APPENDIX E. OVERVIEW OF THE BRICK AND MASONRY BLOCK DATA

E.1 Background

E.1.1 Scope of the work

Originally, SSPHAP's research grant from the Australian Myer Foundation was to be spent on a sub-project, co-ordinated with Sonny Wibisono of the Indonesian National Research Centre for Archaeology, dealing with the coastal fortifications defending Makassar entrepôt (Figure E-1). Following the return of Drs Wibisono to Jakarta, SSPHAP's regular team surveyed further coastal and hinterland fortifications, measured bricks at unfortified sites, and recorded masonry quarrying at Pammangkulang Batua (Photo E-1), thus paving the way for SSPHAP's review of greater Gowa's late 17th century fortifications (Bulbeck, 1990). In all, 1381 bricks and brick fragments were measured from nine fortified sites and twelve non-fortified sites. 90 masoned stones were measured at Tallok and seven partly masoned blocks were measured at Pammangkulang Batua. In addition, signs of earthen fortifications were recorded at four sites (Bayoa 1, Garassik, Paknakkukang, and Kota Galesong).

The individual sites which provided SSPHAP's brick and masonry samples are depicted in Figure E-2. The samples north of Sampulungang are documented in the chapters dealing with the Gowa-Tallok sites (Chapters 6 to 12). Measurements of the brick samples from the sites between Sampulungang and Sanrabone are given in Table E-1. Of these sites, Sanrabone (E.1.3) and Galesong (E.1.4) were fortified.

E.1.2 Methodological considerations in measuring the bricks

The Makassar texts (Chapter 2) provide an incomplete record of the chronology of construction and, after the 1667 Makassar War, demolition of greater Gowa's fortifications. The fortifications themselves range from the almost undisturbed fortress of Anak Gowa, to sites where virtually no original brickworks remain intact. Especially in the more disturbed sites there has been considerable recycling of bricks, while several of the fortified sites enclose structures made from 18th century and later bricks. One isuue, then, is whether certain metrical parameters can distinguish the fortification bricks from later bricks. The second issue is whether patterns in brick size open a window on the sequence of Gowa fortifications.

To answer these questions, controlled probabilistic samples would have obviously been preferable, but SSPHAP's sampling procedures were necessarily opportunistic owing to the highly variable availability of loose bricks and measurable *in situ* bricks. Except at Somba Opu and to a lesser degree at Sanrabone, which were recorded while I was still in the process of formulating an appropriate sampling procedure, we documented the variability of brick size by taking samples spaced along the remnant walls, giving particular attention to any loci where a change in construction style was evident. Bricks from other structures such as graves and wells were also measured at the fortified sites and a sample of unfortified sites. Where a large number of bricks occurred at a locus, a sample size of 30 bricks was considered adequate (cf. Constandse-Westermann, 1972), selected on the basis of completeness and accessibility. However, smaller sample sizes frequently had to be accepted.

The bricks were measured with a three-metre metal tape by placing the tip at one end and measuring to the nearest 0.5 cm mark at the other end. The only exceptions were six bricks from Bayoa measured using sliding callipers with one mm gradations. Analysing the data I have noticed that the 0.5 cm gradients were faithfully observed for the thicknesses, especially with the thinner bricks up to about 5 cm thick. However, the lengths and the breadths are strongly biased towards whole numbers, suggesting that a fractional value was recorded only when the measurement landed on the 0.5 cm mark. My analysis retains the fractional values except in the graphic cross-tabulations where, to condense the data, lengths and breadths with a 0.5 cm fraction (or higher, at Bayoa) are converted to the next whole centimetre.

The original data were entered into the Borland/Analytica (1987) "Reflex: The Analyst" PC programme. A hard copy has been sent to Sonny Wibisono as well as to Bahru Kallupa of Suaka, amd is available from me on request.

E.1.3 Benteng Sanrabone (Takalar 6)

Benteng Sanrabone has approximately 2.2 km of brick wall enclosing 21 hectares (Figure E-3). Evidently the fort had not been built by 1667, as Andaya (1981) does not mention Sanrabone in his comprehensive account of the Makassar War and the Bungaya Treaty which followed. But according to Ibrahim (1985:47), in 1668 the kingdom of Sanrabone was obliged to sign a renewed version of the Bungaya Treaty which included a provision demanding the demolition of Benteng Sanrabone (which may or may not have been carried out). Sanrabone had been without a raja since 1658, and it was only in 1668 that Hasanuddin's son Kg Campagaya (later Sultan Abdul Jalil) was installed (4.6). Hence we can infer that he built his Sanrabone palace in 1668, and that it immediately came to the attention of the Dutch.

Note that even after being installed as Gowa's sultan, Abdul Jalil (r. 1677-1709) initially kept the Gowa regalia at Sanrabone, and his land holdings (at least as recognised by the Dutch) remained confined to Sanrabone as late as 1688 (Andaya, 1981:199,264). The later report by Stavorinus (1798:211), that Sanrabone had been built at around the same time as Tallok and Somba Opu, could be interpreted as support for a 17th century construction date, and need not imply exact contemporaneity of the three forts.

The archaeological evidence confirms a c.1668 construction date. The brick samples around the fortress walls show very little metrical variation (Table E-1), indicating a single event of construction by specialists with considerable prior experience in building brick walls. As observed at several points (e.g. Photo E-2), the walls were built with two vertically standing lines of brick, plus earth packed between the brick lines and on either side. This construction method of "double brick-walls" also characterises most of Benteng Tua's walls (6.4). In addition, Sanrabone's tradeware profile shows a pronounced emphasis on pieces dated to the late 17th and 18th centuries (Bulbeck, in prep. b).

TABLE E-1. FURTHER BRICK SAMPLES NOT DESCRIBED IN CHAPTERS 6 TO 12 (MEASUREMENTS IN CM)

BENTENG SANRABONE	Inner Wall				Outer Wall				Total Bricks			
	(n)	Mean	S.D.	Range	(n)	Mean	S.D.	Range	(n)	Mean	S.D.	Range
Station I												
Length	10	24.80	0.98	(24-26)	10	25.30	0.68	(24.5-26)	20	25.05	0.88	(24-26)
Breadth	10	14.75	0.75	(14-16)	10	15.60	0.88	(14-16)	20	15.18	0.93	(14-16)
Thickness	10	3.50	0.0	(3.5)	10	3.50	0.24	(3-4)	20	3.5	0.16	(3-4)
Station II												
Length					3	24.33	0.47	(24-25)	3	24.33	0.47	(24-25)
Breadth					3	13.67	0.47	(13-14)	3	13.67	0.47	(13-14)
Thickness					3	3.67	0.24	(3.5-4)	3	3.67	0.24	(3.5-4)
Station III												
Length	8	25.64	1.08	(23-26.5)	10	26.00	0.22	(25.5-26.5)	18	25.64	1.08	(23-26.5)
Breadth	8	14.63	1.05	(13-16)	10	14.60	1.28	(12-16)	18	14.61	1.19	(12-16)
Thickness	10	3.30	0.33	(3-4)	10	3.75	0.25	(3.5-4)	20	3.53	0.37	(3-4)
Fortress Wall												
Length	18	24.97	1.24	(23-26.5)	23	25.48	0.74	(24-26.5)	41	25.26	0.96	(23-26.5)
Breadth	18	14.69	0.90	(13-16)	23	14.91	1.23	(12-17)	41	14.81	1.09	(12-17)
Thickness	20	3.40	0.25	(3-4)	23	3.63	0.27	(3-4)	43	3.52	0.26	(3-4)
	Wall Surrounding Gaddonga Graveyard				**Makam Datu Paddada**				**Sanrabone Old Well**			
Length	10	24.90	0.73	(24-26)	10	26.20	0.46	(25.5-27)	4	23.89	1.34	(22.5-26)
Breadth	10	14.10	0.44	(13-14.5)	10	16.85	0.55	(15.5-17.5)	9	15.61	3.44	(12.5-24)
Thickness	10	3.25	0.34	(3-4)	10	5.40	0.49	(4.5-6)	10	4.50	1.11	(3.5-6.5)
	East Royal Kobang				**West Royal Kobang**				**Total Sanrabone Royal Graves**			
Length	10	24.25	0.51	(23-25)	20	25.23	0.54	(24-26.5)	30	24.90	0.79	(23-26.5)
Breadth	10	12.75	0.40	(12.5-13)	20	12.68	0.40	(12-13.5)	30	12.70	0.40	(12-13.5)
Thickness	10	4.35	0.23	(4-4.5)	20	3.90	0.37	(3.5-4.5)	30	4.05	0.34	(3.5-4.5)

TABLE E-1. FURTHER BRICK SAMPLES NOT DESCRIBED IN CHAPTERS 6 TO 12 (CONT.)

BRICKS LACKING MODERN DIMENSIONS

	Manjalling graves, Galesong				Sampulungang large bricks				Jamarang broad bricks			
	(n)	Mean	S.D.	Range	(n)	Mean	S.D.	Range	(n)	Mean	S.D.	Range
Length	9	28.00	0.88	(26.5-29)	5	28.30	0.60	(27.5-29)	31	26.77	2.84	(22-33)
Breadth	18	17.22	1.50	(14-19.5)	14	17.39	1.06	(15-20)	34	16.43	0.74	(15-17.5)
Thickness	18	4.75	0.73	(3.5-6)	14	5.07	0.56	(4.5-6.5)	31	5.32	1.00	(4-9)

BRICKS WITH MODERN DIMENSIONS

	(n)	Mean	S.D.	Range	(n)	Mean	S.D.	Range	(n)	Mean	S.D.	Range
	Bungung Barania, Galesong				Sampulungang small bricks				Jamarang thin bricks			
Length	10	23.45	0.47	(22.5-24)	5	23.30	0.75	(22-24)	34	26.44	0.42	(26-27.5)
Breadth	15	10.77	0.60	(9.5-11.5)	6	12.25	0.25	(12-12.5)	34	12.04	0.32	(11-12.5)
Thickness	15	4.67	0.24	(4.5-5)	6	4.67	0.24	(4.5-5)	34	5.15	0.44	(4.5-6.5)
	Makam Datu Bonto Lebang				Campagaya Lama				Jeknek well			
Length	24	25.27	1.31	(21.5-26.5)	15	25.80	0.95	(24.5-27.5)	2	23.75	-	(23,24.5)
Breadth	28	11.94	0.60	(10.5-13)	15	12.73	0.57	(12-14)	2	11.75	-	(11,12.5)
Thickness	23	5.15	0.27	(4.5-5.5)	15	7.77	0.73	(6-9)	1	4.5	-	(4.5)

N.B. Three rounded bricks were also recorded in the Jeknek well, with an average length of 16.3cm, average breadth of 7.7 cm, and average thickness of 5.2cm. Presumably they are modern bricks shaped to fit the well's contours, resulting in their diminished breadth. They are included in the total brick sample (Table E-2) but are excluded from any groups broken down during analysis.

The other brick structures at Sanrabone have bricks with quite different dimensions from those of the fortress bricks (Table E-1), except for the low wall built around the Gaddonga Graveyard Complex (Photo E-7). All the marked graves and tombs in the complex belong to old styles, notably that of Labbu Kopo which is oriented east-west (Table F-1). Although the names now ascribed to the graves (Table F-1) fail to match the names recorded for Sanrabone's rajas (4.6), it is hard to interpret the complex as anything other than Sanrabone's royal cemetery up to when Kg Campagaya (Abdul Jalil) ascended Sanrabone's throne. As the wall around the complex was apparently built at the same time as the fortress walls, its function was probably to mark off the burial ground associated with Sanrabone's former rulers.

In the early 18th century Abdul Jalil was succeeded as Sanrabone's raja by another Gowa aristocrat, Bahauddin Kg Mamampang, who in turn was succeeded by his son Kg Barombong. In 1734 local rule appears to have been restored with the installation of Salahuddin Kg Alluk (4.6). Although the royal brick *kobang* (Photo E-3; Table F-1) were probably built after Kg Alluk's installation, their association with a mosque in the heart of the fortress (Figure E-3) follows the same plan as Abdul Jalil's Datak palace in Benteng Tua (6.7), reflecting Gowa's profound influence on Sanrabone.

E.1.4 Kota Galesong fortifications

Historical evidence of fortification works at Kota Galesong comes only from the records on Galesong's capture by the Dutch and Arung Palakka (Sahaduddin) during the Makassar War. Summarising the records, Andaya (1981:87-89) describes it as a 'fortified city' and makes it clear that there were numerous "forts". Matching archaeological evidence, however, is slight (see Figure E-4).

Zone 14 in Manjalling contains five rectangular, razed brick structures (Photo E-4), whose north-south orientation and lack of connecting brickworks suggest that they used to be grave markers. Indeed in terms of average size and shape, the Manjalling bricks compare slightly better with old bricks from unfortified sites, such as Sampulungang and Jamarang

(Table E-1), than with known fortification bricks (Tables E-23 to E-26). We also observed patches of brick rubble along the road at the north of Kota Galesong (Photo E-5). But they occur at a peripheral location of Galesong, and are moreover suspiciously close to a former Islamic cemetery (Kompleks Makam Matinroe ri Suli) which has been largely demolished during housing developments (Bulbeck, in prep. b). So these also would appear to have been brick grave markers.

However, Kota Galesong is centred on a series of raised earthen features parallel with the coastline (Figure E-4). Their natural defensive potential could have been readily enhanced by the construction of timber palisades, earthworks or the like. A good example is Makam Takbakka whose original surface has been incised by the passing road. The banks reveal brick and stone rubble which could well have been included as support for an earthen wall (Photo E-6). So the defensive works at Galesong were probably restricted to a network of palisades and stockades.

E.2 Analysis of the Brick Measurements

E.2.1 "Brick Standards" and "Brick Seriation Types"

The total sample of measured bricks and fragments shows great variability in size and shape (Table E-2). However, most of the variability can be accommodated by positing two distinct ways in which particular bricks are related to each other.

TABLE E-2. MEASUREMENTS IN CM OF ALL MEASURED BRICKS (n=1381)

	(n)	Mean	S.D.	Range
Length	782	27.14	6.42	(16-49)
Breadth	1212	15.20	3.47	(7.5-26)
Thickness	1236	4.68	1.51	(2-10)
Breadth/Length	687	56.66%	8.35	(38.5-92.4%)
Thickness/Length	641	17.59%	4.44	(8.0-37.5%)
Thickness/Breadth	1068	31.02%	8.30	(14.3-80.0%)

Breadth:Length Correlation Coefficient Pearson's r = 0.75
Thickness:Length Correlation Coefficient Pearson's r = 0.66
Thickness:Breadth Correlation Coefficient Pearson's r = 0.64

The first relationship involves "brick standards" which can be defined as any group of bricks of similar manufacture and dimensions. Their metrical variation should be due to slight straying from the standard, leading to small standard deviations for the dimensions and shape indices, but moderate to low correlation coefficients between dimensions.

The second relationship involves "brick seriation types", i.e. groups of bricks of similar manufacture and shape but variable size. Standard deviations are large for the dimensions but small for the shape indices, while the correlation coefficients between dimensions are high. Moreover, a brick seriation type should itself be divisible into several groups of similarly size bricks which will behave mathematically like brick standards.

Preliminary study of the data suggested that the original database covers brick standards which are unrelated to the fortification bricks, and that the latter constitute a brick seriation type. To demonstrate the point, it should be possible to identify the extraneous brick standards and remove them from the database whose remaining bricks should then show greater standardisation in shape.

At the Islamic graveyards of Datu Bonto Lebang and Campagaya Lama we observed only one type of brick (Table E-1) and noted that it appeared to have the same fabric as the bricks used in Ujung Pandang's modern housing developments. The very standardised dimensions of these bricks are virtually indistinguishable from those of the bricks assembled in "Kale Kundrulu's grave", Benteng Tua, even though the latter were reportedly produced by the first Dutch brickworks in Makassar (Photo 6-7). The smaller bricks at Sampulungang, Jamarang (Table E-1) and Moncongloe Lappara (10.6.3) have similar dimensions, as do the bricks from the well at Jeknek and the supposedly old well called Bungung Barania at Bayoa, Galesong (Figure E-4; Table E-1).

Altogether these bricks show greatly reduced size and shape variability compared with the total sample, and considerably lower inter-measurement correlation coefficients, indicating that they can be assigned to a "brick standard" (Table E-3). I call it the "Dutch brick standard" as the available clues point to its introduction by the Dutch. Removing them from the database leaves a remainder of "other bricks" (Table E-4) which, compared to the original total sample (Table E-2), are if anything more variable in size, but more standardised in shape as shown by the reduced ratio standard deviations and the higher correlation coefficients. Note also that the "other bricks" are rather longer and notably less thick than the "Dutch standard bricks", as shown by the shape ratios.

TABLE E-3. SIZE IN CM OF "DUTCH STANDARD BRICKS" (n=112)

	(n)	Mean	S.D.	Range
Length	90	25.22	1.46	(21-27.5)
Breadth	112	11.90	0.82	(9.5-13.5)
Thickness	107	5.04	0.47	(4-7)
Breadth/Length	90	47.57%	2.86	(42.3-54.5%)
Thickness/Length	86	21.12%	1.89	(17.0-29.2%)
Thickness/Breadth	108	42.55%	3.84	(32.0-53.8%)

Breadth:Length Correlation Coefficient Pearson's r = 0.60
Thickness:Length Correlation Coefficient Pearson's r = 0.35
Thickness:Breadth Correlation Coefficient Pearson's r = 0.39

TABLE E-4. MEASUREMENTS IN CM OF "OTHER BRICKS" (n=1269)

	(n)	Mean	S.D.	Range
Length	692	27.39	6.77	(16-49)
Breadth	1100	15.55	3.46	(7.5-26)
Thickness	1129	4.64	1.57	(2-10)
Breadth/Length	593	57.99%	8.04	(38.5-92.3%)
Thickness/Length	555	17.20%	4.59	(8.0-37.6%)
Thickness/Breadth	957	29.60%	7.34	(14.3-72.0%)

Breadth:Length Correlation Coefficient Pearson's r = 0.78
Thickness:Length Correlation Coefficient Pearson's r = 0.68
Thickness:Breadth Correlation Coefficient Pearson's r = 0.71

The "other bricks" include not only fortification bricks but also bricks used in various *keramat* (holy) structures and at Sanrabone's "old well". Wherever I noted the fabric, it appeared to be redder and fired at a lower temperature compared to the "Dutch standard bricks". At the fortified sites, only Sanrabone's *in situ* wall bricks (including those from the wall built around the Gaddonga Graveyard Complex) had such small dimensional variation that they could be readily distinguished on the basis of size alone from the old-style bricks used in the graves and wells (Table E-1). Elsewhere there was total overlap, either because the other structures and the fortress were built at the same time, such as the Hasanuddin Complex remnant brickworks and the lining to the Bissu's Well at Benteng Tua (6.4), or because the fortress bricks have been recycled. Apart from Sanrabone, then, I identify old-style fortification bricks (Table E-6) as those found at the fortified sites, and the other old-style bricks (Table E-5) as those at the unfortified sites. Admittedly, my sample of fortification bricks possibly includes some old-style bricks postdating the fortifications, while some of the unfortified sites, particularly those close to the forts, probably include bricks made during the defense works and subsequently recycled from the fortifications. However, if the point of the exercise is to distinguish between these two groups of bricks by their metrical patterns, then it would be circular reasoning to classify them in the first place on the basis of measurements rather than location.

The "other old-style bricks" constitute neither a "brick standard" nor a "brick seriation type". Although the standard deviations on the measurements are less than shown by the total "other bricks" (Table E-4), the ratios show high standard deviations and the correlation coefficients are low. Their ratios which involve breadth are similar to the ratios of the Gowa fortification bricks, but their thickness:length ratio resembles the "Dutch standard". These patterns probably represent some combination of (i) inclusion of at least some fortification bricks, (ii) some influence of the "Dutch standard" on the later manufactured examples, (iii) the bricks' use in a variety of structures, and (iv) a lengthy period of manufacture within communities operating in comparative isolation from one another.

The Gowa fortification bricks, compared with the total "other bricks" (Table E-4), have slightly larger standard deviations on the measurements, but considerably reduced standard deviations on the ratios and higher correlation

TABLE E-5. SIZE IN CM OF OTHER OLD STYLE BRICKS (n=212)

Site and Structure	Reference	Apparent Age
Bukit Bikuling brick sepulchre	7.1.2	17th century?*
Makam Karaeng Campagaya *kobang*	7.3.1	17th century?#
Makam Kg Tompok Balang platform	8.5.3	Undated
Moncongloe Lappara grave platform	10.6.3	Modern; restored?*
Bonto Lakja grave platform	11.4.3	17-18th centuries
Sampulungang old brick graves	Photo E-8	17-18th centuries
Jamarang old grave brick props	Photo E-9	17-19th centuries
Manjalling old brick graves	Photo E-4	17-18th centuries
Sanrabone *kobang*	Photo E-3	18th century
Makam Datu Paddada, Gaddonga	Table E-1	17-18th centuries
Sanrabone "old well"	Table E-1	Undated

* Cases where at least some of the bricks have similar dimensions to bricks at nearby fortifications.

\# Variably sized owing to construction requirements, but with a usual type similar to Benteng Tua's "smaller bricks".

	(n)	Mean	S.D.	Range
Length	161	26.46	3.16	(20.5-45)
Breadth	201	15.97	2.84	(9.5-24)
Thickness	191	5.18	1.30	(3-9)
Breadth/Length	156	59.87%	10.83	(43.2-92.3%)
Thickness/Length	145	20.42%	5.57	(12.5-37.5%)
Thickness/Breadth	178	33.29%	9.56	(18.9-72.0%)

Breadth:Length Correlation Coefficient Pearson's r = 0.42
Thickness:Length Correlation Coefficient Pearson's r = 0.31
Thickness:Breadth Correlation Coefficient Pearson's r = 0.36

Table E-6. SIZE IN CM OF FORTIFICATION BRICKS (n=1053)

	(n)	Mean	S.D.	Range
Length	527	27.75	7.48	(17-49)
Breadth	895	15.48	3.56	(7.5-26)
Thickness	934	4.53	1.60	(2-10)
Breadth/Length	432	57.31%	6.65	(38.5-81.3%)
Thickness/Length	406	16.09%	3.55	(8.0-31.8%)
Thickness/Breadth	772	28.76%	6.43	(14.3-54.5%)

Breadth:Length Correlation Coefficient Pearson's r = 0.86
Thickness:Length Correlation Coefficient Pearson's r = 0.81
Thickness:Breadth Correlation Coefficient Pearson's r = 0.78

coefficients. These points indicate that they indeed constitute a "brick seriation type", with the production of similarly shaped bricks having been maintained by a co-ordinating authority.

E.2.2 Large bricks and smaller fortification bricks

The available measurements of the Gowa fortification bricks essentially fall into a bimodal distribution involving large and smaller bricks. For instance, a length of 34 cm was not recorded once, and lengths between 31 and 37 cm occurred very infrequently. Hence when length is available, 34 cm can be used as an unambiguous sectioning point between the large and the smaller bricks.

To see whether other measurements similarly divide the brick sample, consider those 365 fortification bricks for which all three dimensions were measured, plotting the measurements two at a time (Tables E-7 to E-9). The bottom rows in Tables E-8 and E-9 demonstrate a bimodal distribution in the breadths and thicknesses corresponding to the more strongly bimodal distribution of the lengths.[1] Since these bricks have already been classified as "large" or "smaller", based on their length, we can test whether definitions which exclude length arrive at a comparable classification.

Classifying on the basis of breadth alone, the most satisfactory result comes from defining smaller bricks as those less than 17.5 cm broad. This definition correctly classifies 318/329 (96.7%) of the smaller bricks and 34/36 (94.4%) of the large bricks, or 352/365 (96.4%) of the total (Table E-7). When thickness alone is considered, the best result comes from defining smaller bricks as those 6 cm or thinner (Table E-8). While this definition correctly classifies 325/329 (98.8%) of the smaller bricks and 352/365 (96.4%) of the total, it appears less than satisfactory with the larger bricks, correctly classifying only 27/36 (75%).

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[1] Quite an expectable result given that the total sample of Gowa fortification bricks showed high correlation coefficients between the dimensions (Table E-6). Indeed the few bricks which lie well off the main axes of covariation (e.g. Tables E-7 to E-9) may reflect errors in measurement and transcription rather than anomalous products.

But when both breadth and thickness are available we achieve excellent discrimination by classifying smaller bricks as those below the stepped line shown in Table E-9. 326/329 (99.1%) of the smaller bricks are correctly identified, as are 34/36 (94.4%) of the large bricks and 360/365 (99.4%) of the total.

These then are our definitions. Large bricks are those longer than 34 cm, or above the stepped line shown in Table E-9 if length is the only measurement missing, or broader than 17 cm or thicker than 6 cm if only breadth or thickness is available. The rest are smaller bricks. The large bricks, whose statistics are given in Table E-10, behave mathematically like a "brick standard". The smaller bricks,

TABLE E-7. LENGTH AND BREADTH OF FORTIFICATION BRICKS WITH THREE MEASUREMENTS

LENGTH	BREADTH															
	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	SUM
45 cm												1	1	1		3
44 cm												1	1	1		3
43 cm												3	2	1		6
42 cm									1	1				2		4
41 cm										1	1		1			3
40 cm								1		1	1	5				8
39 cm									1		1	2			1	5
38 cm								1	1				1			3
37 cm												1				1
36 cm																
35 cm																
34 cm																
33 cm							1	1					1			3
32 cm								1			1					2
31 cm							2									2
30 cm							1	2		2	1			1		6
29 cm						1	4	3								8
28 cm				2			4	4								10
27 cm			2	4	4	8	5	12	1							36
26 cm			2	13	9	13	16	5	3			1				62
25 cm		2	3	18	10	4	8	2								48
24 cm		2	6	11	11	9	3									42
23 cm		1	5	13	10	4										33
22 cm	1	4	6	4	10	2										27
21 cm	1	4	11	3	2	1										22
20 cm		3	12	3		1										19
19 cm	1	2	2	1		1										7
18 cm		1														1
17 cm				1												1
SUM	3	19	49	73	56	44	44	32	7	5	5	14	7	6	1	365

TABLE E-8. LENGTH AND THICKNESS OF FORTIFICATION BRICKS WITH THREE MEASUREMENTS

LENGTH	THICKNESS															
	2	2.5	3	3.5	4	4.5	5	5.5	6	6.5	7	7.5	8	8.5	9	SUM
45 cm										1		2				3
44 cm										1	1	1				3
43 cm							1		1	1	2				1	6
42 cm													2	2		4
41 cm												1	2			3
40 cm						1			1		2	3		1		8
39 cm						1			1	1	1			1		5
38 cm							1		1						1	3
37 cm			1													1
36 cm																
35 cm																
34 cm																
33 cm						1	1		1							3
32 cm						1	1									2
31 cm					1	1										2
30 cm			1	1	2		3									7
29 cm				2	2	2		1	1							8
28 cm			1	3	1	1	3		1							10
27 cm			4	4	8	9	4	6	1							36
26 cm			6	16	14	5	3	10	5		2	1				62
25 cm	1		4	15	12	6	7	1	1							47
24 cm	2	2	7	20	5	3	2	1								42
23 cm	3	2	15	8	1	1	2	1								33
22 cm	1	1	4	13	4	1	1		1		1					27
21 cm		5	9	5	2	1										22
20 cm		5	10	2	1		1									19
19 cm		2	4			1										7
18 cm			1													1
17 cm				1												1
SUM	7	17	67	90	53	35	30	20	15	4	9	8	4	4	2	335

TABLE E-9. BREADTH AND THICKNESS OF FORTIFICATION BRICKS WITH THREE MEASUREMENTS

BREADTH	THICKNESS															
	2	2.5	3	3.5	4	4.5	5	5.5	6	6.5	7	7.5	8	8.5	9	SUM
24 cm						1										1
23 cm				1						1		1		2	1	5
22 cm									1	1	2	1	1		1	7
21 cm			1			1	1		2	2	2	4		1		14
20 cm							2		1		1	1				5
19 cm							2				1		2			5
18 cm						2	1	2					1	1		7
17 cm			2	3	7	4	3	5	6		1	1				32
16 cm			4	17	6	8	6		2		1					44
15 cm		1	8	11	10	4	7	2			1					44
14 cm	1	1	11	26	8	2	3	3	1							57
13 cm	2	4	15	19	15	9	2	7								73
12 cm	4	7	17	10	5	2	3		1							49
11 cm		4	7	2	2	2		1	1							19
10 cm			2	1												3
SUM	7	17	67	90	53	35	30	20	15	4	9	8	4	4	2	365

which are relatively broader than the large bricks and indeed show the lowest thickness:breadth ratio of any category (Table E-11), behave more like a "brick seriation type".

These two sizes of bricks were unevenly distributed across the five types of brick wall recognised by SSPHAP's survey (cf. Figure E-1). The demonstration considers those *in situ* bricks for which at least two dimensions are available - so their size can be classified by the breath-thickness definition (Table E-9) if length was not measured - and calculates the percentage frequency of large and smaller bricks in each type of wall (Table E-12). "Single wall" refers to the walls of Benteng Anak Gowa which were made of a single central line of bricks supported on each side by heaped earth. "Central wall" differs in that the central line was flanked on both sides by lateral lines of brick, here

TABLE E-10. SIZE IN CM OF LARGE FORTIFICATION BRICKS (n=229)

	(n)	Mean	S.D.	Range
Length	111	41.12	2.84	(35-49)
Breadth	176	21.05	1.70	(16.5-26)
Thickness	196	7.09	1.08	(3-10)
Breadth/Length	67	50.48%	4.42	(42.5-64.9%)
Thickness/Length	77	16.93%	8.61	(8.1-22.9%)
Thickness/Breadth	134	34.08%	4.67	(24.4-47.2%)

Breadth:Length Correlation Coefficient Pearson's r = 0.33
Thickness:Length Correlation Coefficient Pearson's r = 0.29
Thickness:Breadth Correlation Coefficient Pearson's r = 0.12

TABLE E-11. SIZE (CM) OF SMALLER FORTIFICATION BRICKS (n=824)

	(n)	Mean	S.D.	Range
Length	414	24.16	2.87	(17-33)
Breadth	717	14.09	2.34	(7.5-23)
Thickness	736	3.84	0.83	(2-7.5)
Breadth/Length	364	58.57%	6.22	(38.5-81.3%)
Thickness/Length	328	15.87%	3.68	(8.0-31.8%)
Thickness/Breadth	636	27.62%	6.01	(14.8-54.5%)

Breadth:Length Correlation Coefficient Pearson's r = 0.73
Thickness:Length Correlation Coefficient Pearson's r = 0.40
Thickness:Breadth Correlation Coefficient Pearson's r = 0.41

called "side wall", in addition to the earth fill. This type of brick wall was found along certain sections of Benteng Tua. "Double wall", found at Sanrabone (Photo E-2) and Tallok, has two lines of bricks with earth between them and on either side.[2] "Coastal wall" refers to the brick wall built along the coastline, which would have stretched almost continuously from Ujung Tana to Barombong according to my reconstruction of Makassar, but which was amenable to survey only between Garassik and Barombong.

TABLE E-12. BRICK SIZE TYPES AND WALL TYPES

	Large Bricks >34 cm long, or B-T large	Smaller Bricks <34 cm long, or B-T small
Single Wall	100%	0%
Central Wall	98.8, 100%	0, 1.2%
Side Wall	0%	100%
Double Wall	1.3, 4.3%	95.7, 98.7%
Coastal Wall	5.8, 15.0%	85.0, 94.2%

N.B. Two values are presented in those cells where the two definitions of brick size used here yield different results.

Large bricks were used for the single and central walls. The single apparent exception, from Benteng Tua, is only just excluded from the large bricks by the breadth-thickness definition. Smaller bricks were used in making the side and double walls, except for a small number at Tallok. The coastal wall bricks were also usually short (< 34 cm) but, suspiciously, included a comparatively high proportion of large bricks by the breadth-thickness definition. This last point leads naturally to a more detailed consideration of the southern fortifications which used to guard Makassar entrepôt (see Figure 11-1).

E.2.3 Somba Opu and the coastal wall

Somba Opu was the fortress least well documented by SSPHAP's survey for two reasons. Firstly, our direct observations on

[2] As discussed in E.2.3, the type of wall at Benteng Somba Opu is not fully clear and so the fortress is excluded from this comparison.

the site finished on 14 November 1986, before we were aware of the issues (posed by our later investigations at Benteng Tua) of multiple events in wall construction, and the use of variable brick sizes in the same fortress. Secondly, the visible wall line consisted of either a linear scatter of brick rubble or the half-demolished wall at the west, neither offering any readily available sections. The one small section we could clear at the outer west wall showed the construction method as "one-on-two"[3] and provided some measurements of *in situ* bricks, which appeared to constitute adequate documentation then. Suaka's (1986/87) survey of Somba Opu, which confirmed SSPHAP's site plan (Figure 11-9), seemed at the time to wrap the matter up.

The fortress walls have since been subjected to major excavations by Suaka and reconstruction led by Mukhlis (Hasanuddin University). I imagine that one or more reports have resulted from this work, but I have been unable to track any down either as copies or as titles. Personal communications from Peter Spillett and Anthony Reid, who have visited the site recently, indicate that the fortress wall consisted of a single brick wall. All the photographic evidence I have seen (Photos 11-4 to 11-6) also suggests a single brick wall, one of several metres thickness which would have obviated the need for subsidiary wall lines or additions of heaped earth. A journalist's report (*Minggu*, 13-9-89) describes fully vertical faces for the walls inside and outside, except on the west and south walls whose interior faces slope at 75°-80° from the horizontal. The description possibly suggests two or more lines of brick, at least within the west and south walls, but is inconclusive. Ian Caldwell (as reported in Reid and Caldwell, 1990:89) mentions a single brick-wall around the fortress except along the north which had a single central line of large bricks, two less solid lateral lines of smaller bricks and packed earth fill. The latter method of construction would intriguingly recall Benteng Tua's major walls (6.4). Although the article by Reid and Caldwell (1990) is not designed to

[3] i.e. each brick was laid transversely across the two bricks in the course below.

handle the full complexities of the fortification archaeology, I will follow it as the only published description to which I have access. In any case, all the Somba Opu bricks measured by SSPHAP were found at the southern and western walls which, according to the evidence available to me, apparently had single brick-walls.[4]

By the definitions given in E.2.2, 11 of the 12 *in situ* Somba Opu bricks measured at the outer west wall are "smaller" and only one is "large". Superficially, this might seem to go against the pattern at Benteng Anak Gowa whose single brick-wall (Figure 8-2) had been built of large bricks (Table E-12). However, it is possible that the appropriate analogy for Somba Opu's very thick walls of brick along its western face is the triple brick-wall along the fort's northern face. That is, Somba Opu's west wall might also be made up of lateral additions of wall made of smaller bricks and a central line made of large bricks. But in this particular case the lateral lines had been built to touch the central line, rather than having remained separated by packed earth fill.

As a further complication, all eight of the 12 bricks which could be measured for both breadth and thickness fall very close to the stepped line separating "large" and "smaller" bricks in Table E-9. The same is true of the larger two of the ten Somba Opu bricks measured by Sonny Wibisono.[5] Moreover, one of the two larger bricks reported by Nurhadi et al. (1980:10) measured 34 cm long - the very length SSPHAP failed to record - while the other, 22 cm broad by 6 cm thick, would scrape in as a "large" brick (cf. Table E-9). These points suggest that the larger type of brick used at Somba Opu was intermediate in size between the "large" and the "smaller" bricks as used at the other palaces.[6] The summary statistics of SSPHAP's sample of Somba Opu's

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[4] Note that my computerised database, compiled before any descriptions of the excavations at Somba Opu had appeared, classifies the Somba Opu bricks as "double-wall" bricks.
[5] Included in SSPHAP's database of brick sizes on a data-sharing arrangement.
[6] Indeed, the main reason why SSPHAP's sample of fortification bricks shows such a clear bimodal distribution may well be SSPHAP's poor sampling of Somba Opu with its intermediate-sized bricks.

TABLE E-13. SIZE (CM) OF SOMBA OPU INTERMEDIATE BRICKS (n=14)

	(n)	Mean	S.D.	Range
Length	6	29.83	0.41	(29-30)
Breadth	11	19.50	0.58	(19-20.5)
Thickness	14	4.96	0.50	(4-6)
Breadth/Length	2	65.00%	-	(63.3,66.7%)
Thickness/Length	3	17.22%	1.00	(16.7-18.3%)
Thickness/Breadth	10	25.38%	2.67	(21.1-30.0%)

Breadth:Length Correlation Coefficient Pearson's r = 0.35

N.B. In this table and those that followm where we are often dealing with small sample sizes, inter-measurement correlation coefficients will be shown only when there are at least ten specimens measured for both dimensions.

"intermediate" bricks, given in Table E-13, clearly suggest a "brick standard", notwithstanding the small sample size.

As these "intermediate" bricks overlap in size with the largest "smaller" bricks at Benteng Tua (Table 6-1) and Tallok (Table 14-1), the Somba Opu examples are clearly distinct only because they alone constitute a solid cluster of data. Further, their shorter length alone clearly distinguishes them from the "large" fortification bricks; breadths are particularly inadequate in this regard (cf. Table E-10).[7] Hence to recognise the smae brick standard at another fortified site, it must be represented by a distinct cluster of bricks scarcely straying from 30 X 19.5 X 5 cm. This condition is met by four bricks at Garassik whose lengths, 32 to 33 cm, fall well beyond the range of lengths of Garassik's other bricks (Table E-14).[8] A few bricks of the required specifications also occur at Paknakkukang, and may represent the same type, but at that site are interpreted more parsimoniously as the big end of the range of "smaller" bricks (see below). Only Garassik clearly shares the Somba Opu brick standard, just as Garassik is closest to Somba Opu.

[7] Accordingly, the derived breadth:length index also usefully distinguishes the "intermediate" and "large" bricks.
[8] These four bricks include four of the five previously classified as the longest within the range of "smaller" bricks in the bivariate plots (Tables E-7 and E-8), further confirming their intermediate size.

TABLE E-14. SIZE IN CM OF GARASSIK INTERMEDIATE BRICKS (n=4)

	(n)	Mean	S.D.	Range
Length	4	32.63	0.48	(32-33)
Breadth	4	18.50	2.80	(16-22)
Thickness	4	5.13	0.63	(4.5-6)
Breadth/Length	4	56.71%	8.56	(48.5-66.7%)
Thickness/Length	4	15.71%	1.87	(13.6-18.2%)
Thickness/Breadth	4	27.84%	1.94	(25.6-30.3%)

TABLE E-15. SIZE IN CM OF SOMBA OPU SMALLER BRICKS (n=8)

	(n)	Mean	S.D.	Range
Length	6	23.83	1.60	(21-25)
Breadth	8	15.19	1.93	(11-17)
Thickness	7	3.43	0.53	(3-4.5)
Breadth/Length	6	61.65%	5.24	(62.4-68.0%)
Thickness/Length	6	14.84%	3.36	(12.0-21.4%)
Thickness/Breadth	7	25.38%	7.71	(18.8-40.9%)

Table E-16. SIZE IN CM OF GARASSIK SMALLER BRICKS (n=42)

In situ wall	(n)	Mean	S.D.	Range
Length	1	23	-	(23)
Breadth	13	13.77	2.67	(7.5-17)
Thickness	17	3.56	0.48	(3-4.5)
Breadth/Length	1	65.20%	-	(65.2%)
Thickness/Length	1	13.00%	-	(13.0%)
Thickness/Breadth	13	26.78%	7.90	(19.4-46.7%)

Thickness:Breadth Correlation Coefficient Pearson's r = 0.21

Ex situ bricks	(n)	Mean	S.D.	Range
Length	13	24.00	2.47	(20-28)
Breadth	25	13.02	2.13	(11-17)
Thickness	25	4.25	1.23	(3-7)
Breadth/Length	13	55.58%	9.50	(44.0-75.0%)
Thickness/Length	13	18.70%	5.72	(11.1-31.8%)
Thickness/Breadth	25	33.46%	8.99	(17.6-54.5%)

Breadth:Length Correlation Coefficient Pearson's r = -0.03
Thickness:Length Correlation Coefficient Pearson's r = -0.20
Thickness:Breadth Correlation Coefficient Pearson's r = 0.01

Total sample	(n)	Mean	S.D.	Range
Length	14	23.93	2.35	(20-28)
Breadth	14	13.28	2.31	(7.5-17)
Thickness	42	3.97	0.93	(3-7)
Breadth/Length	14	56.27%	9.75	(44.0-75.0%)
Thickness/Length	14	18.29%	6.03	(11.1-31.8%)
Thickness/Breadth	38	31.17%	8.62	(17.6-54.5%)

Breadth:Length Correlation Coefficient Pearson's r = -0.06
Thickness:Length Correlation Coefficient Pearson's r = -0.15
Thickness:Breadth Correlation Coefficient Pearson's r = -0.02

"Smaller" bricks are also recognisable at both sites. SSPHAP's sample of Somba Opu smaller bricks (Table E-15) appears typical of the smaller fortification bricks in general (Table E-10). As regards Garassik's smaller bricks, no self-evident pattern of bimodality or multimodality in dimensions presents itself, but a contextual distinction can be made between those *in situ* along the stretch of coastal wall passing the site (Figure 11-3a), and those *ex situ* present as rubble or recycled in other contexts. The *in situ* bricks have average dimensions and shape indices similar to those of the smaller bricks in general, whereas the *ex situ* bricks appear on average to be distinctly narrower and thicker (cf. Tables E-16 and E-10). Moreover the Garassik *ex situ* bricks show very low inter-measurement correlation coefficients or, indeed, a pattern in which the longer bricks are the less thick (Table E-16). Let us entertain the hypothesis that Garassik's *in situ* and *ex situ* bricks might somehow represent different types, whilst noting that should we later attribute the metrical contrasts to sampling error, then the total sample of Garassik's "smaller" bricks would generally resemble the *ex situ* "smaller" bricks (Table E-16).

The next closest samples of bricks is from Bayoa, presumed to represent the coastal wall which had run through the site, but comparable to Garassik's *ex situ* bricks as none of the Bayoa bricks was measured *in situ*. And indeed the average dimensions and shape indices at Bayoa (Table E-17) are very similar to those of Garassik's *ex situ* bricks. The Bayoa correlation coefficients are also unusual inasmuch as the broader bricks tend to be the thinner.

Table E-17. Bayoa Bricks: All *Ex Situ* and "Smaller" (n=26)

	(n)	Mean	S.D.	Range
Length	10	24.27	2.52	(19-28)
Breadth	25	14.04	2.56	(10.3-18)
Thickness	26	4.45	0.71	(3-5.5)
Breadth/Length	9	55.27%	8.43	(42.2-64.1%)
Thickness/Length	10	18.34%	2.86	(13.0-21.7%)
Thickness/Breadth	25	32.64%	9.11	(17.6-51.4%)

Thickness:Length Correlation Coefficient Pearson's r = 0.63
Thickness:Breadth Correlation Coefficient Pearson's r = -0.18

The next site to consider is Paknakkukang at the mouth of the Sungai Garassik (Jeknekberang). Here SSPHAP's survey recorded a line of brick wall, which I interpret as coastal wall, terminating at Paknakkukang's earthen enceinte (Figure 11-3b). In addition to a sample of *in situ* bricks along this wall, we measured 31 bricks from a *saukang* platform which have presumably been recycled from the coastal wall.

The Paknakkukang bricks are unusual; despite an apparent bimodality between long (37-39 cm) and shorter (19-31 cm) bricks, these two groups overlap indiscriminately in their breadths and thicknesses. On top of that, the bricks with lengths around 30 cm cannot be consigned to the Somba Opu "intermediate" type because the great majority are narrower and less thin than would be required. After having experimented with the data from various angles, I can see no parsimonious procedure other than to apply the definitions of "large" and "smaller" bricks given above (E.2.2), even though the action effectively draws a sectioning line through what is a cloud of data points. As a result the sample of "large" Paknakkukang bricks is rather small by general standards whilst the "smaller" Paknakkukang bricks are rather large by general standards (cf. Tables E-18 and E-10, Tables E-19 and E-11). The "large" bricks, moreover, are highly variable in shape, with a tendency for the broader examples to be the thinner ones (Table E-18).

As regards Paknakkukang's "smaller" bricks, when treated individually the *saukang* sample and the *in situ* sample appear different from each other or from any other sample yet considered (Table E-19). However, the overriding observation would seem to be the contrast beween the *ex situ* bricks, where breadth and thickness are correlated, and the *in situ* bricks whose thicknesses fail to correlate with either length or breadth (Table E-19). As this pattern precisely reverses the cotnrast between Garassik's "smaller" *ex situ* and *in situ* bricks (Table E-16), any justification for using context as a classificatory criterion for the "smaller", coastal wall bricks is shattered. Rather, the alternative procedure which ascribes the apparent differences to sampling error receives additional support from the combined sample of Paknakkukang's "smaller" bricks (Table E-19). Their mean dimensions and sahpe indices do not differ clearly from those of the Bayoa (Table E-17) and combined Garassik samples (Table E-16), and the Paknakkukang examples highlight the trend for thickness to be negatively correlated with length and breadth. Hence all the Paknakkukang, Garassik and Bayoa "smaller" bricks are most parsimoniously cast in the same light.[9]

TABLE E-18. SIZE IN CM OF PAKNAKKUKANG LARGE BRICKS (n=13)

To large bricks from Saukang

In situ wall	(n)	Mean	S.D.	Range
Length	2	37.50	-	(37,38)
Breadth	3	19.50	1.79	(17-21)
Thickness	4	5.75	0.43	(5-6)

9/13

Saukang platform	(n)	Mean	S.D.	Range
Length	2	39.00	-	(39)
Breadth	9	20.94	0.68	(20-22)
Thickness	9	5.94	0.44	(5-6.5)

Total sample	(n)	Mean	S.D.	Range
Length	4	38.25	0.96	(37-39)
Breadth	12	20.58	0.96	(17-22)
Thickness	13	5.88	0.44	(5-6.5)
Breadth/Length	3	50.81%	5.26	(44.7-53.8%)
Thickness/Length	4	16.01%	0.56	(15.4-16.7%)
Thickness/Breadth	12	28.68%	3.29	(22.7-35.3%)

Thickness:Breadth Correlation Coefficient Pearson's r = -0.16

22

22+34+3

= 22/59

TABLE E-19. SIZE IN CM OF PAKNAKKUKANG SMALLER BRICKS (n=63)

In situ wall	(n)	Mean	S.D.	Range
Length	16	24.41	2.31	(19-30)
Breadth	25	16.06	1.28	(13-19)
Thickness	34	4.66	0.63	(4-6)
Breadth/Length	5	63.14%	5.55	(57.6-72.3%)
Thickness/Length	13	20.52%	3.59	(13.6-26.3%)
Thickness/Breadth	22	28.81%	5.32	(21.0-42.9%)

Thickness:Length Correlation Coefficient Pearson's r = 0.12
Thickness:Breadth Correlation Coefficient Pearson's r = -0.04

[9] Some of the Paknakkukang bricks here classified as "large" may belong to this group as well.

TABLE E-19. SIZE IN CM OF PAKNAKKUKANG SMALLER BRICKS (CONT.)

Saukang platform	(n)	Mean	S.D.	Range
Length	3	30.33	0.94	(29-31)
Breadth	22	16.86	1.86	(14.5-20)
Thickness	22	4.52	0.38	(4-5)
Breadth/Length	3	52.26%	2.65	(50.0-55.2%)
Thickness/Length	3	14.31%	1.32	(12.9-15.5%)
Thickness/Breadth	22	27.03%	2.99	(22.5-33.3%)

Thickness:Breadth Correlation Coefficient Pearson's r = 0.43

Total sample	(n)	Mean	S.D.	Range
Length	19	25.34	2.09	(19-31)
Breadth	47	16.43	1.55	(13-20)
Thickness	56	4.61	0.53	(4-6)
Breadth/Length	8	59.06%	7.16	(50.0-72.3%)
Thickness/Length	16	19.36%	4.10	(12.9-26.3%)
Thickness/Breadth	44	27.92%	4.41	(21.0-42.9%)

Thickness:Length Correlation Coefficient Pearson's r = -0.12
Thickness:Breadth Correlation Coefficient Pearson's r = -0.34

TABLE E-20. SIZE (CM) OF BAROMBONG BRICKS: ALL SMALLER (n=84)

Bastion	(n)	Mean	S.D.	Range
Length	6	27.00	1.26	(26-29)
Breadth	27	15.60	2.42	(11-19.5)
Thickness	30	4.40	0.57	(3-5)
Breadth/Length	4	58.47%	8.09	(48.1-67.3%)
Thickness/Length	6	16.67%	2.11	(13.5-19.2%)
Thickness/Breadth	27	28.80%	6.34	(19.4-40.9%)

Thickness:Breadth Correlation Coefficient Pearson's r = -0.06

Wall	(n)	Mean	S.D.	Range
Length	3	21.83	4.07	(19-26.5)
Breadth	31	13.60	1.44	(11.5-18)
Thickness	54	4.07	0.78	(3-6)
Breadth/Length	2	57.20%	-	(45.3,69.1%)
Thickness/Length	3	22.33%	5.77	(18.9-28.9%)
Thickness/Breadth	30	29.37%	8.20	(19.4-48.0%)

Thickness:Breadth Correlation Coefficient Pearson's r = -0.02

Total sample	(n)	Mean	S.D.	Range
Length	9	25.39	3.07	(19-29)
Breadth	58	14.54	4.35	(11-19.5)
Thickness	84	4.20	0.72	(3-6)
Breadth/Length	6	58.04%	9.81	(45.3-69.0%)
Thickness/Length	9	18.55%	4.35	(13.5-28.9%)
Thickness/Breadth	57	29.10%	7.32	(19.4-48.0%)

Thickness:Breadth Correlation Coefficient Pearson's r = 0.09

Skipping over Pattukangang temporarily brings our focus to Barombong. Here is no need to distinguish between the *in situ* and *ex situ* bricks because both were restricted to the line of wall rubble. A slight difference can be discerned between the bricks from the apparent bastion at the far south of the wall, and the bricks to the bastion's north, in that the former are significantly larger on all dimensions (Table E-20).[10] But the differences are small and involve no perceptible effects on shape, so the Barombong bricks can be analysed as a single sample.

These Barombong bricks do more than simple resemble their Bayoa, Paknakkukang and Garassik counterparts in terms of mean dimensions and shape indices; they bridge the interval between the Paknakkukang and Bayoa/Garassik examples. The lack of a clear correlation between breadth and thickness carries the same import. Hence it may be inferred that the Garassik, Bayoa, Paknakkukang and Barombong "smaller" bricks, all ascribable to wall built between 1634 and 1635 (Table E-28), can be pooled into a single sample of usual coastal wall bricks.

Returning to the Pattukangang wall (as I label it), which appears in the records as the wall built south of Benteng Paknakkukang in 1661 after the Dutch had temporarily occupied the fort (LB:124), we have a very sparse documentation which covers only nine brick pieces.[11] Nonetheless they include the single thickest brick measured during the fieldwork and three other very thick bricks, and show the thickest shape indices of any of the samples. They also seem to be anomalously broad for their length (Table E-21). Thus the Pattukangang bricks appear set apart, which accords with the isolation of the wall's construction within the chronology of greater Gowa's fortifications programme, and may also reflect the haste with which this wall had to be erected.

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[10] Student's t-test for small samples $p < 0.1$ to $p < 0.005$.
[11] Including three measured by Sonny Wibisono.

TABLE E-21. SIZE IN CM OF PATTUKANGANG BRICKS (n=9)

	(n)	Mean	S.D.	Range
Length	5	25.60	1.96	(22-28)
Breadth	7	17.64	3.23	(11-21)
Thickness	7	7.07	2.21	(4-10)
Breadth/Length	5	67.55%	12.68	(50.0-80.8%)
Thickness/Length	3	21.63%	6.25	(17.9-28.8%)
Thickness/Breadth	5	35.51%	5.40	(30.3-43.9%)

TABLE E-22. SIZE IN CM OF LARGE FORTIFICATION BRICKS (n=223)

	(n)	Mean	S.D.	Range
Length	111	41.12	2.84	(35-49)
Breadth	170	21.08	1.74	(16.5-26)
Thickness	190	7.09	1.04	(3-9)
Breadth/Length	67	50.48%	4.42	(42.5-64.9%)
Thickness/Length	77	16.93%	8.61	(8.1-22.9%)
Thickness/Breadth	130	34.24%	4.53	(24.4-47.2%)

Breadth:Length Correlation Coefficient Pearson's r = 0.33
Thickness:Length Correlation Coefficient Pearson's r = 0.29
Thickness:Breadth Correlation Coefficient Pearson's r = 0.21

TABLE E-23. SIZE OF INTERMEDIATE FORTIFICATION BRICKS (n=18)

	(n)	Mean	S.D.	Range
Length	10	30.95	1.50	(29-33)
Breadth	14	19.21	1.50	(16-22)
Thickness	18	5.00	0.51	(4-6)
Breadth/Length	6	59.48%	7.96	(48.5-66.7%)
Thickness/Length	10	16.34%	1.45	(13.6-18.3%)
Thickness/Breadth	14	26.08%	2.67	(19.4-46.7%)

Thickness:Length Correlation Coefficient Pearson's r = 0.18
Thickness:Breadth Correlation Coefficient Pearson's r = 0.48

TABLE E-24. SIZE IN CM OF SMALLER PALACE BRICKS (n=606)

	(n)	Mean	S.D.	Range
Length	347	23.86	2.99	(17-32)
Breadth	536	13.80	2.43	(7.5-23)
Thickness	512	3.61	0.88	(2-7)
Breadth/Length	316	58.60%	5.77	(38.5-81.3%)
Thickness/Length	266	15.27%	3.59	(8.0-29.6%)
Thickness/Breadth	456	26.76%	5.66	(14.8-51.5%)

Breadth:Length Correlation Coefficient Pearson's r = 0.78
Thickness:Length Correlation Coefficient Pearson's r = 0.47
Thickness:Breadth Correlation Coefficient Pearson's r = 0.41

TABLE E-25. SIZE IN CM OF USUAL COASTAL WALL BRICKS (n=209)

	(n)	Mean	S.D.	Range
Length	52	24.76	2.41	(19-31)
Breadth	168	14.71	2.08	(7.5-20)
Thickness	208	4.30	0.71	(3-7)
Breadth/Length	37	56.92%	8.88	(42.2-75.0%)
Thickness/Length	49	18.70%	4.44	(11.1-31.8%)
Thickness/Breadth	165	30.04%	7.19	(17.6-54.5%)

Breadth:Length Correlation Coefficient	Pearson's r = 0.52
Thickness:Length Correlation Coefficient	Pearson's r = 0.09
Thickness:Breadth Correlation Coefficient	Pearson's r = 0.02

E.2.4 Overall appreciation of the Gowa fortification bricks

The foregoing discussion distils three new brick classes: an intermediate-sized brick, recognised only at Somba Opu and Garassik; the usual coastal-wall brick; and the anomalously short, fat bricks at Pattukangang. Our subdivision of the "smaller" bricks into those along the coastal wall and those at the palaces suggests that Paknakkukang's large bricks should also be treated separately from the large palace-bricks. But the Pattukangang examples presumably represent stray imports, and in any case only a small sample is involved. Thus a final appreciation of the fortification bricks divides them into the five classes shown in Tables E-21 (Pattukangang) to E-25.

The statistics of the "large fortification bricks" are affected only slightly as few bricks were reclassified. The main change involves the breadth:thickness relationship whose index variability is now reduced and whose correlation coefficient now resembles the other two (Table E-22; cf. Table E-10). Like the large bricks, the "intermediate" bricks also conform well with the expectations of a "brick standard" (Table E-23).

As regards the "smaller fortification bricks" (Table E-11), their subdivision into palace and coastal-wall specimens brings out several subtle distinctions. The palace bricks are smaller and, in particular, thinner than the coastal-wall examples (cf. Tables E-24 and E-25). Moerover the palace "smaller" bricks retain and indeed enhance the "brick seriation type" traits of the larger sample from which they were drawn. This last point may support the historical evidence that they were produced over a period lasting more than half a century (E.4). On the other hand the coastal-wall examples, when treated as a single sample, stand out convincingly as a "brick standard".

The preferential use of particular brick types in designated construction works stands out almost as clearly as in the earlier comparison (Table E-12). My interpretation of SSPHAP's sample of Somba Opu bricks as single-wall bricks lends the single-wall bricks a variable composition, but as explained above I am unsure about Somba Opu's brickworks. And the unruly metrics of the coastal-wall bricks, noted previously, becomes explicable in light of the four classes of brick represented (Table E-26).

TABLE E-26. COMPOSITION OF THE FORTIFICATION STRUCTURES BY BRICK TYPE (n=1053)

	Large Bricks	Inter-mediate Bricks	Palace Smaller Bricks	Usual Coastal Bricks	Pattu-kangang Bricks
Central Wall	146	0	3	0	0
Single Wall	50	14	8	0	0
Double Wall	12	0	456	0	0
Side Wall	0	0	94	0	0
Coastal Wall	13	4	0	209	9
Internal Structures	2	0	45	0	0

E.3 Masonry Measurements

SSPHAP recorded stone masonry measurements only at Benteng Tallok, in a context which suggests an early 17th century construction date (12.2.3). Otherwise, the Dutch rebuilt Fort Rotterdam (as Speelman rechristened the earlier Makassar fort of Ujung Pandang) with masonry walls, beginning in 1673 (Reid and Reid, 1988:45). Even though Maros is widely reputed as the source of Fort Rotterdam's stone (e.g. Reid, 1990:68), the information we received at Pammangkulang Batua, kampung Bonto Ramba, was that it had been quarried to build Fort Rotterdam. At this Karaeng Demmanari affirmed that Bonto Ramba was indeed reputed as one source of Fort Rotterdam's stone. He was presumably thinking of the rumour which identifies this rôle with Balang Mawang near Bonto Ramba on the Ujung Pandand-Malino highway (Pabbitei, 1976:2). If in fact Pammangkulang Batua had provided some of Fort Rotterdam's stone, then the two Bonto Ramba kampung could have easily become confused over time; but since SSPHAP's survey merely touched on one shore of Balang Mawang (Chapter 9), I cannot dismiss the possibility that a suitable quarry could lie there.

The only published data on the size of Fort Rotterdam's stone are the measurements reported by Pabbitei (1976:2) for its "largest" and "smallest" blocks.[12] The implied ranges fall well within the ranges of block size recorded by SSPHAP at Tallok. The midpoints between the Fort Rotterdam "extremes" hardly differ from the Tallok averages, and length:breadth:thickness proportions of around 3:1.7:1 appear to characterise both data sets (Table E-27). However, the strength of these comparisons is debilitated by Pabittei's scant documentation which does not show that more than two Fort Rotterdam blocks were necessarily measured.

The comparative data from Pammangkulang Batua (Photo E-1) are also very restricted as only seven almost completed blocks had been left at the quarry. These fall into two groups. The two shorter blocks have lengths and breadths similar to the Tallok means and within the reported range at Fort Rotterdam. The five larger blocks, however, are all longer than any block yet reported from a fortress. At the same time the shape indices of the Pammangkulang Batua blocks fall within the Tallok ranges; and the single Pammangkulang Batua block measured on three dimensions coincides in shape with that of Fort Rotterdam's reported midpoint (Table E-27). Nor is it that far-fetched to suggest that Pammangkulang Batua's remnant blocks might represent a larger pre-form which was subsequently whittled back for insertion in the fortress walls.

The suggestive echoes of comparability between these three data sets recommend further attention to the issue. A

[12] Pabittei unjustifiably ascribes this masonry work to Gowa's Sultan Alauddin.

statistically adequate record of Fort Rotterdam's masonry would be easily organised. More complex projects would include the identification and recording of the rumoured Maros quarry sites, and the compilation and analysis of the dimensions of the masonry blocks associated with Makassar graves dated to the 17th century. The project could investigate whether Fort Rotterdam's masonry conforms in its dimensions with greater Gowa's precolonial masonry works, with useful implications for understanding how the Dutch organised the Makassar masons in setting them to work.

TABLE E-27. SIZES IN CM OF RECORDED MASONRY BLOCKS

Fort Rotterdam	"Largest"	"Smallest"	Midpoint
Length	62	44	53
Breadth	34	21	27.5
Thickness	20	10	15
L:B:T ratio (T = 1)	3.1:1.7:1	4.4:2.1:1	3.5:1.8:1

Benteng Tallok	(n)	Mean	S.D.	Range
Length	90	48.60	11.80	(25-70)
Breadth	90	28.77	6.22	(12-48)
Thickness	67	18.87	4.72	(10-30)
Breadth/Length	90	57.70%	14.95	(35.7-100%)
Thickness/Length	67	38.08%	11.44	(17.9-76.9%)
Thickness/Breadth	67	62.28%	14.22	(39.5-100%)
L:B:T ratio (T = 1)		2.6:1.6:1		1.3:1:1 to 4.7:2.5:1 or 5.6:2.3:1

Pammangkulang Batua longer blocks	(n)	Mean	S.D.	Range
Length	5	76.00	2.45	(75-80)
Breadth	5	35.40	2.07	(32-37)
Thickness	1	20	-	(20)
Breadth/Length	5	46.90%	3.78	(42.0-51.3%)
L:B:T ratio (T = 1)		3.7:1.75:1		

Pammangkulang Batua small blocks	(n)	Mean	S.D.	Range
Length	2	49.50	-	(49,50)
Breadth	2	34.00	-	(34)
Breadth/Length	2	68.69%	-	(68.0,69.4%)

E.4 An Overview of Greater Gowa's Fortifications

The descriptions of the various fortification works given in the respective chapters and E.1.3, and the general review of the statistical data adumbrated above, are synthesised in Table E-28. Particular fragilities in the database should be admitted such as SSPHAP's lack of direct survey in Ujung Pandang's urbanised areas and SSPHAP's scant documentation of Somba Opu. As important data from Somba Opu have presumably been collected and may even be available within Ujung Pandang, the general scheme offered here may have to be corrected accordingly at some future date.

The technologically simplest fortification, walls of heaped earth, had appeared by the early 16th century, and continued to be practised into the early 17th century and beyond. During his mid-16th century reign Tunipalangga introduced the simplest form of brick wall consisting of a central line of bricks flanked by lateral additions of heaped earth (e.g. Figure 8-2). This design also appears to have characterised the long stretches of coastal wall built during the 1630s and 1660s. A more sophisticated fortress wall, consisting of two parallel lines of brick sandwiching earth fill and flanked bilaterally by heaped earth, appears to have been introduced by Abdullah at Tallok at around 1615 (Figure 12-3). Application of the new technology to walls previously strengthened by a central line of bricks resulted in triple brick-walls at Benteng Tua (Figure 6-8) and along Somba Opu's north face, although the effects at Somba Opu's south and west faces may have merely been a thickening of the single brick-wall. The most recent palace, Sanrabone, epitomises the technology of double brick-walls (Photo E-2).

Abdullah's other innovation at Tallok, masonry fortifications, does not appear to have been more widely applied until the Dutch built Fort Rotterdam's walls.

The bricks produced by greater Gowa generally decreased in size over the 120-year period involved. This trend did not occur isometrically with the changes in wall construction: as interpreted here, the transitional intermediate-sized bricks may have constituted Somba Opu's earliest brick walls; while

TABLE E-28. SUMMARY OF GREATER GOWA'S FORTIFICATION PROGRAMME

Fortification Work	Sponsoring Ruler	Date	Brick Type	Average Brick Dimensions		
				Length	Breadth	Thickness
Benteng Tua's earth walls	Tumapakrisik Kallona	Before 1547				
Benteng Tua's central brick-walls	Tunipalangga	c.1550	Large	42.7-40.5 (41.2)	21.1-20.2 (20.7)	7.0-6.9 (7.0)
Anak Gowa's central brick-walls	Tunipalangga	c.1550	Large	44.1	21.9	7.75
Somba Opu's central brick-walls	Tunipalangga	c.1550	Intermediate	29.8	19.5	5.0
Tallok's double brick-walls	Abdullah	1615	Large	39.2	22.1	6.25
" "	" "	" "	Smaller	26.4-20.8 (23.1)	16.9-11.7 (13.8)	5.2-3.3 (3.6)
Tallok's masonry superstructure	Abdullah	1615				
Benteng Tua's double and side brick-walls	Alauddin	1615-8	Smaller	25.0-21.1 (23.1)	14.9-12.5 (13.7)	3.9-3.4 (3.7)
Ujung Tana to Somba Opu brick wall	Abdullah	1634	Unknown			
Paknakkukang to Somba Opu brick wall	Abdullah	1634	Large	38.25	20.6	5.9
" "	" "	" "	Intermediate	32.6	18.5	5.1
" "	" "	" "	Coastal	25.3-23.9 (24.6)	16.4-13.3 (14.8)	4.5-4.0 (4.4)

TABLE E-28. SUMMARY OF GREATER GOWA'S FORTIFICATION PROGRAMME (CONT.)

Fortification Work	Sponsoring Ruler	Date	Brick Type	Average Brick Dimensions		
				Length	Breadth	Thickness
Benteng Ujung Pandang (probably earth)	Abdullah	1634				
Benteng Paknakkukang, Bayoa, Garassik (earth)	Alauddin (?)	c.1634				
Barombong coastal brick-wall	Alauddin (?)	1635	Coastal	25.4	14.5	4.2
Somba Opu town gate	Abdullah	1635	Not recorded			
Pattukangang coastal brick-wall	Hasanuddin	1661	Pattukangang	25.6	17.6	7.1
Barombong second wall	Hasanuddin	1662	Not recorded			
Sanrabone double brick-walls	Abdul Jalil	1668	Smaller	25.3	14.8	3.5

N.B. Where a range of brick sizes conforming to a clear directional trend was observed at a particular work, this table shows the range of means of the samples, and the means of the combined sample in brackets below.

a few large bricks were included in Tallok's double brick-walls. The general trend may have resulted from a growing realisation that smaller bricks were easier to work with, particularly in rounded structures such as bastions, or because detritus tended to adhere to the the sides of the molds. In any case, the trend matches the steadily decreasing size of Roman bricks observed by studies on Roman brickworks (Meiggs, 1973:542-543; Wilson, 1975:15).

My preferred scenarios of the construction sequences at Benteng Tua (6.4), Tallok (12.2.3), and to some degree the Paknakkukang-Somba Opu coastal wall (11.1.2), rely on the notion of gradual decrease in average brick size. However, when we consider the palace walls built of smaller bricks over the 50-year interval between Tallok and Sanrabone, scarcely any trend in average dimensions can be observed. Rather the oldest such walls, in Tallok, show the greatest variability in average brick dimensions at different stations along the wall; followed by Benteng Tua in this regard (Table E-28); while Sanrabone's bricks were very standardised (Table E-1). Presumably this pattern reflects some combination of fortress size, greater scope for renovations and additions at the older palaces, and improved technical standards. We may also infer that a conscious decision to produce the same size of bricks was made in each case, either by working from a mold which served as a blueprint for the molds used during construction, or by re-creating a mold of the same size from previously fabricated bricks. But these same points would also allow a reversal of my original notion to suggest that brick size gradually increased during any particular works. On balance I prefer my original inference, given the general trend towards smaller bricks, and the particular trend of the large bricks towards reduced size.

Rigorous application of this inference would suggest that the undated brickworks at Anak Gowa preceded even Benteng Tua's. I can see no good reason to dismiss this implication, particularly given the vulnerability of Gowa's southern flank during the mid-16th century (8.2.1).

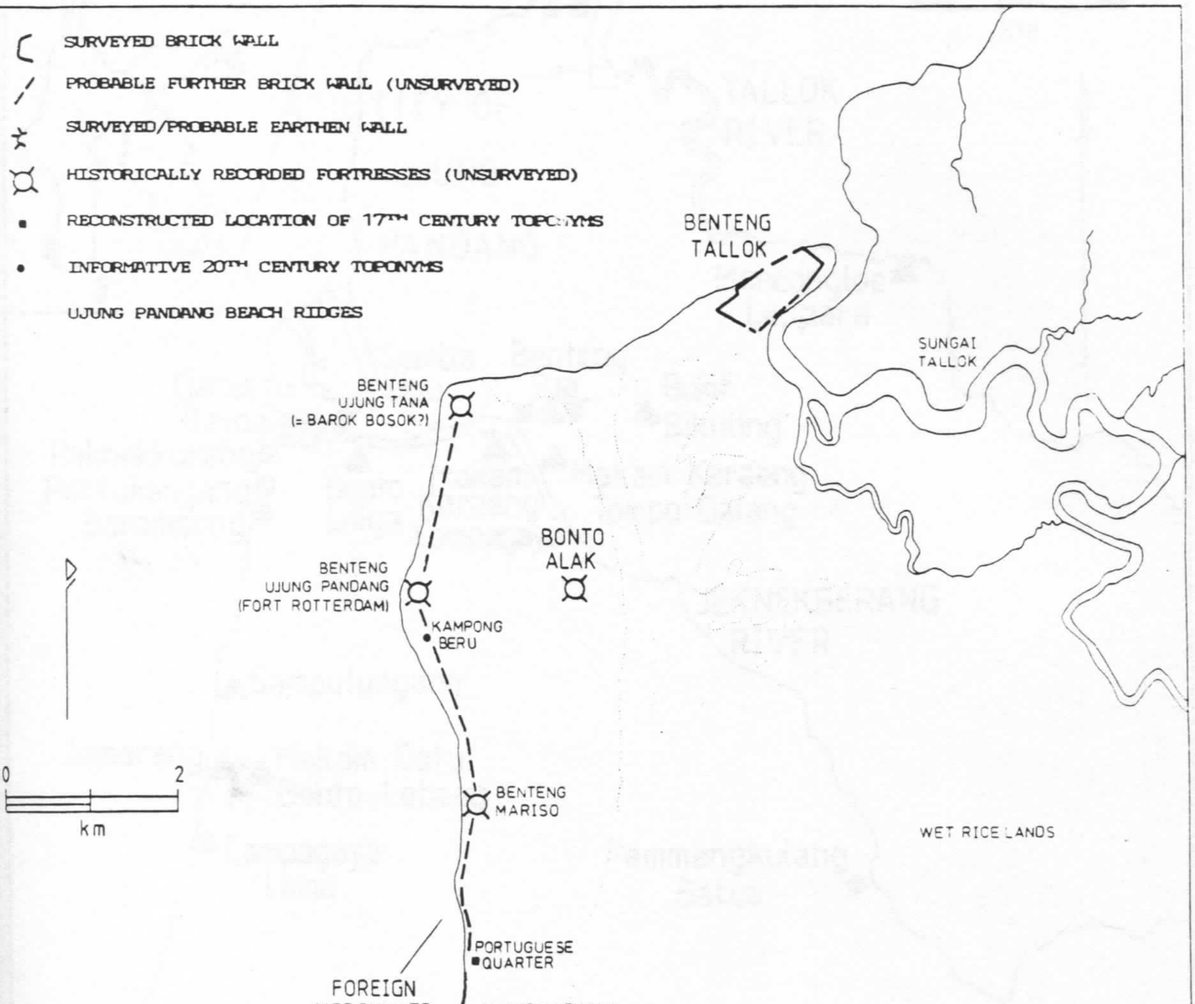

FIGURE E-1. RECONSTRUCTION OF MAKASSAR AND ITS FORTIFICATIONS 1667

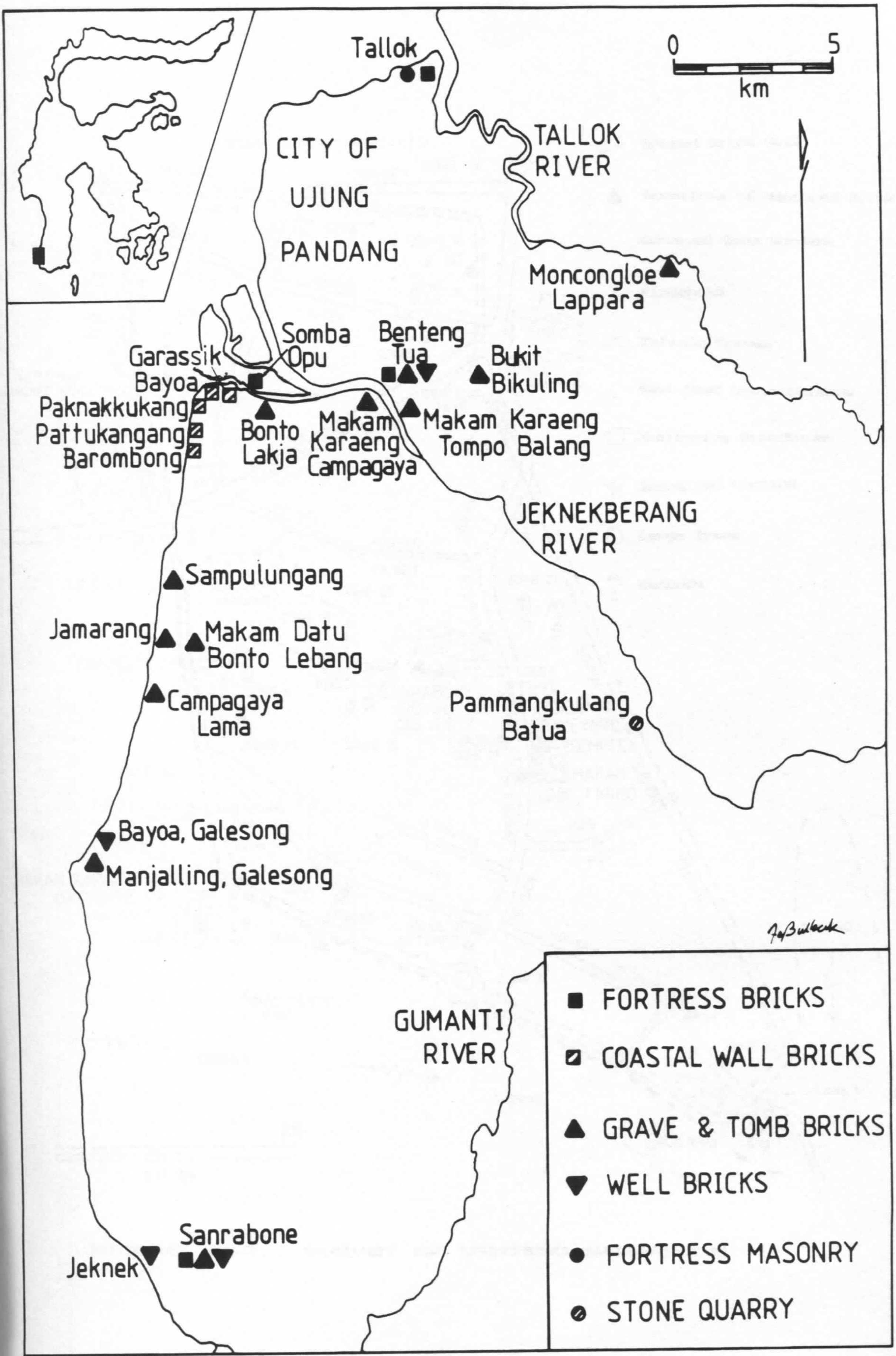

FIGURE E-2. LOCATIONS OF SSPHAP'S BRICK AND MASONRY SAMPLES

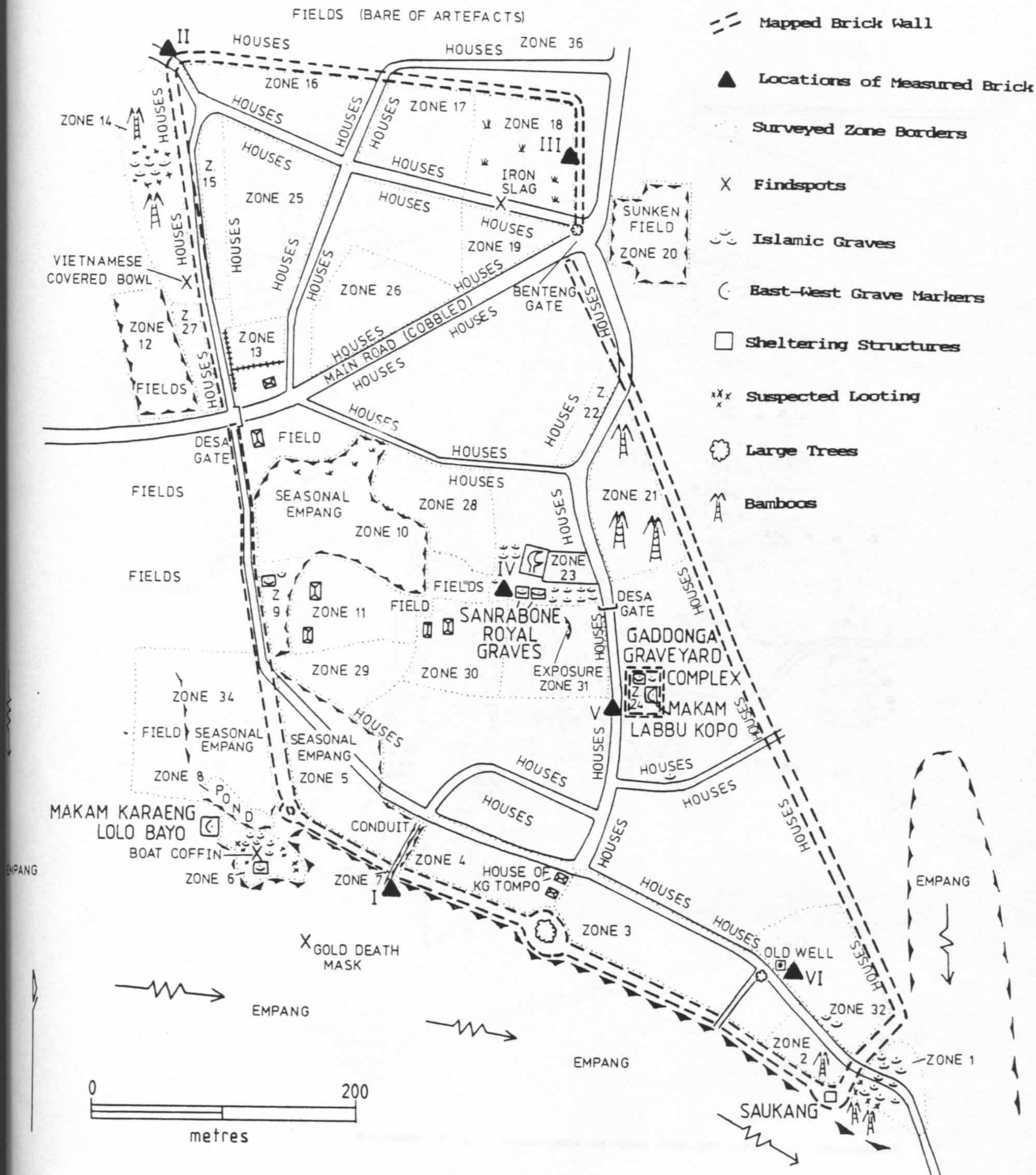

FIGURE E-3. SURVEY OF BENTENG SANRABONE

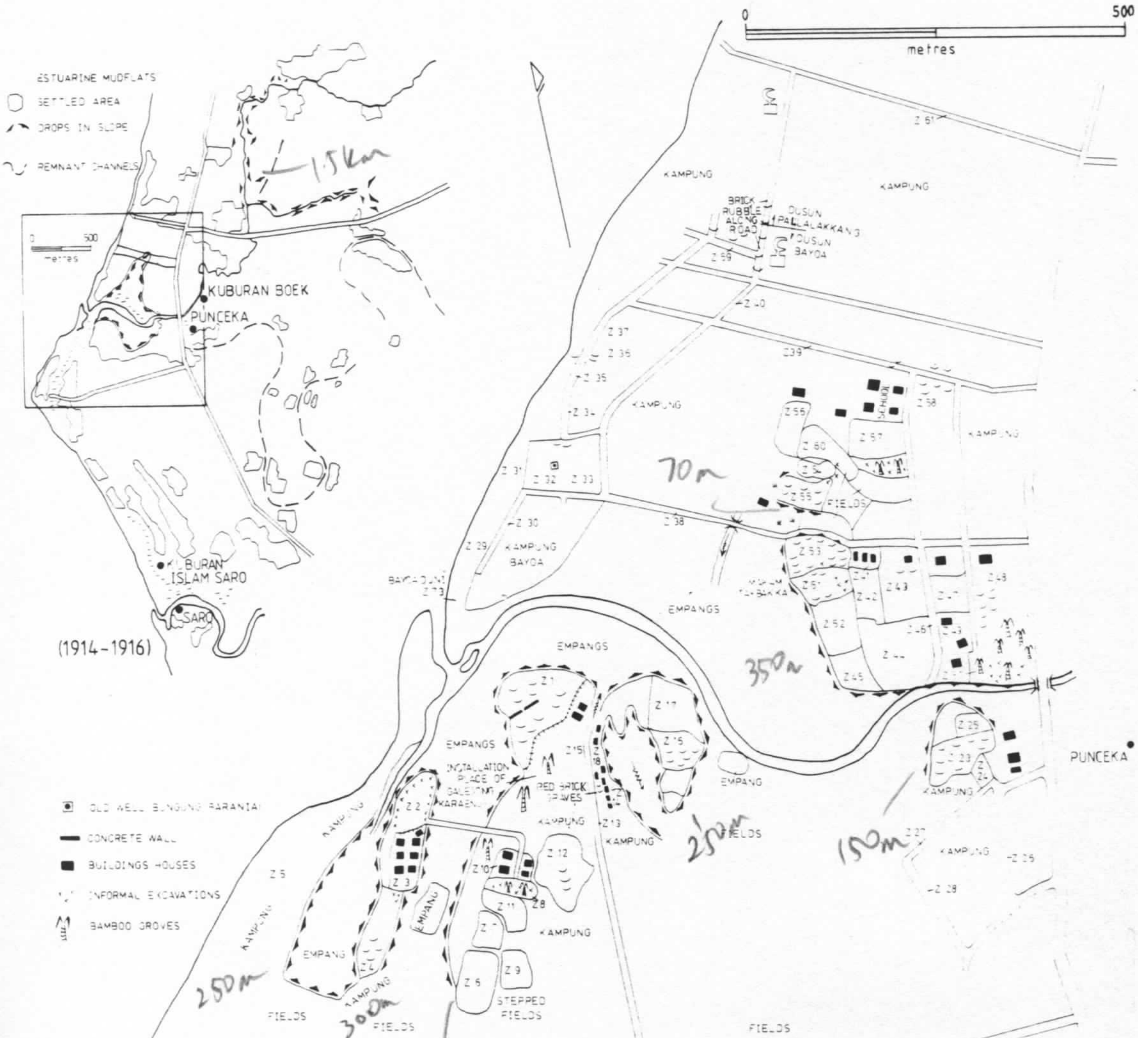

FIGURE E-4. ARCHAEOLOGICAL SURVEY OF KOTA GALESONG

Photo E-1.
The measurable masonry blocks left attached to their volcanic conglomerate matrix, Pammangkulang Batua (Gowa 84).

Photo E-2.
A section of the walls of Benteng Sanrabone exposed by a channel feeding a fish pond (Station I).
Note the layer of earth (now mixed with collapsed brick rubble) between the two lines of brick.

Photo E-3.
The 18th century brick *kobang* tombs, Benteng Sanrabone.



Photo E-4.
One of the square brick features, best interpreted as the brick foundation of an Islamic grave marker, Manjalling, Kota Galesong (T.16.14).

Photo E-5.
Line of brick rubble within dusun Bayoa running north into dusun Paklallakang, Kota Galesong.
Tentatively interpreted as brick grave foundations.

Photo E-6.
Makam Takbakka, Tabbuncinik, Kota Galesong.
Note its raised location with respect to the land below the ridge, and the apparent basal fill of brick and stone (to earthen walls?) where the road has cut into the side.

Photo E-7.
A partly intact, exposed segment of the brick wall around Kompleks Makam Gaddonga, Benteng Sanrabone.

Photo E-8.
Some of the grave foundations of large old bricks, Makam Sampulungang, exposed in the cliff face cut by the encroaching shoreline.

Photo E-9.
The grave of Karaengloe ri Jamarang, Jamarang Tua, showing the range of bricks arranged around the outline of the grave and into the surrounding brick platform.