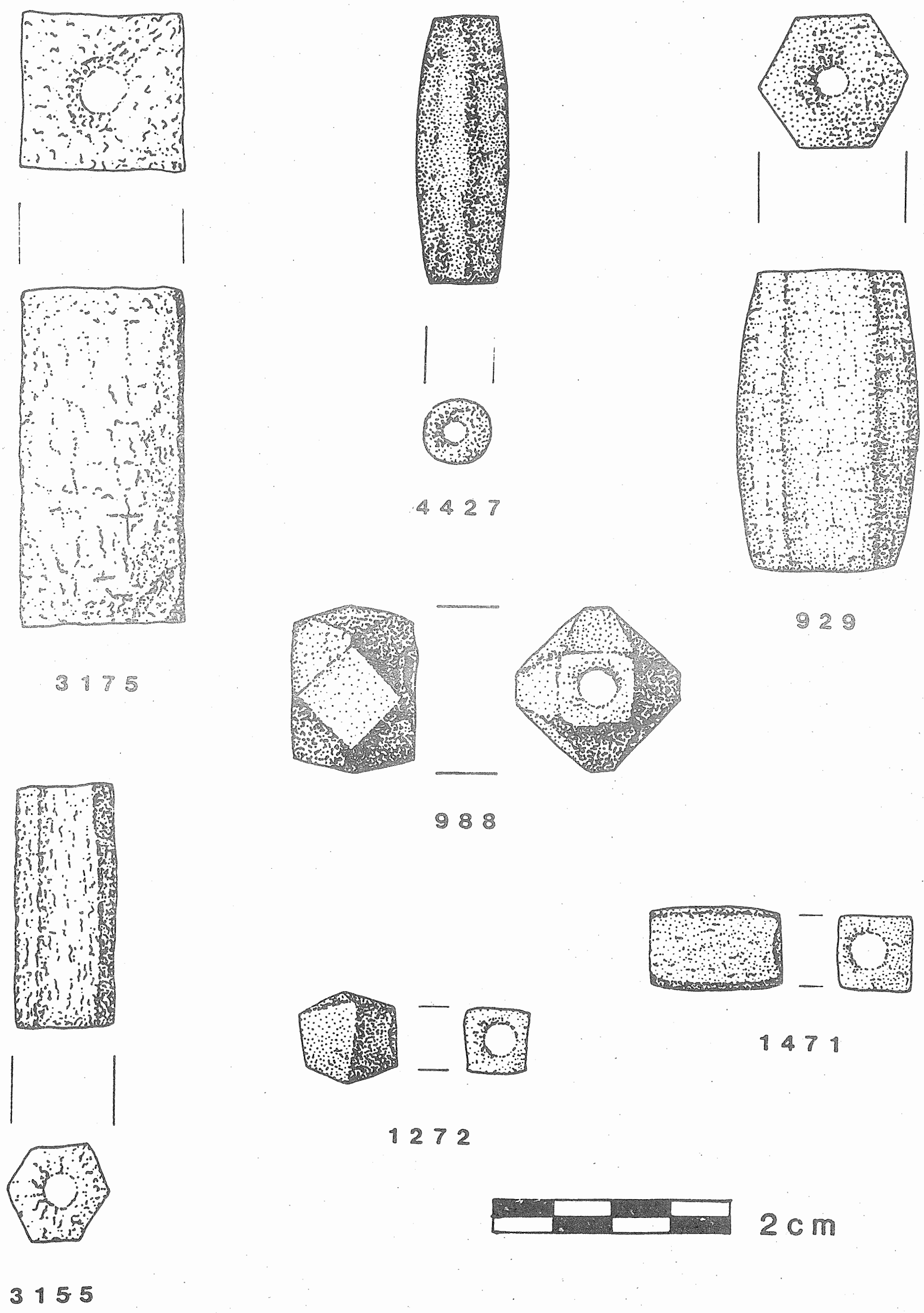


FIGURE 3: LARGER AND PRISMATIC BEADS FROM BAN DON TA PHET

3175 and 1471 square prisms; 4427 long barrel; 929 and 3155 hexagonal prisms; 988 cornerless cube; 1272 bipyramidal bigger tube, and some also have more than one hole, from gas bubbles trapped in the drawing process and exposed when the drawn tubes were cut. These are clear signs of the "lada" technique of manufacture (Francis 1990:8-15). *Mutisalah* belong to the general category of "Indo-Pacific Monochrome Drawn Glass Beads" as identified by Francis (1990:2). Glover (1990b: 13-5) mentions that a number of the translucent glass beads at Don Ta Phet have cubic, bipyramidal, square prismatic, or hexagonal prismatic shapes (Fig. 3) and imitate the forms of natural mineral crystals, especially the famous beryl crystals of South India. Prismatic glass beads are a type so far noted only rarely in Southeast Asia, for instance at Ban Chiang and Oc Eo in Vietnam (Malleret 1962:250).

One diamond shaped tabular glass bead from Ban Don Ta Phet was clearly cut and polished (Fig. 2, no. 5341) and resembles a type of faceted carnelian bead quite common at Ban Don Ta Phet and elsewhere in Southeast Asia, for example at Leang Buidane in Salebabu Island in Indonesia (Bellwood 1985:309, fig.9.29) and at Khao Sam Kaeo in Peninsular Thailand. This specimen shows a formal and technical connection between glass and stone bead technology, suggesting some proximity between craftsmen working in the two materials. Some translucent green and translucent dark blue and opaque yellow glass beads show rope-like features. In a few cases, two or three of these beads are fused together end to end and are described as "accidentally segmented" beads.

Although it is argued below that most of the beads from Don Ta Phet, as with other early glass in Southeast Asia, were imported in antiquity from India it is worth pointing out that at least one, a most unusual comma shaped ear ornament (Fig. 4, and see Chin You-di 1978: Colour Plate 5) was found during the 1975-76 excavations[3]. Although made from a translucent colourless glass such as found in other beads at this site and in India, it is a shape quite unknown in India, indeed is unique to Thailand, and strongly suggests that some bead manufacture was practised in Thailand, perhaps from imported glass cullet.

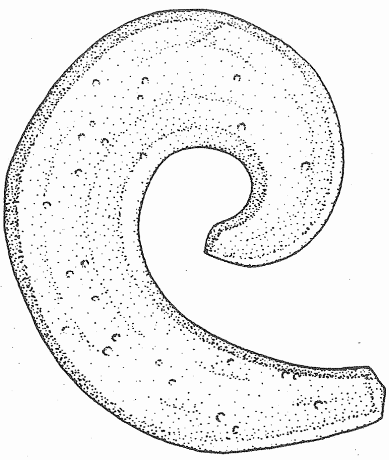


FIGURE 4: UNIQUE COMMA-SHAPED TRANSLUCENT LIGHTLY TINTED GLASS EARRING FROM BAN DON TA PHET, 1975-6 SEASON
(max. diam. about 5 cm)

Some of the bracelets too, (eg Glover 1990a fig.20) do not resemble ones known from contemporary Indian sites.

EARLY GLASS IN INDIA AND THE TRADE OF GLASS FROM INDIA TO SOUTHEAST ASIA

Glover (1990b), Basa (1991) and Ray (1989 and this volume) have summarised the archaeological evidence for trade between India and Southeast Asia. The items traded include semiprecious stone beads (especially the etched varieties), high-tin bronze artefacts, Rouletted Ware, seals and intalgios, knob-base bronze vessels and ivory combs, as well as glass. From work on early Indian glass (Dikshit 1969; Francis 1982c, 1990; Singh 1989; Basa 1991: Chapter 9) it appears that, from at least the middle of the first millennium BC, India had a number of manufacturing centres of glass with their own regional specializations. Moreover, glass beads have been found at many sites important in trade. For example, Taxila was a major centre on the Silk Route. Kausambi, Rajghat, Kumrahar and Chandraketugarh were important stages in the Gangetic trade, and Ujjain in central India linked the Ganga valley with Broach (ancient Bharukacca, and Barygaza of the *Periplus*) on the western coast (Casson 1989:197-200). In the south, Arikamedu (Poduke of the *Periplus*) (ibid.228) and Karaikadu on the Tamilnadu coast were active in trans-peninsular trade with the Roman Empire and perhaps, given the large number of *mutisalah* beads in Southeast Asia, transmitted Western and Indian goods to the east across the Bay of Bengal. As Glover (1990b) has argued, there is now evidence to show that the trade routes linking the Mediterranean to India continued on, perhaps at a reduced rate, taking low bulk, high cost items to Southeast Asia, and no doubt returning with valuable products from East Asia such as tortoiseshell, silk cloth and silk yarn, as well as the high-tin bronze vessels which survive in some archaeological sites.

Monochrome beads of different colours (the "Indo-Pacific beads" of Francis 1990) are the most common bead type in Late Prehistoric Southeast Asia. Among them the opaque browny red and opaque orange red *mutisalah* beads constitute an important component. In South Asia, the earliest evidence of red glass beads comes from Rajghat from Period IB (c.600-500 BC) (Bhardwaj 1979:44) and from the Bhir mound at Taxila (5th century BC) (Dikshit 1969:5). From that time onward they were plentiful in various parts of India. However, Arikamedu (Wheeler *et al.* 1946; Begley 1983), which flourished between the late centuries BC and the early centuries of the Christian Era, was one of the most important manufacturing centres of the monochrome beads, including the *mutisalah* varieties (Francis 1982a, 1982b, 1991; Stern 1987). In Thailand they have been found in many Late Prehistoric sites such as Ban Chiang, Ban Na Di, Non Muang, Ban Tha Kae, Ban Don Ta Phet, Prasat Muang Sing and Kok Ra Ka (Basa n.d.). They have also been found at Kampong Sungei Lang (late centuries BC to the early centuries AD) in Peninsular Malaysia, and at Sembiran in Bali (late centuries BC to the early centuries AD; Ardika and Bellwood 1991).

The earliest evidence for manufacturing glass beads in Thailand comes from Khlong Thom, dated to about the 4th century AD onwards (Bronson 1990; but remember our comment above on the presence of some locally shaped glass at Don Ta Phet). In

Peninsular Malaysia the earliest evidence for manufacturing beads comes from Kuala Selinsing, recently dated between 200 BC and AD 1000 (Shuhaimi 1991). However, the chronology of the glass-bead-yielding levels is not yet clear. In Indonesia, Gilimanuk, a coastal site in Bali dated to the turn of the Christian Era, is claimed to be a manufacturing centre for glass beads (Indraningsih 1985:138), although Francis (pers. comm. to ICG 20.1.91) has cast doubt on claims that glass beads were actually made there. Oc Eo in Vietnam has yielded the highest number of glass beads (about 8000 and mostly from illegal digging), dated to between the 2nd and 7th centuries AD on the basis of recent radiocarbon datings (Ha Van Tan 1986:93). Oc Eo is regarded as a glass bead manufacturing centre, although the importation of some glass beads is also likely (Malleret 1962:155).

At present we can only speculate about the identity of the early glass bead makers in Southeast Asia. It is possible that some merchants from India took skilled artisans to make glass ornaments in Southeast Asia to meet local demand in certain areas, perhaps following cargo losses. However, it seems unlikely that the locally-made glass could have satisfied the demand throughout the whole of Southeast Asia during the period between 400 BC and AD 500. Few manufacturing centres are known and very large numbers of glass beads have been found in most parts of Southeast Asia. Thus it seems reasonable to infer that most, if not all, of the monochrome glass beads came from India; the *mutisalah* beads from South India, and other types as well which are rare in Southeast Asia but well known from Indian collections. For instance, a type of deep translucent (apparently "black") round bead with spiral grooves originally filled with white strips was found at Prasat Muang Sing on the Kwae Noi River in Thailand and at Ban Chi Nam Lai, Inburi district, Singhburi province. Rare in Southeast Asia, this is a typical North Indian bead and has been found in the surface collections from Kausambi and in the excavations at Narhan, Chandraketugarh and Kodumanal. At Kodumanal this type is dated to c.100 BC-AD 200 and at Narhan to the Gupta period.

Cornerless cube beads of translucent dark blue glass are found at Ban Don Ta Phet. One such blue bead has been reported from a cist burial near Tegurwangi in South Sumatra (Hoop 1932). Similar beads are reported from Taxila from the Bhir mound (Beck 1941:27) and from Sirkap Phase II, dated to about the beginning of the Christian Era to AD 50 (Ghosh 1948:75, Plate X: no. 21). This shape is common in the Mediterranean, Egypt, Mesopotamia and Persia (Beck 1941:27) and may be a direct import from there.

Ban Don Ta Phet has yielded 349 translucent lightly-tinted glass beads of a type only rarely reported elsewhere in Southeast Asia; a few are known as surface or uncontexted finds from Ban Chiang and Oc Eo and one or two come from the stone cist graves at Tegurwangi in South Sumatra (Hoop 1932). Many of these are in the form of hexagonal prisms, hexagonal barrels, square prisms and square barrels which, as pointed out earlier, mimic the beryl crystals of South India which were popular in the Buddhist cultures of North India as well as the Roman world. These caught the attention of Pliny the Elder who mentioned that glass imitations were made in India (Eicholz 1962: 227). Francis

(1991: 34) says that such hexagonal prismatic glass beads were manufactured at Arikamedu in South India. If this is so, they are surprisingly rare in South Asian archaeological collections; Basa (1991) has recorded a few such beads in surface collections from Ahichchhatra, Kausambi and Narhan, the last being dated by three radiocarbon dates to the 2nd-3rd centuries BC. Two hexagonal barrels of almost colourless glass, one of green glass, and a square barrel bead were found at the 4th-3rd century BC Bhir mound at Taxila (Beck 1941:27, Plate IX3). A hexagonal bead was also obtained from Phase III at Sirkap, dated to the early centuries AD (Ghosh 1948:75, Plate X, no. 19). Similar beads are found in Western Asia but are not common; the Department of Graeco-Roman Antiquities of the British Museum, for instance, holds only two beads of this type - one from the surface at Amrit and another from Tyre.

Glass beads of similar shape are also reported from Ulu Sungei, Southeast Borneo, but their colour is not mentioned (Heekeren 1958: Plate 13, 3rd string). Truncated biconical beads of translucent dark blue and turquoise blue glass, from Ban Chiang and Ban Na Di, are typical of Northeast Thailand, but seem to be rare in India; only one from Taxila (Beck 1941: Plate I, no. 22) appears to belong to this group. It is clear that the sources for all kinds of glass beads are not yet fully determined. For example, to our knowledge, there is as yet no parallel to the tubular glass beads with oblique cut ends, obtained from the surface collections around Ban Chiang. And the bipyramidal glass beads from Ban Don Ta Phet have only a single parallel, from Oc Eo (Malleret 1962:250).

CHEMICAL COMPOSITIONS OF LATE PREHISTORIC SOUTHEAST ASIAN GLASS

The compositions of twenty-four glass beads from Southeast Asia were determined[4]; eighteen from Ban Don Ta Phet, one from Ban Chiang and five from Sembiran. Samples were mounted in epoxy blocks, polished and coated with carbon. The samples were principally unweathered and taken from bead interiors. Some analytical totals are low, and this may partly be attributable to a limited degree of weathering. In Tables 2-5 the results are given as percent element oxides by weight; the lowest level of detection for many was c.0.1%. The system used was a Cambridge S2000 Scanning Electron Microscope with a Link System energy dispersive X-ray spectrometer and a ZAF 4 correction program. In Tables 4 and 5 a dash or a question mark indicates that the presence of a certain compound was not listed in the sources consulted.

The beads from Don Ta Phet (identified by their find numbers) were from archaeological contexts dating to the 4th century BC. Those from Sembiran (S2-6) were also from good archaeological contexts and probably date between AD 1 and 200 (Ardika and Bellwood 1991). The specimen from Ban Chiang (BC1) was a surface find. Colours are indicated by abbreviations; thus TCG means translucent clear greenish, TDG means translucent dark green, TCW means translucent (clear) colourless (some of the colourless beads have internal cracks which appear whitish due to light reflecting off the internal fractures), OBR means opaque brownish red, TP means translucent purplish and TOG means translucent olive green. The red colour is quite different from a much brighter "sealing-wax" red glass found in ancient glass technology; differences borne out in the microstructures and chemical compositions of the two kinds of red. On the basis of their compositions, the glass beads can be grouped into two broad types - mixed-alkali glass and potassium-rich glass. Sodium predominates in the mixed-alkali glass and potassium oxide in the potassium-rich glass.

Mixed-Alkali Glass

Mixed-alkali glass (Table 2) has significant levels of both soda (Na_2O) and potash (K_2O) (Henderson 1988:77). The glass in the mixed-alkali group is only of a brownish-red colour and includes six of the eight opaque browny red *mutisalah* beads analysed. The mixed-alkali glasses can be characterized further as having high aluminium oxide (Al_2O_3), high copper (Cu) and low calcium oxide (CaO) contents. The reddish colours are due to the high levels of copper oxide, which was found to be present as a sub-micron dispersion of cuprous oxide (Cu_2O).

Bead No.	Bead type	Na20	MgO	Al203	SiO2	P205	SO3	K20	CaO	TiO2	Fe203	Cu20	Total %	Total alkali	K20/Na20
265	OBR/barrel	10.4	1.5	6.6	68.6	1.1	0.1	5.1	2.8	0.5	2.3	2.5	101.6	15.5	0.49
3939	"	11.1	0.9	5.6	63.7	0.6	0.3	4.2	2.8	0.4	1.9	2.0	93.6	15.3	0.38
3957	"	11.8	1.1	5.5	66.9	0.7	0.3	4.7	2.9	0.5	2.2	2.4	99.1	16.5	0.40
6114	"	11.3	1.4	6.7	62.9	0.6	0.3	3.4	2.6	0.4	2.4	2.4	94.5	14.7	0.30
6075	OBR/oblate	12.0	1.5	6.2	66.0	0.9	0.1	4.9	4.0	0.5	2.7	2.5	101.4	16.9	0.41
S5	OBR/cylinder	6.1	1.7	3.8	60.9	2.5	ND	4.7	3.9	0.2	2.0	14.2	100.0	10.8	0.77

TABLE 2: MIXED-ALKALI GLASS FROM BAN DON TA PHET AND SEMBIRAN (WT. % AS OXIDES).
The figures for Cu and Fe are expressed in the oxidised form, but are probably present in the reduced form, FeO and Cu_2O. ND = not detected. For explanation of colour codes used see p. 374.

Potassium-rich glass

Eighteen glass beads have potassium oxide (K_2O) as their main alkali (Table 3) although in most cases a little soda is also present. Out of these, thirteen are from Ban Don Ta Phet, four from Sembiran and one from Ban Chiang. In contrast to the mixed-alkali glass, the potassium-rich glass has more silica (SiO_2) but is low in calcium oxide. Within the potassium glass group, eight beads from Ban Don Ta Phet contain silica between 68.1% and 78.5%, potassium oxide between 15.6% and 18.2%, calcium oxide between 1.8% and 5.7% and aluminium oxide at below 1%, with very few other other oxides apart from colorants (1293, 1432, 1435, 4415, 5653, 7171, 9046 and 9142). The high silica levels in some of these beads indicates that slightly weathered glass samples were analysed, though it is significant that the same overall compositional characterstics are observed in unweathered samples. The other beads in the potassium group (3096, 4248, 5234, 5236 and 8010) from Ban Don Ta Phet, all the beads from Sembiran and the one from Ban Chiang have higher levels of other compounds; aluminium oxide occurs at between 1.0% and 4.0%, iron oxide (Fe_2O_3) is present at levels between 0.8% and 2.0% in three of the four Sembiran beads and in five of those from Ban Don Ta Phet. In sample 5653, an intense dark brown bead from Ban Don Ta Phet, the iron oxide content is higher at 9%. An iron oxide level above 0.8% would certainly modify, if not produce, the glass colour, although the final colour achieved would depend on a range of other factors (Green and Hart 1987). Copper oxide is present in five beads from Ban Don Ta Phet, ranging up to 2.4%.

Bead No.	Bead type	Na20	MgO	Al203	Si02	P205	S02	Cl	K20	Ca0	Ti02	Mn0	Fe203	Cu0	Total	%Total alkali	K20/Na20
1293	TCG/sq.barrel	0.2	0.7	0.6	72.8	0.4	ND	ND	16.6	5.7	ND	ND	0.3	0.1	97.4	16.8	83.0
1432	TCW/bipyramid	ND	0.4	0.2	74.9	ND	0.1	ND	15.6	4.8	ND	ND	0.2	ND	96.2	15.6	78.0
1435	TCG/hex.prism	0.7	0.6	0.2	74.5	ND	ND	0.1	16.2	4.9	ND	ND	0.2	0.1	97.5	16.9	23.1
3096	TOG/fragment	1.3	1.3	2.2	69.6	0.6	0.4	ND	17.4	3.9	ND	0.2	1.0	1.8	99.7	18.7	13.4
4248	TBG/elliptical	0.5	ND	1.5	71.7	ND	0.2	ND	15.0	1.2	ND	ND	ND	2.4	93.8	15.5	30.0
4415	TDG/oblate	ND	0.5	0.6	73.0	ND	ND	ND	17.3	3.2	ND	ND	1.0	0.8	95.1	17.3	87.0
5234	TBG/barrel	3.8	0.5	3.1	71.8	0.1	ND	0.1	14.4	2.4	0.1	ND	1.0	1.6	98.9	18.2	3.8
5236	TOG/barrel	1.4	0.5	1.9	69.5	ND	0.3	ND	15.6	3.1	0.1	ND	0.8	1.1	94.3	17.0	11.1
5653	TB/fragment	0.2	0.2	0.8	68.1	ND	0.7	0.5	17.4	1.5	ND	ND	9.0	ND	98.4	17.6	87.0
7171	TB/fragment	ND	0.5	0.3	77.1	0.6	ND	0.1	18.2	3.7	0.2	ND	ND	ND	100.7	18.2	91.0
8010	TOG/fragment	1.4	0.4	1.9	70.3	ND	0.1	ND	18.2	3.1	ND	ND	0.6	1.2	97.2	19.6	13.0
9046	TDB/fragment	ND	0.3	0.9	74.3	ND	ND	ND	16.5	3.8	ND	ND	ND	ND	95.8	16.5	82.5
9142	TCW/bipyramid	0.2	0.6	0.6	78.5	ND	ND	ND	16.6	3.9	ND	ND	0.2	ND	100.6	16.8	83.0
S2	OBR/oblate	ND	1.3	4.0	66.8	0.6	0.3	ND	12.8	2.6	0.1	0.3	2.0	3.1	93.9	12.8	64.0
S3	TDB/barrel	ND	0.4	2.8	77.7	ND	0.4	ND	15.6	0.9	0.3	1.9	1.2	ND	101.8	15.6	78.0
S4	TP/fragment	1.4	ND	1.0	74.1	0.3	0.3	ND	16.3	1.1	ND	3.3	1.0	ND	98.8	17.7	11.6
S6	OBR/barrel	0.8	1.9	2.6	70.1	1.0	0.1	0.2	17.3	3.0	ND	0.3	0.1	2.5	100.3	18.7	21.6
BC1	TDB/bicone	1.2	ND	3.7	75.5	ND	ND	ND	13.4	0.3	ND	0.4	0.5	ND	95.0	14.6	11.2

TABLE 3. POTASSIUM-RICH GLASS FROM BAN DON TA PHET, SEMBIRAN AND BAN CHIANG (WT. % AS OXIDES).

The figures for Cu and Fe are expressed in the oxidised form, but are probably present in the reduced form, FeO and Cu_2O. ND = not detected. Beads with four figure nos. are from Ban Don Ta Phet, S2-6 are from Sembiran and BC1 is from Ban Chiang. For explanation of colour codes used see p. 374.

In the potassium group there is no absolute relationship between the copper content and the bead colour since some translucent clear and greenish beads have copper contents as high as 1.1-2.4%. This can be explained by the fact that copper in translucent glasses would be dissolved and present in its oxidised form (CuO), whereas in the red opaque glass the copper is present in a reduced oxide form as crystals (Cu_2O). The high iron (ferrous oxide) in both mixed-alkali and potash brownish-red glasses is consistent with the use of an internal reducing agent which would help the Cu_2O to precipitate out of solution. Indeed, the levels of iron, copper and lead in these glasses are similar to those found in Roman brownish-red glasses of the 1st century AD and later (Henderson 1991) used in the West, even though the compositions are quite distinct in other ways. The only two brownish-red *mutisalah* beads in the potassium glass group (S2 and S6 from Sembiran) contain 2.5-3.1% copper oxide, present as cuprous oxide crystals.

THE COMPOSITION OF SOUTHEAST ASIAN GLASS AND ITS SOURCES

Brill (1987:4) mentions that mixed-alkali glass is rather rare in the west, but recently it has been identified from Bronze Age contexts of 11th-7th centuries BC in northern Italy, Switzerland and Ireland, implying the possibility of a European source for this earlier glass (Henderson 1988:84). According to Henderson (*ibid.* 81, 89), there were three main compositional types of silicate glass in Europe before the 2nd century AD. They were:

i) glass with high soda, low magnesia (MgO) and low potassium oxide (K_2O) (soda-lime = LMG);

ii) glass with high soda, high magnesia and low potassium oxide (soda-lime = HMG);

iii) a group of mixed-alkali glasses, further characterised by low magnesia and calcium oxide (low magnesia, high potassium glass = LMHK).

Site	Na20	MgO	Al203	Si02	P205	SO3	K20	Ca0	Ti02	Mn0	Fe203	Cu0	Cu20	Total	%Total Alkali	K20/Na20
Arikamedu	11.4	2.4	3.4	64.8	5.0	0.1	4.3	4.8	0.3	-	1.2	0.7	1.3	100.1	15.7	0.38
Arikamedu	4.3	1.3	2.9	75.9	4.8	0.2	3.9	1.8	0.2	-	2.6	1.5	-	100.0	8.2	0.91
Arikamedu	13.5	2.1	5.1	64.5	-	-	3.9	5.0	0.3	0.2	1.5	1.9	-	98.0	17.4	0.29
Arikamedu	14.3	2.0	4.5	66.7	-	-	4.0	4.6	0.3	0.1	1.3	2.1	-	100.0	18.3	0.28
Brahmagiri	15.0	0.6	9.0	61.2	-	-	4.6	6.4	0.2	0.0	2.4	0.2	-	100.1	19.6	0.31
Kausambi	8.6	2.1	6.9	63.2	-	-	7.4	4.8	0.2	0.1	2.6	3.9	-	99.9	16.1	0.86
Kausambi	7.5	2.2	4.7	57.3	2.0	-	6.9	3.3	0.4	0.4	4.5	-	10.9	100.0	14.4	0.92
Sar Dheri	15.8	3.4	5.7	61.2	-	-	6.4	5.2	0.4	0.1	1.5	0.1	-	100.0	22.2	0.41
Sar Dheri	16.3	3.5	3.9	61.7	-	-	7.2	5.2	0.3	0.1	1.3	0.2	-	100.0	23.5	0.44
Sar Dheri	17.0	5.0	2.3	59.6	-	-	7.2	5.0	0.1	0.1	1.2	2.0	-	99.8	24.2	0.42
Sar Dheri	15.1	3.2	4.2	61.7	-	-	7.5	6.4	0.3	0.1	1.2	0.1	-	100.0	22.6	0.50
Sar Dheri	16.7	4.5	4.0	60.0	-	-	6.3	6.4	0.2	0.4	1.5	0.1	-	100.1	23.0	0.38
Taxila	16.7	4.0	5.7	58.1	-	-	4.8	8.9	-	0.2	1.7	-	-	100.2	21.6	0.29
Taxila	12.9	0.5	2.9	70.7	-	-	4.9	7.1	-	0.0	0.8	-	-	99.7	17.7	0.38

TABLE 4. MIXED-ALKALI GLASS IN SOUTH ASIA (WT. % AS OXIDES).

Components <0.1% have been omitted[5]. For explanation of colour codes used see p. 374.

Site	Na20	MgO	Al203	Si02	SO3	K20	Ca0	Ti02	Mn0	Fe203	Cu0	Pb0	Sn02	Total %	Total Alkali	K20/Na20
Arikamedu	2.1	1.4	1.9	73.6	-	13.4	3.9	-	0.4	3.1	-	-	-	99.8	15.5	6.4
Arikamedu	1.3	0.3	1.4	7.6	-	12.8	2.0	-	5.0	3.8	-	0.1	-	100.3	14.1	9.8
Arikamedu	0.2	0.7	1.1	72.5	-	14.4	2.9	-	2.0	6.5	-	0.1	-	100.1	14.3	72.0
Nasik	6.3	2.9	9.9	55.6	-	16.1	5.6	-	tr	3.1	-	-	-	100.0	22.4	2.6
Ter	3.2	0.3	2.3	72.9	0.5	11.4	2.4	-	-	0.9	1.4	3.7	0.2	98.6	14.6	3.6
Ter	0.1	0.6	2.1	76.3	0.2	14.4	2.0	0.2	0.8	1.8	-	-	-	98.9	14.5	144.0
Ter	0.8	0.6	3.3	76.9	0.3	12.9	1.8	0.2	0.8	1.8	-	-	-	99.6	13.7	16.1
Ter	0.8	0.8	2.1	74.0	-	16.1	1.2	0.2	1.5	2.2	-	-	-	99.2	16.9	20.1
Hastinapur	0.8	0.5	0.8	80.4	-	10.7	3.9	-	-	2.6	0.1	-	-	100.0	11.5	13.4
Kausambi	0.7	0.9	2.5	76.4	-	14.1	2.0	0.1	1.5	1.4	-	-	-	100.0	14.8	20.1
Hulaskhera	0.2	0.1	-	?	-	16.9	3.6	-	0.1	0.5	0.3	-	-	?	17.1	84.5
Udayagiri	4.1	2.0	3.4	59.6	-	19.0	7.6	-	-	3.2	-	-	-	98.9	23.1	4.6

TABLE 5. POTASSIUM-RICH GLASS IN SOUTH ASIA (WT. % AS OXIDES).

Components <1% are not included[6]. SiO_2% not listed. For explanation of colour codes used see p. 374.

All the six mixed-alkali glass beads analysed had soda as their main alkali along with relatively high alumina (distinguishing them from most western glasses) and low calcium oxide, variable phosphorus pentoxide and quite high titanium oxide levels compared with soda-lime-silica glasses. In his study on Indian glass, Brill (1987:4) observed that the most noteworthy feature of some Indian glass is a combination of high alumina (>3.5%) and low lime (<5%). Such glass is unusual though an example comes from Rathgall in Ireland dating to the 9th-7th centuries BC (Henderson 1988: Table 2,16) and other examples have been found in earlier Bronze Age contexts (Henderson, unpublished data). Mixed-alkali glass with soda as the main alkali is reported from Arikamedu and Brahmagiri in south India, from Sar Dheri and Kausambi in north India and from Taxila in Pakistan

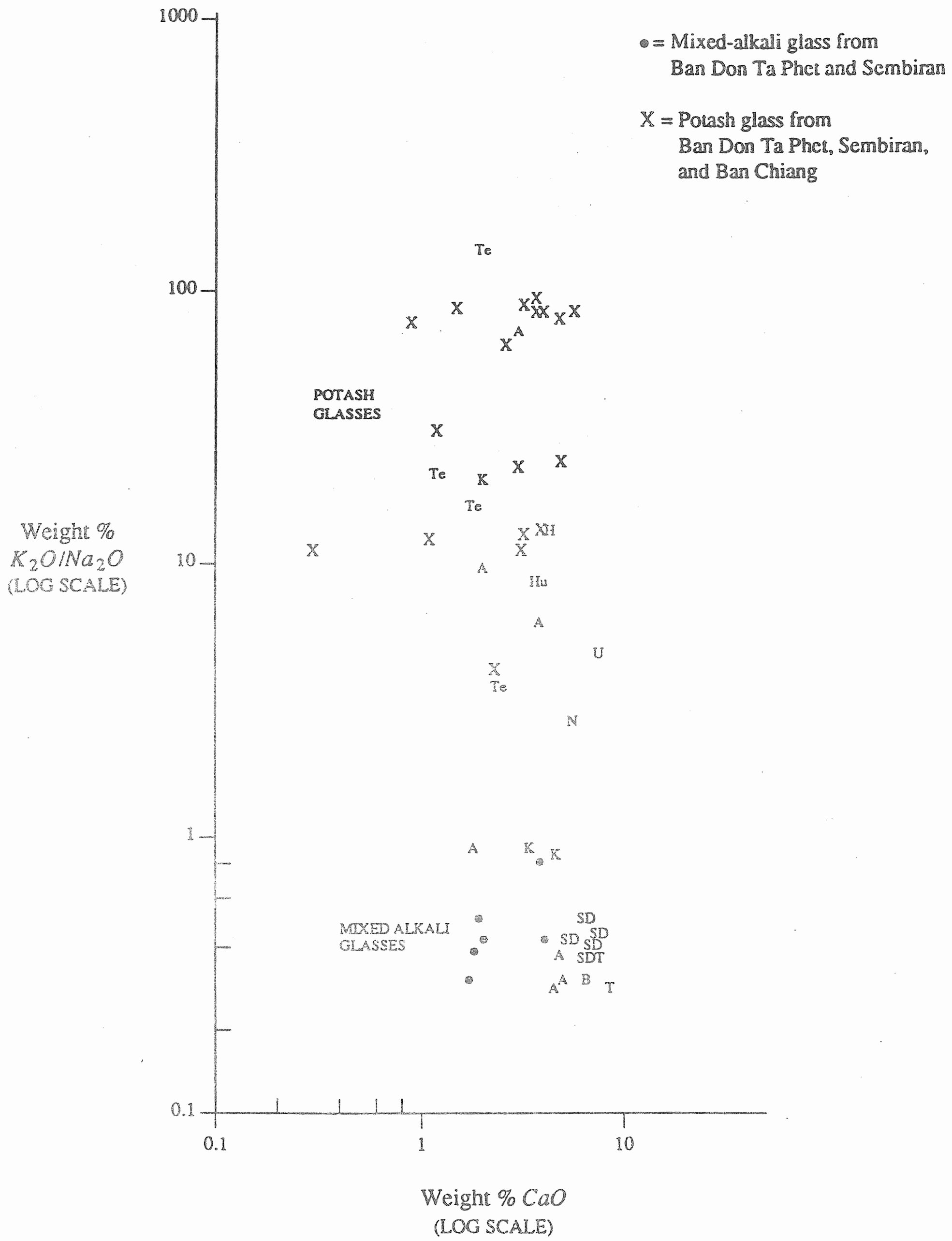


FIGURE 5: WEIGHT % CaO VERSUS WEIGHT % K_2O/Na_2O (LOG SCALE) IN BEADS FROM INDIA AND SOUTHEAST ASIA.

O = Mixed-alkali glass from Ban Don Ta Phet and Sembiran; X = potash glass from Ban Don Ta Phet, Sembiran and Ban Chiang; A = Arikamedu; B = Brahmagiri; H = Hastinapur; Hu = Hulaskhera; K = Kausambi; N = Nasik; SD= Sar Dheri, T = Taxila; U = Udayagiri.

(Table 4)[5]. Mixed-alkali glass with soda as the main alkali, along with high alumina and low calcium oxide, is reported from Arikamedu, Brahmagiri and Kausambi (Table 4 and Figure 5). One opaque red bead from Kausambi has a high copper oxide content (10.9%) like bead S5 from Sembiran (Table 2). It is argued that these early mixed-alkali beads with diagnostically high alumina and copper levels are probably also all of Indian origin, and it can be seen in Figure 5 that mixed-alkali glasses from BDTP and Sembiran group quite closely with Arikamedu, Kausambi and Sar Dheri glass. If the same analytical technique had been used it is possible that the Indian and Asian glasses would have grouped more closely. From the range of glass colours analysed, opaque red glasses are liable to be the most technically difficult to manufacture.

Potassium glass is very rare in the Middle East and Europe at such an early date (Brill 1987:4), although two recently published chemical analyses of Roman colourless and translucent blue glass vessel fragments from Stradonice, Bohemia of the 1st-4th centuries AD apparently indicate that the Roman glass occasionally contained 12-14% potassium oxide and soda levels as low as 0.8-2 % (Frána *et al.* 1987:82, Nos 6 and 7). These exceptional compositions can be added to the unusual occurrence of mixed-alkali glass of 1st century AD Roman date (Henderson 1988), but within a generally conservative Roman glass technology in which soda-lime glasses (LMG) predominate. However, the view that Bhardwaj (1987b: 68) expresses, that "potash" glasses (presumably at least 10% K_2O) from Ter in western India, Kausambi in northern India and Arikamedu in southern India, are of foreign origin is very unlikely to be true, unless he means soda-lime glasses with potassium oxide at about 1%. Both Han China (Gan Fuxi 1986; Shi Meiguang *et al.* 1987; and Zhang Fukang 1987) and India have yielded potassium-rich glass. For instance, in addition to the sites mentioned by Bhardwaj (*ibid.*) it has been reported from Hulashkera and Hastinapura in northern India (Table 5)[6]. The import of potassium glass from China to Ban Don Ta Phet in the 4th century BC seems unlikely since the forms of early Thai beads closely resemble those of India and there is no other evidence of Chinese material on the site.

Lal (1987:54) mentioned that some of the glass beads from Arikamedu have a four component composition: potassium oxide-lime-silica-alumina. Many of the beads in Table 3 could be said to fall into this category, especially those with high aluminium oxide contents.

An apparently "black" glass bead from Ban Don Ta Phet (5653) has a high iron oxide content (9.0%). This is actually dark green when examined in transmitted light and the colour is probably caused by reduced iron; it can be compared with one from Arikamedu (Dikshit 1969:151).

The Sembiran glass beads most probably came from south India, perhaps from Arikamedu, the most important manufacturing centre for the Indo-Pacific glass beads which made both mixed-alkali and potassium glass. The recovery of the Rouletted Ware at Sembiran (Ardika and Bellwood 1991) strengthens the link between Arikamedu and Bali. However, it does not follow that all the glass beads from the Late Prehistoric period in Southeast Asia were imported only from Arikamedu. Compositional and typological studies show that certain types of typical north Indian glass beads are also found in Southeast Asia and it is fair to assume that more than one centre in India exported them.

RELATIONSHIPS BETWEEN INDIA AND SOUTHEAST ASIA

During the period under study (400 BC-AD 500), India witnessed the emergence of mature states - the Mauryas, Kushanas and the Guptas in north India and the Satavahanas in the Deccan. During that period, south India had some powerful chiefdoms such as the Cheras, Cholas and the Pandyas, some of which emerged as urbanised states like that of the Pallavas who ruled over Tamilnadu during the 4th-6th centuries AD. Despite the political plurality, what mattered for trade was the diversification of arts and crafts under some form of guild (*sreni*) system, and the issue of a wide range of coins by cities (*nigama*) and tribes (*gana*) in different areas. Trade based on profit is well described in the *Arthasastra*. An elaborate bureaucracy developed, especially in the Mauryan state, and there was a considerable development of both overland and maritime trade routes. There were regional variations in organization of trade as Ray (this volume) makes clear. For example, in the north-western part of the Indian sub-continent, trade was controlled by a *sahaya* association. In Tamilnadu, the *paratvar* comprised inhabitants of the coastal tract who had diversified from their traditional occupation of salt making and fishing into long distance trade. Moreover, the term *nikama*, meaning *nigama* or exchange centre, is mentioned in the Tamil Brahmi inscriptions from the Madurai region on the river Vaigai. Inscriptions from Mathura and the Deccan also refer to the organization of guilds by traders in specified commodities. Guilds also acted as banks and places for investment.

Politically, India's interest in Southeast Asia was commercial and not imperialist or interventionist. The only evidence of the latter is the invasion by the Chola kingdom of south India of the Srivijaya kingdom in Sumatra in the 11th century AD. In Southeast Asia at this time the highest levels of political organisation were chiefly societies and at best some nascent states. Barter is likely to have been the only mode of exchange. Wisseman Christie (n.d.) has argued for the emergence of three clusters of producer-trading states in Peninsular Malaysia during the late centuries BC; in the Perak-Bernam river valleys, in the lower courses of the Kelang and Langat rivers, and in the upper Pahang-Tembeling river valley in the mountainous interior. Nevertheless, the first issues of coinage in Southeast Asia, the so-called "Pyu coins", do not seem to predate the 7th or 8th centuries AD (Cribb 1981) and seem to have had a restricted circulation in the major river basins of modern Burma, Thailand, Cambodia and southern Vietnam.

With a lack of written records we cannot analyse, in the same detail as is possible for India, the structure of exchange within Southeast Asia for the thousand years from the 5th century BC. Good archaeological documentation is still scarce and we depend on models based on analogies from more recent historical and ethnographic situations. For instance, Bronson (1977), Wheatley (1975), Wolters (1982), Miksic (1984) and Wisseman Christie (1982 and n.d.) have all proposed evolutionary or structural models for Southeast Asian exchange systems. Although useful, these are generalised and abstract and, for the most part, lack firm support from empirical data from the past. Elsewhere, Basa (1991) has explored in some detail the implications of these models, and also a modified "World Systems" approach, for achieving a higher-level understanding of the role of the glass bead trade in the development of social elites in Southeast Asia.

In this brief report we can sum up the position by emphasising that the westerly trade of Southeast Asia during the period from about 400 BC to AD 500 was not a mere "trickle of trade", nor can it be described simply as the "drift" of a few exotic and precious items to the east from India. Rather it operated on a considerable scale at pan-regional, regional, and local levels; it was developed as a commercial enterprise by Indian merchants; and there is little doubt that Southeast Asian sailors and traders were also active in the exchanges. The trade stimulated the growth of chiefly societies in Southeast Asia and prepared the ground for the transformation to state-level organisations in the mid first millennium of the Christian Era.

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FOOTNOTES

1 The Pasir Angin dates are 1050±160 bp (ANU 1110), 1280±170 bp (ANU 1112), 4370±1190 bp (ANU 1109) and 2460±440 bp (ANU 1113).

2 Table 1 shows the glass beads from all the three excavation seasons at Ban Don Ta Phet. It has been compiled from Figures 5.8-5.10 in Basa (1991) where more typological distinctions are indicated and the totals for the three seasons are separated.

3 This ornament was described as "crystal" when published by Chin You-di (1978: Colour Plate 5), but is described as "glass" in a fine postcard of the piece on sale at the National Museum, Bangkok. Mr Somchai Na Nakorn Phanom and Dr Warangkhana Rajpitak of the National Museum recently examined the piece for us and confirm that it is indeed made of glass (pers. comm. 29.3.1991).

4 The analyses of glass from Don Ta Phet, Sembiran and Ban Chiang were done at the Ancient Monuments Laboratory of English Heritage. Analyses of glass from other sites in Southeast Asia have been published by van der Hoop 1932:170; van Heekeren 1958:41; Malleret 1962:465-9; Harrisson 1963:237, 1964:38, 1968:129-31; Lamb 1965a:100-8, 1965b:36, 1966:86-7; Lugay 1974:161-2; Indraningsih 1985:139; and McKinnon and Brill 1987:9-12. Results of further analyses on beads from Don Ta Phet are awaited, and when these are available a more ambitious statistical analysis of Asian glass will be made. [Tables 2 to 5 have been printed as received from the authors; subscript chemical numbers would have necessitated retyping- Ed.]

5 Table 4 is based on analyses published by Dikshit 1969:151; Lamb 1966: 87; and Brill 1987:17. More analyses of South Asian glass have been published by Sen and Chaudhuri 1985.

6 Table 5 is based on analyses published by Dikshit 1969:150; Lal 1952a:25 and 1952b:56; Agrawal *et al.* 1987:60; Brill 1987:18-20; and in the *Annual Report of the Archaeological Survey of India* for 1922-23, p.158.

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