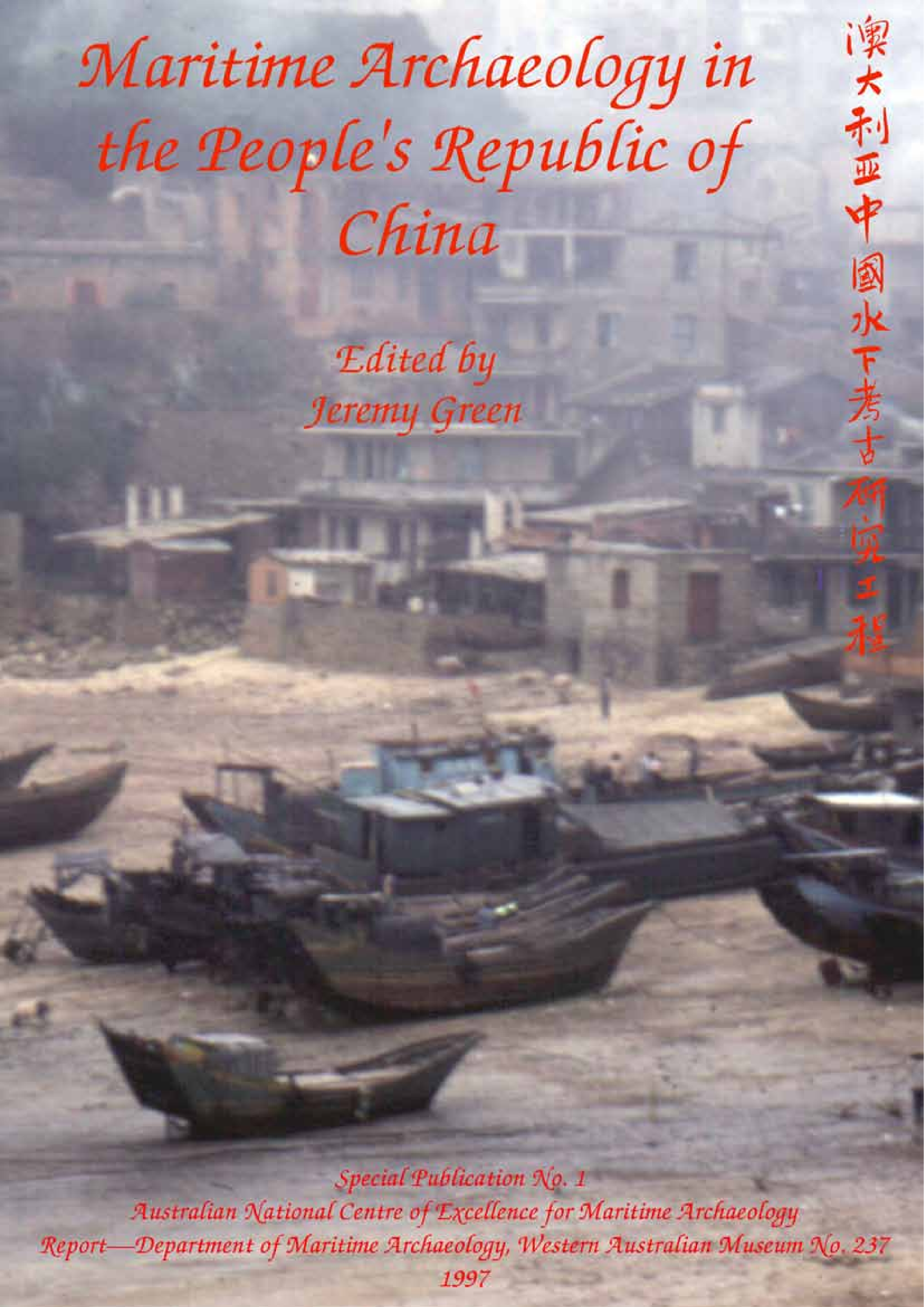
Maritime Archaeology in the People's Republic of China

澳大利亚中國水下考古研究工程

Edited by
Jeremy Green



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Part 1.
The Song Dynast Shipwreck at Quanzhou

Jeremy Green & Nick Burningham

Chapter 1. Chinese shipbuilding in a historical context

Jeremy Green

Figure 1. Museum of Overseas Communication History, Quanzhou, Fujian, the building housing the Quanzhou Ship seen from the West Pagoda of the The Kaiyuan Temple.

Figure 2. The Quanzhou ship in the Museum.

The origins of the Chinese 'junk' are still today not well understood. Hornell (1934) suggested that the concept for these vessels originated from bamboo rafts which can still be found today in parts of South China, Vietnam and Taiwan. Other authors have suggested that concept of building originated from a concept of replicating the septa of the bamboo: others disagree. This lack of understanding is largely due to the fact that East Asian vessels have never been systematically studied; partially because, in Asia, there is a lack of both written evidence and archaeological information. While many authors have described the 'junk' of the modern period (Audemard, 1957; Waters 1938, 1939, 1940, 1946 & 1947; Worcester, 1971, for example), such studies have lacked the breadth of comparable European works such as the studies of the Viking boats, the Medieval cog, Mediterranean Roman and Greek vessels and Post-medieval shipwrecks. The European studies have relied on extensive archaeological exacvation work and, where appropriate, thorough archival and iconographical studies. It is interesting to note that many hundreds of examples of archaeologiacl ship exacvations exist within the European context, whereas there are few examples of proper archaeological excavations of sites within the Asian region.

Chinese vessels fall into a number of categories: the large flat-bottomed vessels of the North China Seas or the inland waterways of China; the keeled vessels with a distinct V-shape from the Southern part of China; the 'dragon' boats belonging to the South and Southeast China Seas region; the sewn vessels of Hainan and parts of Vietnam; bamboo raft-type vessels of South China and Southeast Asia; and basket boats. In Korea there is a different tradition of boatbuilding with possibly connections with North China and Japan. Japan has a distinct tradition with vessels which resemble those of China, but it is unclear if the connections are with North China, or the Ruykuy Islands and hence Taiwan and Southeast Asia. In Southeast Asia, one can find vessels bearing no relationship to the Chinese shipbuilding traditions, and others with a mixture of Southeast Asian and Chinese traditions.

Much of the problem in resolving the origins of these vessels is that there is very little surviving information about shipbuilding, either in Chinese or Southeast Asian literature. Our first evidence occurs sporadically from the Tang dynasty in Chinese literature and paintings. The arrival of foreigners in China does little to clarify the picture, they either wrote little, and the Europeans in particular misunderstood much of what they saw and often dismissed it as inferior. Marco Polo stands out as one of the best, early chroniclers of Chinese ships and what he says about ships—as with other things—can often be confirmed.

Today, with an emerging archaeological studies in East and Southeast Asia, it is possible to overview the current and past thinking of the origins and development of Chinese 'junks'. Needham's encyclopedic work: *Science and Civilisation of China* (Needham, 1971) is a monumental study of great importance and significance and can be used a starting point for the analysis of Chinese shipbuilding. While some authors have written about Chinese ships, few have dealt with the issue in such a broad context. Although there are some authors who criticise Needham for his Sinocentric bias, the study is of great scholarly importance. Within the specific areas of shipbuilding Needham suffered from a lack of archaeological information, which at the time that he wrote was just beginning to emerge. Had this information been available his conclusions may have been different.

Needham (1971) was doubtless correct when he noted that it was regrettable that:

> Chinese naval architecture never found…its systemising scholar! At any rate one would not be far wrong in believing that the shipwrights of the Ming were probably the most accomplished artisans of any age in civilisation who were at the same time illiterate and unable to record their skill.

However, he seems to be confused on two issues: firstly, the significance of ocean-going vessels in China and secondly,

Figure 3. Map of East and Southeast Asia, showing main sites referred to in the text.

and more obviously, the question of the existence in China of ships with a keel in the traditional European sense.

Needham (1971) used the flat-bottomed Jiangsu or Pechili freighter as an example of a typical Chinese 'junk'. He qualified this generalisation by stating that 'Geographical factors have had considerable influence in differentiating the craft found along the coasts of China'. Some Chinese writers had noted the differences between the vessels of north and south China. A scholar of the 17th and 18th century Xie Zhan-Ren commenting on a passage in the *Ri Zhi Lu* (Daily Additions of Knowledge) of Gen Yan-Wu, itself finished in +1673, wrote as follows:

> The sea-going vessels of the Jiang-nan are named 'sand-ships' (*sha chuan*) for as their bottoms are flat and broad they can sail over shoals and moor near sandbanks, frequenting sandy (or muddy) creeks and havens without getting stuck…But the sea-going vessels of Fujian and Guangdong have round bottoms and high decks. At the base of their hulls there are large beams of wood in three sections called 'dragon-spines' (*long gu*). If (these ships) should encounter shallow sandy (water) the dragon spine may get stuck in the sand, and if the wind and tide are not favourable there may be danger in pulling it out. But sailing to the South Seas (Nan-Yang) where there are many islands and rocks in the water, ships with dragon-spines can turn more easily to avoid them.

Here Needham suggests that this is:

> … a reference to the better sailing qualities of ships with deep hulls and centreboards. With this passage in mind we may look again at Fig. 939 [Needham], where the *long gu* is the central strengthening member of the hull of the Fujian and Guangdong sea-going junk, with round bottom and high decks. Such timber is called a *long gu* by Chinese shipwrights, *but it should not be regarded as a keel in the European sense* [our italics]…for it is not the main longitudinal component of the vessel, this function devolving rather on the three or more enormous hardwood wales which are built into the hull at or below the waterline.

It is unclear from this passage if Needham has confused the strengthening wales with the true keel. He attributes *long gu* of flat bottomed vessels (which are a type of wale or chine wale), with the true keel of deep hulled vessels. The passage in the *Ri Zhi Lu* clearly indicated this error, since it refers to the *long gu* getting stuck in the sand—obviously wales cannot get stuck in the sand. Later, Needham (1971: 430) states: 'But Chinese ships, as we have said, were not always flat-bottomed; though lacking any true keel…' Needham quotes Xu Jing who states in the *Gao Li Tu Jing* (Illustrated Record of an Embassy to Korea) dated to 1124, that 'the upper parts of the vessel are bottom of the ship (deck) is level and horizontal, while the lower parts sheer obliquely like the blade of a knife…for since the bottom of the vessel is not flat.' Needham infers that this shape could be found in modern times in certain types of fishing vessels and smaller naval junks of the Qing dynasty and all sea-going junks of the south of China.

Needham (1971: 409) also refers to the *Tien Gong Wu* (Exploitation of the Works of Nature) by Song Ying Xing in 1637. Here a description of a canal grain-carrying vessel is given and then his description of the shipyards:

> The construction of the boat begins with the bottom. The strakes of the hull are built up on both sides from the bottom to a height (equivalent to that of the future) deck. Bulkheads are set at intervals to divide the vessel (into separate compartments), [we may interpret this statement as an indication that the vessels were built shell-first] and (the holds have) sheer vertical sides which are called *qiang*…The horizontal bars (*heng mu*) which grasp the mast's foot below this are called 'ground dragons' (*di long*), and these are connected by components called 'lion-tamers' (*fu shi*), while underneath them lies another called a 'lion-grasper' (*na shi*). Under the 'lion-tamers' are the 'closure pieces' (*feng tou mu*) otherwise known as triple tie-bars (*lian san fang*)…

Song Ying Xing mentions that the ocean-going vessels from Fujian and Guangdong have bulwarks of half bamboo for protection against the waves, examples of this can be seen in the illustrations of the Mongol invasion of Japan (see below).

Wang Gungwu (1958) suggests that there were no large Chinese-built vessels involved in the Nanhai trade in the Tang, although it is known that large Chinese vessels sailed to Korea and Japan. However, Wang Gungwu states that:

> 'On all these routes [from Guangdong south and then east] sailed Chinese and K'un-lun [Vietnamese or Southeast Asian] as well as Arab, Persian, Ceylonese and Indian ships. Only past the Nicobars, and especially past Malabar it is doubtful whether Chinese and K'un-lun were ever found at this time [800 AD].

However, by the 15th century according to Ch'oe Pu:

> From Su-chou, Hang-chou, Fukien, Kwangtung, and other places in our country, sea-going smugglers go to Champa and the Islamic countries to buy red sandlewood, black pepper and foreign perfumes (Meskill, 1965).

The illustrations of Chinese vessels are limited in number. One of the earliest illustrations of Chinese ships is on a stele in the Wan Fu Su temple at Chengdu dating to the Liu Chao Period (Six Dynasties 3rd to 6th centuries AD, Fig. 6). Slightly later are some ships shown on the frescos in the Dunhuang cave

Figure 4. Map of Fujian Province showing main sites.

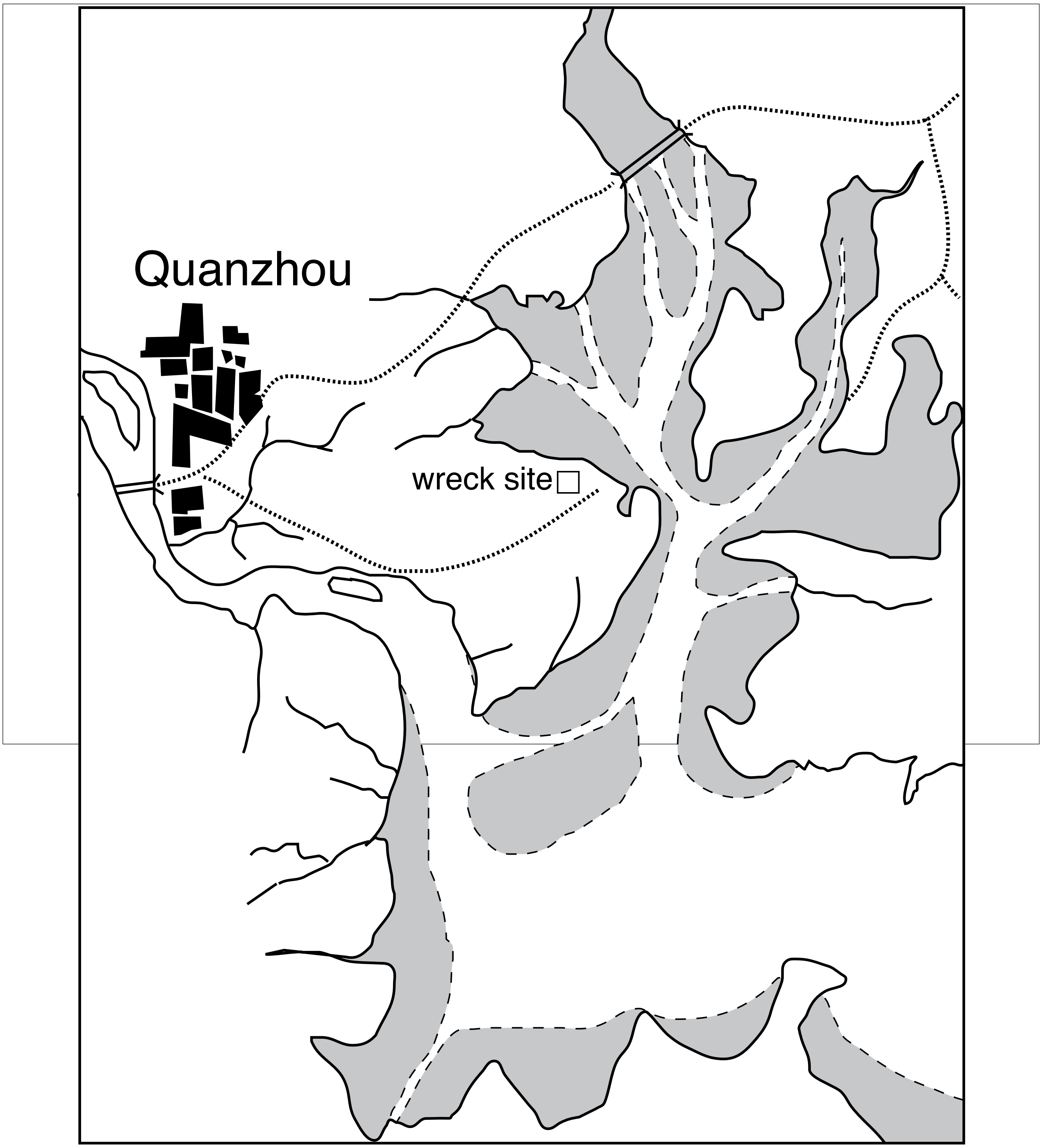

Figure 5. Map of Quanzhou showing site of Quanzhou and Fa Shu sites.

temples in Gansu Province, dating to the 7th century (Fig. 7). Both are mentioned and illustrated by Needham (1971: 646) who suggests that these vessels have steering oars rather than axial rudders. While the illustrations are rather unclear, the largest ship in the Dunhuang cave-temple frescos has square ends, a square sail and what looks like poles or oars at both ends of the vessel. Audemard (1957) illustrates a large range of vessels with axial rudders and strange steering sweeps set at the stern in pairs or singly projecting from the transom above the rudder (Fig. 8). These are different from the sweeps, possibly *yulo* (*yuloh*) that are set at the side of the vessels. Audemard's illustrations come from an 18th century description of warships entitled *Tu Shu Ji Cheng* (Imperially Commissioned Compendium of Literature and Illustrations, Ancient and Modern). It is, therefore, possible that the Dunhuang illustration, like the Audemard illustrations, show a combination of stern sweeps and an axial rudder.

The Wan Fu Su Temple stele has a well defined square sail, a large stern structure and a square bow, in this illustration it is uncertain if a rudder depicted. Needham suggested that these

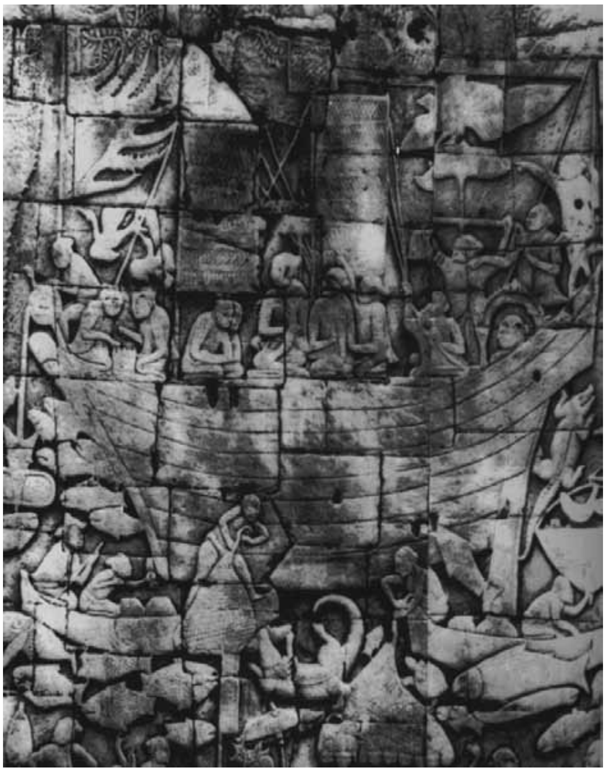

Figure 6. Carving of a ship on a 3–6 century AD stone stele in the Wan Fu Su Temple, Chendu (from Needham 1971).

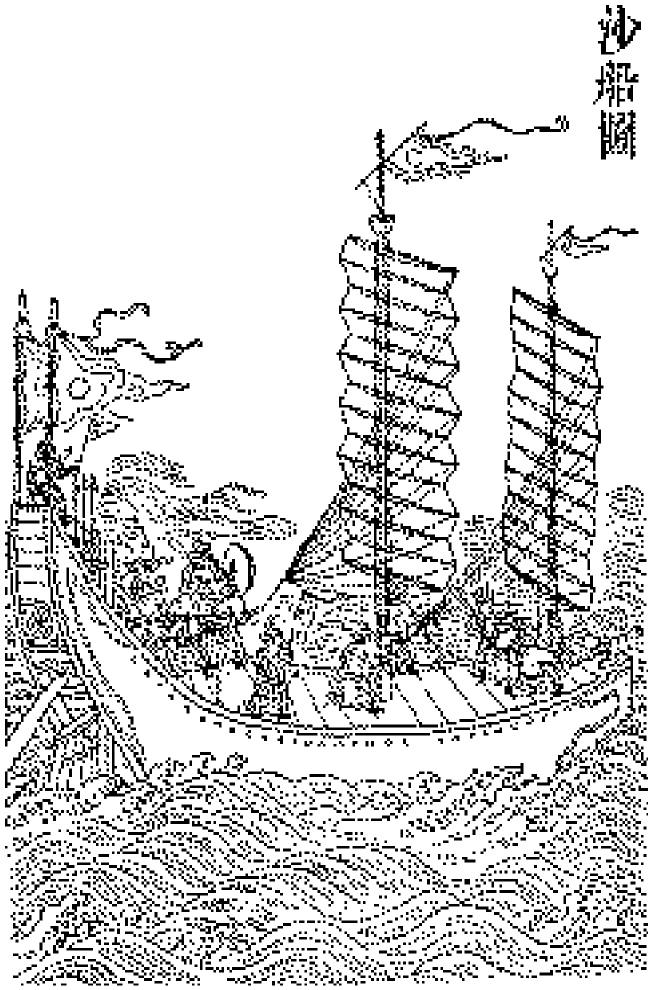

Figure 8. Illustration of fighting vessel showing axial rudder and 'steering' oar (from Audemard 1957: fig. 23)

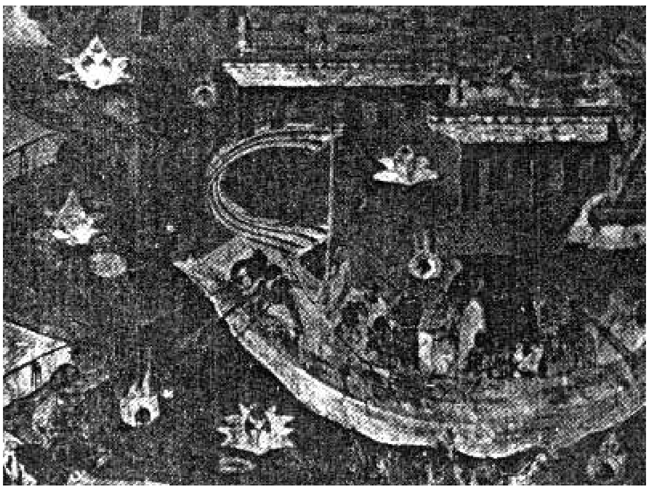

Figure 7. Frescos from the Dunhuang cave temples in Gansu Province, dating to the 7th century (from Needham 1971).

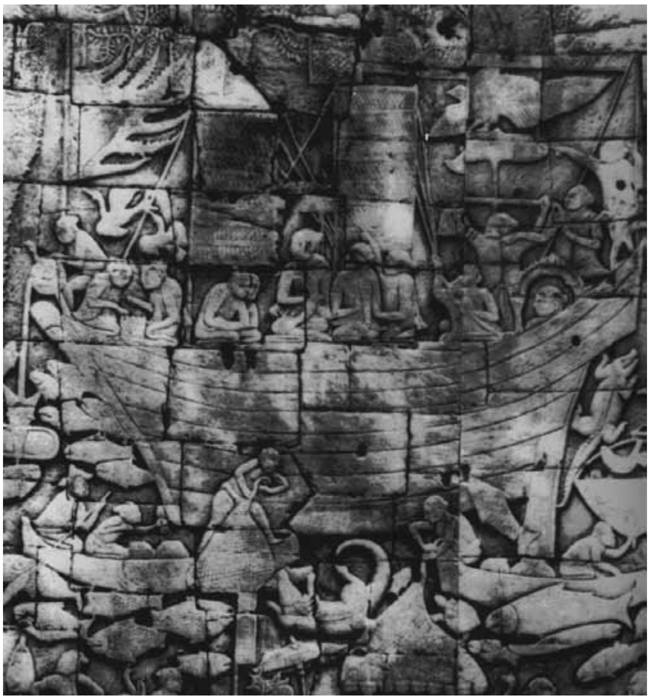

Figure 9. Vessel carved on the Bayon at Ankor Thom, Kampuchia dated to about 1185 (from Needham 1971).

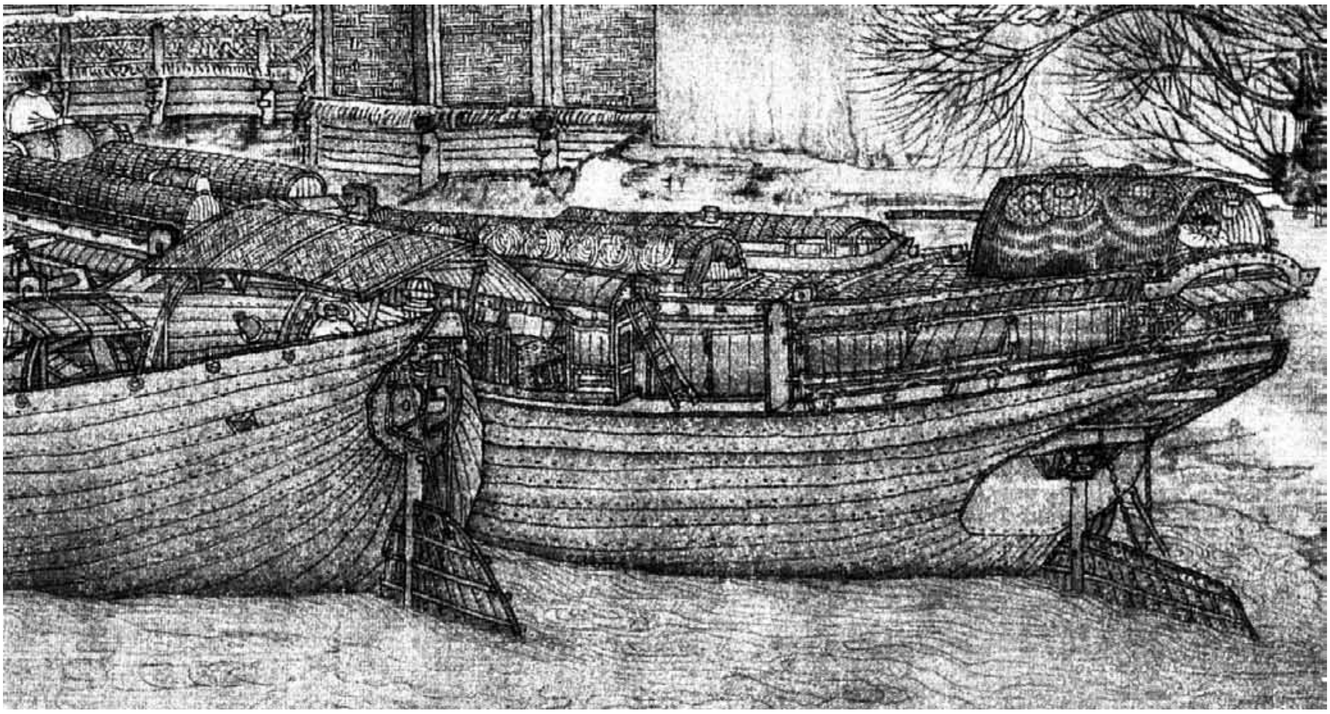

Figure 10. Two ships from the Song Dynasty scroll by Zhang Zeduan entitled *Qing Ming Shang Ho Tu* (Going up the river the capital (Kaifeng) at the Spring Festival), showing *fluit*-like stern (left) and overhanging transom.

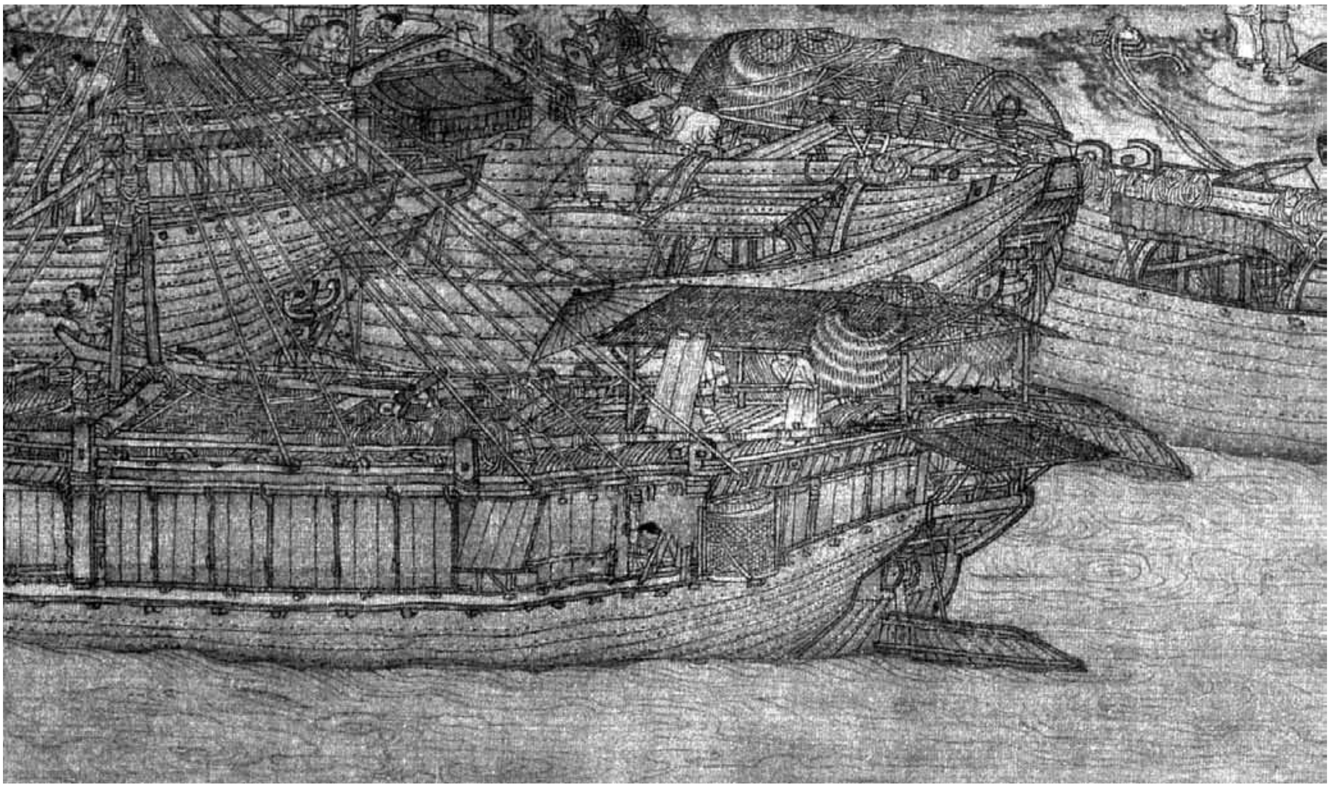

Figure 11. The stern of a passenger-carrying vessel showing the chine and overhanging transom, from the Song Dynasty scroll.

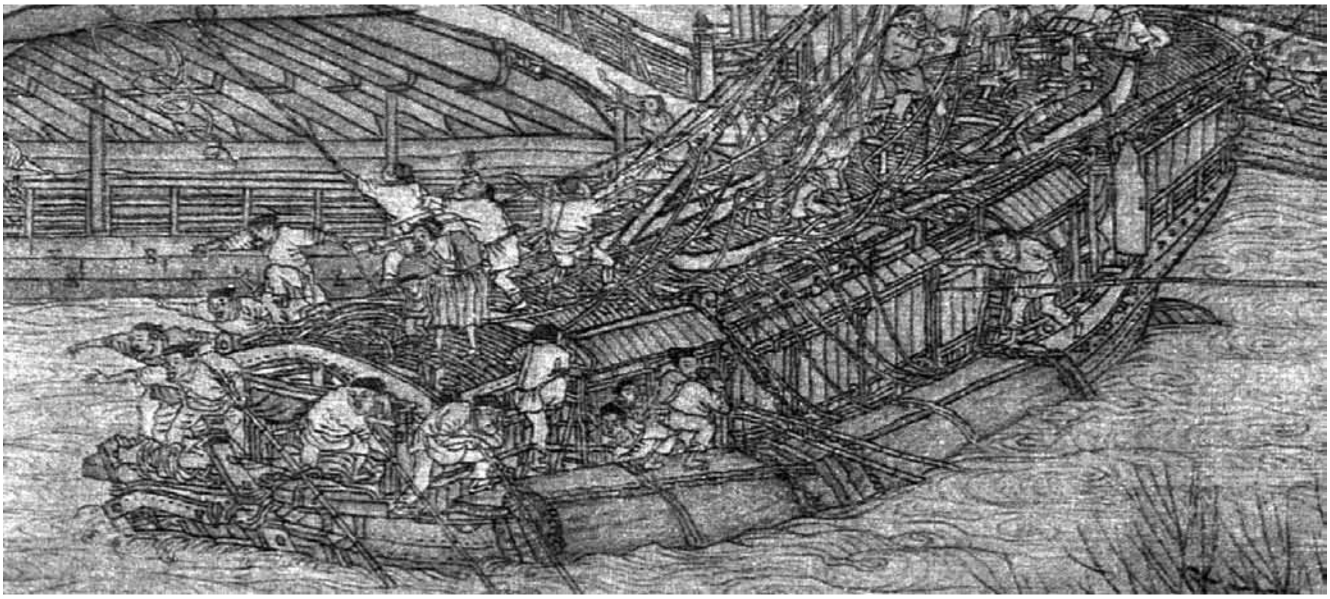

Figure 12. A detail from the Song Dynasty scroll showing a vessel negotiating a bridge, with detail of the bow arrangement..

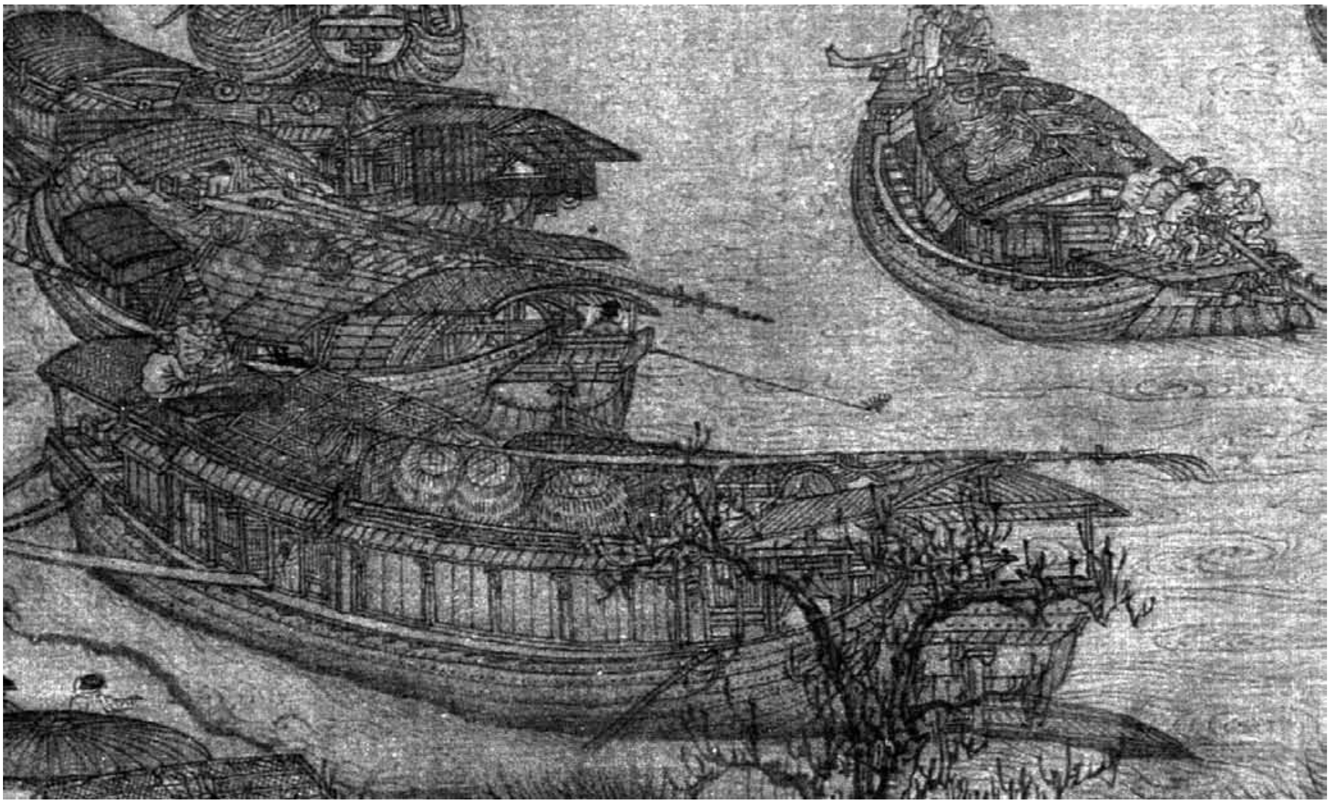

Figure 13. Four vessels from the Song Dynasty scroll showing the stern arrangement.

illustrations of vessels may be of Indian rather than Chinese, particularly because of their Buddhist origins.

The carving on the Bayon temple at Angkor Thom, Cambodia, dated to 1185 shows, among other vessels, a large two-masted ship with forestays, mat and batten sails, multiple sheets and no mast shrouds (Fig. 9). The vessel is thought to be Chinese since it has many characteristics typical of a Chinese ship, and is relatively untypical within the illustration where other, obvious Southeast Asian vessels appear. There appears to be two flag poles with forestays: a jack staff (at the bow) and an ensign staff or at the stern. The jack staff flag has multiple points (typically Chinese). At the top of the fore and main masts there seems to be a small square mat sail (?), flag or crows-nest. The ensign flag pole has a mattting flag. At the bow a sailor is operating the anchor windlass and lifting a crown stocked anchor. Sitting on the deck in pairs are six people apparently not engaged in any nautical activity (possibly merchants). Aft of them are two sailors working the fore and main sheets. Aft again are three people standing apparently looking forward and involved in the activity of sailing. The

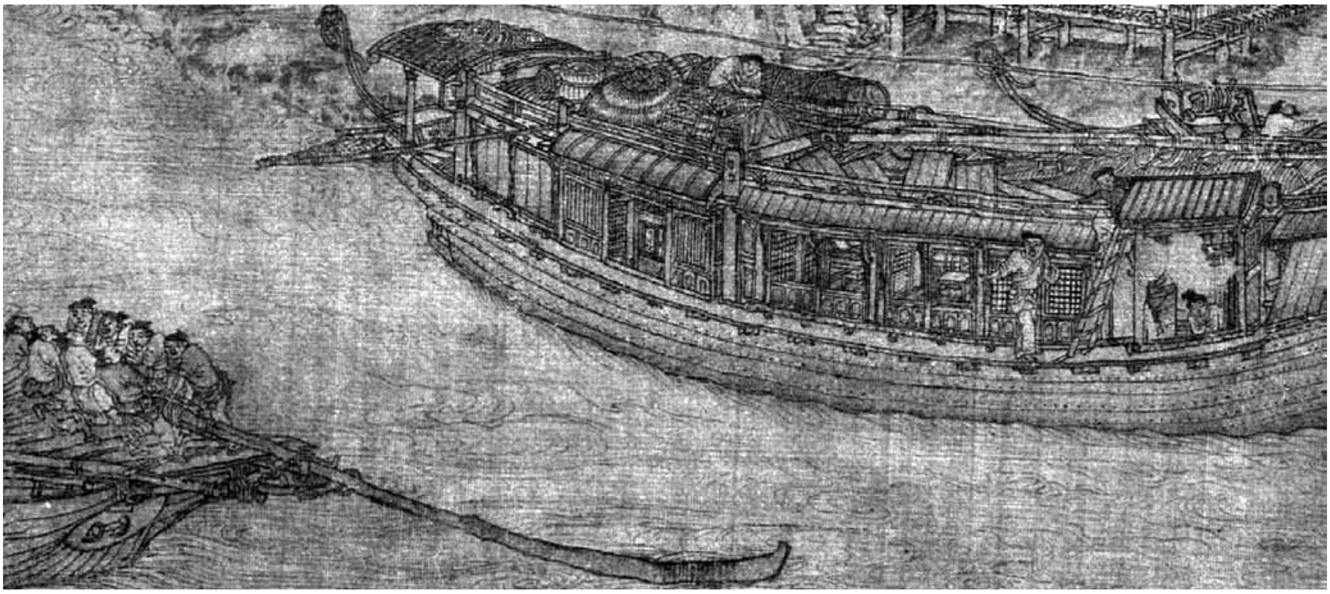

Figure 14. Detail of the steering arrangement on a vessel with rudder unshipped, from the Song Dynasty scroll.

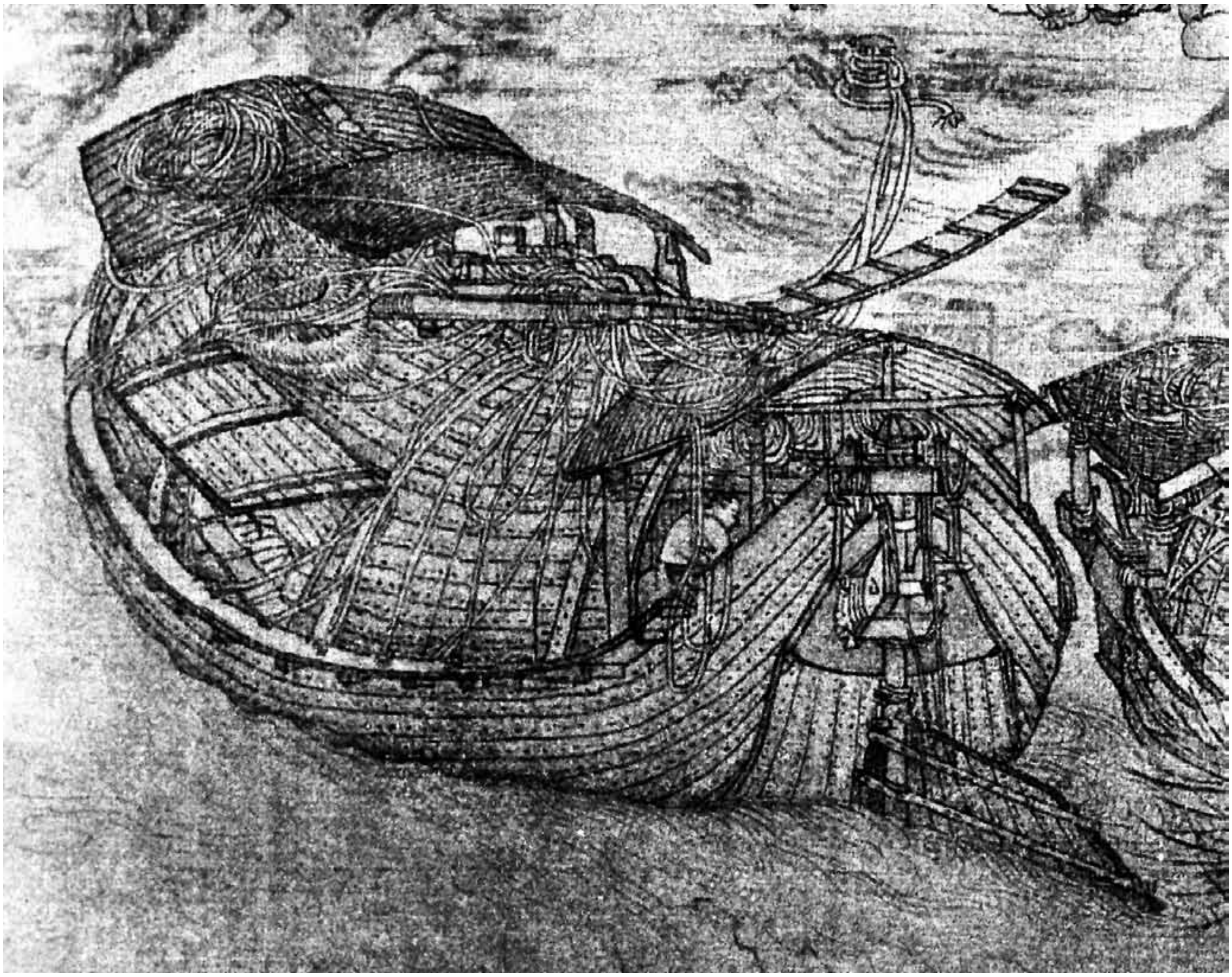

Figure 15. Details of stern arrangement of a vessel with a hard chine from the Song Dynasty scroll.

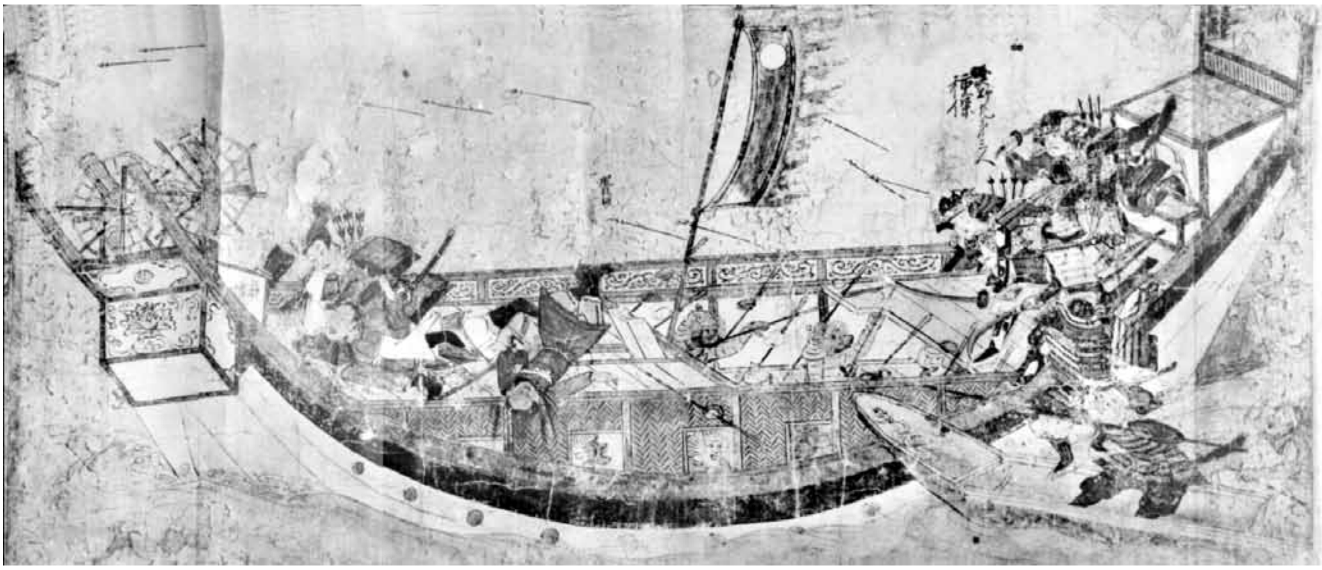

Figure 16. The *Moko Shurai Ekotoba* or Illustrations and Narrative of the Mongol Invasion of Japan, produced in 1292 showing a Mongol vessel under attack by a small Japanese vessel.

Figure 17. Large Mongol vessel (foreground) retreating two Mongol vessles advancing, from the *Moko Shurai Ekotoba* .

head of one person shows just above the gunnel at the line of the stern post and is presumably the helmsman. The stem post is slightly concave and thicker at the top. There seem to be eight strakes, the stern top three strakes extend to form a counter over the sternpost. The sternpost is much narrower than the stem extending from the counter down two strakes where it combines into an extended rudder which projects below the keel. The carving is unclear and some writers have suggested that it represents a quarter rudder rather than an axial rudder but this is unconvincing. Possibly the confusion is the result of the stone mason unfamiliarity with ships below the waterline.

Large river vessels of the Song Dynasty are illustrated in the famous scroll by Zhang Zeduan entitled *Qing Ming Shang Ho Tu* (Going up the river the capital (Kaifeng) at the Spring Festival) and painted with meticulous care sometime around 1126 (Figs 10–15). It shows three separate groups of vessels, the down-stream group has six vessels, the middle group shows a large vessel, bows-on, negotiating, with difficulty, the passage under a bridge and the upstream group shows two vessels tied up to the river bank. The largest vessel is about 15 metres long. The vessels all have no noticeable sternpost and the axial, semi-balanced rudders appear to be fixed on a hinge system on the transom with chains so that they can be raised and lowered. There are three different types of vessels:

1. Vessels with the hull planking sweeping up, in a uniform manner, to a small, high, vertical transom, reminiscent of the Dutch *fluits* of the early 17th century (Fig. 10 left).
2. Vessels with a small counter overhanging a small low transom and with a noticeable chine indicating a flat bottomed vessel (Figs 11 & 14).
3. Vessels with a large low transom and a considerable over-

Vessel No	Direction	Features
C1 (large) Fig. 16	L	Viewed three quarters bow-on. Windlass on bows with crooked support struts, c 9 oar holes, oars shipped, wicker wash boards with 4 square 'windows' (note as described by Song Ying Xing, above), raised decking, level with top of wash boards, running from stem area back to about midships, aft a ladder (?) down to the deck below, indication of deck, raised deck in aft quarter. Flag pole midships. Stern stepped with one small step and one larger step, with what looks like tiles. Axial rudder in a slot. The vessel appears to have a hard chine
C2 (large) Fig. 17	L	Viewed three quarters stern-on. Similar, but smaller than C1, strong sheer. Windlass on bows with crooked support struts, 4 oars in operation, 3 rowers facing forward, oars have small handle at end indication that they were sculling (yuloa) oars, wicker wash boards with no 'windows', the raised decking, level with top of wash boards runs whole length of vessel (unlike C1). No flag pole. Stern stepped with one small step and one larger step. No step forward but 'flanges' on gunnel. Axial rudder set in slot at stern, hard chine, indication that the flat bottom runs upwards past rudder slot to false stern transom. At least 3 drums or gongs being used (sounding alert?). Square shield at stern.
C3 (medium) Fig. 17	R near	Strong sheer. Vessel appears to be approaching and attacking the Japanese on board Vessel C1. This vessel has a crooked support structure with the windlass unshipped possibly to allow archers to operate in the bow section. This vessel seems to have two large masts the aft leaning back towards the stern the forward leaning towards the bow. The illustration is unusual as it cuts off the lower part of both C3 and C4 with the background of C2. This may be an artistic convention or a repair to the scroll. On the stern of the vessel a steersman (?) is seated on the single step. Little can be seen of the interior of the vessel because of the screening of C2. Evidence of wash screens on far side of vessel. Square shields at bow.
C4 (medium) Fig. 17	R far	Similar to and behind C3 (obscured and fragmentary). No evidence of crooked structure, largely obscured by C3. Square shields at bow.
C5 (small) Fig. 18	R far	Small, very crowded vessel with slight sheer flattening at bow. Bow lateral section is slightly concave (downwards). Ring on front with small bow transom. Wash strake of some sort, uncertain stern. Vessel appears to be round bottomed. Evidence of oars or yuloa. Occupants with padded 'armour', numerous shields with swastika and lotus-form tops. Numerous incoming arrows.
C6 (small) Fig. 18	R near frag.	This vessel has similar ring in bow, round bottomed. Otherwise quite different with wicker wash boards, a steep bow with section at the top flattening to the front with a small flag pole. Numerous incoming arrows.
C7 (?) Fig. 19	R frag.	Section of crowded vessel with steep bow, and smooth sheer with no recurve at bow, round bottomed. Bow ring and small flag pole on bow. Decorated wash board and small mast without sail. Shields are lotus-form with square section in centre, possibly a peep hole.
C8 Fig. 20	L near frag.	Vessel moving away from the action, largely occupied with non-combatant personnel. Rowed with 2 oars visible (far side, near side obscured). Axial rudder. Square flat 'tiled' area on poop with upward-sweeping poop. Wicker shields. Pole mast. Curved and decorated square stem with 2 projecting horizontal beams as part of continuation of sheer.
C9 Fig. 20	L mid frag.	Vessel, lower part obscured, stern upward-rising with upward projecting beams continuing sheer line. Part of rugger slot in stern, but rudder not visible. Wicker shields and wicker washboards running along mid body of ship. Pole mast and fore mast. Stem with two slightly upward projecting beams with suspended anchor.
C10 Fig. 20	L far frag.	Two oars visible (far side, near side obscured). Flat stern as C8 with 'tiles'. Decorated sheer. Main and aft mast. Bow section with series of 'steps' up to flat area with ornate ironwork (?) two horizontal projecting beams
J1 Fig. 21	L near	Small crowded vessel with axial rudder, hard chine being rowed with 6 sets of yuola (oars have clear right angled stub which the oarsmen are grasping. Oarsmen, facing aft crouch on an external framework. The rudder has a rope for lifting or tilting. There is a small stocked anchor which seems to have a stone(?) stock at right angles to the two shafts. See Fig. 21.
J2 Fig. 21	L far	As J1 but 4 rowers
J3, 4 & 5 not illustrated		Three small rowed vessels with oarsmen facing forward. Axial rudder in a transom thwart beam with slot for shaft of rudder.

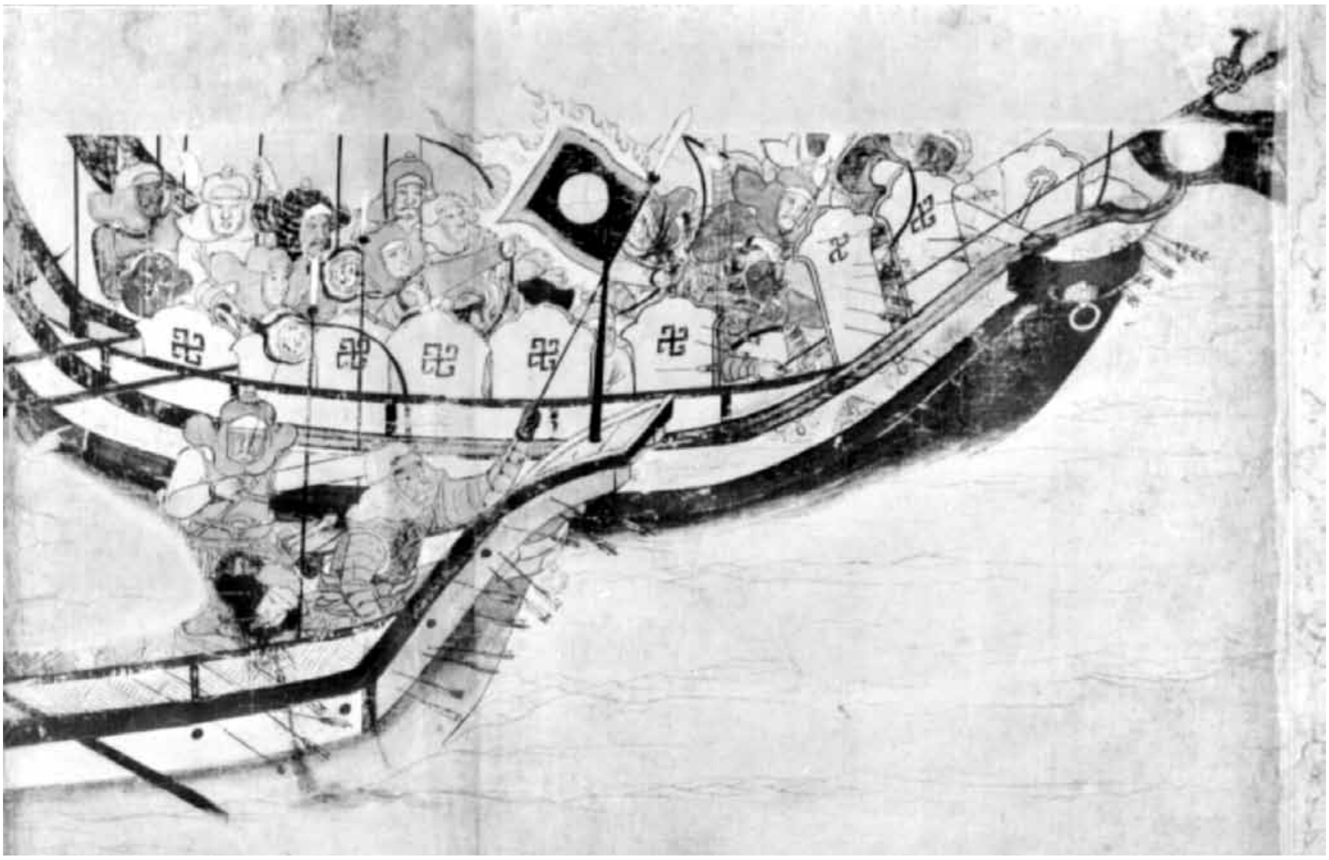

Figure 18. Two medium sized Mongol vessels under attack, from the *Moko Shurai Ekotoba* .

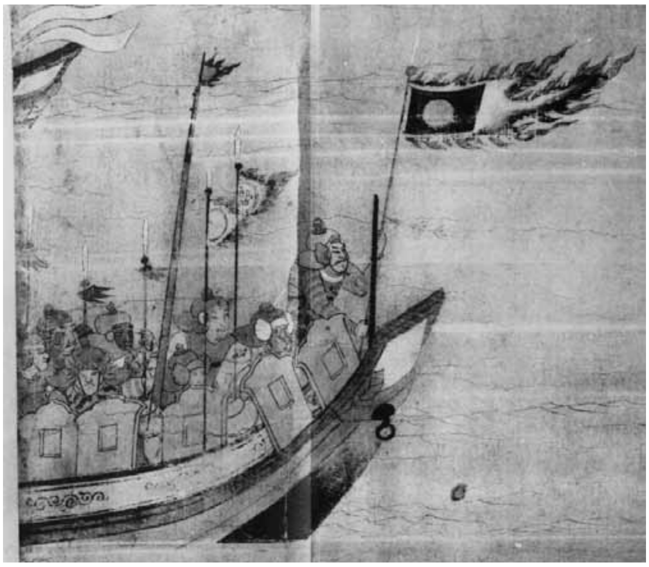

Figure 19. A fragment from the *Moko Shurai Ekotoba* showing medium sized Mongol vessel.

hanging counter. The planking is uniform with no chine (Fig. 10 right).

The vessels all show very clearly the nail pattern on the lower part of each strake, except where the vessel has a flat bottom (type 2) where the nailing is on both sides of the strake. It is uncertain if the vessels are clinker- or carvel-built, but at the transom there is no evidence of clinker, suggesting carvel construction with skew nails. The masts which are used to attach the tracking lines are bipod. While these vessels are obviously river-craft, their construction is of great interest because of the detail of the illustration.

The *Moko Shurai Ekotoba* or Illustrations and Narrative of the Mongol Invasion of Japan, produced in 1292 and preserved in the Imperial Household Museum illustrates the Second Mongolian invasion of Japan in 1281 (the first was in 1274) (Figs 16–20). The scroll illustrates the adventures of the nobleman Takezaki Suenaga and it has been suggested that he was responsible for illustrating part of the scroll. The central part of the maritime scenes from the scroll show two large Chinese or Mongolian vessels retreating to the left. From the right (in the direction of reading and chronology) come the Japanese in small vessels to attack the Chinese fleet (Fig. 16). At the left come some vessels to counter this attack and some in retreat. The scroll has been damaged and possibly repaired, but it is lively, and suggests an active engagement between a small lightly armed Japanese force against a larger and more unwieldy Chinese force. The two large Chinese vessels have several interesting features. Because of the complexity of these illustrations and their significance, their features are

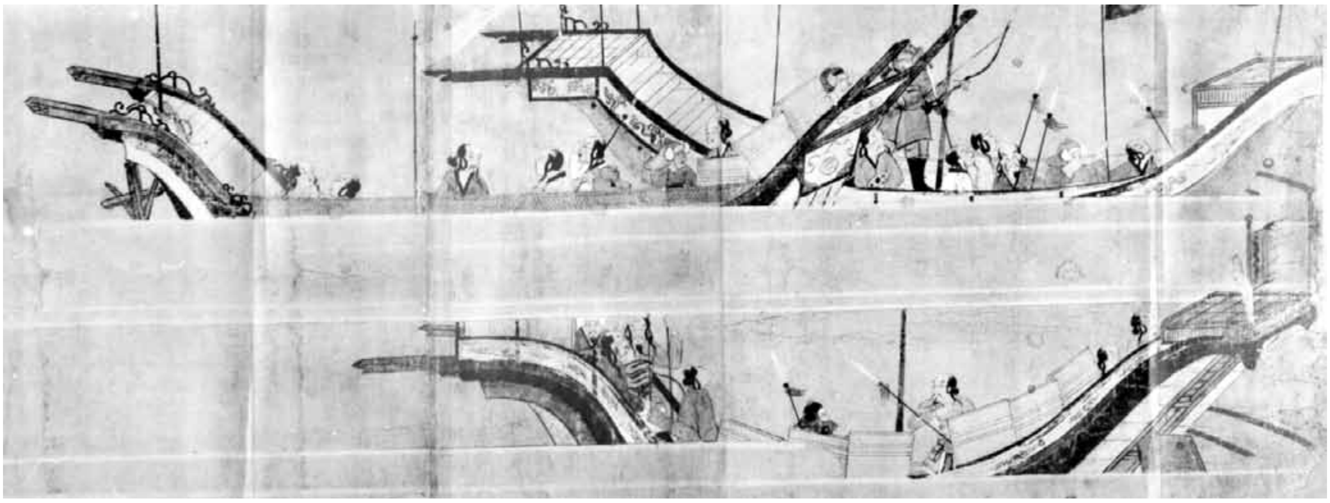

Figure 20. Fragments from the *Moko Shurai Ekotoba* of three vessels.

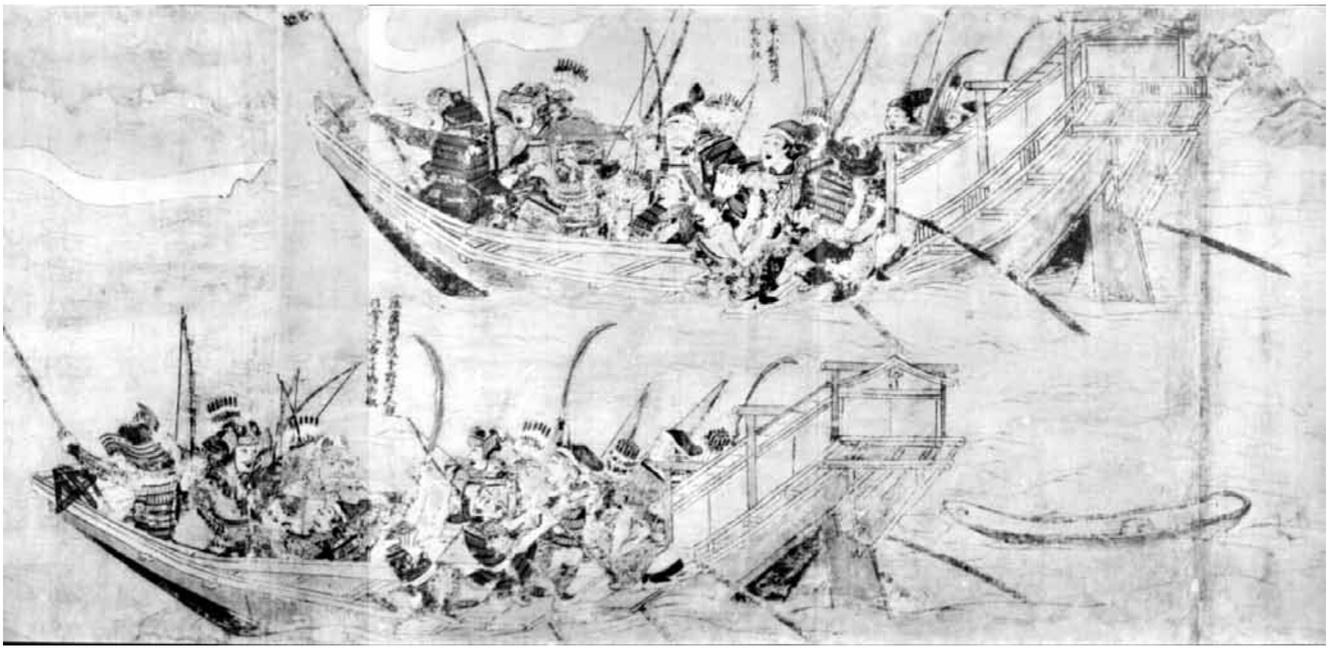

Figure 21. Two medium sized Japanese vessels advancing on Mongol fleet, from the *Moko Shurai Ekotoba* .

tabulated in Table 1.

Most invading vessels and some shields on these vessels carry a device with light circle (Moon?). Vessels C1–4 have three types of people on board: rowers, dressed in tunics with shaved heads; warriors with head dress which seems to have winged effect at side of face, mostly bearded and some dark skinned; and others, possibly important people, wearing boots and either being slaughtered by Japanese or sitting in area furthest away from direction of attack. Soldiers in C 5–7 are distinctly different from C1–4, with padded dress and beardless and in some cases dark skinned. Shields are distinctive with recurving swastika and lotus-form tops. No evidence of other types of people. This illustration is particularly important because the vessels are contemporary with the Quanzhou ship and are clearly illustrated. It is known that there were vessels from South China and Korea involved in this invasion. This work merits a more thorough study to analyse the details and significance of the vessels and their occupants.

Another important source from the period of the Quanzhou ship is Marco Polo who resided in China between 1275 and 1292. He wrote on Chinese river shipping and also on sea-going vessels of Guangdong and Fujian. As with all translations one needs to approach the works with caution. For example, there are interesting variations in the translation of *The Travels of Marco Polo*. The version translated by Latham (1958) gives the following account at the beginning of Chapter Six: From China to India:

> To begin with, we shall tell you first of the ships in which merchants trading with India make their voyages.
> This then I would have you know, is how they are made. They are built of a wood called spruce or fir. They have one deck; and above this deck, in most ships, are at least sixty cabins, each of

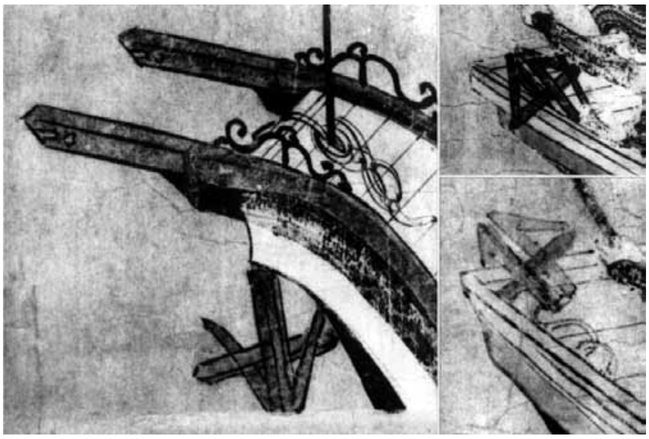

Figure 22. Anchors from Mongol (left) and Japanese vessels (right) in the *Moko Shurai Ekotoba*.

which can comfortably accommodate one merchant. They have one steering oar and four masts.

Needham (1971) gives an alternative and unreferenced translation which will be quoted here in full. Note the differences between the two versions:

We shall begin first of all to tell about the great ships in which the merchants go and come into India through the Indian Sea. Now you may know that those ships are made in such a way as I shall describe unto you.

I tell you that are mostly built of the wood which is called fir or pine.

They have one floor, which with us is called a deck, one for each, and on this deck there are commonly in all the greater number quite 60 little rooms or cabins, and in some, more, and in some, fewer, according as the ships are larger or smaller, where, in each, a merchant can stay comfortably.

They have one good sweep or helm, which in the vulgar tongue is called a rudder [the earliest recording of the word rudder seems to be around the early 14th century, this may imply that Marco Polo was unfamiliar with the term rudder and an axial rudder in particular, since at that time quarter rudders in the Mediterranean were the norm].

And four masts and four sails and they often add to them two masts more, which are raised and put away every time they wish, with two sails, according to the state of the weather.

Some ships, namely those which are larger, have besides quite 13 holds, that is, divisions, on the inside, made with strong planks fitted together, so that if by accident that the ship is staved in any place, namely that it either strikes on a rock, or a whale-fish striking against it in search of food staves it in. And then the water entering through the hole runs to the bilge, which never remains occupied with things. And then the sailors find out where the ship is staved and then the hold which answers to the break is emptied into the others, for the water cannot pass from one hold to another, so strongly are they shut in; and they repair the ship there and put back the goods which were taken out.

They are indeed nailed in such a way; for they are all lined, that is, that they have two boards above the other.

And the boards of the ship, inside and outside, are thus fitted together, that is, they are in the common speech of our sailors, caulked both outside and inside, and they are all well nailed inside and outside with iron pins. They are not pitched with pitch, because they have none of it in those regions, but they oil them in such a way as I shall tell you, because they have another thing that seems better than pitch. For I tell you that they take lime and hemp chopped up small and they pound it all together, I tell you that becomes sticky and holds like birdlime. And with this thing they smear their ships and this is worth quite as much as pitch. Moreover I tell you again that when the great ships wish to be decorated [?], that is to be repaired, and it has made a great voyage or has sailed a whole year or more and needs repair, they repair it in such a way. For they nail yet another board over the aforesaid original two all round the ship without removing the former at all, and then there are three of them over the whole ship everywhere, one nailed above the other, and then when it is nailed they also caulk and oil it with the aforesaid mixture and this is the repair which they do. And at the end of the second year at the second repair they nail yet another board leaving the other boards so that there are four. And this way they go each year from repair to repair until the number of six boards, the one nailed on the other. And when they have six boards the one upon the other nailed then the ship is condemned and they sail no more in her on too high seas but in near journeys and good weather and they do not overload them until it seems to them that they are of no more value and that can make no more use of them. Then they are dismantled and broken up.

Much of what Marco Polo says here can be related to the Quanzhou ship, however, the statements about the watertight bulkheads are of considerable interest and presents an apparent conflict with the archaeological record. Marco Polo is the origin of the theory that Chinese ships had bulkhead compartments that were completely watertight. Later writers, up to and including Needham followed this suggestion. However, every Asian vessel with bulkheads that has been excavated by archaeologists, shows evidence that the bulkheads, although sealed with luting, had limbers to allow water to flow between the compartments. Additionally, in alll the wrecksites there has been no evidence of stoppers or bungs in the limbers, indicating at the time of sinking the limbers were open. This issue is discussed in more detail below. The statement about the multiple planking is also of great interest, since it provides historical evidence for a technique that would be hard to understand from the archaeological evidence alone.

Ibn Battutah, who was in China in 1347, was a less detailed observer than Marco Polo. He noted that:

We stopped in the port of Cálicút, in which there were at the time thirteen Chinese vessels, and disembarked…On the Sea of China travelling is done in Chinese ships only, so we shall describe their arrangements.

The Chinese vessels are of three kinds; large ships called *chunks* [in other translations*jonouq,* in Needham *chuan*], middle sized ones called *zaws* (dhows) [elsewhere *zaw*, *cao* or *sao*] and the the small ones *kakams*. The large ships have anything from twelve down to three sails, which are made of bamboo rods plaited into mats. They are never lowered, but turned according to the directiopn of the wind; at anchor they are left floating in the wind. A ship carries a complement of a thousand men, six hundred of whom are sailors and four hundred men-at-arms, including archers, men with shields and arbalists, who throw naphtha. Each large vessel is accompanied by three smaller ones, the "half", the "third" and the "quarter".These vessels are

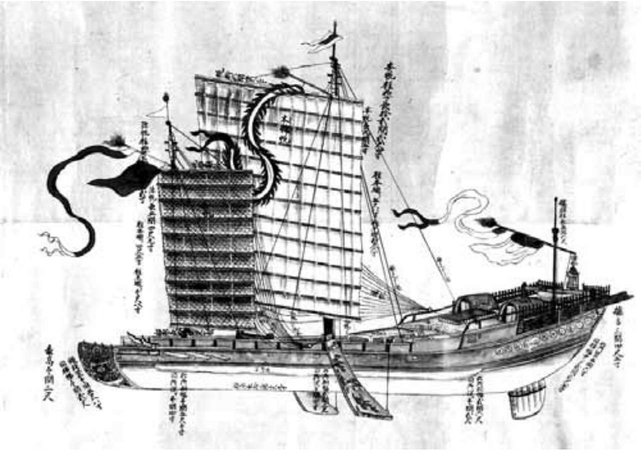

Figure 23. Nanjing ship from Japanese scroll.

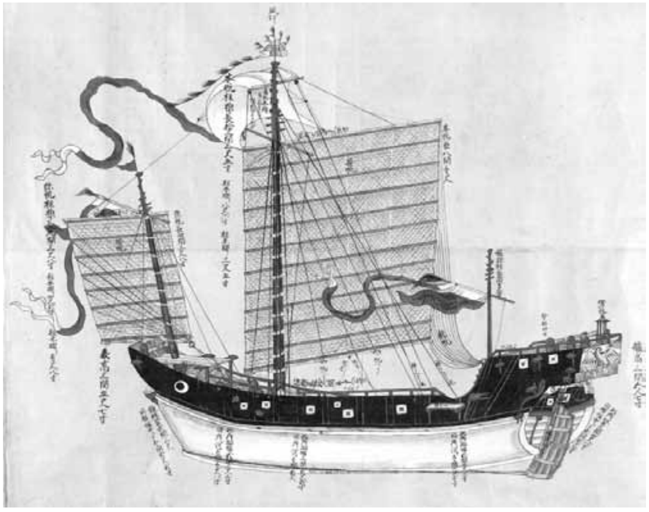

Figure 24. Ningbo ship from Japanese scroll.

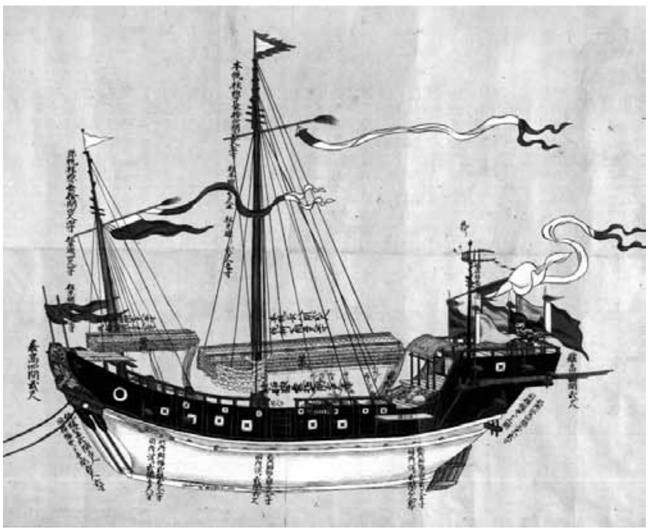

Figure 25. Ningbo ship at anchor from Japanese scroll.

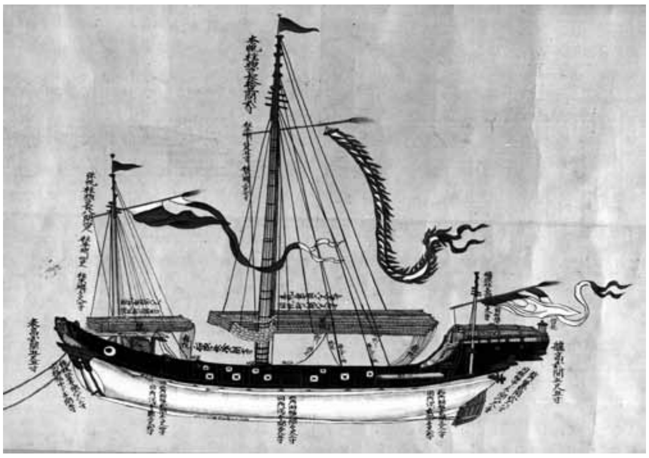

Figure 26. FFuzhou built ship (Nanjing sent) at anchor from Japanese scroll.

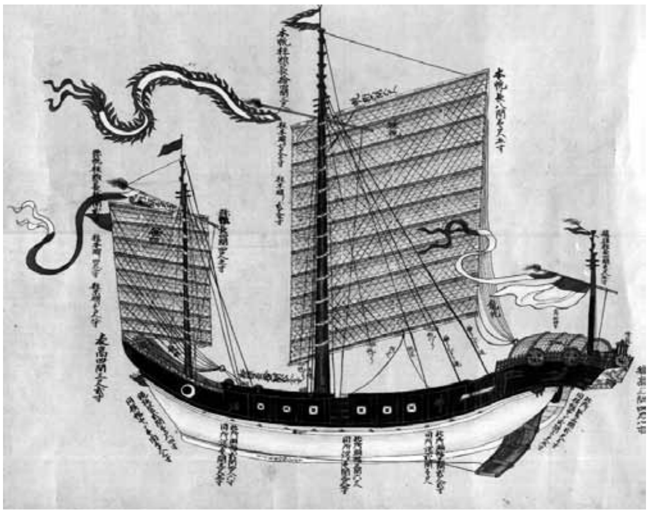

Figure 27. Taiwan ship from Japanese scroll.

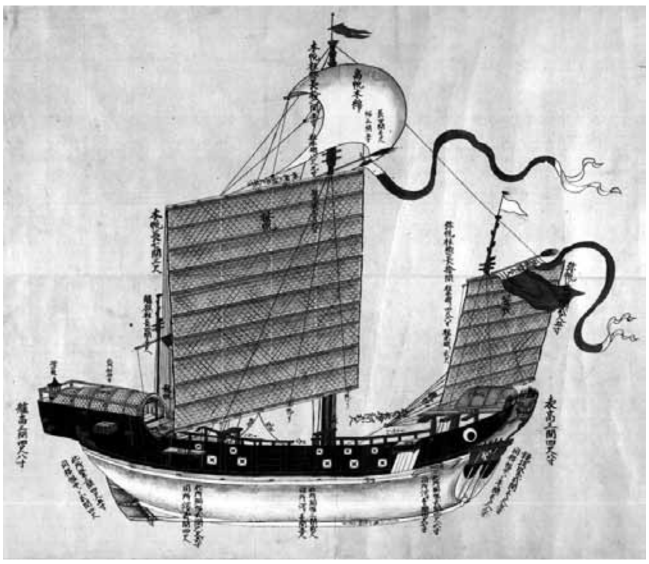

Figure 28. Guangdong ship from Japanese scroll.

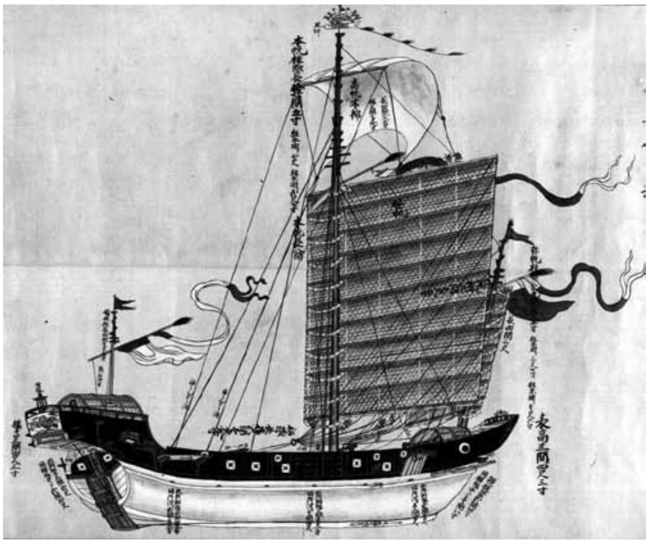

Figure 29. Fuzhou built ship (Guangdong sent) from Japanese scroll.

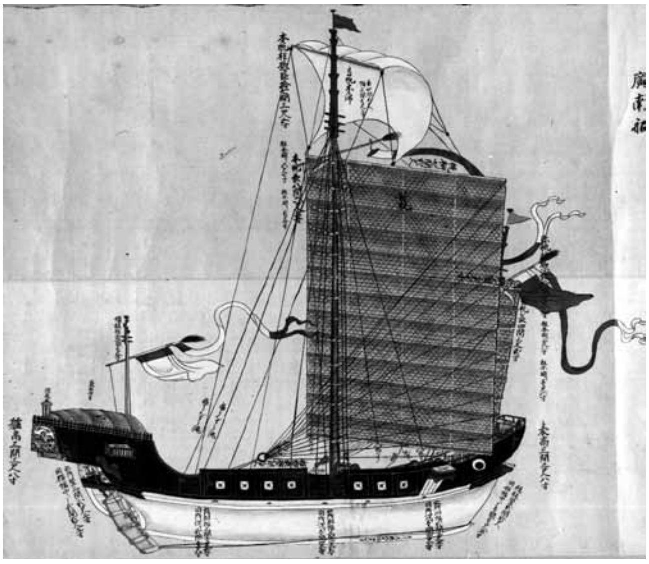

Figure 30. Guangnan ship from Japanese scroll.

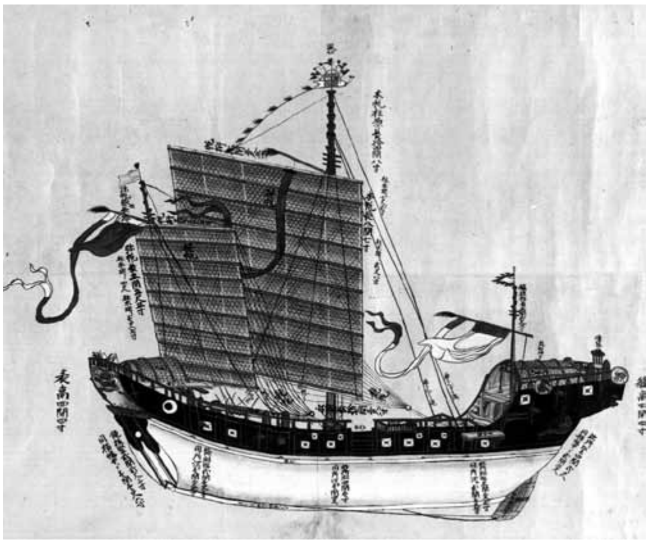

Figure 31. Amoy ship from Japanese scroll.

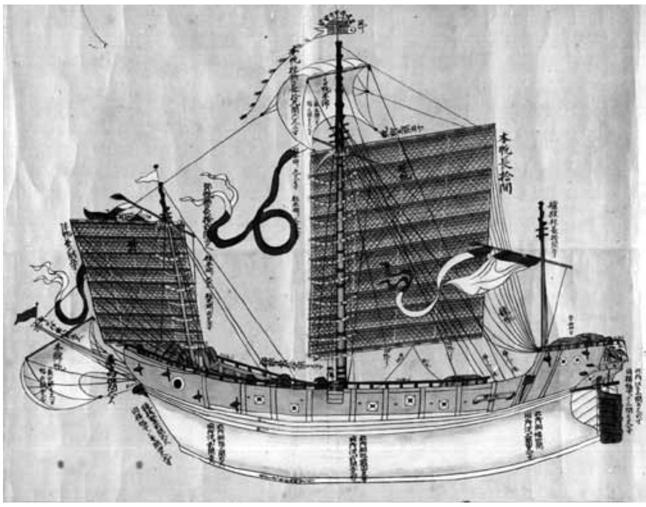

Figure 32. Siam ship from Japanese scroll.

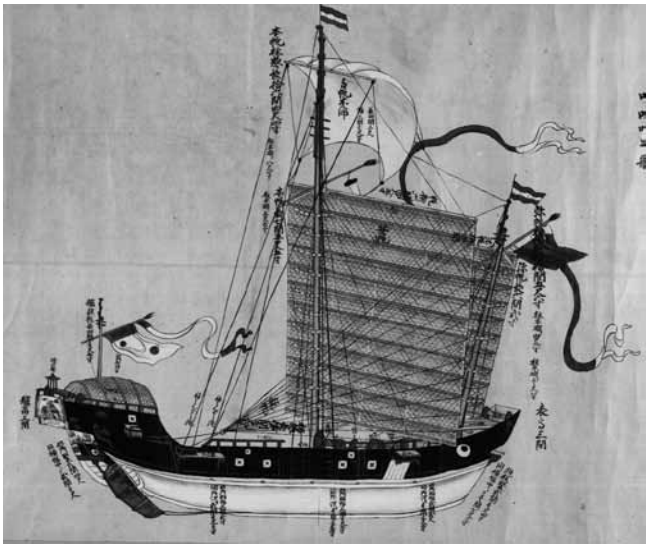

Figure 33. Batavia sent ship from Japanese scroll.

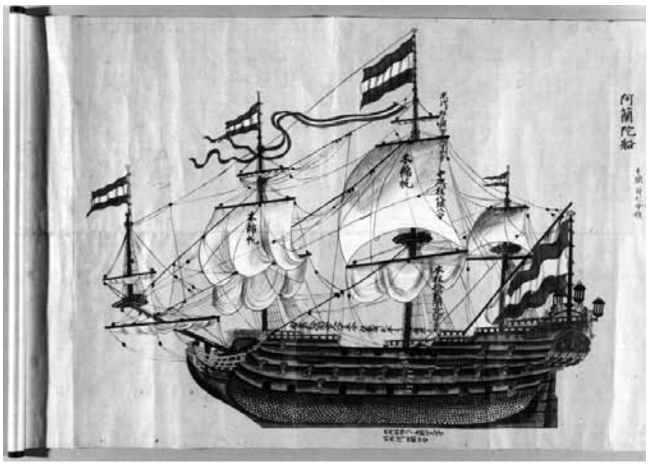

Figure 34. European vessel

Dimension	Nanjing	Ningbo 1	Ningbo 2	Guanghan	Amoy	Fuzhou Guangdong	Batavia	Siam	Guangdong	Taiwan	Fuzhou--Nanjing
OAL	24.57	29.19	31.05	29.7	31.74	29.37	30.9	41.97	29.4	29.43	29.01
BowH	2.7	7.11	7.8	6.54	7.32	6.69	5.4	9	6.84	8.16	5.25
BowTvert	3.54		4.5	4.2	4.29	3.72	4.02	5.4	4.05	4.02	3.69
BowTwidth	2.4		2.46	2.25	2.28	2.04	3.99	3.27	2.19	2.19	1.95
Fhullwidth	3.33	4.59	4.29	3.09	2.97	3	2.85	5.1	3.21	2.85	2.76
Fhulldepth	1.92		4.14	4.65	5.91	3.9	4.2	6	4.98	4.98	4.02
Mhullwidth	4.5	6.06	6.51	3	3	3	2.85	4.5	3.3	2.85	2.85
Mhulldepth	1.92	2.16	4.2	6.66	7.23	5.79	5.85	8.4	6	7.2	5.79
Ahullwidth	5.4	5.19	6.03	3.9	5.85	3.9	3.93	6.81	4.8	3.9	3.96
Ahulldepth	2.4	3.69	5.46	5.76	6.36	4.8	5.46	7.2	5.46	6.06	4.59
SternH	6.75	7.11	7.8	6.54	7.32	6.69	5.4	9	6.84	6.84	5.25
SternTvert	10.8	6.84	8.16	6.09	7.8	6	4.8	6.96	6.75	6.03	3.84
SternTwidth	4.35	4.35	3.6	4.47	5.1	4.2	3.9	5.91	4.8	4.05	3.69
FmastL		17.34	19.32				19.68	22.5	18	18.6	15.6
Fmastcbase	1.35	1.26	1.32	1.14	1.2	1.11	1.38	1.8	1.38	1.29	1.2
Fmastctop	0.54	0.54	0.51	0.48	0.45	0.48	0.54	0.75	0.6	0.54	0.51
FsailL	10.47	8.34		8.16	10.65	8.1	10.86	10.95		8.67	9
Fsailboom	2.7									5.79	5.55
MmastL	22.32	24.45	25.95	31.68	25.44	30.75	30.12	36.09	28.95	26.1	27.6
Mmastbasec	1.74	2.58	2.25	2.01		2.1	2.61	2.73	2.67	2.13	2.55
Mmastctop	0.78	1.05	0.87	0.81		0.87	0.96	0.9		0.87	1.11
MsailL	16.35	14.7	15	16.35	14.61	14.4	14.25	18	13.5	14.85	14.46
Msailboom	12.09	13.05	14.25	13.2	12.45		12.15	16.35	12.45	12.6	12.72

> built in the towns of Zaytún and Sín-Kalán. The vessel has four decks and contains rooms, cabins, and saloons for merchants; a cabin has chambers and a lavatory, and can be locked by its occupant…This is the manner after which they are made; two (parallel) walls of very thick wooden (planking) are raised and across the space between them are placed very thick planks (the bulkheads) secured longitudinally and transversely by means of large nails, each three ells in length. When these walls have thus been built the lower deck is fitted in and the ship is launched before the upper works are finished (Ibn Battúta, 1929).

Both Marco Polo and Ibn Battutah refer to the large size of the vessels and the large crews. However, the interesting issue is the reference by Marco Polo to a number of features of Chinese ships that can be related to both the Quanzhou Ship and other Asian built vessels.

A Japanese scroll of the early Qing shows eleven Chinese ships and one Dutch ship (**FIGS**). The scroll (*Tosen no zu*) and its associated scroll showing foreign ships' tools (*Gaikoku Sengu Zukan*) is housed in the Matsuura Historical Museum with a copy belonging to the National Gallery of Victoria. It has been approximately dated by Oba (1974) to between 1718 and 1727. These illustrations are well drawn, given a scale, most of the major dimensions of the vessels and a description of their features. Oba suggests that the scroll was produced to help the customs officials identify foreign vessels and assist in the control of smuggling. The authors are grateful to Professor Zae Geun Kim who translated the text. From this it has been possible to tabulate the major dimensions of the eleven Chinese vessels (see Table 2 below).

The most striking aspect of these vessels is their relative uniformity, with the exception of the flat bottomed Nanjing ship and the ship from Siam, which is larger and has a flat transom.

Nanjing	A flat bottomed vessel unlike any of the others. Highly ornemented and painted, large counter at wide stern, with axial rudder in slot, leeboards. Matting foresail and cotton main.
Ningbo	Matting sails, small canvas topsail, backstays on main and fore
Ningbo at anchor	
Gunagnan	
Amoy	
Fuzhou built Gunangdong sent	
Batavia sent	
Siamese	
Gunagdong	
Taiwan	
Fuzhou built Nanjing sent	

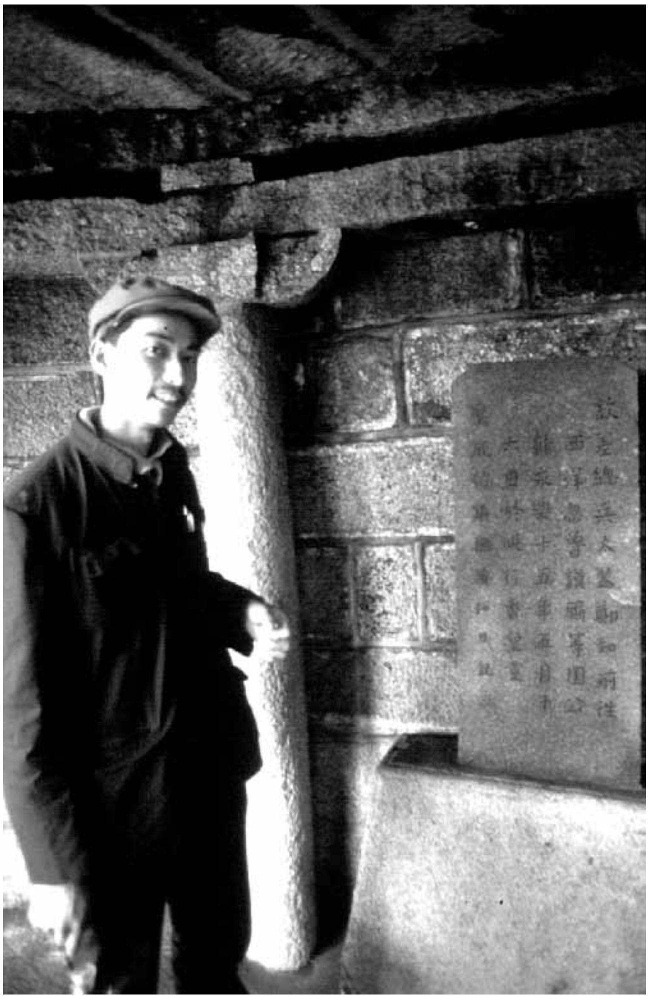

Figure 35. Tomb of Zheng He outside the city of Quanzhou.

Chapter 2. Archaeological evidence East Asian vessels
Jeremy Green

Over the last 25 years a number of excavations have been carried out in the Asian and Southeast Asian region on vessels that have relevance to the discussion of the Quanzhou Ship. The vessels are: (Chinese) Dongmenkou, Fa Shi, Shandong, Shinan, Ko Si Chang Two; (Southeast Asian) Pattaya, Ko Si Chang One and Three, Ko Khram, Rang Kwien, Phu Quoc, Con Dao and Bukit Jakas.

The Fa Shi Ship

The Fa Shi ship which was discovered in 1982 near Quanzhou is not well documented. This vessel was partially excavated, the remains were located partially under a building. It is generally described as Song Dynasty. The excavation is briefly reported in Xu Yingfan (1985) and shows bulkheads and wooden pegs similar to the Shinan Ship (**FIG**).

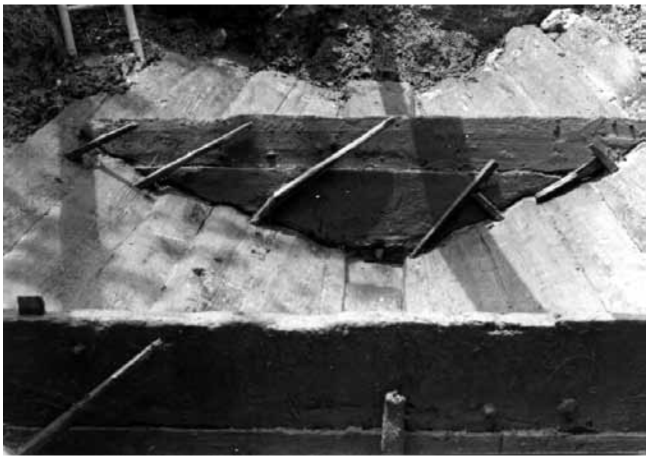

Figure 36. Fa Shi excavation showing the bulkhead with the diagonal stiffeners.

Figure 37. Fa Shi site showing the bulkhead and the watyerway.

The Ningbo Ship, Dongmenkou

The archaeological excavation of the Song ship at Dongmenkou, Ningbo has been described by Shimin *et al*. (1991). The site consisted of the fore part of the vessel, including seven bulkheads (the stern-part was missing) (**FIGS**). The keel was made up of of at least three parts and attached to it was a stem (?) angled at about 35° to the horizontal (the term stem will be used here but it could be described as a foreward keel extension or a strongly raked stem).

When it was uncovered the ship was approximately horizontal in position, the timbers were greyish yellow in colour and its shape and components could be clearly seen. Unfortunately after being exposed to the sun, the timbers shrank and the components of the ship were distorted out of shape and broke making it impossible to preserve them.

The remaining part of the ship was 9.30 m long and 1.14 m high. Taking the keel as the central line, half of ship's breadth is 2.16 m, the upper structure having rotted away. The remaining stem, bilge, planking, garboard and keel was well preserved. The marks of the bulkhead and an inlaid repair consisting of a round wooden plug on a plank were very clear. The steps of the fore and main masts were carefully made. A supporting timber was installed behind the bulkhead under the main mast step to strengthen the planking and the mast. The remains of part of the rudder was found at the stern of the ship. This ship was probably a three masted sea-going vessel with a sharp bow, 'V'-shaped bottom and a square stern.

The remaining part of the pine wood keel was 7.34 m long, 0.26 m wide and 0.18 m thick, the aft part being broken. Judging from the joints the keel, it is made up of three parts

Figure 38. Ningbo site showing the shipwreck site in relation to the dockyard.

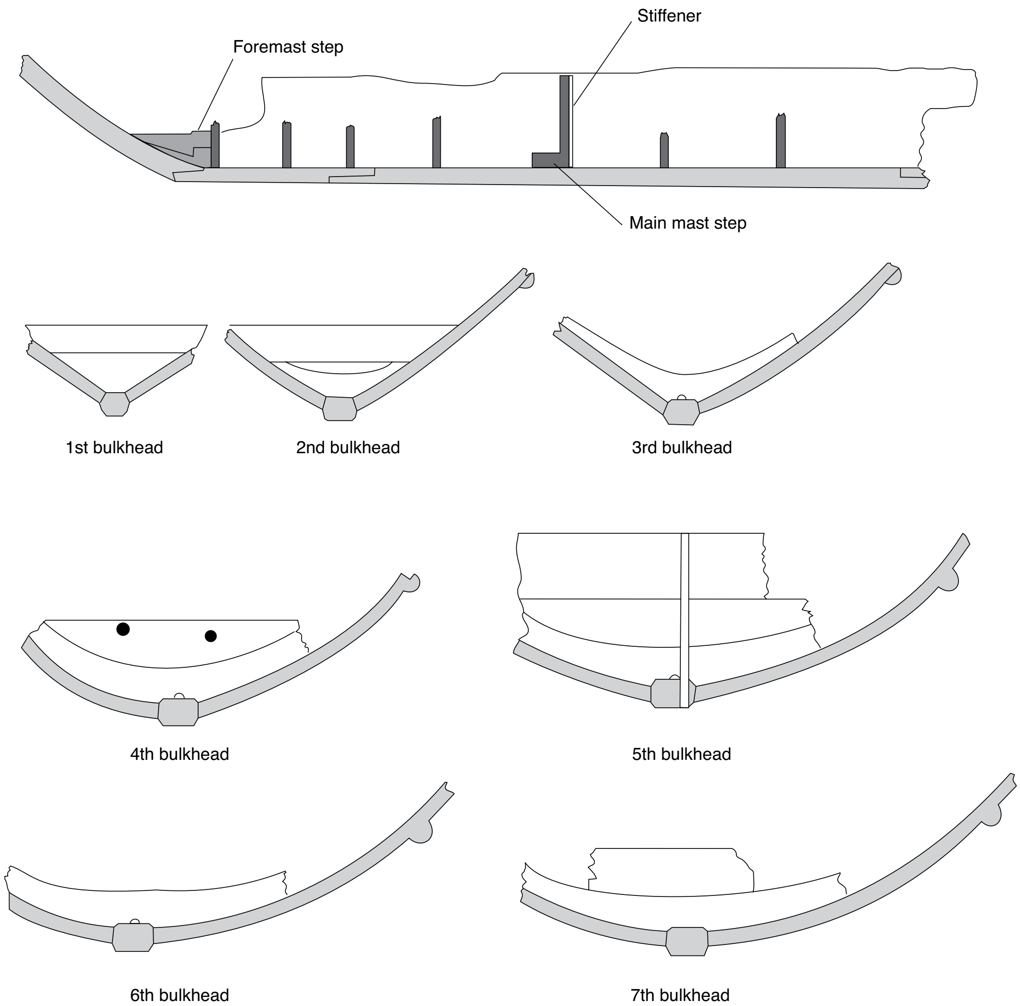

Figure 39. Cross sections of the Ningbo site showing the bulkheads and the longitudinal profile.

with the third one turning slightly upwards. The length of the first part is 1.98 m (not including the mortice and tenon joint at the stem post), the second part is 5.10 m long and the mortice and tenon joint with the first part is 45 cm; the remaining third part is about 3.45 m according to these, the total length of the main keel would be over 10.5 m.

The stem was made of China fir, triangular in cross-section with the widest place 18 cm, the thickness 20 cm, the remaining length 1.55 m and there was evidence that the planking was rabbeted to the stem. In the scarf joint between the keel and the stem were two small rectangular holes, 3 cm long, 2.5 cm wide and 4 cm deep separated by 3 cm containing six coins in each hole. These holes are called Holes of Longevity (*baosongkong*). The 12 coins are of the early Northern Song and are Hing De Yuan Bao, Tian Sheng Yuan Bao, Huang Song Tong Bao. The scarf was jointed with a mortice and tenon to the keel and was fastened by nails of 1–1.5 cm in diameter, 15–17 cm in length, which were arranged in plum flower pattern.

The planks were made of China fir, pine or camphor. The planks were 6–8 cm thick, the widest was 42 cm, the narrowest 21 cm. The remaining large planks were 3–8 m long. The planks were joined scarf jointed with the oblique side up to 1.55 m long and the scarf usually spans one or two frames (Fig. 6.1). Tongue and groove joints were used when butt joining the planks. The tongue was 2–4 cm high and nailed up with rectangular iron nails. The planking was skew nailed with rectangular iron nails, 1.5 x 1 cm in cross-section, 12–20 cm long. The interval between two nails was 10–25 cm, but at the bow, the interval is closer, only 10 cm. The seams were filled with mixture of tung oil, lime and hemp.

All the frames were made of camphor wood in regular shape and generally 16–25 cm wide, 7–10 cm thick (at bottom) becoming narrow at the top. At the bottom of the ship, each frame has a 3 x 4 cm semi-circular limber hole level with the keel.

The remaining ship has six compartments, of which the fifth is the largest, being 2.05 m long and having a maximum half beam 2.16 m. The smallest is the second compartment, 0.62 m long, the smallest half beam 1.64 m. The fourth one 1.16 m long, largest half beam 1.64 m; the sixth 1.14 m long, largest half beam 2 m. Most of the bulkheads are made of pine, some are of cypress. The bulkhead aft of the main mast at the fourth hold is 7–10 cm thick, 70 cm high. Only one bulkhead of 7–10 cm thick, 28–30 cm high remained. The bulkheads were nailed to the frames which were in turn nailed to the hull.

The bulkhead at the middle of the rear of the 4th compartment which had the mid-mast fixed to it, had a concave mortice of 4–5 cm wide, 0.5 cm deep, in which square supporting timber or stiffener was fixed. This timber was fixed into the mortice on the keel to strengthen the bulkhead and support the mast.

At the stem before the first bulkhead there is the mast step for the foremast, 84 cm long, 21 cm wide and 14 cm thick. Two holes for the tabernacle of the mast were 14 x 7 cm in size, 5 cm in depth with 13 cm interval were opened in the middle of the step. The step is made out of a complete piece of camphor wood.

The mid-mast had a relatively large mast step at the back part of the fourth compartment from the fore part of the ship. This was made out of several kinds of wood, the step was 105 cm long, 25 cm wide and 18 cm thick. There were two holes for mast tabernacle which were 15 x 8 cm in size, 5 cm in depth were opened in the middle of the step. Because the stern of the ship was broken, there was no evidence for the existance an aft mast step, however, given the proportions of the vessel and the location of the mast steps it is likely that there was at least one other mast, possibly stepped on the deck.

No complete components of the rudder were found. A remaining piece of timber, found at stern of the ship, was 186 cm long, 42 cm wide and 18 cm thick with a hole of 26 cm in diameter in the middle and is thought to be part of the rudder.

At the outer side of the joint between the seventh and eighth strakes, a semi-circular protecting strake or whale was attached, 710 cm long, 14 cm wide and 9 cm thick. Both ends were broken, the whale tapered towards the bow (10 x 4 cm). The whale was made of cypress wood and was nailed to the hull by two rows nails with 4–50 cm intervals.

The Jinan Ship, Shandong

This vessel was discovered in 1956 in the province of Shandong and is now preserved in the Shandong Provincial Museum at Jinan (Fig. 00). A very brief report in English has been published by Needham *et al*. (1971). The vessel is about 20 m long by 3.5 m wide, transom-ended with 13 compartments. The vessel is flat bottomed and has a sharp chine, thus typical of the river and North China Seas design. The ship dates from the 14th century: an anchor was dated 1372 and a bronze gun 1377. It is thought to have been a government river patrol boat.

The Shinan Ship

The Shinan ship has been widely described, mainly for its exotic cargo of Chinese and Korean ceramics (**FIGS**). Relatively little has been published about the hull structure which is both interesting and important to the understanding of Chinese-built vessels (see Kim 1980, Green (1983), Green & Kim (1989), Hoffmann et al (1991), Mokpo Conservation and Restoration Centre (1985)). The vessel has been dated to about 1323 from artefacts and coins. The remains of the ship include the keel, about 14 strakes of the starboard side and six strakes of the port side of the ship, part of the transom bow and a small section of the stern transom.

The hull of the ship is rabbeted clinker construction with evidence of sheathing. In the fore part of the vessel the rabbeted clinker changes to rabbeted carvel allowing a flush joint on the transom bow. The strakes are butt-jointed. In most cases the butt-joint is a lap joint, but on the garboard strake and on at least one other place the joint is a tongue and groove joint. On the internal face of the butt-joints there are butt plates which sit over the top of the joints and clamp them together. In some

Figure 40. The Jinan ship showing the bow from the port side.

Figure 41. The Jinan ship showing the bow from the starboard side.

cases these butt plates are set under a frame, indicating that the frames were put in place after the completion of the planking. The strakes are rabbeted clinker construction, with the rabbet cut out of the uppermost plank, on the lower inside edge.

The seven bulkheads are supported by frames and stiffeners. Bulkheads forward of the mast step are supported on the aft side with frames and on the forward side by stiffeners—aft of the mast step the reverse is true. The stiffeners, which are pointed wooden pegs, penetrate each strake from the outside of the hull planking through the middle of the plank and are not rebated into the bulkhead. Thus the stiffeners locate the opposite side of the bulkhead to the frames and are attached to the face of the bulkhead.

There is a fore and a main mast step, a structure that is possibly part of the decking of the ship and evidence for a water tank of some sort forward of the main mast. A research model has been built by the Mokpo Conservation and Restoration Centre at a scale of 1:5 based on measurements made of the hull timbers. This model raises a number of complex and interesting problems, however, the model has some limitations. Firstly, because of the poor visibility on the wreck site, it was not always possible to establish the exact orientation of the pieces, thus in some cases their relationship is uncertain. Additionally, the plans of the timbers were made from individual measurements made on the timbers, but not

Figure 42. View of the model of the Shinan Ship showing the bulkhead arrangenments.

Figure 43. View of the model of the Shinan Ship showing the details of the stiffeners.

Figure 44. Shinan Ship photograph of a bulkhead/frame section form the keel area showing the waterway.

Figure 45. Shinan Ship view of keel during raising process.

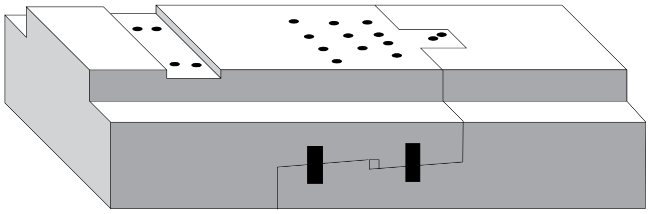

Figure 46. Shinan Ship keel scarf joint.

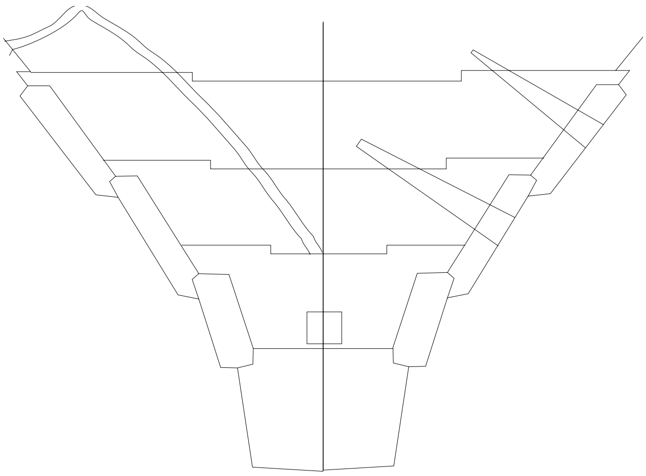

Figure 47. Shinan Ship detail of transverse cross-section of keel showing stiffeners, waterway, frames and planking.

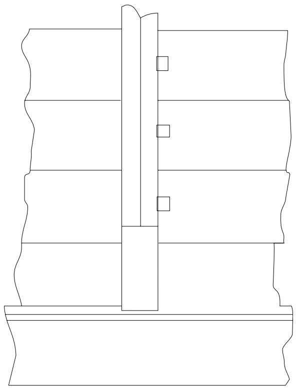

Figure 48. Shinan Ship longitudinal cross-section of bulkhead.

Figure 49. Shinan Ship cross-section of the Shinan Ship.

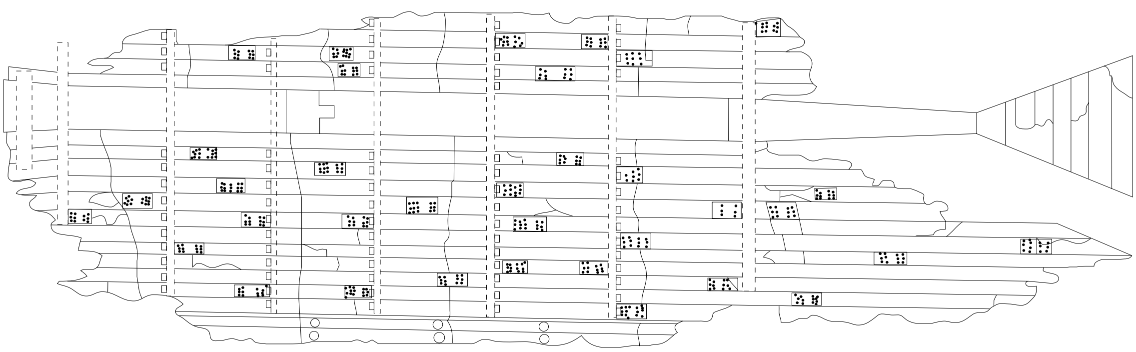

Figure 50. Shinan Ship plan of the Shinan Ship showing the butt-plate positions.

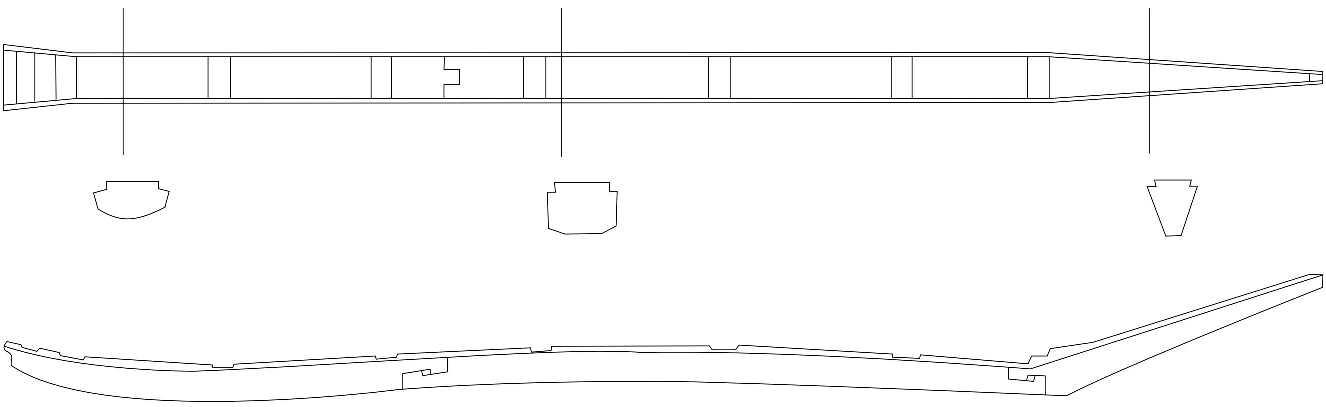

Figure 51. Shinan keel cross-section.

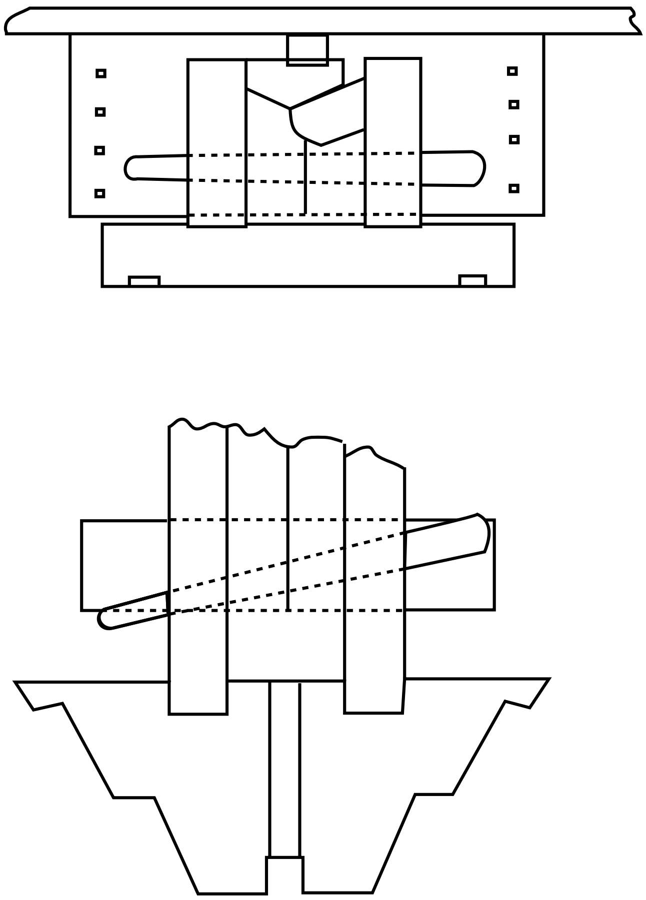

Figure 52. Shinan Ship mast step arrangement, plan (above) and end view (below).

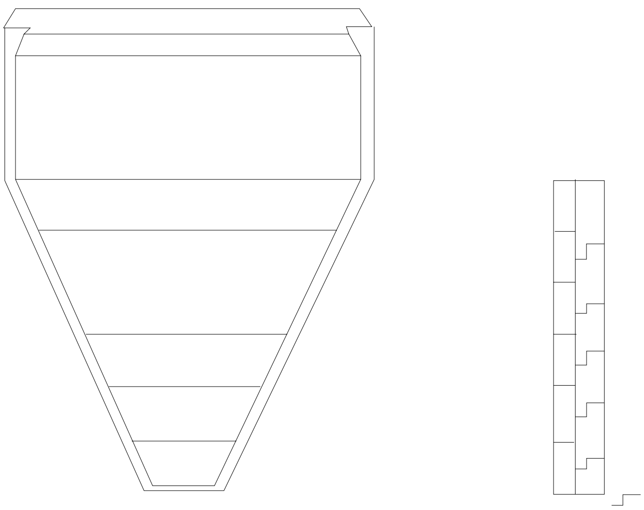

Figure 53. Shinan Ship bow plan showing arrangement of planking.

direct 1:1 tracings. In spite of these drawbacks, the model is of great interest, and of course is just one step in the development of a complete understanding of the structure.

One of the major problems that has not yet been resolved is that the keel has a distinct hog, the centre is 220 mm higher than the fore and aft ends, over the length of the keel. It is not certain at present if this is a feature that was incorporated in the construction of the ship, or is a result of forces on the hull structure after the sinking. It is expected that further work on the research model will resolve this problem. The scarf joints in the keel have a similar arrangement to the Quanzhou ship (Green 1983a) but with coins and a mirror placed on the sloping horizontal face of the joint rather than the vertical faces, as in the Quanzhou ship.

The arrangement of the mast step and the composite three part mast is unusual. It is possible that the orientation of the mast in the plan is wrong. It will be noticed that the main mast does not make contact with the bulkhead. The foremast, however, is arranged to lie against the bulkhead and the bulkhead, it seems, has been especially angled so that is aligned with the rake of the mast. There is also a pin to fix the base of the masts.

The way that the transom bow is attached to the keel is not absolutely certain. However, it is double planked. A single cant frame was recovered. It is unusual because it has a series of semi-circular holes cut from the upper surface through to the side face of the frame. The purpose of these holes are unclear.

The arrangement of the upper part of the side of the ship is also uncertain. It is thought that the structure that projects into the body of the ship is a deck of sorts. However, it has also been suggested that this may have been a coaming. Thus, it is not certain if the timbers that are associated with this were separated from the main part of the hull or not. The bulwark associated with this has circular holes 150 mm cut in them. It is not clear what these holes were for. They may have been scuppers or possibly holes for oars. Until the position of the bulwark on the section of the hull is known more precisely, the function of the holes is uncertain.

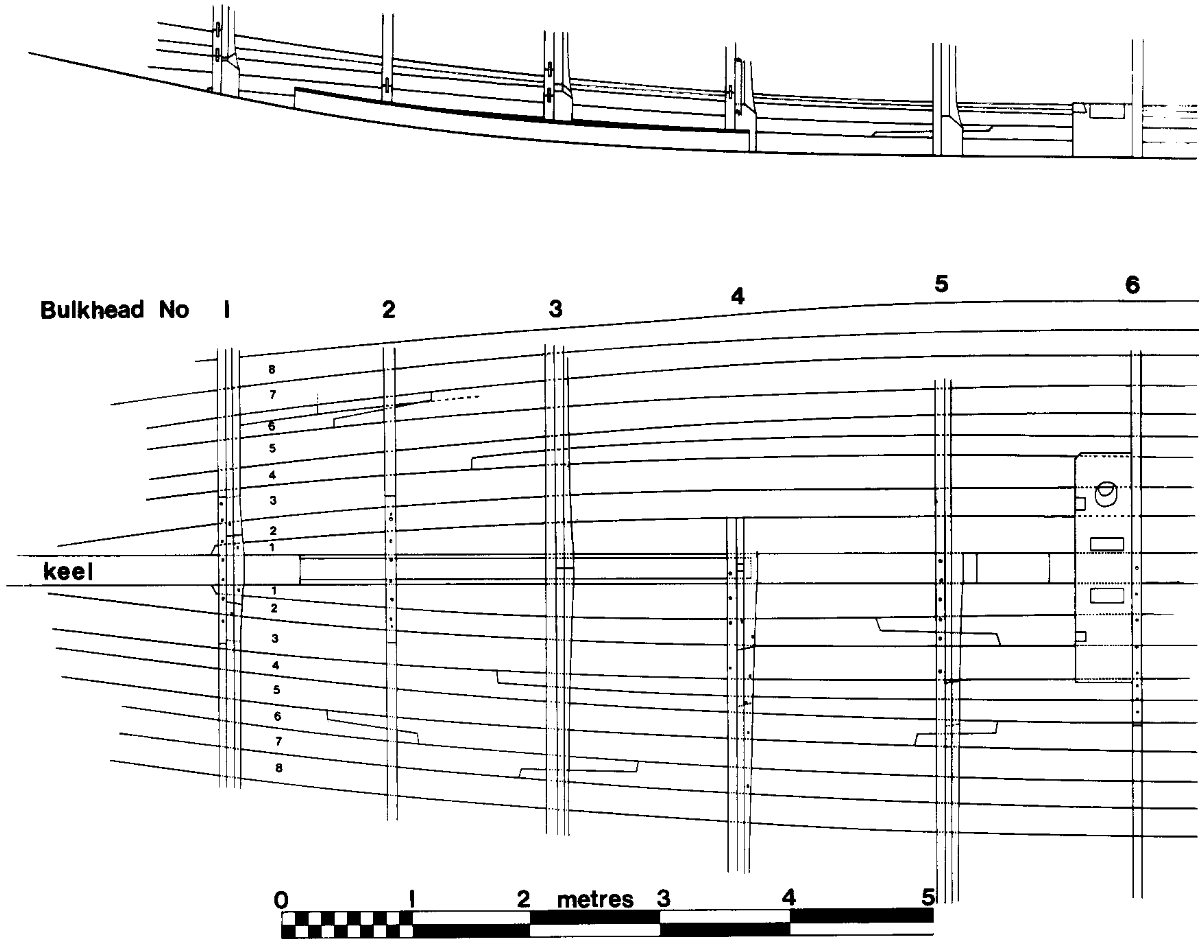

Figure 54. Plan of the Pattaya site showing cross-section and plan of the site.

Pattaya

The Pattaya wreck site was investigated in 1982 (Green & Harper 1983, Green & Intakosi, 1983) (**FIGS**). This was one of the first sites in the Gulf of Thailand to be excavated where substantial hull structure was uncovered. Only the bow-half of the site was excavated.

The ship had triple planking, the inner layer 70 mm and the outer two 40 mm thick. At least one strake had a trapezoidal cross-section, it may well have been the garboard, the sharp angles resulting from the hollow deadrise adjacent to the keel (FIG). There were at least six bulkheads between the mast step and the forward part of the vessel. Bulkheads varied in separation, ranging from 1.40 to 1.60 m. The bulkheads were supported by frames on the side facing the centre of the vessel. Both the bulkheads and the bulkhead frames had two large limbers cut into their base. There was luting covering the joints and face between the bulkhead and bulkhead frame. This was a hard resinous putty. The modern Thai fishing vessels use material almost identical in consistancy and smell, called *cham*.

The keel had a block sitting on top of it 3.6 m long 200 mm wide by 150 mm thick running from bulkhead 1 through to bulkhead 4 where it was rebated into the bulkhead and bulkhead frame. It is thought that this was a type of clamp covering and supporting the scarf joint in the keel.

One of the aspects of this excavation not appreciated at the time was evidence as to how the cargo was arranged on the ship. Between bulkheads 3 and 5 on the starboard side of the vessel was a very large concretion which was confined to a line 300 mm off the centre line of the vessel. There was also evidence of bamboo dunnage protruding from the concretion. It is likely therefore that the concretion was confined by a partition to the starboard side of the vessel and that because the iron cargo remained largely confined by this after the vessel sank, it reflects the internal arrangement that otherwise would not be seen. This may explain the problem concerning the function of the watertight bulkheads and the limbers. It is unclear why one would go to such lengths to seal the bulkheads while having large limbers on the bilge. Marco Polo's statement that the compartments were watertight has been taken in the past to mean that the compartments were sealed. However, every vessel with bulkheads has been found

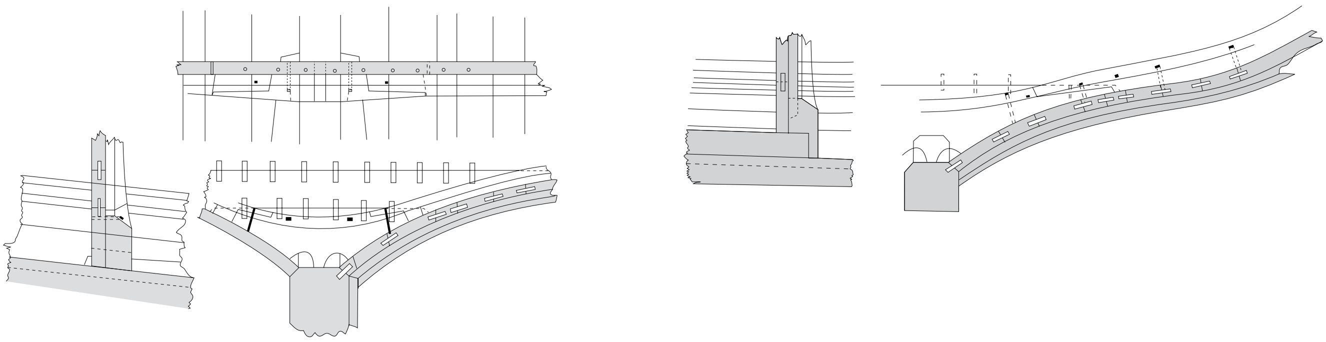

Figure 55. Bulkhead from the Pattaya Site showing two waterways, the luting and the rebates on upper surface of bulkhead for the next plank.

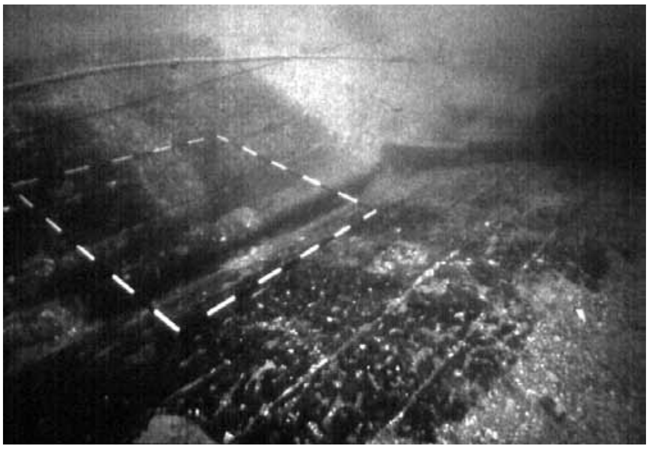

Figure 56. View of the Pattaya Site showing the ‘V’-shaped cross-section.

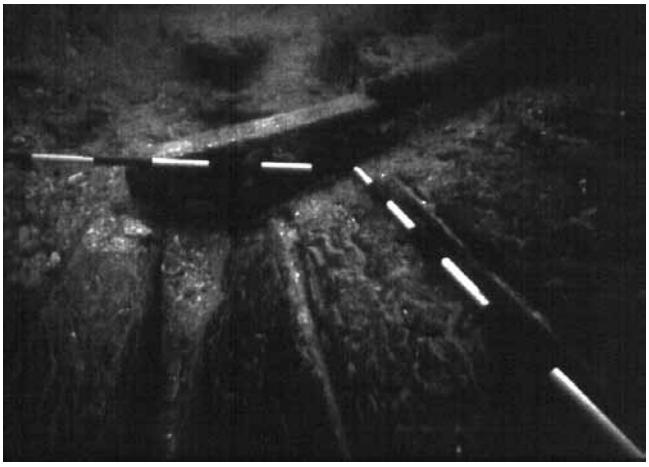

Figure 57. Pattaya Site showing half-frame lying across the keel.

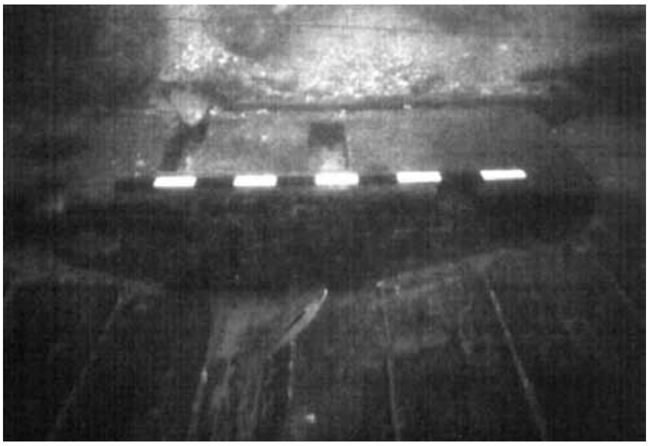

Figure 58. Pattaya Site mast step.

to have limbers. How then do these work, if cargo filled the compartment? It now seems possible, from the evidence of the Pattaya shipwreck, that in some cases there was a space in the centre of the compartment, about 600 mm wide which was kept clear. Presumably there was some form of longitudinal partition to confine the cargo space. This would then provide a narrow, but clear access to the limbers at the bottom of the bulkheads and thus explain the anomaly of the watertight luting of the internal seams of the bulkhead and the presence of limbers, which in all wreck sites have never been found blocked up with bungs. The possibility is, therefore, that in the event of the vessel springing a serious leak, the crew would gain access to the limbers and block them so that the leak could be confined to the hold affected. In normal circumstances, the limbers were free to allow the movement of bilge water to the lowest point where it could be bailed or pumped out. If there were no limbers then the bilge water would collect in each compartment, necessitating a bilge pump to be located or used in each compartment.

Ko Si Chang One

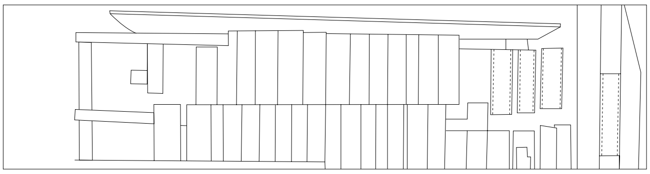

Figure 59. Ko Si Chang 1, plan of ceiling or dunnage boards.

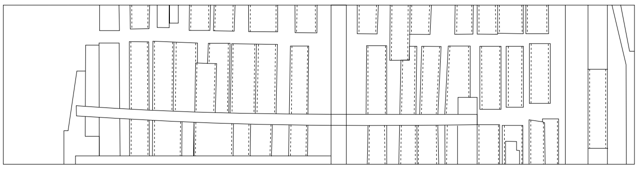

Figure 60. Ko Si Chang 1 cover boards on planking.

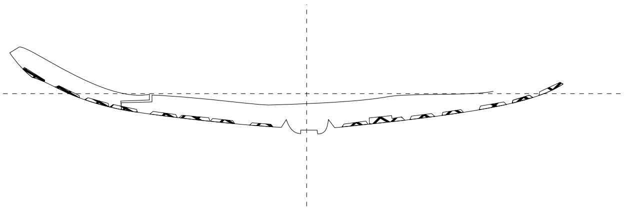

Figure 61. Ko Si Chang 1 cross-section of hull reconstructed.

This excavation (Green 1981, Green *et al*. 1985) uncovered part of the hull of a Southeast Asian-type vessel. A single compartment flanked by two bulkheads was uncovered (**FIGS**). The construction of the vessel was very difficult to interpret, partially because of the limited extent of the excavation, but also because the site was deep and the visibility was very poor. The inner planking was 45 mm thick, edge-joined with dowels at 190 mm intervals. There was evidence of several stiffeners or pegs protruding through the planking and these were thought to support the frames (although this may be a misinterpretation and could have supported the bulkheads). There was evidence for more than one layer of planking. On top of the planking in a rather irregular manner were a series of 'cover boards' made of a pale wood, softer than the hull planking. These boards were attached to the inner planking, and were about 25 mm thick with a 25 mm bevel on the sides. It is possible that these boards were intended either to protect the inner planking from wear from the cargo or to seal the joints. In addition to the bevelled boards, there were some boards that were unbevelled and placed over the bevelled ones. These boards were rebated in the frames, which is rather unusual. It appears that there was a series of light frames 125 mm thick, three of which were identified in the excavation trench. These frames consisted of a floor, scarfed at each end to fit the next futtock. The frames lay slightly asymmetrically across the keel. The frame was rebated on one side of the keel to allow an unbevelled board set on top of the cover boards to pass under the frame. On the other side a bevelled cover board that was set on top of the 'normal' cover boards has a short 20 mm rebate into the body of the frame. Both rebates were set symmetrically on either side of the keel, but their function and significance is not clear. The bulkhead arrangement is also complex, since the bottom of the bulkhead appears to be floor and the bulkhead plank butts against the first futtocks, but utilises the thickness of the floor for the bottom of the bulkhead. The poor visibility on the site made the interpretation of these features very difficult. In addition to the cover boards there were a series of dunnage boards that were set on top of the frames and clearly were a method of keeping the particular cargo in the particular compartment that was excavated off the planking. Why there was a need for both cover boards and dunnage planks is uncertain. The site is dated to 1570±90.

Figure 62. Partially excavated trench showing the 2m grid square and the sceiling or dunnage boards reting on the frames.

The Ko Si Chang 2 Ship

It is interesting that this is one of the only sites in the Gulf of Thailand that is likely of non-Southeast Asian construction (**FIG**). The vessel has planking that is skew nailed from the inside, with traces of *cham* putty in the heads of the nail holes. The skew nailing suggests a Chinese or East Asian origin, although skew nailing from the inside has not be recorded to date. It is double planked (plank thicknesses 120 mm and 40 mm) but there is little surviving detail of the bulkheads and keel since the hull structure was extensively damaged. There is evidence that there was a keel and the remains of two bulkheads, and traces of at least six. The planks have short hooked, diagonal scarfs located under the bulkheads. This site is dated to 1290±60.

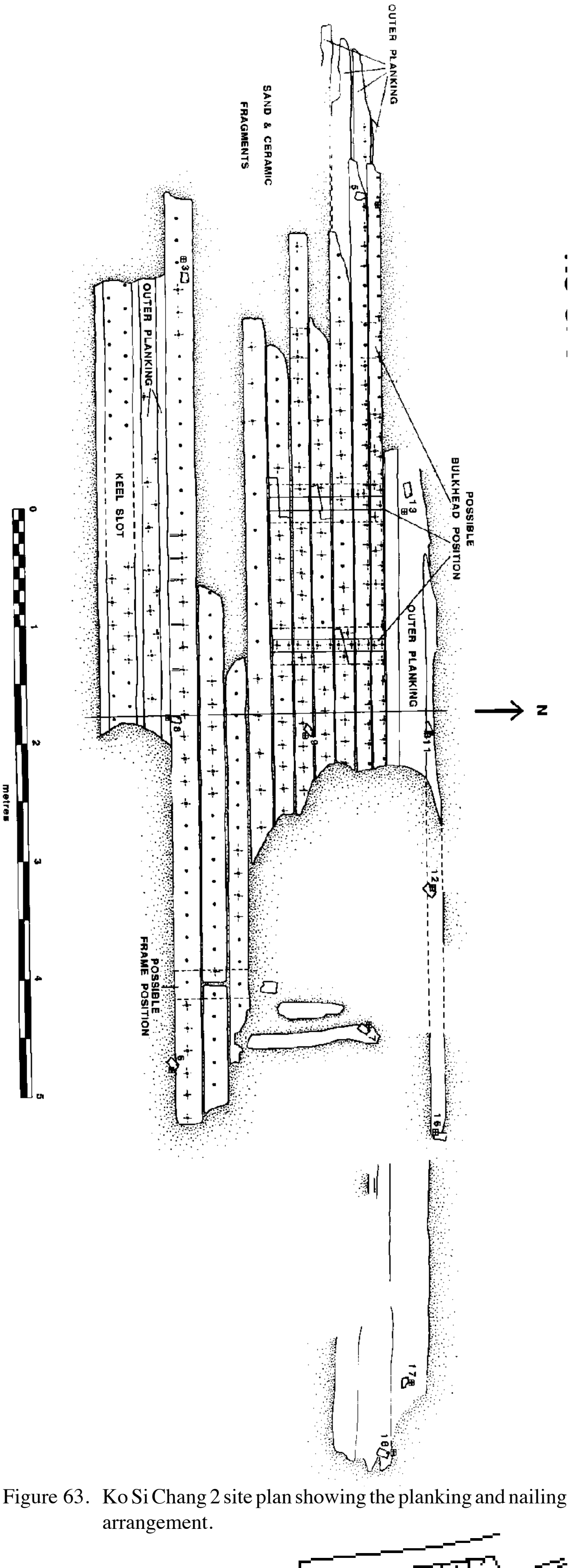

Figure 63. Ko Si Chang 2 site plan showing the planking and nailing arrangement.

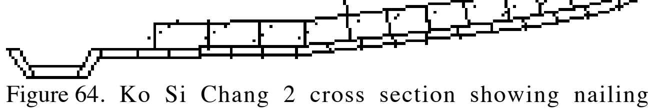

Figure 64. Ko Si Chang 2 cross section showing nailing arrangement.

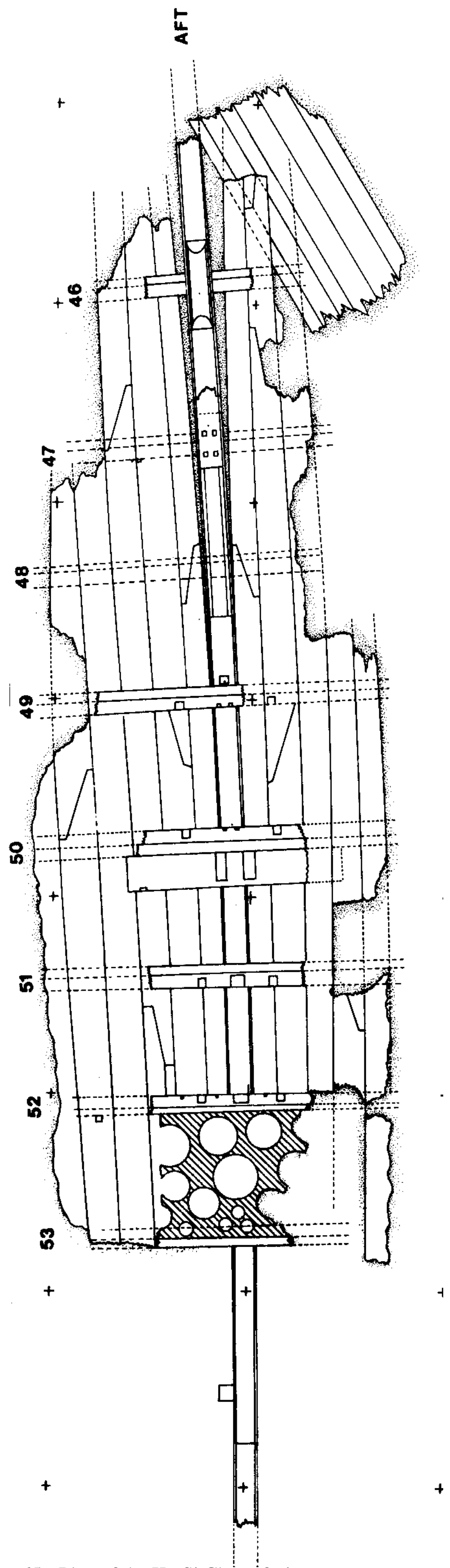

Figure 65. Plan of the Ko Si Chang 3 site.

Ko Si Chang Three

This site which was completely excavated in 1986 was carefully documented, although the hull structure was not dismantled (**FIGS**). The planks, 80 mm thick, were edge-joined with dowels at intervals of 75 to 85 mm. There was a second, outer layer of planking 30 mm thick. The planks were joined with scarfs that were distributed with almost no discernible pattern. In most cases the scarfs lay under the bulkheads. It was suggested that the vessel may have been old as there was evidence that some of the strakes had been repaired. The vessel had at least 10, possibly a total of 16 bulkheads which were arranged in a rather unusual manner. Assuming that the mast step was set on the side of the bulkhead facing the fore part of the vessel, with the frame on the aft side. Then the bulkheads aft of this all had the frames on the forward side of the bulkhead. At the bulkhead foreward the mast step this situation was the same. Foreward of this the frames were on the aft side of the bulkhead. There is evidence for some form of longitudinal bracing between the bulkhead frames both fore and aft of the mast step. This is arrangement and may be related to some form of complex bracing of the mast step and the fact that the side of the bulkhead that the frames are set are not symmetrical about the mast step. In order to brace the mast step and the frame on the other side of the mast step bulkhead, the frames fore and aft must face the mast step bulkhead. Hence the arrangement described above.

The keel had three blocks (similar to the block on the Pattaya ship) the two larger are thought to be clamps covering scarfs on the keel. Interestingly, the evidence of an iron cargo in one compartment with storage jars placed on top of this cargo, suggests that this vessel, unlike Pattaya, did not have a clear access to the keel area. The site is dated 1440±60 and 1540—120.

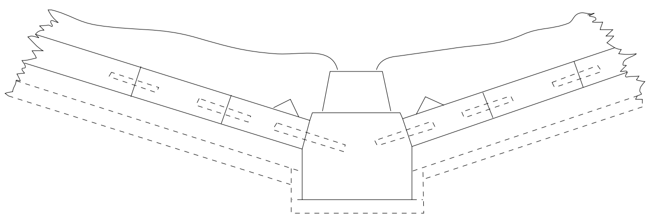

Figure 66. Ko Si Chang 3 cross-section.

The Ko Khram Ship

The Ko Khram site was found near the island of Ko Khram near Sattahib, on the SE coast of the Gulf of Thailand; it was inspected and a limited excavation then took place between 1975 and 1977 (Brown 1975, Howitz 1977, Green 1981; Green & Harper, 1983a). Despite attracting considerable interest because of the quantities of Thai ceramics on board, very little has been published on the hull structure. The little evidence extant on this site indicates a V-shaped lower hull, edge-joined with dowels. The ship is variously dated 1520±140, 1680±270 and 1380±50.

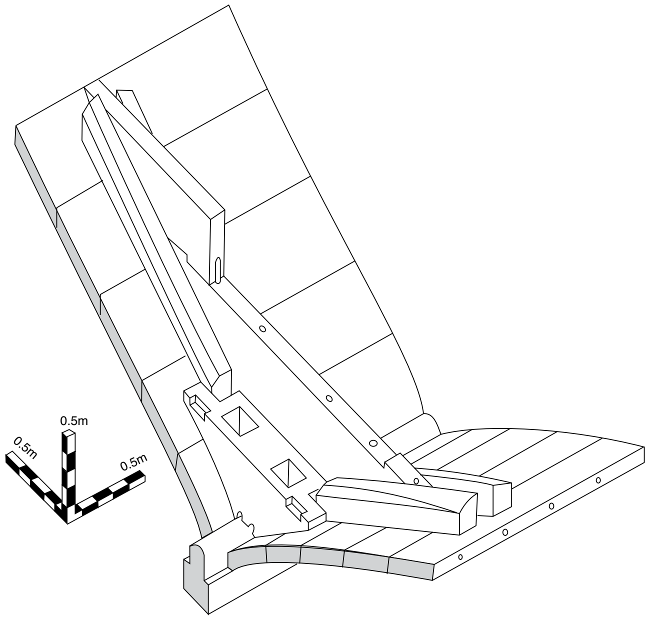

Figure 67. Cross-section of Bukit Jakas site showing the fore mast step and bulkhead frames.

Bukit Jakas

Manguin (1983a) and Manguin and Nurhadi (1987) discussed a Southeast Asian vessel found in the Riau Archipelago at Bukit Jakas, Pulau Bintan, Indonesia (**FIG**). This vessel was edge joined with dowels (250 mm intervals) and had a keel length of about 25 m, planks are about 100 mm thick with a maximum width of 370 mm. The vessel had 17 bulkheads and the remains of (possibly) a fore mast step. The step had two rectangular holes for the tabernacles (100 x 150 mm by 100 mm deep). The seperation of the holes was about 250 mm. The site is tentatively dated to 1445±80 (Manguin, 1983a).

Phu Quoc Ship

Blake & Flecker (1994) describe a site near Phu Quoc Island (**FIGS**). The vessel is clearly of Southeast Asian construction, about 25 m long, with 15 bulkheads. At either end of the vessel there was a single, more substantial frame without bulkheads. The bulkheads are constructed from planks edge joined with dowels. The bulkhead timber *Pterocarpus* sp. is Southeast Asian in origin and in the case of *Pterocarpus macrocarpus* highly regarded as a boat-building timber (*P. macrocarpus* (*chengal*) is the favourite boat-building timber on the East coast of Malaysia). The bulkheads had two limbers on either side of the keel and single limber hole level with the frame. The function of the latter is obscure since there is no indication of ceiling planking it is unusual since it is triangular or five sided (pointed at top). The bulkheads are located with frames on one side and stiffeners (similar to Shinan and Fa Shi) on the other, but the arrangement is reversed with the stiffeners on the midships-facing side. The planking has three layers (inner 80–90 mm, 48 mm middle and 32 mm outer), the main (inner) layer is edge-dowelled with a regular spacing of 180 mm. The middle and inner layer are teak (*Tectona grandis*). The planks are joined with short stepped scarfs located under bulkheads in all cases. In the two compartments excavated (between bulkheads 2–3 and 12–13), the former has evidence

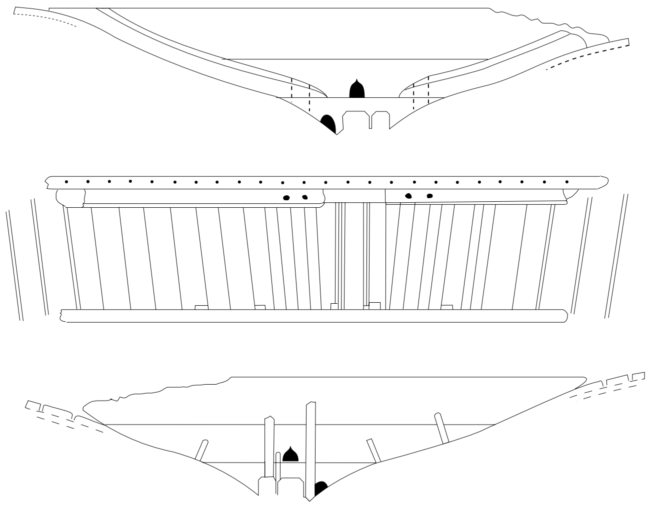

Figure 68. Cross-section of bulkheads 2 and 3 and compartment plan (after Blake and Flecker. 1994).

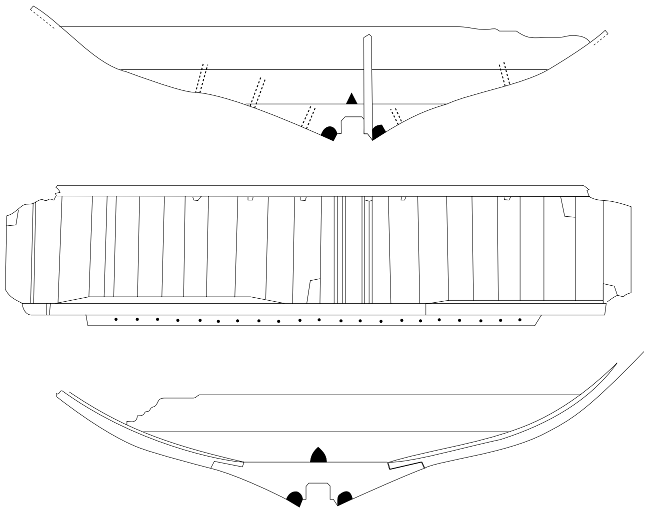

Figure 69. Cross -section of bulkheads 12 and 13 and compartment plan (after Blake and Flecker. 1994).

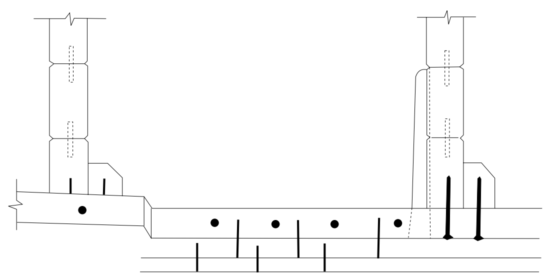

Figure 70. Schematic section of a typical hull compartment (after Blake and Flecker. 1994).

on bulkhead 2 (side towards centre) of 5 stiffeners (40 x 60 mm section) penetrating the inner planking and rebated into the face of the bulkhead. The Blake and Flecker (1994) conclude that this vessel closely resembles the Pattaya wreck both in construction and dating. The site is not accurately dated, but is thought to be 14th century.

Con Dao

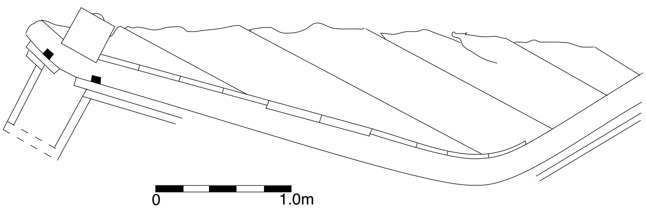

Figure 71. Section of the Con Dao bulkhead 2 including the frame just aft of the bulkhead (after Flecker, 1992).vpxcn`v

Flecker (1992) described the excavation of a late 17th century Asiatic vessel at Con Dao, Vietnam (**FIGS**). The vessel had seven compartments of varying dimensions made up of two wide, one narrow, two wide, one narrow and two wide (minimum width 1.34 m maximum 2.52 m). The bulkhead planking was skew nailed and had small rectangular limbers. Between each bulkhead there were two, three or four frames which consist of first futtock, scarfed and clamped at the keelson, then the second futtock, which is not laterally fastened to the first futtock, and the same with the third futtock. The hull planking is double (inside 60 mm outer 40 mm) and the inner is edge-joined with skew nails. The outer seems to be nailed directly onto the inner. There is ceiling planking and a keelson. Flecker concludes that the vessel was a lorcha (a vessel with both Asian and European componments), dated to about 1690 and possibly Chinese owned. Flecker notes that there are longitudinal bulkheads between bulkheads 2 and 3 and 5 and 6 (both narrow compartments). The main cargo of floor tiles was located in large compartments 4–5, 6–7, and 7–8 and while the site plan is unclear, the details suggests that at least compartment 6–7 had a clear space in the central part of the hold thus providing access to the bilge. Since the vessel broke along the garboard strake, it is uncertain if each compartment had this arrangement since the tiles have spilled out across the site. The mast-step, just forward of bulkhead 6, had a very heavy and complex support and bracing structure, although no measurements of the tabernacles or their separation is available.

Rang Kwien

This vessel is about 15 m long and was excavated by the Fine Arts Department (Intakosai, 1983) and discussed in Green *et al*. (1989) (**FIG**). The vessel is unusual as it has a keel with a hollowed out section on the top. There is evidence for stiffeners, bulkheads and frames. The 1983 excavation report is brief and it is unclear if the vessel is edge-joined with dowels, the 1989 inspection by Green also does not mention the presence of dowels.

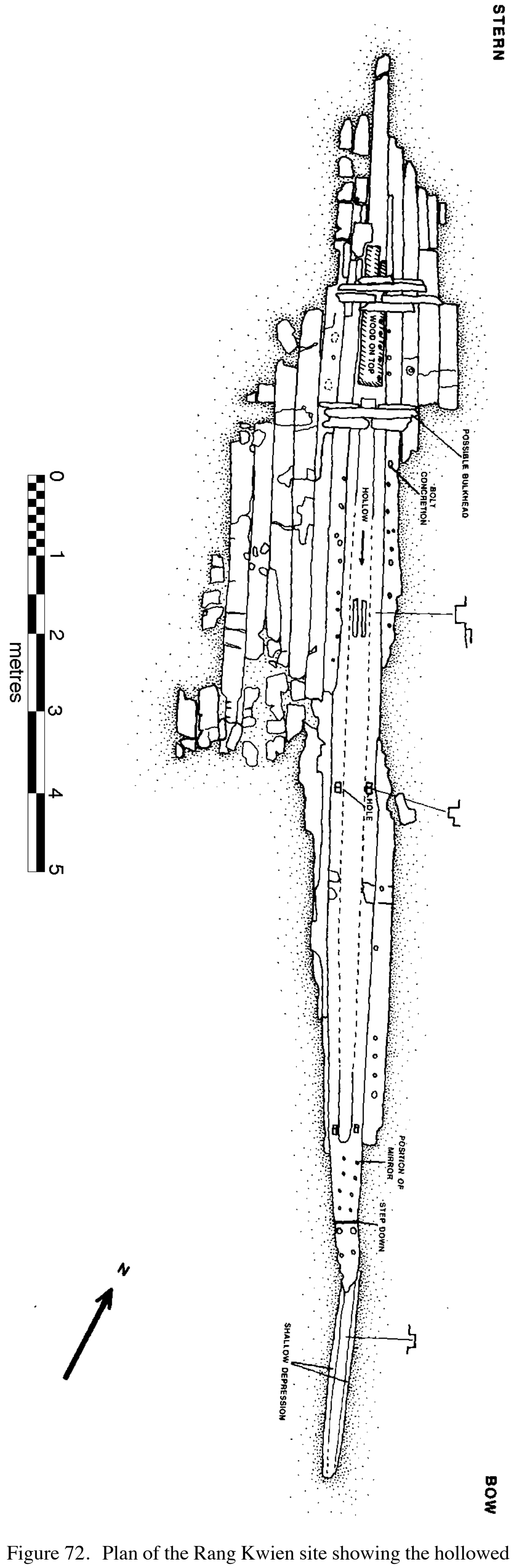

Figure 72. Plan of the Rang Kwien site showing the hollowed keel and strakes.

Chapter 4. Description of the Quanzhou Ship

Nick Burningham and Jeremy Green

Figure 73. Photograph of the Quanzhou ship during excavation phase.

The Initial discovery

Hull Form and Structure

The surviving portion of the hull is approximately 24 m in length and 9 m wide. The midsection of the hull shows considerable deadrise and there is distinct hollow in the deadrise close to the keel. The turn of the bilge is gentle: only the lower part of the turn of the bilge survives and the exact sectional shape at this point cannot be determined since it is not confirmed by the remains of any bulkheads, but the appearance as that the full beam of the hull must have been substantially greater than the 9 m of the surviving portion. There is only a slight increase in deadrise, and no increase in the hollow, towards the stern. Towards the bow, both deadrise and hollow increase markedly. The hollow is greatest in the vicinity of the junction of the keel and forward keel extension. This is an unusual characteristic, it would give the hull greater lateral resistance forward than aft and suggests that a large and deep rudder was used to counter the 'grip' of the bow.

The sheer plan of the hull shows the bow-buttock lines with very gentle curves both forward and aft. This is, in part, because only the lower portion of the hull survives but also reflects the construction method discussed below. The bow-buttock lines in the bow actually rise less steeply than the keel extension: this is one of the features that suggest the use of a transom in the bow.

The lines of the extant hull were drawn from offsets measured to the plank seams of the outer planking at stations one metre apart. When first plotted the lines showed significant irregularity, particularly when the run of the plank seams and clinker steps were plotted. This must have been partly due to the degraded condition of the timber—the ragged edges of the planks—and perhaps some distortion and irregular shrinkage that had occurred during the dismantling, transport, re-assembly and air-drying of the timber. When the external sections of the hull were compared with the internal sections (measured with EDM in 1994) it became apparent that some misaligning of the outer sheathing planking had occurred during reassembly. This had resulted in the planking being three layers thick, instead of two, where unintended overlap had occurred immediately above the clinker steps of the inner planking (fig) and had caused some distortion of the hull form. It was found that in places the outer planking was not flush with the inner planking, but hung away by 30 mm or more. (This is hardly surprising and no discredit to the team who undertook the reassembly

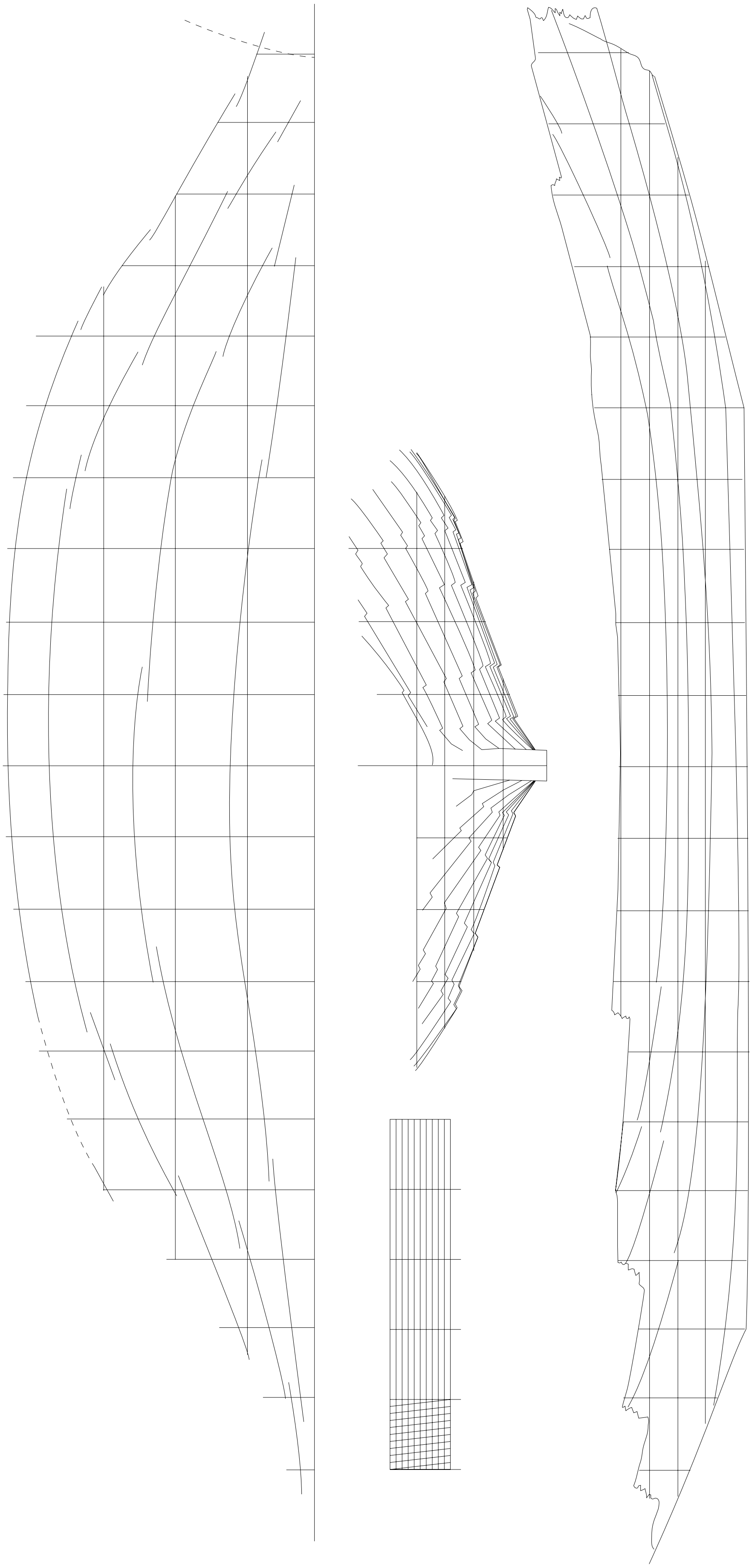

Figure 74. Lines plan of the remaining ship[structure.

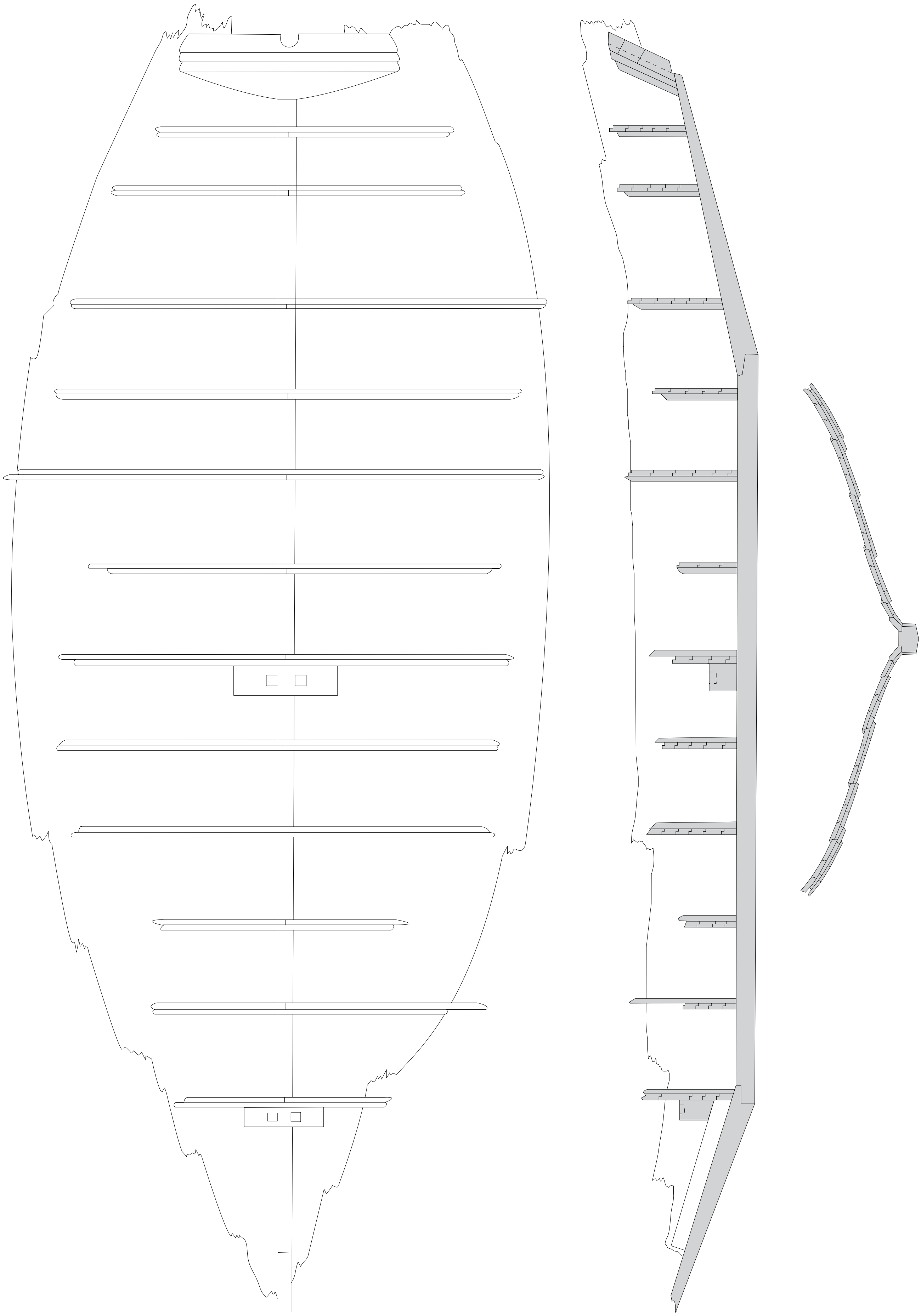

Figure 75. Plan, lateral and longitudinal cross-section of the vessel.

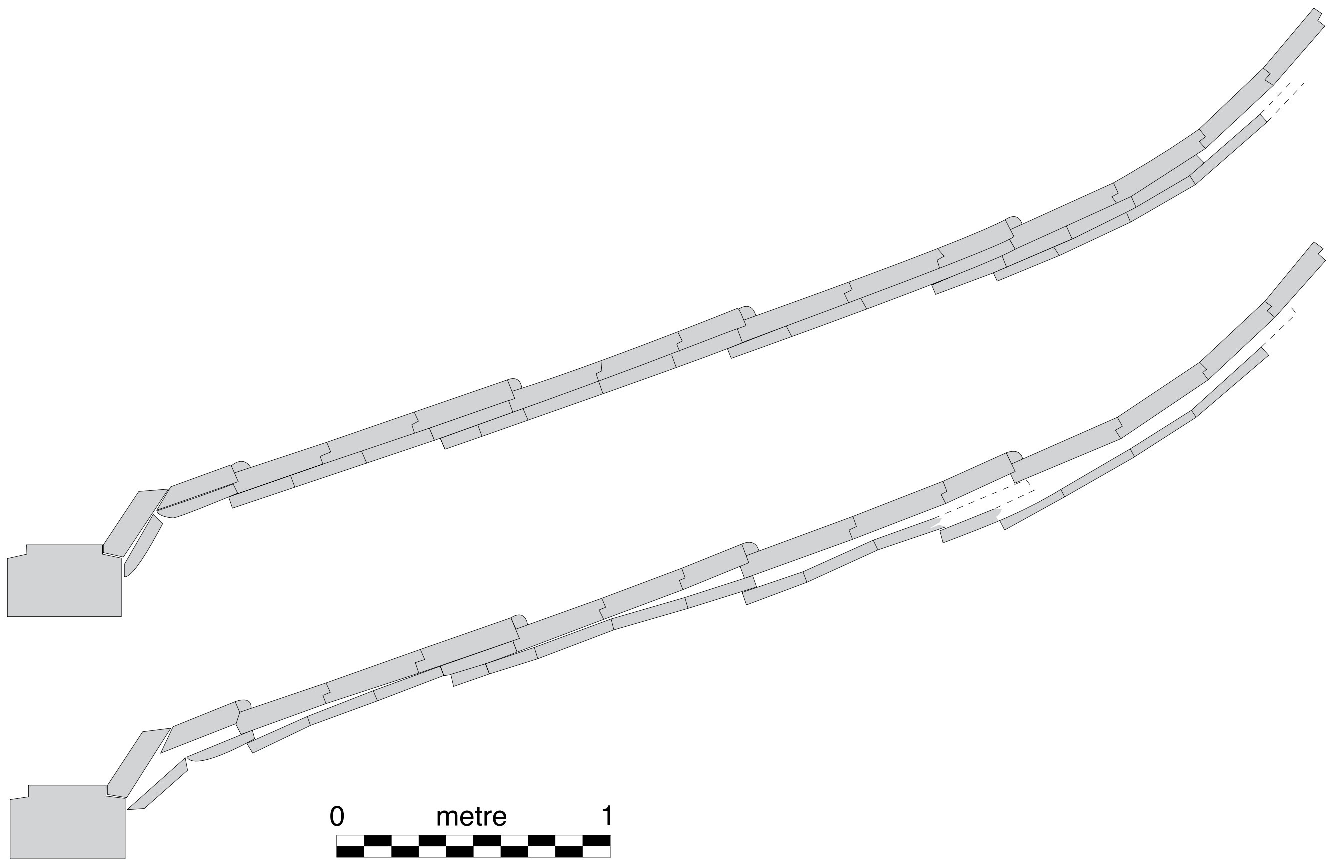

Figure 76. Existing cross-section (below) showing plank anomalies and theoretical reconstructed cross-section (above).

Figure 77. Photograph of keel scarf at the time of excavation showing the *baosongkong*.

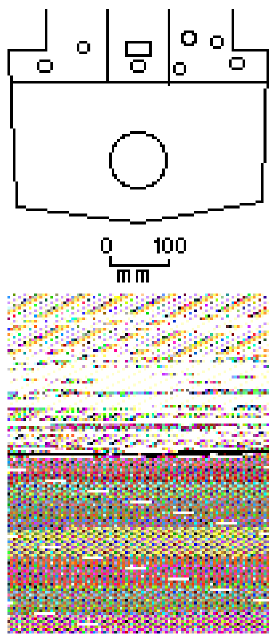

Figure 78. Plan of keel scarf joint.

Figure 79. The fore mast step at the time of excavation.

Figure 80. The main mast step at time of excavation, note longitudinal braces.

of this ancient and fairly massive hull.) The lines have been redrawn with the misalignment corrected and some fairing of other irregularities.

The keel

The keel is constructed in three parts, the forward and aft portions are made of pine, the central portion is made of camphor wood. The forward and aft keel portions are scarfed to the central portion. The central keel portion is 12.57 m long by 420 mm wide and 270 mm deep. The aft portion slopes upwards 27˚ and the garboard strake runs parallel to this aft extension of the keel all the way aft to the transom. In the bow, the extension of the keel slopes upwards 35˚. The forward extension, 4.5 m long could be regarded as a strongly raked stem since the lower planking does not run parallel to it, but terminates in the rabbet. There is reason to suspect that the extension was surmounted by a transom, so it is described here as a forward keel extension (if there was a transom, then whether it is correct to call this part a forward keel extension instead of a stem is unclear and not readily answered by looking at traditional Western usage).

The mast steps

The scarf joints and good-luck *baosongkong*

The forward and aft portions of the keel were scarfed to the central portion with a complex joint 340 mm long. In the vertical upper face of the forward scarf, seven iron coins with traces of leaf decoration were found recessed into holes (25 mm diameter and 28 mm deep). In the lower forward face, recessed in a hole (110 mm diameter and 20 mm deep) a copper alloy mirror was found (102 mm diameter, 17 mm thick and weighing 79 grams). In the aft scarf there were 13 copper coins and a copper mirror (100 mm diameter 17 mm thick and weighing 31.5 grams). The coins are known as Ba*osongkong* or symbols for good-luck or longevity. In the forward scarf they were set in such a way as to represent the constellation of *Ursa Major*, the mirror is thought to represent the Moon. It is not known what the 13 stars in the stern section represent. It was reported that the square holes in the centre of all of the coins was fill with an unidentified substance. This could possibly be the remains of iron nails used to hold the coins in place or another substance, perhaps related to an unknown symbolic function (for example, in Indonesia rice or other food stuff is often put in the keel scarf to ensure prosperity). The symbols have Daoist significance, bringing either good luck and fair winds, or representing the Seven Star Ocean where there are many dangerous rocks, the mirror is there to reflect light and ensure a safe journey. This tradition is apparently continued today in traditional shipbuilding, the stars represented by nails and the Moon by a silver coin. The scarf joint is shown in figure ?.

There are knees reinforcing the short scarf joins of the extensions to the keel. These knees are fairly light, sawn from small pieces of timber and left half-round in section. They are fastened to the keel with a few nails which are driven through off-centre. They would appear to have been used to position the keel extensions during assembly rather than as an important part of the ship's main longitudinal structure.

Plank Structure

The hull is double planked up to the beginning of the turn of the bilge, where it becomes triple planked. The planking is made of cedar, constructed in a complex manner, in a mixture of carvel and clinker design. In order to describe this structure adequately, some liberties have been taken with conventional Western shipbuilding terms. The terms that have been used relating to the hull are defined here purely for the sake of convenience.

Inner or inside refers to the surface or side facing the interior of the hull; conversely, outer or outside refers to the side facing the water. Upper refers to the part (edge or strake) away from the keel, lower refers to the part towards the keel.

Carvel seam: (as in the conventional definition), the edge-to-edge seam between two adjacent strakes is a flat seam made at right angles to the surface of the strakes, and producing a smooth (carvel) surface on the inside and outside of the hull.

Rabbeted carvel seam: (unconventional definition), the edge-joint between two adjacent strakes is rabbeted along the whole of the seam by a type of step-joint.

Clinker seam: (as in the conventional definition), the strakes overlap one another, so that (in this case) the upper strake

Figure 81. Photograph of the main mast step after reconstruction.

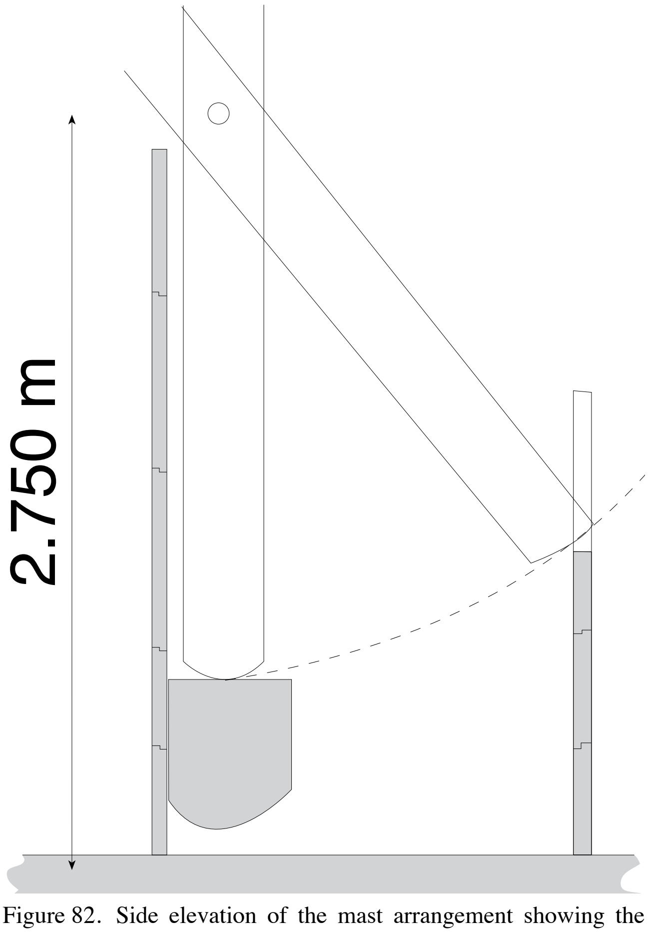

Figure 82. Side elevation of the mast arrangement showing the projected arrangement for lowering the mast.

overlaps the lower strake on its outer surface, the jointing surface is between the outer and inner faces of the strakes. This type of joint produces a discontinuity or step in both the inside and outside surfaces of the hull.

Rabbeted clinker seam: (unconventional definition) in this case a rabbet is cut into the inside of the lower edge of the upper strake; the upper (unrabbeted) edge of the lower strake is set in this rabbet, giving an external appearance of a clinker overlap, but the thickness of the step between the strakes at the surface is reduced by the depth of the rabbet (Fig. 4). This type of seam has been found on both the Quanzhou and Shinan ships (Green, 1983).

The inner planking of the Quanzhou ship is 80 mm thick. The garboard strakes are fairly massive planks and rise near vertically from the keel through the midbody of the hull, so that, together with the keel they form a narrow, channel-sectioned structure, on to which the plank shell of the hull is built. It is possible to see this structure as a development from a vestigial dugout canoe/keel. The keel is rabbeted so that the lower edge of the garboard strake lies against the horizontal surface of the keel rabbet and a short part of the vertical face of the keel. The second and third strakes are joined with a rabbeted clinker seam. A system of two rabbeted carvel seams and one rabbeted clinker seam continues up to the 12th strake, above this there appear to be no more clinker seams. Each rabbeted clinker seam on the inner surface of the hull has a strip or lath of wood set over the top of the joint to fair it and prevent water and grot from accumulating in the step.

The outer planking is 50 mm thick and is carvel joined, the

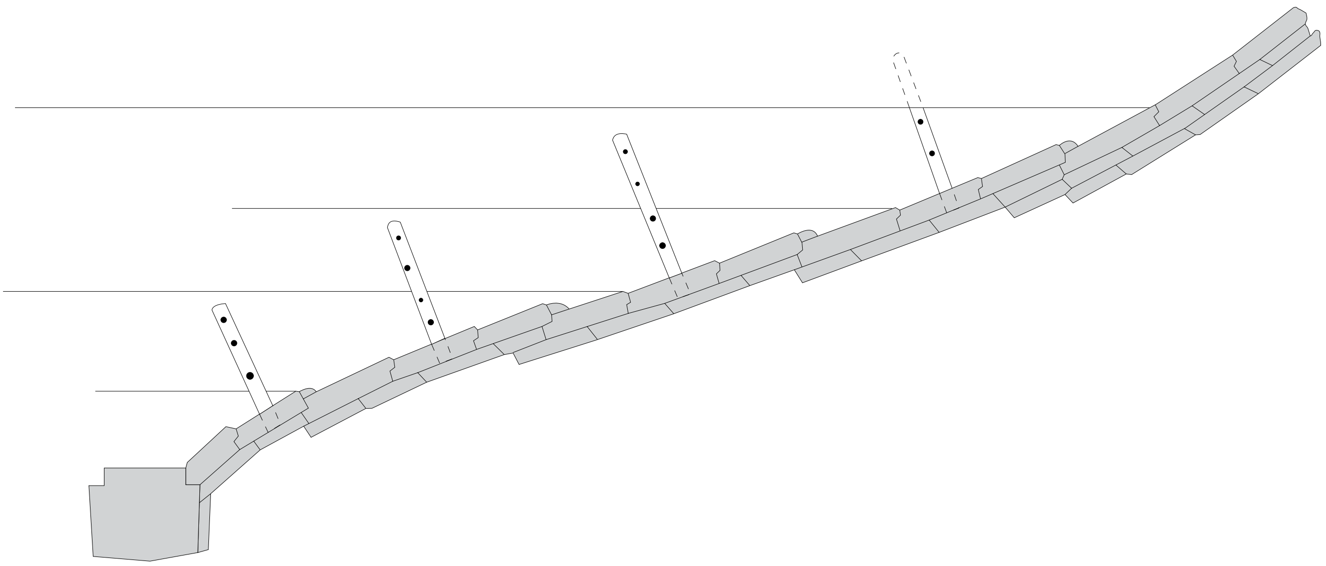

Figure 83. Cross-section at bulkhead 7.

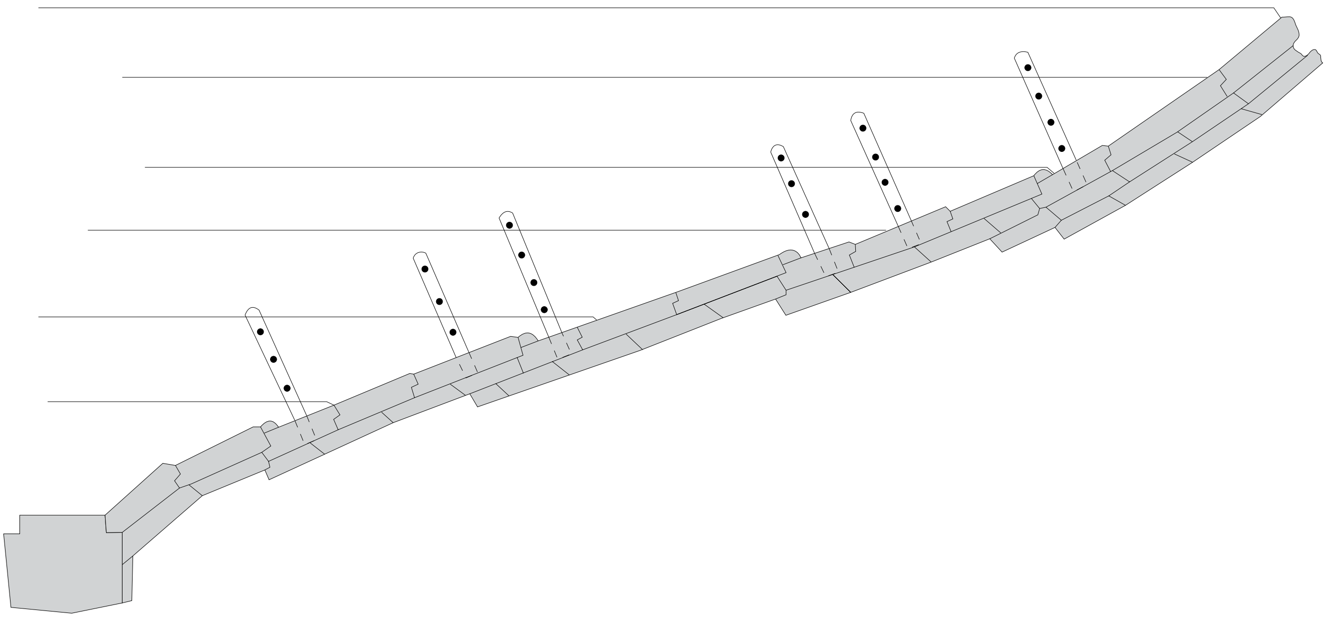

Figure 84. Cross-section at bulkhead 8.

Figure 85. Photograph showing the bulkheads 4 to 9 (right to left) just aft of the mast step with the stiffeners (note to the right, the bulkhead with the frame on the aft side).

Figure 86.

Figure 87. Bulkheads 7 to 10 (right to left).

Figure 88. Photograph at the time of excavation showing the various layers of planking.

Figure 90. View looking aft.

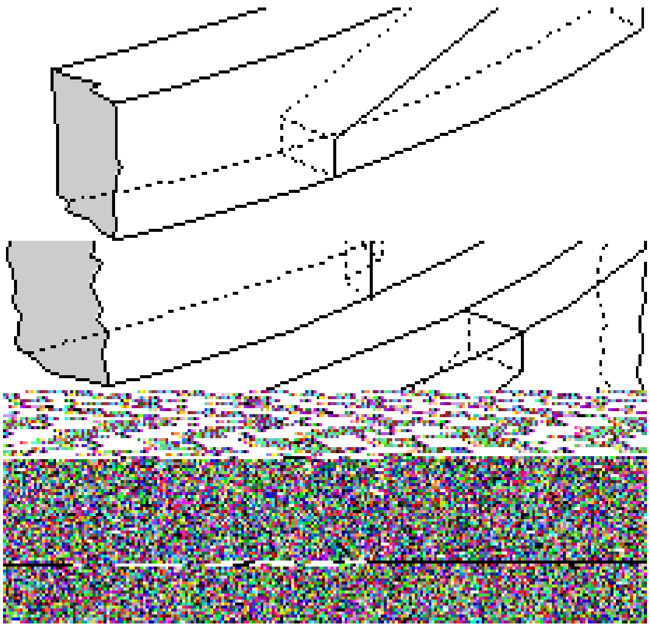

Figure 89. Sketch of two types of plank joints.

planking being irregularly nailed with light nails to the inner planking. The garboard strake of the outer planking covers the seam between inner planking garboard and the keel, with an additional plank attached to the vertical surface of the keel as a sheathing.

The rabbeted clinker seams on the inner planking are cut so that the thickness of the projection of the strake on the outside is 50 mm. This allows the plank edge of the 50mm thick outer planking to fit neatly into the clinker step and form a smooth carvel-like joint. The next strake of the outer planking is then attached with a clinker lap, the arrangement is shown in Fig.

From inspection of the grain, the planks appear to have been whole sawn from logs that were not very much greater in diameter than the width of the planks. In some cases it is possible to judge that the face of the plank which shows timber from closest to the centre of the original tree is used on the outside face of the planking, but it is not certain that this was a general rule. There is no sign of charring on the inner surfaces of the planking, so, it is unlikely that heat was used to pre-bend the planks to shape (this technique is less successful with conifers than with hard woods in any case). If the planks were simply forced into shape, the rabbeted plank edges would be important for holding the edges of the planks in alignment during assembly. The very gentle curves of the bow-buttock lines reflect smooth and gentle curves in the planking which are consistent with the planking bent into place to form a plank shell in a plank-first constructed hull. There would be some initial difficulty in forming the required bend at the end of each midship plank, but the rabbet of the subsequent strake and the later fastening of that strake by iron brackets to the adjacent bulkhead would clamp the plank butts into the required smooth curve. The positioning of brackets in strakes immediately above and below plank butts is obvious a deliberate part of the design The details and significance of this are discussed below.

At the fourth clinker joint on the outer planking, at the turn of the bilge, a third layer of planking is applied to the hull. This planking is 25 mm thick and is carvel joined, continuing for five strakes to the edge of the hull remains. The authors' impression was that the second layer of planking was reduced to the same thickness so that the two layers were together the same thickness as the outer layer on the lower hull, however this has not been confirmed by measurement.

The rabbeted clinker seams taper into rabbeted carvel seams towards the bow, presumably to facilitate their entry into the rabbet on the stem or fore keel. Aft they are carried right through to the transom. The seam between the garboard strake and second strake is not rabbeted through the midbody of the hull, because the angle at which the two strakes meet in the midbody is too great for a rabbetted seam to be effectively employed. The bottom edge of the second strake appears to be fitted to the outside surface of the garboard, but as the sectional shape changes towards the bow and stern the two strake come more into alignment and a rabbetted clinker seam develops. However, the condition of the two strakes is poor and it was not possible to be sure exactly how they fitted together in the apparent transition to a clinker joint.

It has previously been assumed that the clinker steps in the inner planking are fairly close to the steps in the outer planking, but this is not so. In some places the steps in the two layers are separated by more than a plank width. The outer layer does function as a continuous sheathing layer.

Nailing

The planks of the main planking are skew nailed together through the seams. The skew nails have been driven down from the upper plank to the lower from the outside of the hull; during this process the rabbeted seams would help hold the planks in alignment. There are only three places where the external face of the inner planking is exposed allowing measurement of the distance between the skew nails, the longest of these exposed portions is two metres. It was found that the skew nails were very regularly spaced at exactly 200 mm! The nail heads are set into small chiselled recesses in the planking about 90 mm above the plank seam. The nails used were approximately 200 mm in length (pers. comm. Prof Li Guo Qing). The garboards were skew nailed to the keel with nails about 160 mm apart, the strong fastening of the garboards to the keel seemingly reflects the importance of the garboards in reinforcing the relatively weak scarfs of the keel structure in this tradition of construction.

Alignment of butts

All plank butts (see fig) in the main planking are positioned under bulkheads. This makes it impossible to detect any butts except by close inspection, and even then the majority remain hidden. Assuming that the construction was plank-first then the positions of the bulkheads must have been predetermined. The butts in the main planking are short half lap joins (fig) or possibly tongue and groove joins. The lap joins forward of midships 'look' forward, while those aft of midships look aft. This suggests that the long midships planks were fitted first in the assembly of each strake, then the strakes were extended towards the bow and stern. No strake consists of more than three planks as far as we could tell. The *Wen Wu* article translated by Merwin (1977) gives the length of planks as ranging between a minimum of 9.21 m (presumably the is the minimum length of planks that remain complete) and maximum 13.5 m which confirms that all extant strakes are composed of either two or three planks. The uppermost remaining strake, strake 16 on the starboard side, has only one butt, which is positioned at bulkhead 6; however, no other butts were identified at the midships bulkheads 6,7 & 8.

The plank pattern of the main planking is completely symmetrical port and starboard—if strake seven has a butt at bulkhead ten on the port side, then there is also one there in strake seven on the starboard side. The one exception to this is a long tapered scarf running almost the full distance between bulkheads ten and eleven in strake nine: on the starboard side this a genuine scarf between the long midbody plank and a very broad plank that extends aft from it. But on the port side, there is a butt under bulkhead ten and aft of it a short triangular piece extends the midships plank to form the (false) scarf with the broad after plank—this appears to be a device to accommodate, or disguise, a mistake made when a butt was cut at the end of the port side midships plank.

The positions of all the plank butts that could be detected are shown if figure X. In the five strakes where both ends of the midbody planks could be seen (strakes 7, 8, 9, 10 & 13) the

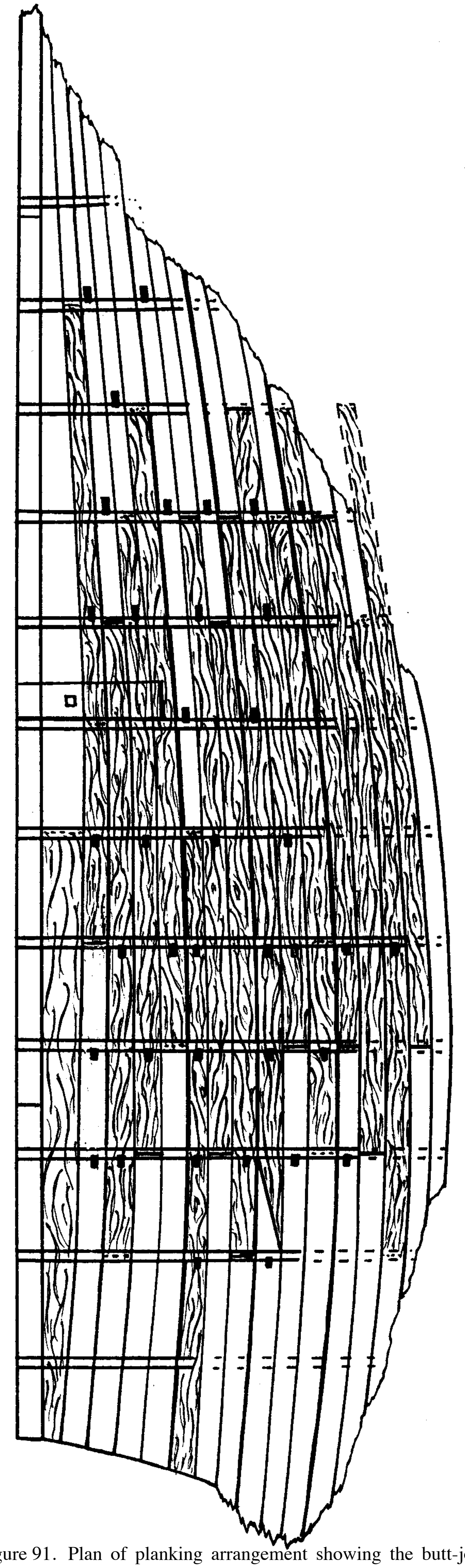

Figure 91. Plan of planking arrangement showing the butt-joint arrangement.

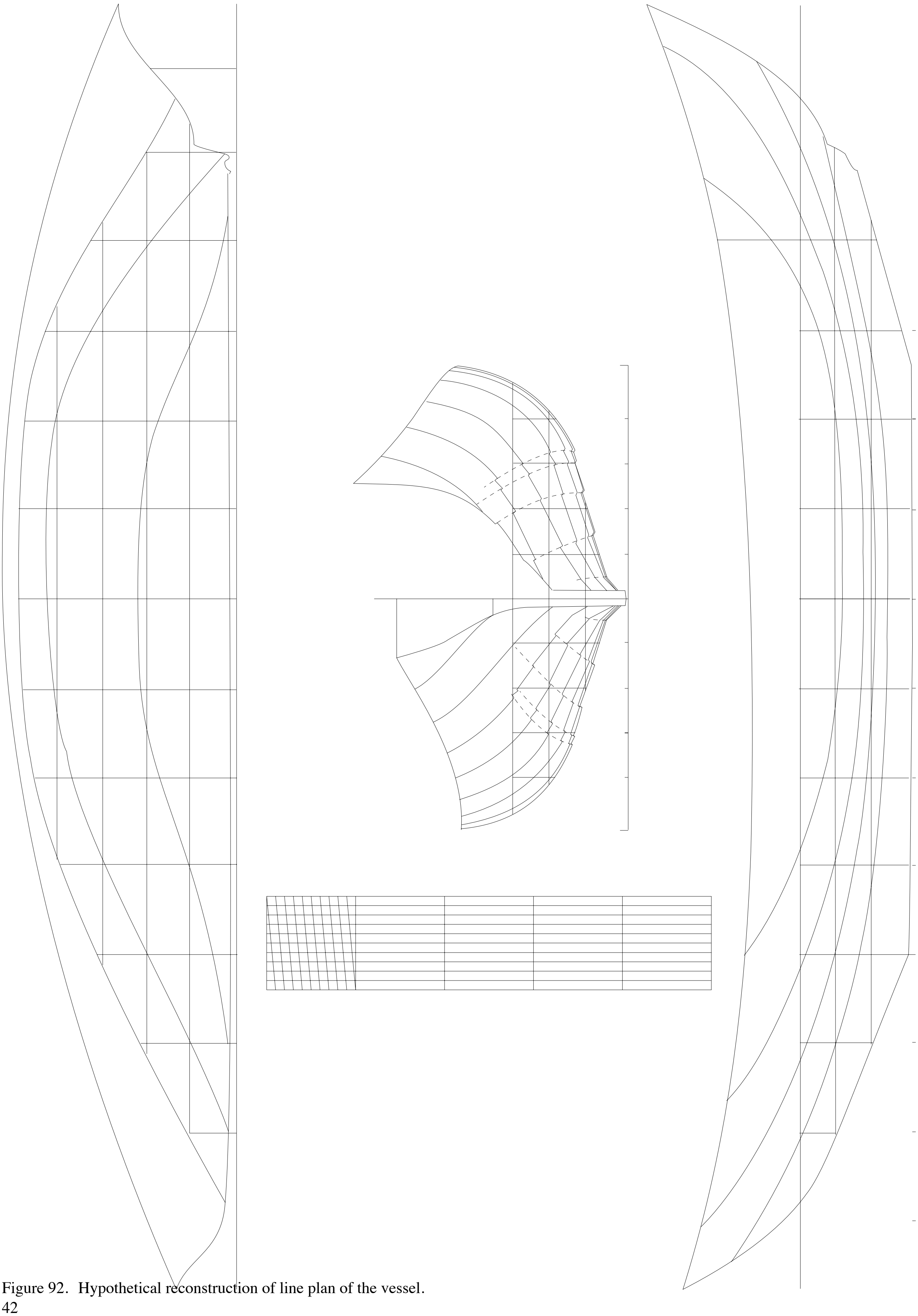

Figure 92. Hypothetical reconstruction of line plan of the vessel.

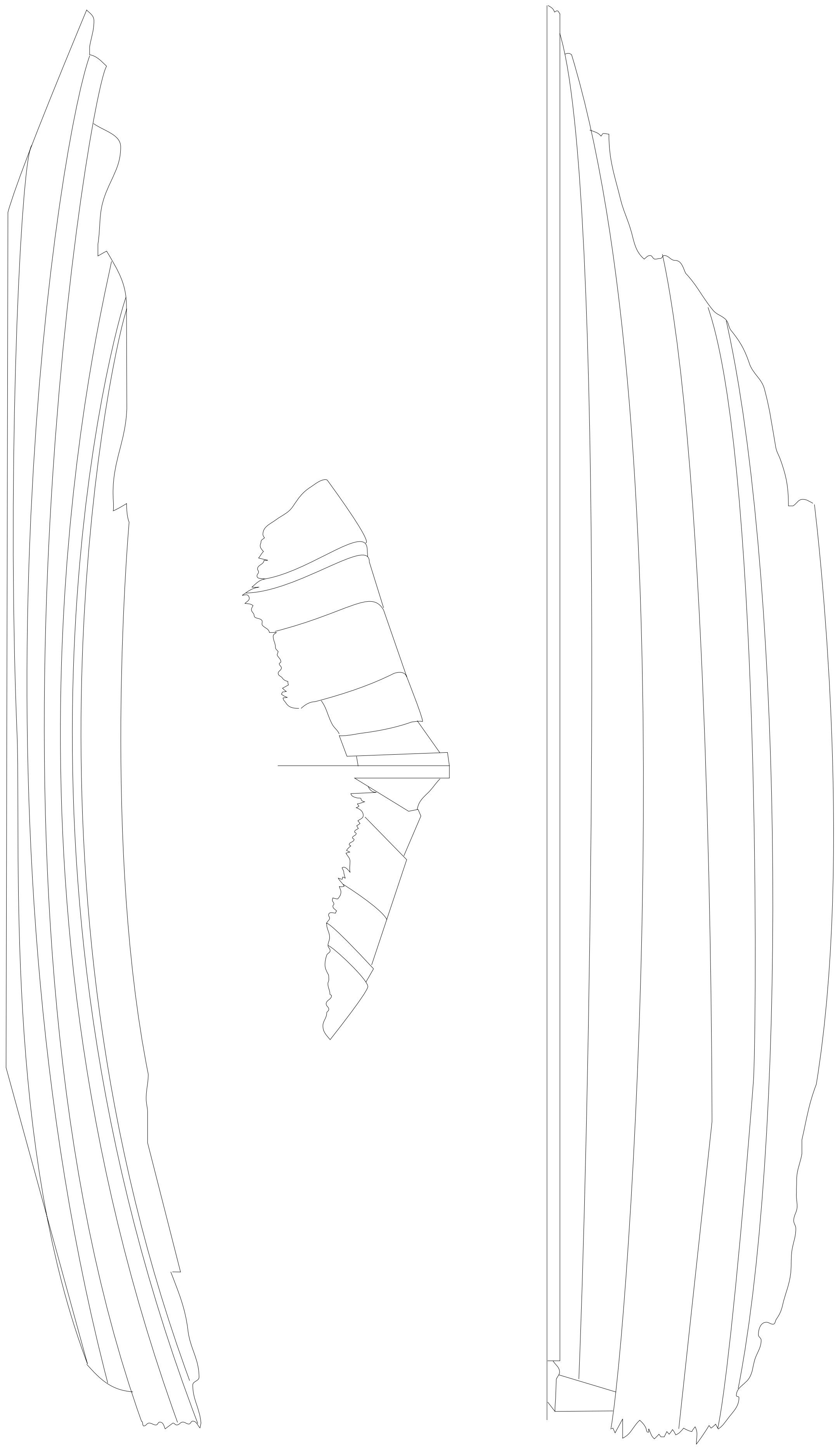

Figure 93. Lands of the external hull structure.

ends of the planks were seven bulkheads apart; in other words the length of the planks was equal to six hull compartments, but those compartments are not of a standard length. Only one plank butt was discovered in each of the strakes 3, 4, 6, 12, 15 & 16. If it is assumed that the midbody planks in those strakes were also six compartments in length a near complete plank pattern can be drawn. That pattern conforms with an hypothesised rule that the brackets that secure the bulkheads to the plank shell (described below) are never positioned at a butt, but usually lie in the planks on either side (above and below) of a butt. This rule can be used to reconstruct a probable plank pattern for the strakes where no butts were detected. It seems likely that the butt in the garboard strake would be near midships to keep it away from the joins in the keel structure. As noted above, the scarfs in the keel structure are rather short and the knees that reinforce them are light and lightly fastened, but the heavy garboards, skew nailed into the rabbets in the keel with nails at 160 mm centres would greatly strengthen the structure.

Ju-nails or *Gua-ju* (iron cramps)

The main planking is fastened to the bulkheads by L-shaped metal brackets *gua-ju* or *ju*-nails (Xu Yingfan, 1985 and Li Guo-Qing, 1989). The brackets are recessed into the bulkheads, and the feet of the brackets are recessed into the outer face of the main planking according to Museum of Overseas Communication History, (1987: 20). The brackets vary in length from about 400 mm to 550 mm and they are all about 60 mm wide. They seem to have been not more than about 7 mm thickness, but given the entirely oxidised condition of the remains of the brackets this can only be determined from the width of the slits where they passed through the planking. Most brackets are aligned within about 7–8˚ of normal (90˚) to the plank that they fasten, when viewed in transverse section; but a few are as much as 10˚ from normal. This suggests that the ends were bent over *in situ*, since if they were pre-bent all brackets could be expected to be bent at the same angle (about 90˚) and to lie more or less precisely normal. Like the pattern of plank butts, the positioning of the brackets is symmetrical port and starboard (except for an extra bracket in strake ten at bulkhead eight on the starboard side). The positioning of the brackets is tabulated in figure Y. The strakes immediately below the clinker steps (strakes 5, 8 & 11) have only one or two brackets connecting them to the bulkheads throughout their length. Whereas the strakes immediately above the steps (strakes 6 & 9: too little remains of strake 12 and the bulkheads at the height of strake 12 to constitute a useful sample) have the greatest number of brackets—thus these strakes clamp in place those immediately below them.

The slits where the brackets pass through the planking show that the brackets were only about 5–7 mm in thickness, but in a few cases they were recessed as much as 12 mm into the bulkhead because the slits were not always perfectly positioned in relation to the face of the bulkhead with which they were required to align. This suggests possibilities about the construction sequence. The slits could have been cut before the bulkheads were fitted since the bulkhead positions were predetermined to align with the plank butts. The less likely alternative is that the slits were cut from the outside estimating the position of the face of the bulkhead that was already in place. But the slits are very cleanly cut when seen from the inside; any attempt to chisel through from the outside would produce a ragged hole on the inside. Most likely the slits would be made by first boring small holes through to mark either end of the slit, then it could be chiselled from inside and outside to avoid producing ragged edges. This could only be done before the bulkheads were installed.

Distribution of brackets.

The brackets which secure the planks to the bulkheads are curiously distributed. They are never positioned at butts in the planking, but are often in the plank above or below a butt and also at the bulkhead immediately forward or aft of a butt in the same strake, thus they do serve to secure the planking around the butts. There are four structurally significant positions around a butt at which a bracket can be sited: stake above, strake below, adjacent bulkhead towards midships, and adjacent bulkhead away from midships. There are, therefore, sixteen (4 x 4) permutations, including no brackets, for bracket distribution around butts. Coincidentally, there are sixteen butts of known of theorised position with intact bulkheads around them that allow us to check which permutation of bracket positioning is actually used.

Over sixteen brackets, twelve permutations are used. The four not used are: no brackets, bracket in same strake away from midships only, brackets in same strake away from and towards midships, and brackets away from midships and above the butt. The repeated permutations are: brackets away, towards and above; and brackets in all four positions—these are used twice—brackets above, below and towards midships is used three times. There is a clear bias towards three or four brackets around a butt; in fact one of the two butts in every strake has three or four brackets around it, though in some cases the other butt in the strake has only one bracket sited close to it. The exception to this is strake eight in which both butts have two brackets in proximity. Permutations that are used forward of midships are not repeated aft of midships, with one exception (above, below, towards) that appears in strake five, bulkhead nine; and strake seven, bulkhead four.

It may be that three or four bracket permutations are the ideal but another rule or constraint does not allow that in all cases, however, that rule or constraint has not been identified. The standard shift of butts of only one bulkhead helps to implement the ideal because it allows many brackets to be proximate to two or three butts. It appears that there is a preference against brackets piercing planks where there is a seam in the bulkhead structure, but it is certainly not a rigorously applied rule. Only two examples exist of brackets piercing adjacent strakes at the same bulkhead. Strakes five and eight, which lie below the clinker seams have least brackets (one and two respectively) while strake six has seven brackets and strake nine has four and may have had two more in bulkheads two and three.

There is the possibility that the master builder applied an arcane theory of numerology along with more practical considerations in distributing the brackets.

Fairing strips

There are fairing strips on the inside of the hull at each clinker

Figure 94. View of the aft section opf vessel.

step, presumably to prevent water and grunge from lying in the step. Initially it was thought that these fairing strips run under the bulkheads. In 1994, however, during the inspection of the inside of the hull, the fairing strips were discovered to be short lengths cut to fit between bulkheads. They appear to have been lightly fastened with only one or two nails on each length. It is not clear whether they went under the frame timbers which lie against each of the bulkheads on the side facing midships.

Bulkheads and Frames

The bulkheads are constructed from planks about 80 mm thick, skew nailed together. The skew nails were driven downwards and were inserted from both forward and aft faces of the bulkheads. Unlike the plank shell skew nails, they are very irregularly spaced (<100 mm–400 mm). The few scarfs in the planks that make up the bulkheads are complex and carefully made. The planks have been planed, or smoothed in some other way, but in some cases this has been done in a rather cursory way and marks remain showing that the planks were sawn.

On the side of each bulkhead closest to midships there are half frames. The half frames are on the aft side of bulkheads 1–6 and the forward side of bulkheads 7–11. There are no half frames at bulkhead 12. The brackets that secure the bulkheads to the planking are on the opposite side of each bulkhead: there are no brackets on bulkhead 12. It may be that bulkhead 12 is not correctly fitted, it does not conform with the sectional shape of the hull on the starboard side.

Limbers are cut in the bulkheads to allow passage of bilge water along the keel, they are about 250 mm high and 90 mm wide. Limbers cut through the ends of the half frames where they meet at the keel are the same width but not quite as high. The presence of these large limbers make it clear that neither the bulkheads nor the frames could have been strongly fastened to the keel, indeed there is no evidence that they are fastened to the keel at all, therefore it is highly unlikely that they were set up before the plank shell was assembled.

There are no bulkheads forward of the junction of the keel with its forward extension. This suggests that the complete hull did not extend a great deal forward of the forward extremity of the currently extant hull, which contributes to the argument for a transom in the bow. Forward of the first bulkhead, there is a kind of apron or deadwood which lies on top of the keel extension. It is made up two large timbers and smaller filler pieces. The forward mast step lies on top of the aft end of this apron.

Reassembly of the hull has been done with new metal fastenings driven into old fastening holes. The new metal fastenings have now almost completely corroded and are being replaced with bamboo spikes that are made to replicate the square-sectioned, spike shape of the original fastenings—a clever and appropriate conservation strategy devised by conservation head Prof. Li Guo Qing. Because the bulkheads are not all aligned exactly as they were originally were—they do not align precisely with the slits for the brackets— it is not possible to be certain whether the planks were originally fastened (nailed) to the bulkheads or to the frames. There are not enough nail holes for the planks to have been regularly fastened to both the bulkheads and the frames. On the very limited evidence where fastening holes and adjacent bracket holes are exposed, it seems that the planks were nailed to the frames rather than the bulkheads, although this principle has not been followed in the reassembly, probably because the frames are far more degraded than other parts of the hull. The frames are nailed to the bulkheads. It seems that the frames were fitted to prevent any fore and aft movement of the bulkheads which might loosen the brackets that secure the bulkheads to the plank shell.

The stern transom

The stern transom appears to be composed of baulks of timber in three layers plus a layer of thin sheathing on the outside. The timber is fairly degraded and it may be that the inner layer has split neatly in two, in which case there are only two layers plus the sheathing. The inner layer(s) are fitted inside the main planking; presumably the ends of the strakes are fastened to this inner transom. The outer layer is aft of the end of the main planking but inside the outer planking layer. The outer planking layer is extended aft of the transom to form a kind of false counter. The outer layer of the transom has a slot cut in it for the rudder stock and is made of baulks of timber only slightly thicker than the diameter of the rudder slot, thus the slot almost cuts them in half and the strength of the transom relies on the inner layer(s). The uppermost of the extant outer transom baulks appears to have its ends cut square, so it did not extend right out to the sheathing planking at its upper face. This suggests that the outer transom did not continue above this height though there would need to have been baulks forming brackets to hold the rudder stock higher in the transom, as there are on traditional vessels of the region today (fig).

Lime putty, wash or plaster

Everywhere on the hull, inside and out, there is the remains of a layer of lime. The use of this lime is discussed in some detail by Li Guo-Qing (1989). It is in all the seams, behind the brackets, between the layers of planking, and it plugs the tops of holes for fastenings. It is only the lime plugs that show the position of nails used to fasten timbers such as the half frames and the knees at the scarfs in the keel; and it is possible to trace the original outline of the degraded half frames because of the thick line of lime that collected between the upper face of the frame and the face of the bulkhead. Probably the lime in the seams and in the fastening holes, and perhaps that between the layers of planking, was applied as a lime putty, as it is today in the traditional boat and shipbuilding of the region. The oil used to make the putty is tung (*t'ung*) oil extracted from the nut of the t'ung oil tree (*Aleurites fordii* [Li Guo-Qing 1989: 279]) In the Song Dynasty, Quanzhou was known as *Ci Tong* or 'Tung Harbour' because of the many tung oil trees in the region (Pers, com. Wu Chunming).

Li Guo-Qing (1989) analysed the lime putty from the seams and found that it contained very fine jute fibres (*Corchorus capsularis)* evenly dispersed throughout the putty indicating that the jute and putty had been thoroughly pounded together. Under this paying of putty he found that the seams had been caulked with ramie (*Boehmeria nivea*). Putty without addition

Figure 95. View of stern of vessel showing axial rudder slot.

of fibre was used to fill and coat the surface of the planking. This is somewhat different from the caulking and paying now used in the region. Today tung oil and lime putty is pounded together with fine bamboo shavings and this is hammered into the seams as caulking.

A small sample of the lime from the external layer has been analysed for organic remains by Dr Ian Godfrey (Western Australian Museums, Conservation Department); the lipid content was so low (0.00113 mg per gram) as to suggest that the lime may have been applied as an aqueous slurry rather than an oil based putty. (A very fine lime slurry is sometimes used to seal woven basket boats in northern Vietnam, Burningham 1994.)

Song Dynasty Salvage?

Some of the brackets in the uppermost remaining planking seem to have been removed by roughly chiselling them out of the hull planking. There is a hole in the main planking, hacked out with an axe or similar implement, in strakes 11 and 12, between bulkheads 2 and 3 on the port side. It might be that the upper hull was deliberately removed in a partial salvage operation. This idea is reinforced by the excellent condition of nearly all of the surviving planking of the hull and the bulkheads: if the upperworks had been lost by natural degradation while the lower hull was preserved in the virtually anaerobic silt, the remains could be expected to show a gradual transition from good preservation below the mud through degrees of degradation to complete absence, but the uppermost planks are in excellent condition. Generally wooden shipwrecks once buried are preserved, it is surprising that the cut off between aerobic and anaerobic is so sharp and generally only just below surface in this case. Possibly the remaining portion was already largely buried in mud when the upper works were removed. The lowest planks on the hull are actually more degraded than the uppermost remaining planks: presumably this reflects degradation during the vessels working life with water lying in the bilge and the lower planking rarely, if ever, properly dried and coated with lime anti-fouling.

A Reconstruction of the Original Lines and Appearance of the Quanzhou Ship

The extraordinary beam to length ratio of the remains of the ship present a problem for any attempt at reconstruction. To what extent should the reconstruction be slanted to 'rectify' the unexpectedly great beam relative to length presented by the remains? The transom stern prevents any reconstructed extension of the hull further aft, although gallery structures or a kind of false counter are quite likely to have extended the deck and superstructure further aft. The gentle turn of the bilge suggests that the reconstructed midsection should fill out to have considerably greater beam than the extant hull, but the reconstruction published in Wen Wu (1975: fig 1) has hardened the turn of the bilge to minimise the beam.

In the bow, the forward extension of the stem can be extended forward to create a long bow and thus give a more normal beam to length ratio. This has the effect of moving the maximum beam, or midsection, well aft of the mid-point of the vessel's length, and this is a regular feature of Chinese tradition of recent times. However, there are problems with extending the bow too far forward; the sharp sectional shape in the bow gives a hull form that would float significantly down by the bow if the hull was extended forward—the 'gripe' at the junction of the keel and its forward extension would be very much the deepest part of the hull unless cargo or ballast were stowed well aft.

The forward mast step is positioned at the junction of the keel and its forward extension, thus, if the hull is extended considerably forward, the resultant long foredeck forward of the mast invites the placing of another small mast further forward in the bow. The limited iconographic data on sea-going Chinese ships from the Song, Yuan and early Ming Dynasties show that this is a possibility.

Transom bows are very much a standard feature of vessels of the region, they appear in all the iconography that we are aware of, and the Shinan ship had a transom bow; so it would be difficult to argue for a reconstruction of the Quanzhou ship that lacked a bow transom. The Shinan ship's transom was narrow, V-shaped when seen from ahead, and raked and curved upwards when seen in profile. This is the design of transom seen on many traditional Fujian vessels today and it conveniently extends the bow forward without using too long an extension of the forward keel extension.

A Light Vessel with a Light Rig

The mast steps indicate the diameter of the masts which seem very slight for the size of the vessel. This in turn implies that the bulk and displacement of the original vessel were probably rather light relative to the length and beam of the hull. The mortices in the main maststep show that the tabernacle uprights were about 375mm apart, this must have been the diameter of the heel of the mast; the uprights of the foremast are the same distance apart. It is a small diameter mast for a vessel of 10 m beam, particularly for a Chinese vessel. Standing rigging is not usually an important part of the rigging of Chinese vessels, indeed it is entirely absent in the northern Chinese tradition and stays cannot be permanently set-up with the square-headed battened lugsail that is shown in all the iconographic representation of medieval Chinese shipping. (The battened lug rigged vessels of Southern China and neighbouring Southeast Asia, that employ standing rigging in this century, carry very high-peaked sails so that the top spar does not swing thwartships and foul the stays when the sheets are eased.) Without standing rigging, or with only a small number of relatively light stays, masts have usual been massive on traditional Chinese vessels of the recent past. Iconographic evidence suggests that the Chinese did make some use of standing rigging in the medieval period. The drawing by Ma Hezhi detailed above, dated 1170, showing large river craft does appear to show multiple stays supporting a bipod mast, but the mast was probably used to attach a tow line rather than set a sail. The stays appear very thin by comparison with the representation of standing rigging on late-medieval European craft.

Any standing rigging that supported the masts of the Quanzhou ship would have been natural fibre rope or rattan rope. Rattan rope is strong and much less elastic than most natural material ropes, however it is obviously not as strong or inelastic as steel cable which is now used to stay masts in the region. Therefore the masts of the Quanzhou ship would theoretically need to be of similar diameter, at the lower end, to those of similar sized European vessels before the introduction of steel cable rigging. In fact, the Chinese rig only allows the standing rigging to be attached to the top of the mast which suggests that greater diameter would be necessary to prevent the mast from bowing in the middle.

Various formulae have been used to calculate the appropriate diameter for masts, usually as a function of the mast's total length or otherwise a function of the vessel's beam (which is the main determinant of stability and therefore of strain on the rig). The length of the Quanzhou ship's mainmast is not known, although a likely minimum length can be proposed. The beam is known to be about 10 m. If the traditional formula seven-eights of an inch mast diameter for every foot of beam (Leather 1970:17) is applied (diameter = beam x 0.0729166), a mast diameter of 0.729 m is indicated, and this is almost double the actual diameter or four times the cross-sectional area.

The traditional rule for mast diameter relative to mast length in the days of natural-fibre rigging was one-inch for every yard (Anderson 1955; Underhill, 1970) ie diameter = length x 0.02777. Many Chinese vessels have a mainmast nearly equal in length to the hull. Applying this to the Quanzhou ship, on the basis of an overall hull length of 28 m, produces a mast diameter of 0.73888 m, almost exactly the same as the above calculation. Using a low factor of 0.75 hull length to calculate mast length, the mast would be 21 m long and ought to have a diameter of 0.58333m, still significantly greater than the actual mast diameter indicated by the mast tabernacle step. Applying the formulae to the actual mast diameter of 375 mm, the Quanzhou ship would have a mainmast only 13.5 m tall, less than half of the hull's overall length and not enough to lift the sail out of the lee of the high stern of some proposed reconstructions. With a battened lug sail rig, a mast 13.5 m in length would not provide anything like adequate sail area to allow the vessel to sail except on a downwind course. A rather taller mast is necessary. Since this mast would not be very strong, the Quanzhou ship would need to be a fairly light and easily driven vessel with rather limited deadweight capacity—this suggests that the hull did not have much depth in the hold.

The Pattaya ship and the Shinan ship have somewhat thicker masts relative to their hull dimensions, but they also are lightly sparred by comparison with European tradition and recent Chinese tradition.

There is some other evidence that the Quanzhou ship was built with little depth in the hold. A gap in the bulkhead forward of the main mast step appears to be intended to allow the heel of the mainmast to swing forward when the mast was lowered. The position of this gap relative to that of the mast step allows us to calculate by triangulation the approximate maximum height of the pivot or fulcrum pin in the tabernacle: it is only about 2.750m above the keel. It seems unlikely that the mast would pivot much below deck level (if it did, a long aperture in the deck would be needed to allow the mast to be lowered and this would be an inconvenient feature and a structural weakness) so depth in the hold would not have been more than about 2.750m. Thus the Quanzhou ship was a rather broad-beamed, but shallow drafted ship; seemingly designed to carry a relatively light cargo and to sail lightly over the water rather than drag a deep and capacious hull through the water.

Chapter 5. The excavated artefacts from the compartments
Museum of Overseas Communications History, Quanzhou

There were a large number of artefacts recovered from the compartments, including scented woods, medicine, wooden tablets, copper coins, earthenware, porcelain, bamboo and rattan goods. The former two items comprised the majority.

Scented wood and medicine

This material included, scented wood, pepper, areca nuts, frankincense, dragon's spittle, cinnabar, quicksilver, tortoise shell, etc. Scented wood was of different lengths (0.2 to 1.68 m) and thicknesses (5 to 50 mm diameter) and was found in each compartment, mainly in the 2nd and 5th compartments. The total weight was about 4700 katis??? The woods were identified as lak wood, sandal wood, aloes and other varieties. About 5 pints?? of pepper came from the bases of the cabins.

Wooden tablets

There were 96 pieces recovered from the compartments, 33 tablets and 63 slips. The shapes are square, pentagonal and rhomboid clipped in the centre (resembling two diamond shapes). A total of 88 tablets had writing in ink on them. Some of the tablets had string attached and are thought to be labels for the cargo.

Copper money

A total of 504 copper coins were recovered. Of these, 33 are Tang Dynasty, 358 Northern Song, 70 southern Song and 43 uncertain. The coins were found in most of the compartments, only the 3rd compartment had 39 coins on a string. There were 44 types (excluding the Tang Dynasty coins) of which there were 40 reign date types.

Ceramics

A total of 56 pieces were recovered, mostly from the bow and stern. The porcelain is yellow, green, black, white and brown and the shapes include, bowls, containers, alms bowl, phial, cauldron and cover box.

Bamboo and rattan goods

A bamboo ruler was found in the 13th cabin, broken in three parts. The remaining length is 207 mm and 23 mm wide. The surface of the ruler has five divisions of 26 mm.

There are 12 items from compartments 2, 3, 5, 6, 7 and 9. Others are pentagonal or have a bamboo pattern. There are also jute and leaf made goods. There was also a wooden hammer head 325 mm long. A scraper 400 mm long, a small wooden container and 4 pieces of the walls of a wooden pail, wooden hairpins, 4 wooden pegs, 6 wedges of wood, 82 round wooden box covers, one with the surname 'Nan' written on it. There were 7 rattan hats from the 6th and 10th compartments. Various ropes and strings of jute, rattan and bamboo were found.

Miscellaneous

Copper and iron wares included priest's alms bowl, copper spoon, 3 copper buttons, copper hook, copper lock, iron axe, a long iron hook and iron nails.

There were 20 wooden chess men found in the 3rd, 10th and 13th compartments. There was a red piece with the word horse carved on it. Ten others had the words general (red), officer (red), scholar (red and black), vehicle (2 black), elephant (black), cannon (black) and soldier (2 black) on them, the rest were unclear.

A broken writing board was found with writing on it, possibly a poem. Also a coral bead in the 7th compartment (3 mm diameter with a 1 mm hole) and a glass bead in the 12th compartment (5.5 mm diameter 3.5 mm high with a hole of 1.5 mm).

Over 2000 shells were found mostly from the 9th and 13th compartments with some from the 3rd and 5th compartments.

Organic material included 14 coconut shells, 55 peach seeds, 2 plum seeds, 5 strawberry seeds, an apricot seed, 8 olive seeds, 10 lychee skins were found. There were also 76 animal bones 19 pig, 8 goat 2 dog, 38 rat and 9 fish and bird bones.

The main cargo of the ship consisted of 2300 kg of fragrant, wood thought to come from Indonesia or Southeast Asia, together with pepper, betel nut, cowries, tortoise shell, cinnabar and ambergris (identified from the analysis of 18 sources, to be from Somalia).

Provisions included: nuts (coconut, olives, peach, plum and lychee); bones (rat, bird, fish, dog, goat, pig and cow). Other items, possibly ship's supplies, included: a wooden ruler, an axe, a lock, a bronze ladle, celadon bowls and plates, a narrow stoneware wine jar, Chinese chessmen, a rattan hat, bamboo matting, linen and glass beads. A total of 540 brass cash coins were found on the site. These provide the main dating evidence, the last coin dating from the reign of Duzong (1265–74). Further dating evidence was said to come from the geological data of the sediments that the ship was found in, the ceramics, the type of ship construction and the charcoal (it is not clear if this has been carbon dated). All the evidence indicates a date of about 1277 almost at the end of the Southern Song Dynasty.

Chapter 6. The maritime activities of Quanzhou in the Song and Yuan Dynasties

Wu Chunming

Quanzhou in the southeast of Fujian Province has a long history and a significant place in the cultural development of the region. Quanzhou was a very important seaport for overseas transportation in Medieval China, it played a major role in the development of maritime trade and the development of economic and cultural relations with foreign nations. During the Song and Yuan it was known as *Ci Tong* Harbour: *Ci Tong* is one of the species of tree in the genus *Paulownia*, known as "pheonix" or "tung" and used for oil production. Large numbers of the trees were cultivated in the region of Quanzhou during the Song and Yuan.

Earlier, in the Zhou and Qin dynasties (1000 — 220 BCE) indigenous people of Yue nationality lived in Quanzhou. At the end of the Han dynasty (220 BCE — 220 AD), and in the succeeding "six-dynasties" (220 — 581 AD) the population was greatly increased by Han nationality refugees from the wars that ravaged the Zhong Yuan region of northern China. In the peaceful environment of Quanzhou they developed the economic basis of the area, principally agriculture and the ceramics industry. With this economic foundation, the government policy of open trade allowed Quanzhou to develop and to become one of the great harbours for overseas trade through the Tang and Song dynasties (618 — 1271 AD), and to reach pre-eminence as the greatest Chinese port, and thus one of the greatest ports of the World, in the Yuan dynasty (1271 —1368 AD).

The Economic Background of Quanzhou during the Song and Yuan Dynasties.

At the beginning of the Song, Quanzhou region was already one of the most productive in China. During the Yuan Feng years (1078 — 1085) Quanzhou was recorded in the "Record of Nine Regions in the Yuan Feng Years (*Yuan Feng Jiu You Zhi* compiled by Wah Qin) as one of the six largest cities of China and with a population of 200 000. Much of the population were immigrants from the north of China who brought advanced science and technology and this was the reason for the rapid economic advancement. This economic development led, in turn, to considerable increase in the population.

The main agricultural exports of the region were rice, the famous *Wo long* (Black Dragon) tea, plus silk, ramie and jute for textile production. The ceramics industry was of major importance. There are now more than 110 Song or Yuan kiln sites known and investigated in the vicinity of Quanzhou, mainly in the counties of Dehua, Anxi, Nan An and Jin Jiang. Most of the ceramic production was destined for export.

A third important industry was shipbuilding. The type of ship built at Quanzhou was designated the *Fu Chuan* (Fujian ship). It was one of the four main types of the time; the others were the *Sa Chuan* (sand ship) of north China, *Nioa Chuan* (bird ship), and *Guan Chuan* (Guanzhou or Guan Dong ship).

The Geographic Range and Navigation Routes from Quanzhou in the Song and Yuan Dynasties

The pre-eminent port of Quanzhou was taken as the starting point for calculating voyages to Southeast Asia, India, Arabia and North Africa in the three known books of sailing direction from the late-Song and the Yuan. ("Records of some Foreign Nations", *Zhu Fan Zi* by Zhou Ru Kuo; "Records of some Foreign Island States", *Doa Yi Zhi Iue* by Wang Da Yuan; "Records of Foreign Regions", *Yi Yu Zhi* by Zhou Zhi Zhong.)

The main trade and navigation routes from Quanzhou, sailed by Chinese or foreign shipping were:

1 From Quanzhou across the South China Sea to Zhang Cheng (southern Vietnam).
2 Via Zhang Cheng to San Fu Oi (northeast Sumatera), Zhe Bo (Cirebon, north Java), Bo Ni (northern Borneo), and other destinations in island Southeast Asia.
3 To Southeast Asia, through the Straits of Malacca to Guling on the southeast coast of India and on to the Persian Gulf and states of southern and southwest Asia.
4 Via the Persian Gulf to Bi Pa Luo (Somalia) and Cheng Ba (Tanzania) on the east coast of Africa.
5 Via Taiwan to Ma Yi and San Yu in the Philippines.
6 To Korea and Japan.

The Organisation and Volume of Overseas Trade

Historical documents such as the Yuan dynasty *Wen Xian Tong Kao* ("The General Study of Historical Records") by Ma Rui Lin, and the Song dynasty *Song Hiu Yao Ji Gao* ("Collection of Various Important Documents of the Song", editor unknown) reflect a division of trade into two distinct sectors: the government sector and the private sector. The records show that the volume of government trade was greater, but the private traders were much greater in number and their voyages were conducted with greater frequency.

The government trade was organised in two ways. Firstly the government accepted tribute sent from foreign states and presented gifts in exchange, thus avoiding its own customs levies on trade. Secondly, the *Shi Bo Si* ("Department of Maritime Trade", the equivalent of modern customs and excise) purchased all or part of cargoes imported by merchants. Private merchants had to be approved and licensed by the *Shi Bo Si*; they were only permitted to deal in specified goods. Some commodities were a state monopoly (eg tortoise-shell, shell beads, rhinocerus horn, ivory) and could only be sold through the *Shi Bo Si*, others could be traded privately but an agreed proportion depending of the type of goods had to be sold to the *Shi Bo Si*.

In the Yuan there was some reform to trade policy and the government set up a corporation to assist the private traders. The government provided ships and capital for foreign trade to approved merchants who undertook the voyaging and trading. The government took 70% of the profits from each voyage.

Volume and Variety of Trade

From archival research, more than 330 types of goods are known to have been imported into Quanzhou during the Song and Yuan. Some of the more valuable commodities were frankincense, eaglewood (*Aquilaria agallocha*), cloves, musk, sandalwood, shell-beads, hawksbill turtle shell, rhinoceros horn, ivory, agate and coloured glass. As an example of the volume of trade, during the year 1130 (fourth year of the southern Ming, in the Jiang Yuan) the *Shi Bo Si* of Quanzhou purchased 86 780 *jin* (approximately 40 000 kg) of frakincense, and in the year 1155 the goods imported from Zhang Cheng (southern Vietnam) included 63 334 *jin* of aromatics and perfumes such as the highly valuable eaglewood. Marco Polo recorded that the volume of pepper imported into Quanzhou was one-hundred times that sent from Alexandria to the whole of Europe.

More than sixty types of goods were exported. These included lacquerware, silk, tea, lychees (dried?), wine, sugar, a range of manufactured goods made from bronze, iron, gold, silver, tin and lead. Ceramics identified as having come from Song or Yuan kilns in the region have been found in the Philippines, Japan, Indonesia, Sri Lanka and even Egypt.

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